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The Economic Impact of the Huron River

Grand Valley State University

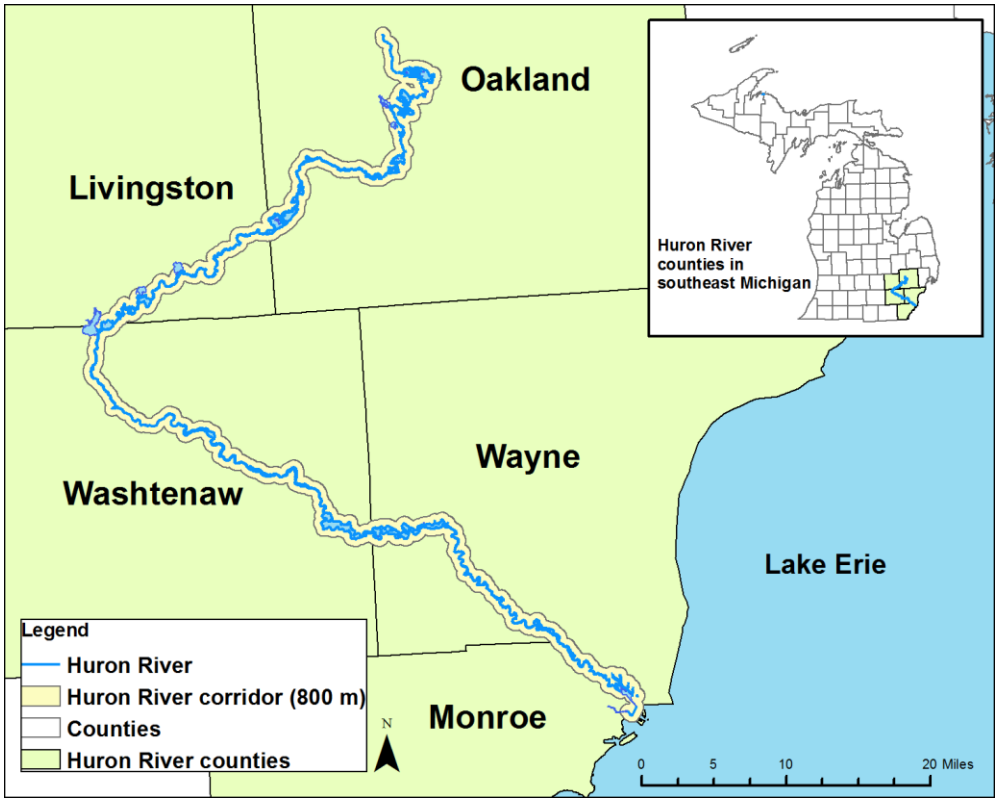
Paul Isely
Grand Valley State University, iselyp@gvsu.edu

Christian Glupker
Grand Valley State University, glupkerc@gvsu.edu

Erik E. Nordman
Grand Valley State University, nordmane@gvsu.edu

Julie M. Cowie
Grand Valley State University, cowiej@gvsu.edu

See next page for additional authors



THE ECONOMIC IMPACT OF THE HURON RIVER

Research Team:

Paul Isely, PhD
Associate Dean

Christian Glupker, MBA
Clinical Professor of Economics

Erik E. Nordman, PhD
Associate Professor of Natural Resources Management

Julie M. Cowie, MDiv
Project Manager

Hailey LaMay
Research Assistant

Seidman Research Office/Grand Valley State University
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A research report like this is always a team process. At the Seidman Research Office at Grand Valley State University, we are grateful to our client, the Huron River Watershed Council, and specifically Elizabeth Riggs, Deputy Director, for inspiring this relatively rare task of measuring the economic impact of a river and water trail. Elizabeth remained positive, inquisitive, and focused on outcomes as we worked together to set the scope for the project.

And, she recruited volunteers. We could not have achieved the data that underpins this project without the willingness of the following people to survey strangers as they disembarked from the river in weather of all kinds: Max Lubell, Leah Dumouchel, Dan Spegel, Bill Lee, Lindsey Messing, Janis Eckstein, Belinda Friis, Sally Lusk, Andrea Kline, Rob Goodspeed, Liz Berghoff, Walter Gauthier, Jesus Bautista, Paul Arnold, Carl Scarbro, Mary Lofy, Ed McCarter, Kaylan Petrie, Nikki Van Bloem, Nayeli Sanchez, Elizabeth Riggs, Anita Twardesky, and Carolyn Dulai.

Jason Frenzel, Volunteer and Stewardship Coordinator of the Huron River Watershed Council, assisted with volunteer recruitment and training. The training was augmented by a webinar produced by GVSU student, Catherine Fox, and Seidman Research Office Project Manager, Julie Cowie.

The data collected by volunteers was inputted by Hailey LaMay, GVSU student and research assistant.

The research team worked from their strengths: number cruncher Christian Glupker, Clinical Affiliate in Economics; and natural resource expert Dr. Erik Nordman, Associate Professor of Natural Resources Management at Grand Valley State University. When they weren't engaged in outdoor recreation themselves, they got the research done. Overall leadership and expertise was offered by Dr. Paul Isely, Associate Dean at the Seidman College of Business.

The Seidman Research Office offers research services and economic impact studies throughout Michigan. For additional information about the work of the Seidman Research Office based at Seidman College of Business, Grand Valley State University, contact Julie Cowie, Project Manager, at cowiej@gvsu.edu or 269-214-1227.

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I. INTRODUCTION

A beautiful river for kayaking. Trails along the water's edge for running or birdwatching. Riverfront breweries to visit after a sunny afternoon of paddle boarding. Marshes and wetlands that host spectacular wildlife to enjoy from one's backyard. A Michigan basement spared from flooding because the Huron River watershed is healthy. These are the amenities a river brings to a region. And as people enjoy the recreational, scenic, and other benefits of a river corridor, they spend money doing so: in renting or purchasing recreational gear, using watercraft, being refreshed by a craft beer and meal, and enjoying an overnight getaway.

Exactly what economic benefits does a river bring to a community? This study, initiated in 2016 by the Huron River Watershed Council (HRWC) and conducted by the Seidman Research Office at Grand Valley State University, puts a number to the economic impact the Huron River and the Huron River Water Trail (HRWT) bring to the five Trail Towns and surrounding region.

The scope of this project focuses mostly on recreational users of the river and its shoreline. River and trail users were surveyed at specific public access points in the City of Ann Arbor; the City of Dexter; the City of Flat Rock; the Village of Milford, and the City of Ypsilanti.

The economic information contained within this report quantifies what users spend as they tap the recreational opportunities afforded by the Huron River and the Huron River Water Trail. Beyond dollars spent, this report also addresses the ecological and property values the Huron River brings to a five-county region that includes Livingston, Monroe, Oakland, Washtenaw, and Wayne.

Finally, this report estimates the number of visitors who access the Huron River and avail themselves of recreation along the Huron River Water Trail. This research uncovers who these users are, where they come from, what they spend money on, how frequently they visit the Huron River Water Trail, and what they do for recreation.

This report builds on prior research of the Washtenaw County Office of Community and Economic Development that, in 2013, explored the economic impact of the Huron River Water Trail. At that time, trends in water-based recreation were being recognized. Paddle sports were growing and the launch of the Huron River Water Trail, a 104-mile inland paddling trail, was seeing expanded use. Most significantly, these prior reports set a benchmark for the number of visitors using the river and the estimated economic impact from that recreational activity.

It is not surprising that, a few years after the publication of these initial studies about the Huron River and its recreational users, this research shows increased usage and growing economic impact. Prior to this study, the Huron River Watershed Council did not have specific economic information randomly gathered from actual users. The 2013 Economic Impact Analysis relied on estimates garnered from two other studies, the Border-to-Border Trail (B2B) study produced by Michigan State University in 2009; and the Outdoor Industry Foundation's Economic Impact Study (2006). While the report produced by the

Washtenaw County Office of Community and Economic Development in December 2013 certainly provided helpful information about the growing popularity of the Huron River Water Trail and paddling enthusiasts, its succinct nature did not offer detailed information on the river's economic impact. Three years later, the GVSU research team has revisited recreational river use. Through this research using the intercept survey method and hedonic modeling, the Huron River Watershed Council and its partners have compelling data to guide decisions for the next five to seven years.

Why collect data like this? Knowing the economic impact of the Huron River can strengthen programs like RiverUp! which is focused on keeping the Huron River healthy and positioning it as a tourist destination. Measuring the economic impact of a healthy river ecosystem and better understanding its recreational users guides expenditures of public funds, priorities of land and water management entities, and helps organizations like the Huron River Watershed Council leverage necessary investments for infrastructure improvements.

It is hoped that the research provided here will assist the Huron River Watershed Council, its Trail Towns, the adjacent five counties, and the wider region in investing further to restore, protect, and enhance the Huron River and the Huron River Water Trail and encourage the development of other water trails throughout Michigan and the nation.

Water-based recreation, water-focused amenities, and waterfront property are key segments of Michigan's economy. It is the goal of this research team to provide helpful data and analysis to ensure that Michigan's waterways, including the Huron River, provide ecological benefit, recreational enjoyment, and economic gains in ways that visitors and residents alike can enjoy.

A. A note about terms

Within this research, reference to the Huron River includes the river, the shoreline, linear trails, public access points, and parks along the riverfront. The Huron River Water Trail refers to a designated subsection of the river, namely a marked paddling trail on the Huron River. However, this nuance is not necessarily understood by every survey respondent.

Generally, in the discussion presented here, reference to the Huron River or accessing the river means enjoying the river environment at a park, trail, or backyard and recreating on or alongside of it. Reference to the Huron River Water Trail means engaging in recreational activity involving a paddle on the water.

B. Recommendations for the future

It is recommended that an economic impact study be conducted every five to ten years. In the meantime, an ongoing method for sampling users of the Huron River Water Trail and the river corridor could be implemented. Surveys secured over a two-year period would allow more detailed analysis of the economic impact that both the Huron River and the Huron River Water Trail have on the region. Housing values for Washtenaw County should also be secured so aesthetic values can be more precisely ascertained.

A second ongoing random intercept survey method should be conducted of people in a

location away from the river to provide a method of measuring value of the river as a recreational asset.

This report values the potential of the Huron River Water Trail, but a larger sample size would be needed, precisely focused on the boundaries of the Huron River Water Trail itself. A future study should determine if recreational users are using the river specifically because of the Huron River Water Trail, or simply because it is the Huron River. This report does provide data concerning the value of the activities people are engaging in on the river and along the river corridor and awareness of the Huron River Water Trail was also measured.

II. EXECUTIVE SUMMARY

The Huron River and Huron River Water Trail are estimated to have the following economic impact on the five-county region in which they are located:

- $53.5M in annual economic output, which is the sum of $29.9M in direct spending and $23.6M in indirect and induced spending
- 641 local jobs added to the region
- $628M in added property value
- $150M in annual environmental value
- 2.6M visitor days

We find that:

- Visitors use the Huron River corridor on average 21 times a year.
- 57% of all users are very satisfied with their recreational experience.
- Over half of the river users have an annual income between $25,000 and $85,000.

A. Valuing the Huron River

Rivers and other water bodies provide various ecosystem services such as biodiversity, recreation, and aesthetic enjoyment. Southeast Michigan's Huron River is a regionally-important natural resource, and this report highlights the economic value of its ecosystem services.

A research team based at the Seidman Research Office of Grand Valley State University presents this report on the economic value of the Huron River understood through the lens of:

- recreational access to and use of the river and the Huron River Water Trail;
- biodiversity and contributions to the watershed;
- scenic amenities; and
- increased real estate values and home sale prices.

This information, along with associated analyses of economic impact, will be used by the Huron River Watershed Council to both understand and value what the river and the

Huron River corridor bring to the region and to help prioritize capital investments in the region.

The research team from Grand Valley State University pursued three methods to generate a value for the Huron River:

1. ***Surveys***, used to estimate the economic impact of recreation on the Huron River and validate the recreational value of the users;
2. ***Hedonic valuation,*** used to estimate the river's effect on property values along the Huron River;
3. ***Benefit function transfer,*** used to value biodiversity, flood management, and, in conjunction with the surveys, the recreational value of the users.

B. Summary of economic impact

A brief questionnaire was developed to determine the economic impact of recreational users. Surveys, conducted by trained volunteers of the Huron River Watershed Council, were performed at five different locations on the Huron River in towns considered "Trail Towns": City of Ann Arbor, City of Dexter, City of Flat Rock, Village of Milford, and City of Ypsilanti.

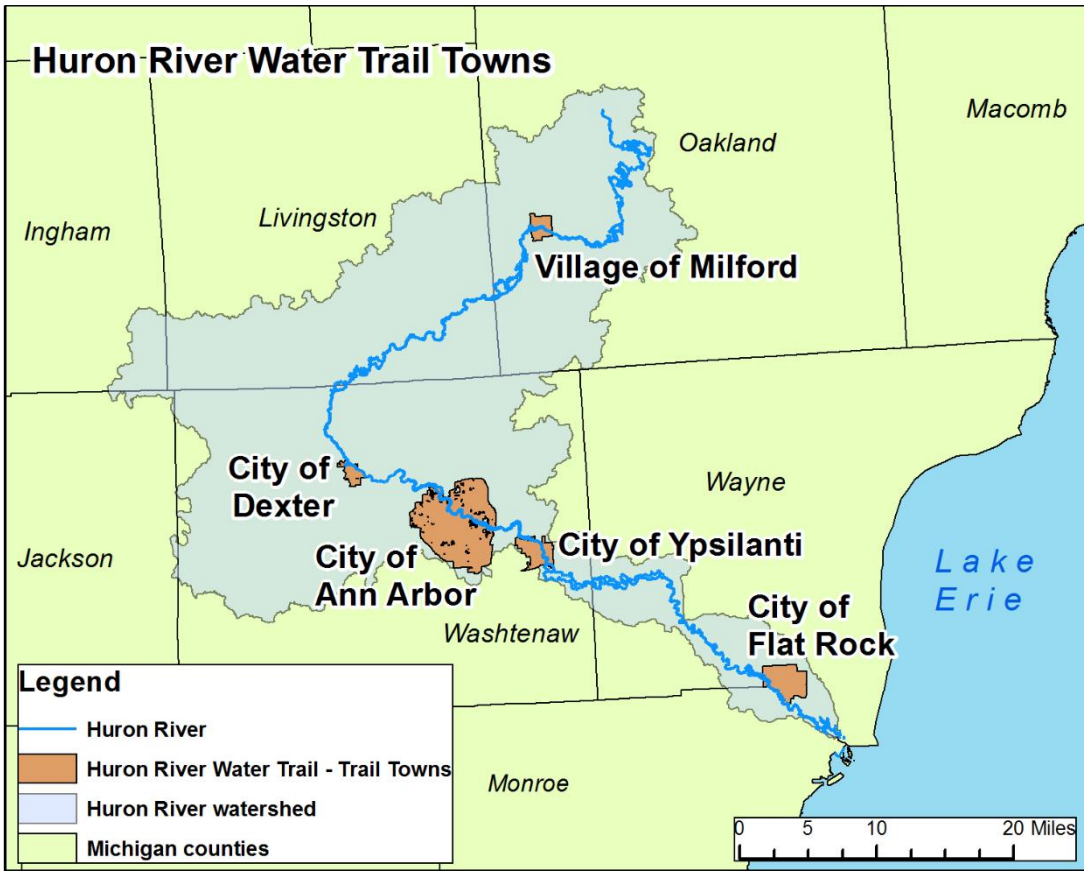

Figure 1: Trail Towns of the Huron River Water Trail

Individuals passing these locations were randomly selected, as every third passerby was asked to fill out a survey. The day of week, time of day, and surveying location were varied to compile a representative sample of recreational users. This process produced 168 valid surveys completed during the summer of 2016. In addition, surveys were taken in Ann Arbor to determine the percentage of the local population that use the Huron River recreationally.

Using this data, we estimate that approximately 122,981 unique visitors access the Huron River Water Trail and river corridor each year, visiting nearly 21 times per year per person. This results in approximately 2.6M visitor days spent in recreation along the Huron River Water Trail annually. Visitors spend an estimated $29.9 million each year on recreation-related goods and services.

Direct spending by visitors also leads to indirect and induced spending. For example, a recreational user buys food at a local restaurant (direct spending). That restaurant must then purchase more supplies from local distributors (indirect spending). Restaurant owners and employees receive income from the spending of the recreational users, and they spend some of that greater income in area stores (induced spending).

The dollar value and effect on employment of indirect and induced spending can be estimated using the Regional Input-Output Modeling System (RIMS II) multipliers developed by the U.S. Department of Commerce's Bureau of Economic Analysis. In this way, the total impact of the recreational tourist visiting the Huron River is found to be $53.5 million annually. This discussion will be presented with more detail in the economic analysis section.

Business owners understand the value of being near the river implicitly, as 33% of 61 surveyed businesses located near the river stated that the Huron River influenced the decision to locate in their present venue. A quarter of the businesses also stated that more than 50% of their customers were recreational users of the river.

C. Property values

The value of a house is influenced by many components. The size of the house and number of bathrooms are examples of housing characteristics that influence the value of a house. Other characteristics like the school system and the neighborhood also matter. Using a statistical procedure (a hedonic model), the total value of a property can be broken into individual components, including proximity to the river.

The premium for a house next to the Huron River was between 39% and 65%. Aggregating all the properties along the river, the added value of the houses near the Huron River (compared to the same houses without the presence of the river) totals $628 million in added value. This increase in property values is generally attributed to the aesthetic amenity provided by the river. More information on this estimate can be found in the hedonics section later in this report.

D. Benefits transfer

Some values that the Huron River provides to the region were found by using values researchers calculated elsewhere and applying them here, adjusted for local conditions.

These include the recreational value, biodiversity, and flood control attributed to the wetlands surrounding the river. This is done when values are stable between locations and when a recalculation would be needlessly complicated and expensive.

E. Value of all components

The value of each of these components is distinct. If added together, they provide a picture of the annual and ongoing economic impacts a river (and water trail) bring to a region. The following table depicts these values both annually and as a total. The total sums the annual values over time and uses a 4% discount rate (Table 1).

Table 1: Economic values of services provided by the Huron River

	Annual	Total
Recreation	$108.2 M	$2.7 B
Biological Diversity	$1.1 M	$27.7 M
Wetland Flood Reduction	$15.6 M	$390 M
Aesthetic	$25.1 M	$628 M
TOTALS	$150 M	$3.8 B

Thus, the environmental value of the Huron River suggests that its value is $150 million annually, or $3.8 billion. Environmental value includes many values that accrue to society, and cannot be acquired by individuals. So, the *economic impact* is smaller than the *total economic value* because economic impact only includes those values that directly influence spending by individuals. By taking the $25.1M in aesthetic value listed in the table above, plus $53.5M in annual economic output described earlier, the Huron River adds approximately $78.6M in annual economic activity that directly impacts the wages and jobs in the region. Understanding the environmental value helps decision makers as higher societal value is highly correlated with economic impact opportunities.

In addition, this is not an exhaustive list of value created by the river. For example, there is the value of "place," meaning that people locate and choose to live in the area because of the Huron River. As such, the $150 million in annual environmental value, or the $78.6M in annual economic activity resulting from the presence of the Huron River, should be considered a conservative estimation.

III. ECONOMIC IMPACT OF THE HURON RIVER

Primary authors: Christian Glupker, MBA and Paul Isely, PhD

A. Visitors

One way that the Huron River Water Trail impacts the regional economy is by bringing visitors to each of the five Trail Towns. As these individuals come to the region, they spend money on meals, lodging, gear rental, transportation, and other items. This spending translates into greater earnings for area employers and employees as well as greater job creation.

To determine the economic impact of the Huron River on the region, surveys were conducted. These surveys were used for two reasons – to estimate the total number of users and to understand their spending. The survey process and the questionnaire content were reviewed and approved by the Grand Valley State University Human Research Review Committee. The Huron River Watershed Council supervised the data collection using trained volunteers to conduct the survey.

Three types of surveys were used:

- a Huron River economic survey, referred to as an intercept survey;
- a Downtown Ann Arbor survey, surveying people away from the river; and
- a local business survey.

In May of 2016, the Huron River Watershed Council solicited volunteers through electronic communications. An informational meeting/training was held on June 2, augmented by a survey method training webinar posted on the Huron River Watershed Council YouTube channel. Volunteers were trained to conduct a random survey, meaning that they used a specific counting method to identify which water trail users to survey. Targeted survey recipients who declined to participate were tracked, providing a count of water trail users as well as a survey completion rate. The surveying was conducted during a five-week period, from June 12 to July 17, 2016.

Surveys were conducted at locations in or near the trail towns.

1. HuRoc Park in the City of Flat Rock
2. Riverside Park in the City of Ypsilanti
3. Argo Park in the City of Ann Arbor
4. Gallup Park in the City of Ann Arbor
5. Mill Creek Park in City of Dexter
6. Central Park in the Village of Milford

Figure 2 depicts the locations of these intercept survey points.

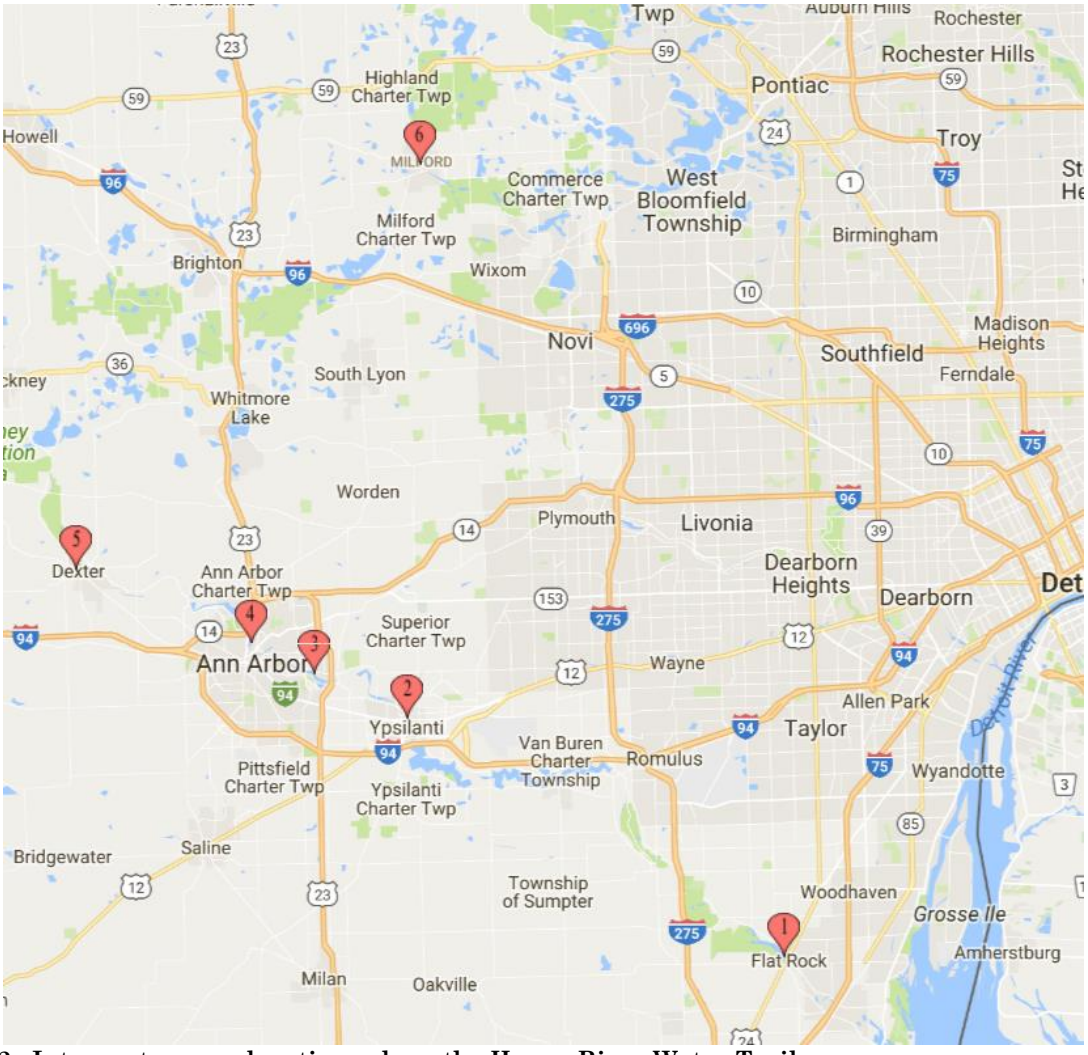

Figure 2: Intercept survey locations along the Huron River Water Trail

Each shift lasted two hours and ranged from 6 A.M. to 8 P.M. across all days of the week. A random and representative mix of dates, times, and locations was generated for the two-hour survey shifts, which occurred regardless of the weather. Volunteers had the option to identify themselves as survey volunteers by wearing a "volunteer" badge. Training of volunteers included suggested language to use when asking the randomly identified Huron River Water Trail user to complete the survey and how to address unusual circumstances. This type of survey is known as an intercept survey. Participants completed the paper survey themselves, using a clipboard, and placed it in a collection box, ensuring privacy and anonymity.

Volunteers completed check-out sheets alerting researchers to any notable factors that occurred during the surveying shift. Completed surveys were mailed back directly to the research team at Grand Valley State University by the volunteers, who were provided

postage-paid envelopes for that purpose. A total of 168 respondents completed the Huron River economic survey, which is approximately 60% of all those asked to take the survey.

The Huron River Water Trail surveying of direct users was followed by an electronic survey of businesses located along the Huron River. Using Google maps as well as lists of businesses secured from area Chambers of Commerce and Downtown Development Authorities, approximately 160 businesses along the Huron River were identified. Representatives at these businesses were contacted by email and asked to complete an online survey.

The last surveying for the project occurred on Saturday, September 11, 2016, at the downtown Ann Arbor Farmer's Market. Surveying began at 7:15 a.m. and concluded at 11:00 a.m. Over 189 surveys were received. A small quantity of this type of survey had been secured earlier in the project, with surveyors positioned along Main Street in Downtown Ann Arbor, but the sample size was too small to be useful.

The use of volunteers resulted in some limitations to the study. There was variability in the skills of the survey takers, thus each survey shift had a different efficiency. In addition, there were 36 hours of missed shifts. These two issues could result in the sample not being representative. Finally, the survey count targets were missed, increasing the statistical error. Statistical error is a function of the size of the sample compared to the size of the population, the smaller the sample the bigger the uncertainty in the final answer. In this case the sampling plan was trying to achieve a sampling error of +/- 4% or less (95% confidence); the smaller sampling resulted in +/- 7% (95% confidence) for yes/no questions.

B. Estimating visits

Calculating the number of visitors to the Huron River is necessary to understand the total impact of the river. To calculate the number of visits to the Huron River, two surveys are used. The first survey is of individuals who are using the river. This survey asks questions about how often they use the river and in which ZIP code the individual lives. In addition, spending, demographic, and usage questions are asked. The second survey is of individuals in the area engaged in activity that has nothing to do with the river; the majority of these surveys were taken during a football weekend in the Ann Arbor area. This survey asks their ZIP code and if they use the Huron River for recreational purposes. Using both surveys, an estimate of the river usage can be made provided the people surveyed are representative of the river users and non-river users.

The first step to finding the number of people using the Huron River is to understand how many adults in a given population use the river. For the purposes of this study, the adults living in specific ZIP codes, namely Dexter (48130), Ann Arbor (48105), and Ypsilanti (48197) were tallied. The total adult population of these three ZIP codes is 88,569 adults. The survey taken away from the river identified that 29.7% of the people surveyed use the Huron River for recreation. This provides a figure of 26,305 (+/- 1,850 with 95% confidence) adults from the three ZIP codes who use the Huron River for recreation.

The next step is to understand what percentage of the people using the river come from the three ZIP codes. Using the survey of individuals using the river for recreation, 33% of the respondents came from the three ZIP codes. Starting with 26,305 adults and applying the 33% ratio, the number of unique adult visitors (from all ZIP codes) is estimated to be 79,393 (+/- 5,557 with 95% confidence). Many of these individuals also have children under 18 traveling with them. Applying the number of children per adult found in the survey, the total number of unique visitors to the river is 122,981.

Finally, the number of unique visitors is used to calculate the total number of visits to the river. From the user survey, the number of visits for an average user can be estimated. The sample size was relatively small, so outliers could substantially bias the average. Therefore, the top 10% and bottom 10% of responses were removed before calculating the average. Multiplying the number of unique visitors by the adjusted average number of visits results in 2,576,604 visits to the river. Because the survey was conducted at public locations and people who reported spending 365 days on the river were removed as outliers, this number is unlikely to include people who live on the river. This is important as their value will be derived later in the Hedonic portion of the analysis.

Table 2: Visitor count

Total visitors to the Huron River	122,981
Total visitor days	2,576,604

To understand if this number is reasonable and passes the "smell test," this number can be compared to a user number that is well known. The Ann Arbor liveries provided their rental numbers for 2016. During the year, they had 99,270 individuals in their rental boats. Given the estimates above, there were 2.8 million total visits to the river. Using the intercept survey information, approximately 36% of the respondents stated that their primary activity was either canoeing or kayaking. In addition, just over 23% of total visits reported by those surveyed was to the Ann Arbor area. This would suggest that the number of visits using a canoe or kayak in Ann Arbor would be around 239,000. This number is a little more than double the projections from the Washtenaw County economic impact study completed in 2013. So, 42% of the canoe and kayak visits in the Ann Arbor area would be attributed to the livery rentals. Although we do not have a direct estimate of the ratio of livery visits vs non-livery visits, 42% is at least a plausible number given the size of the livery operation.

C. Defining who is a local recreational user

To determine the economic effect of spending by individuals, the number of visitors to the river and the number of visitor days while at the river need to be determined. To

accomplish this, we differentiated the river visitors who are residents of one of the five Trail Towns from visitors who reside outside of the five Trail Towns. This was accomplished by asking for ZIP code information on the survey. If the respondent answered with any of the ZIP codes listed in Table 3, they were considered "local". If they answered with any other ZIP code, they were considered "non-local". This allows us to differentiate "new" money coming into the Trail Towns compared to locals who likely would have spent money in the local economy anyway.

D. Trail Town ZIP codes

Table 3: Trail Town ZIP codes

Ann Arbor	48103, 48104, 48105, 48108
Dexter	48130
Flat Rock	48134
Milford	48380
Ypsilanti	48197, 48198

Figure 3: Respondent ZIP codes shows the proportion of surveyed participants and their home ZIP codes. Nearly half of the surveyed water trail users came from outside of the local region.

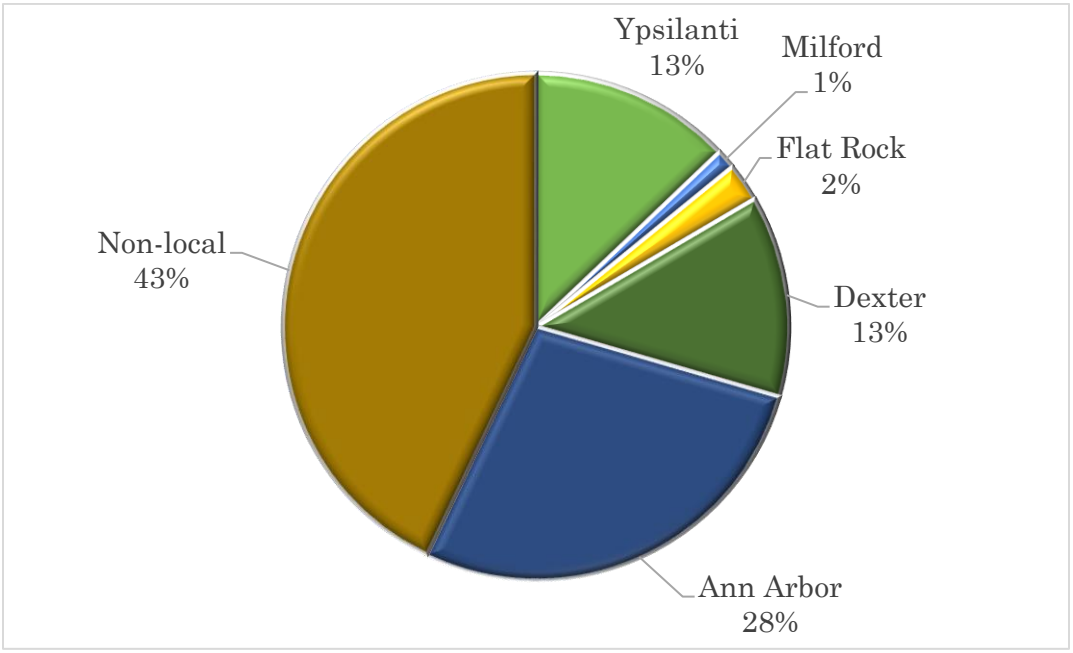

Figure 3: Respondent ZIP codes

The following figure depicts the boundaries of the local ZIP codes considered in this study. The black lines in Figure 4 map the ZIP code areas considered local.

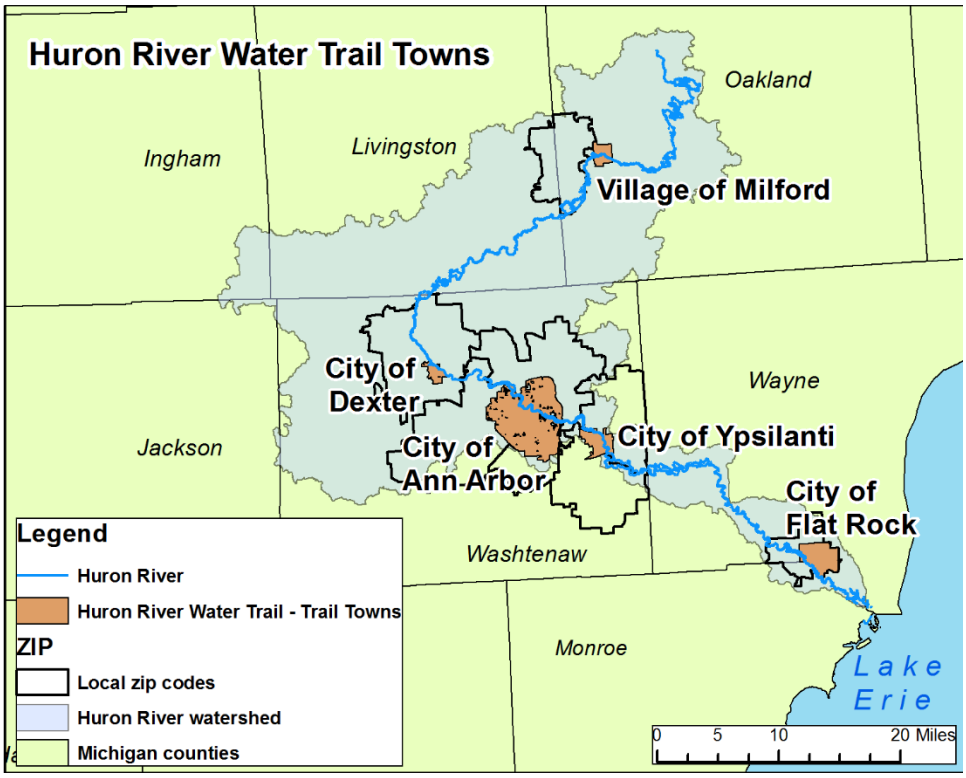

Figure 4: Boundary map of local ZIP codes

With local and non-local visitors identified, we then need to determine the primary reason for visiting the Huron River. This was accomplished by the survey question "Is the Huron River your primary reason for being at this location ***today***?" An average of 76% of all respondents stated that the Huron River was the primary reason for being at the survey location.

Figure 5 illustrates the significant level of awareness of the Huron River Water Trail as a regional resource:

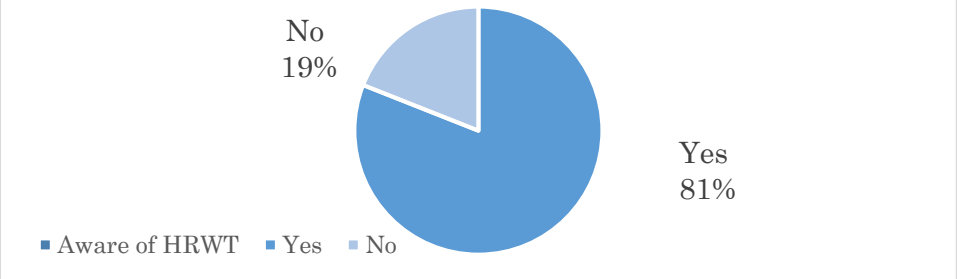

Figure 5: Awareness of the Huron River Water Trail prior to taking survey

Respondents were asked a series of questions to gain insight into their recreational preferences. The results from these questions are presented in Figure 6.

Survey respondents were asked for their preferred Trail Town when visiting the Huron River. Ann Arbor is by far the most popular, which is expected, given the population disparity with the other Trail Towns. Figure 6: Preferred Trail Town when visiting the Huron River illustrates the survey respondents' preferred Trail Town.

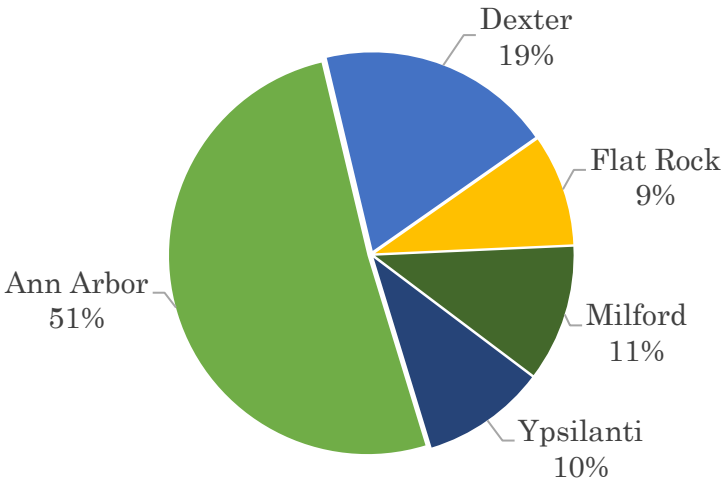

Figure 6: Preferred Trail Town when visiting the Huron River

Table 4 shows the average visiting trend based on all survey respondents. This data is consistent with Figure 6, as the average user accesses the river in Ann Arbor on a monthly basis and Dexter on a quarterly basis. The average recreational user accesses the river from the other three Trail Towns at least once a year.

Table 4: Frequency of average user access of the Huron River

	Monthly	Quarterly	Annually
Ann Arbor	x		
Dexter		x	
Flat Rock			x
Milford			x
Ypsilanti			x

Figure 7: Primary activity when visiting the Huron River (all respondents) includes the results from all survey respondents. Additional detail about the recreational activities of local and non-local Huron River users is available in the appendix.

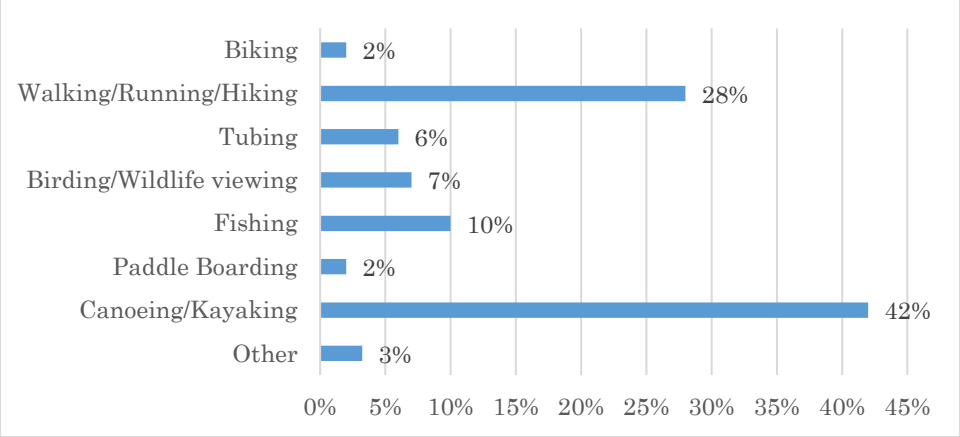

Figure 7: Primary activity when visiting the Huron River (all respondents)

For those who name the Huron River as their primary reason to be at the location, 60% are engaging in water-dependent activities, like paddling, that take advantage of the Huron River Water Trail. The rest are engaged in activity along the river, using trails, or enjoying the aesthetics of the nearby river.

Seventy-five percent of the people reporting that their primary reason for visiting the Huron River is recreational and who visit from outside the local ZIP codes are engaged in activities that take advantage of the Huron River Water Trail. It is important to acknowledge that bikers, motorized watercraft users, and paddle boarders are under sampled as our survey process was based on stopping passersby and asking them to participate in the survey.

E. Respondent demographics

The intercept survey asked for standard demographics of the river users. These questions centered around income, recreational budget, gender, age, homeownership and education level. Figure 8 focuses on all survey respondents who stated that the Huron River was the primary reason for their visit. These bands are relatively wide to increase response rates, but given household income in the region, 55% of the individuals were in the top half of the income range.

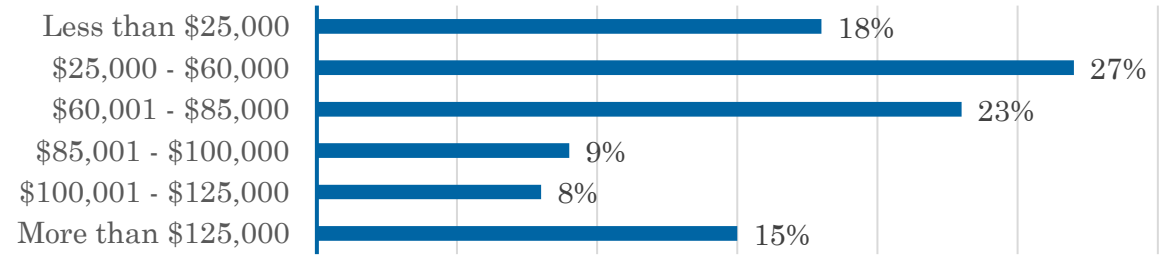

Figure 8: Survey respondents' household income tiers

Figure 9 illustrates the percentage of household budget spent on recreational activities, with the overwhelming majority of respondents spending 15% or less of their household budget on recreation. Nearly 20% of Huron River users spend 16% or more of their budget on recreation.

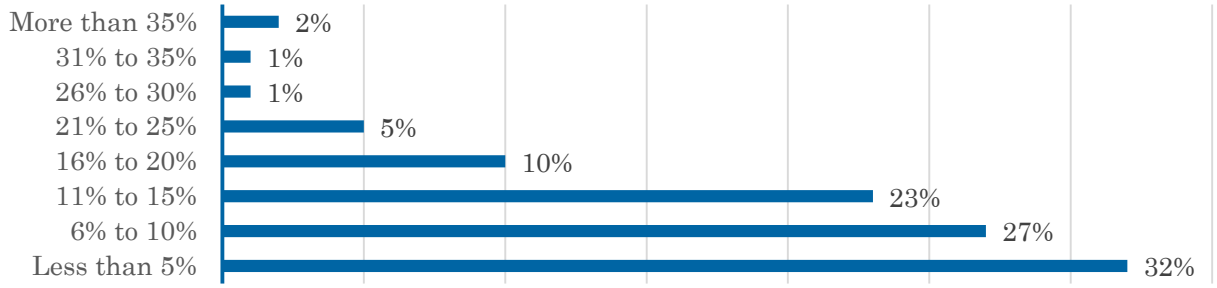

Figure 9: Recreational spending as a percentage of household budget

F. Economic analysis

To measure the economic impact of recreation on and around the Huron River, we focused on all those using the river. The intercept survey allows a distinction to be made between two types of visitors, however. One group is primary visitors, understood as visitors whose primary purpose for visiting the river *is* the Huron River. A second group of respondents stated that the Huron River was not their primary reason for visiting the area.

The primary visitors account for 76% of all spending. The average daily spending per visitor is presented in Table 5.

Table 5: Average spending, per person (all visitors)

Activity	Spending
Meals	$5.07
Shopping	$1.73
Lodging	$0.00
Transportation	$1.32
Gear Rental	$2.84
Other Spending	$0.62
Total	**$11.58**

With visitor days (Table 2: Visitor count) and average spending per visitor per day (Table 5: Average spending, per person (all visitors)Table 5), we are able to calculate the total direct spending by these visitors. Table 6 summarizes the direct spending for each category.

Table 6: Estimated total direct spending by primary visitors

Activity	Spending
Meals	$9,715,529
Shopping	$2,018,835
Lodging	$7,957
Transportation	$2,110,006
Gear Rental	$7,838,058
Other Spending	$808,951
Spending	$22,499,334

Table 7: Total economic impact of all visitors

	Impact
Direct Spending	$29,852,766
Indirect and Induced Spending	$23,664,614
Total Output	$53,517,380
Total Earnings	$14,718,160
Total Employment	641

Direct spending does not account for the total economic impact. This spending leads to indirect and induced spending. For example, a visitor makes purchases at a local store (direct spending). This store must then purchase more inventory from suppliers (indirect spending). The store owners and employees receive more income from the visitor's spending, and they spend some of their increased income in the local economy (induced spending). This indirect spending, induced spending, and job creation can be estimated using the Regional Input-Output Modeling System (RIMS II) multipliers. Detail of the effect of these multipliers is presented in Table 7 and summarized in Table 8.

Table 8: Annual estimated total economic impact (all visitors)

Category	Impact
Total Output	$53.5 M
Total Earnings	$14.7 M
Total Employment	641
Value Added	$30.6 M

G. Business survey

As a final perspective on the economic impact of the river ascertained through a survey process, local businesses sited very near or along the river were surveyed. An electronic survey was distributed to 163 email addresses, with 61 returned. The results of this survey are presented in the figures below. Importantly, the business survey corroborates the information from the visitor survey. The types of firms locating near the river mesh with the types of spending that visitors claim to make.

The presence of the Huron River influences companies to locate in the area. This is to take advantage of visitors coming to use the Huron River for recreational purposes, but also because the amenity of the river improves recruiting through improved amenities for workers. Shopping, dining, and recreational businesses are likely locating near the river to take advantage of the population choosing to use the river. However, 36% of the respondents are listed as "other". These businesses could be anything from a dentist office to light industry. These industries do not need the people coming to the river but still chose to locate near the river – and for many of the businesses, the river was part of their decision. We could only speculate why, but the sense of "place" appears to be very strong for people in the watershed. This data is summarized in figures 10 to 14.

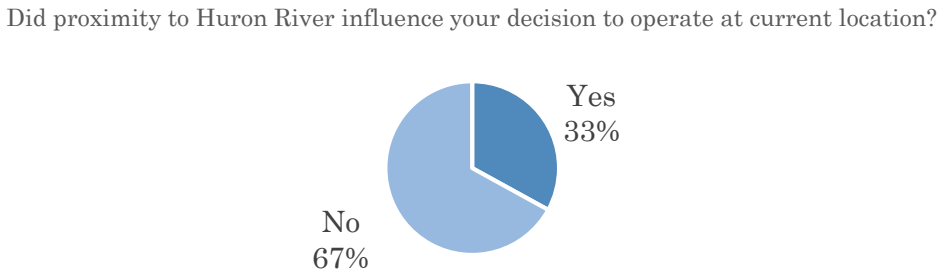

Figure 10: Proximity to Huron River, influence on location

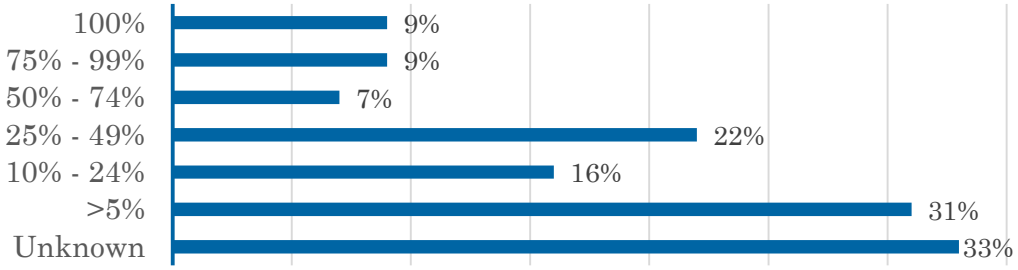

Figure 11: Business patrons who are recreational users of the Huron River

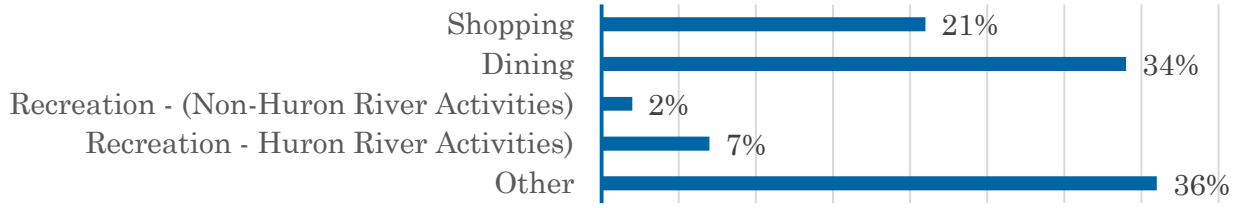

Figure 12: Industry classifications of business establishments

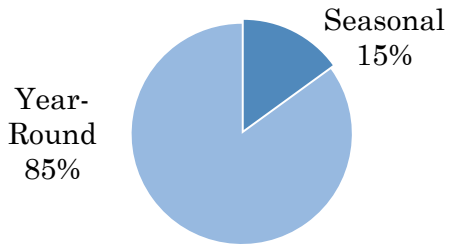

Figure 13: Seasonal or year-round business

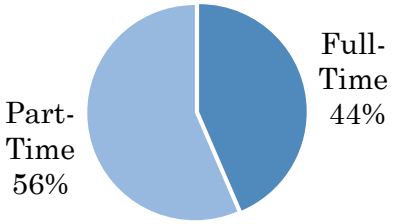

Figure 14: Proportion of full-time to part-time jobs

H. Conclusion

Visitors play an important role in the economic vitality of the region. They directly spend more than $29 million annually. Businesses have responded to this by locating near the river with 25% of these businesses indicating that more than 50% of their patrons are river users. These businesses employ people who are then able to also spend money in the area, increasing the impact of the $29 million directly spent to more than $50 million annually.

IV. VALUING THE ECOSYSTEM SERVICES OF THE HURON RIVER

Primary Author: Erik E. Nordman, PhD

In addition to the economic impact where the dollar values can be privately held, there are societal values that are appropriate to everyone in the watershed. These values are called ecosystem services. Whereas the economic impact is found using business tools that add up how much money is spent or how much an investment increases in value, the societal values cannot be addressed in the same manner. The result is a more academic treatment of the societal costs, evaluating how much a service is valued. The results are summarized for the reader in the executive summary.

This section provides the processes and statistical tests used, which makes this section more technically complicated than the earlier sections. A glossary of many of the terms is provided on page 52.

A. Introduction

Rivers and other water bodies provide ecosystem services such as biodiversity, recreation, and aesthetic enjoyment. Southeast Michigan's Huron River is a regionally-important natural resource, but the economic value of its ecosystem is presently unknown. This section reports on the scenic amenity and recreation values as they are reflected in home sale prices. This information, along with associated analyses of recreation, biodiversity, and economic development impact, will be used by the Huron River Watershed Council to help prioritize natural capital investments in the five-county Huron River corridor (Figure 15). Six ecosystem services were evaluated using two methods: hedonic (property sale) model and benefit transfer (Table 9).

The hedonic model assumes that homes are a bundle of attributes, such as the lot size, floor area, and, important to this analysis, waterfront location. By looking at hundreds of home sales, an analyst can tease apart each attribute's contribution to the sale price. The travel cost method analyzes recreational spending to determine how much a visitor is willing to pay to engage in a recreational activity. The more someone is willing to pay, in money and time, the higher that activity's value. Benefit transfer uses values from previous studies and applies them to the target community. It is an indirect method for measuring the value of ecosystem services.

Boyd and Banzhaf (2007) define final, as opposed to intermediate, ecosystem services as "components of nature, directly enjoyed, consumed, or used to yield human well-being." This definition constrains the accounting of ecosystem services to those processes or things that directly contribute to human well-being. For example, a fish caught by an angler would meet the definition of a final ecosystem service or good. The ecosystem processes that enable the fish to thrive, which are often described as regulatory services (e.g. Ecosystem Services n.d.) such as water quality, would not meet Boyd and Banzhaf's more restrictive definition. In addition, an ecosystem service is the "use of the ecological asset [i.e. natural capital] over some time period" for a particular purpose (Boyd and Banzhaf 2007). In one context, an ecosystem component may be enjoyed directly as a final ecosystem service. In

another context, that same ecosystem component may be an input (intermediate service) for a different final ecosystem service.

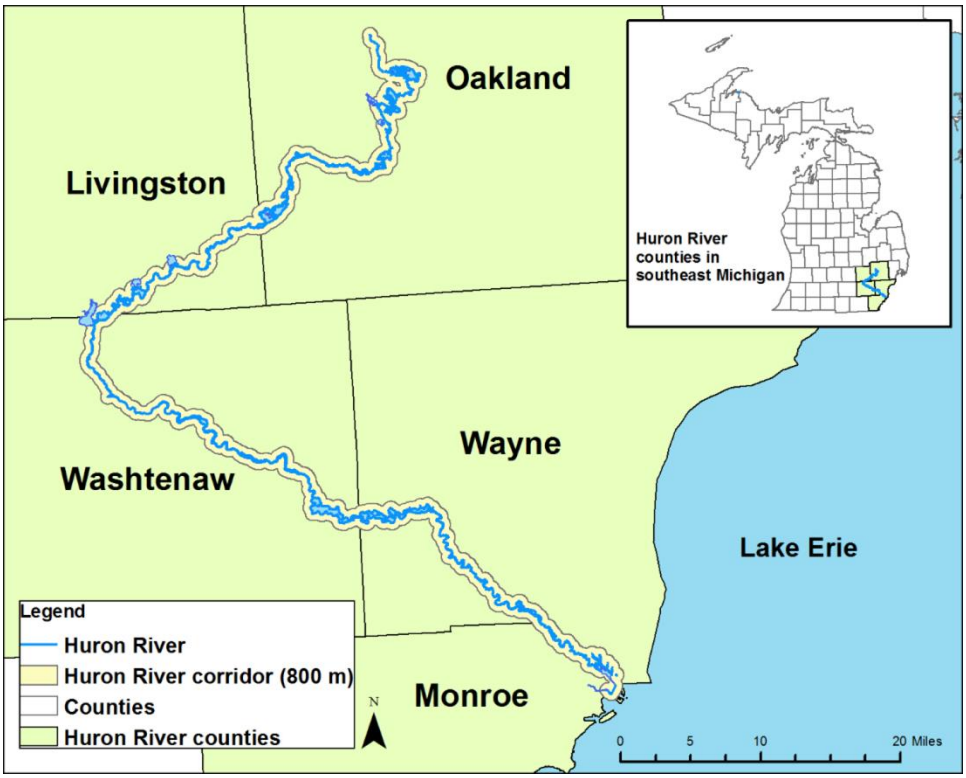

Figure 15: Five counties of the Huron River

Table 9: Ecosystem services analyzed for the Huron River

Human benefit	Final ecosystem service or good	Measurement tool
Recreational boating	Huron River	Benefit transfer
Scenic amenity	Adjacency to Huron River	Hedonic (property sale) model
Flood damage mitigation	Wetlands	Benefit transfer
Existence of biodiversity	Populations of rare organisms	Benefit transfer
Waste assimilation	Huron River	Benefit transfer
Economic development impact	N/A	User survey

B. Methods

i. Hedonic model

Data on housing prices and attributes were provided by Oakland County (Table 10) and Wayne County (Table 11). Requests were made to other counties in the watershed, but data was not provided in a format or quantity necessary for this type of modeling. The data included parcels that were within 800 meters (one-half mile) of the Huron River. Arms-length sales greater than $10,000 from January 2010 to April 2016 were included in the dataset. Vacant properties were not included, nor were bank sales. For Wayne County, the data were limited to those with residential zoning codes. Multi-family dwellings were excluded.

Several jurisdictions within Wayne County lacked zoning code information, and these were excluded from the analysis. The municipality of Brownstown did include zoning information, but it was physically separated from the other areas by several miles. Inspection of the 33 sales in Brownstown using spatial autocorrelation tools suggested that these sales were substantially different from those in the rest of the dataset. Therefore the Brownstown sales were not included in the Wayne County analysis. Only properties in the zoned areas of Belleville and Romulus were included. This roughly corresponds with the boundaries of Van Buren Township. Observations that had incomplete data (for example, lacking the number of bedrooms or floor space) were also removed. Housing prices were adjusted to 2016 dollars using the Consumer Price Index for the Detroit metro area housing. The two counties were modeled independently. The final dataset for Oakland County included 1,186 observations and Wayne County included 307.

Structural, neighborhood, and environmental characteristics were included in the models. The full dataset included numerous structural variables that could potentially help explain variation in sales prices. Many of these variables, however, presented multicollinearity problems when included in the regression model. The final suite of variables only included those with a variance inflation factor (VIF) less than 2.0.

The lot size (ACRES) was provided by Oakland County in the data table and was confirmed by measuring the parcel area in ArcGIS. For Wayne County, the lot size was converted to acres based on the GIS shapefile's parcel area. Both data sets included the residential floor space (square feet) and sale year. Additional structural characteristics were available for Oakland County including garage space (square feet), number of bedrooms, style of construction (ranch, colonial, etc.), and year built. Age at sale was calculated by subtracting the year built from the sale year.

Both data sets included school districts as a neighborhood attribute. School district spatial data were obtained from the Michigan Geographic Data Library (MiGDL). In each case, school district was coded as a dummy variable. In Oakland County, location within the Huron Valley school district was coded as one and all others were coded as zero. In Wayne County, location within the Van Buren school district was coded as one and the rest as zero. The Oakland County data included both rural properties and those in the Village of Milford, which is designated as a Huron River Trail Town. We hypothesized that location within the village may interact with acres in affecting sales price. Therefore an interaction variable (Mil_X_ACR) was included in the Oakland County model.

The key environmental variable was location along the Huron River. For both counties, location along the Huron River or adjacent water bodies was determined using ArcGIS with data downloaded from MiGDL. We defined RIVERFRONT as a parcel that intersects with a hydrological feature (river, lake, or stream) or is adjacent to public land in the floodplain. A GIS query was used to identify those parcels that directly intersect the hydrological features.

Additionally, parcels that were adjacent to the floodplain were selected by hand using the analyst's judgment. This captures a continuum of riverfront amenities from immediate adjacency with direct access to the river to an unobstructed view of the river to adjacency to a water body that drains into the river. Some portions of the Huron River are classified as flood risk areas by the Federal Emergency Management Agency. Adjacency to the river and location within a FEMA flood zone were highly and significantly correlated in Oakland County (R=0.81, p<0.05). Therefore only adjacency to the river (RIVERFRONT) was included in the hedonic models. All variables except age at sale were expected to contribute positively to sale price, that is, their regression coefficients should be positive.

The adjusted sales price (in real 2016 dollars) for both Oakland County and Wayne County data showed evidence of non-normality (Table 12). Therefore the adjusted sales price was natural log-transformed to normalize the data. The semi-log functional form was used in the hedonic models for both counties. Hedonic models of home sales often exhibit spatial autocorrelation. The dependent variable (Ln_AdjSalePrice) in each model was tested for spatial autocorrelation using Moran's I in ArcGIS (row standardized, threshold distance = 1000 m) (Table 13).

Table 10: Variables for the Oakland County hedonic model

Variable	Code	Mean	SD	Minimum	Maximum
Dependent					
Adjusted sales price (2016 $)	AdjSale	$242,883	126,460	$10,768	$1,132,384
Ln Adjusted sales price (2016 $)	Ln_AdjSale	12.28	0.50	9.28	13.94
Structural					
Lot size (acres)	ACRES	0.57	1.17	.09	23.56
Floor space (ft^2)	RESB_FLOOR	1,896.87	749.44	424	5,862
Garage space (ft^2)	RESB_GARAG	521.10	267.95	0	4,642
Home style (Colonial = 1, others = 0)	STYLE_COL	0.39	0.49	0	1
Number of bedrooms	RESB_NBED	3.16	.68	1	6
Age at sale	AgeAtSale	37.19	25.74	0	181
Sale year	SALEYEAR	2013.27	1.60	2010	2016
Neighborhood					
Huron Valley School District (Yes = 1, others = 0)	HURONVALLE	0.39	0.49	0	1
Milford (Yes = 1, no = 0)	MILFORD	0.18	0.38	0	1
Environmental					
Riverfront (Yes = 1, others = 0)	RIVERFRONT	0.19	0.39	0	1

Table 11: Variables for the Wayne County hedonic model

Variable	Code	Mean	SD	Minimum	Maximum
Dependent					
Adjusted sales price (2016 $)	AdjSale	$215,753	110,308	$26,255	$845,210
Ln Adjusted sales price (2016 $)	Ln_AdjSale	12.16	0.51	10.18	13.65
Structural					
Lot size (acres)	ACRES	0.65	1.19	<0.01	11.58
Floor space (ft^2)	RESB_FLOOR	2,067.55	701.63	600	4,220
Sale year	SALEYEAR	2013.17	1.71	2010	2016
Neighborhood					
Van Buren School District (Yes = 1, others = 0)	VanBuren_SD	0.97	0.16	0	1
Environmental					
Riverfront (Yes = 1, others = 0)	RIVERFRONT	0.28	0.45	0	1

Table 12: Tests for normality in sales price for Oakland and Wayne counties

County	Adjusted Sale Price		Log-transformed Adjusted Sale Price	
	Skewness (SE)	Kurtosis (SE)	Skewness (SE)	Kurtosis (SE)
Oakland	1.75 (0.07)	5.57 (0.14)	-0.35 (0.07)	1.63 (0.14)
Wayne	1.53 (0.14)	4.48 (0.28)	-0.38 (0.14)	0.65 (0.28)

Table 13: Moran's *I* test for spatial autocorrelation

County model	**Moran's *I***	
	Inverse distance	Inverse distance squared
Oakland County	0.268*	0.420*
Wayne County	0.271*	0.426*

Spatial autocorrelation was further explored using the GeoDa spatial econometric software package. Local indicators of spatial autocorrelation (LISA) show several hot spots where high sales prices are correlated with one another as well as areas where low prices are correlated with one another. In Oakland County (Figure 16), high sale prices are correlated with one another in the northwest and southwest areas. Low home sale prices tend to be clustered in the middle region and the northeast. In Wayne County (Figure 17), high sales prices are clustered on the west end of the region.

A spatial lag regression model (semi-log form) was used to correct for spatial autocorrelation. The spatial lag hedonic model was estimated using GeoDa. The spatial weights matrix was calculated in GeoDa using a 1000 m threshold. The minimum distance needed to ensure all properties have at least one neighbor was 588 m. The spatial lag model includes a spatially-weighted dependent variable, in this case W_Ln_AdjSale, that accounts for the influence of neighboring properties on sales price. Both the non-spatial ordinary least squares (OLS) and spatial lag models for each county were computed in GeoDa.

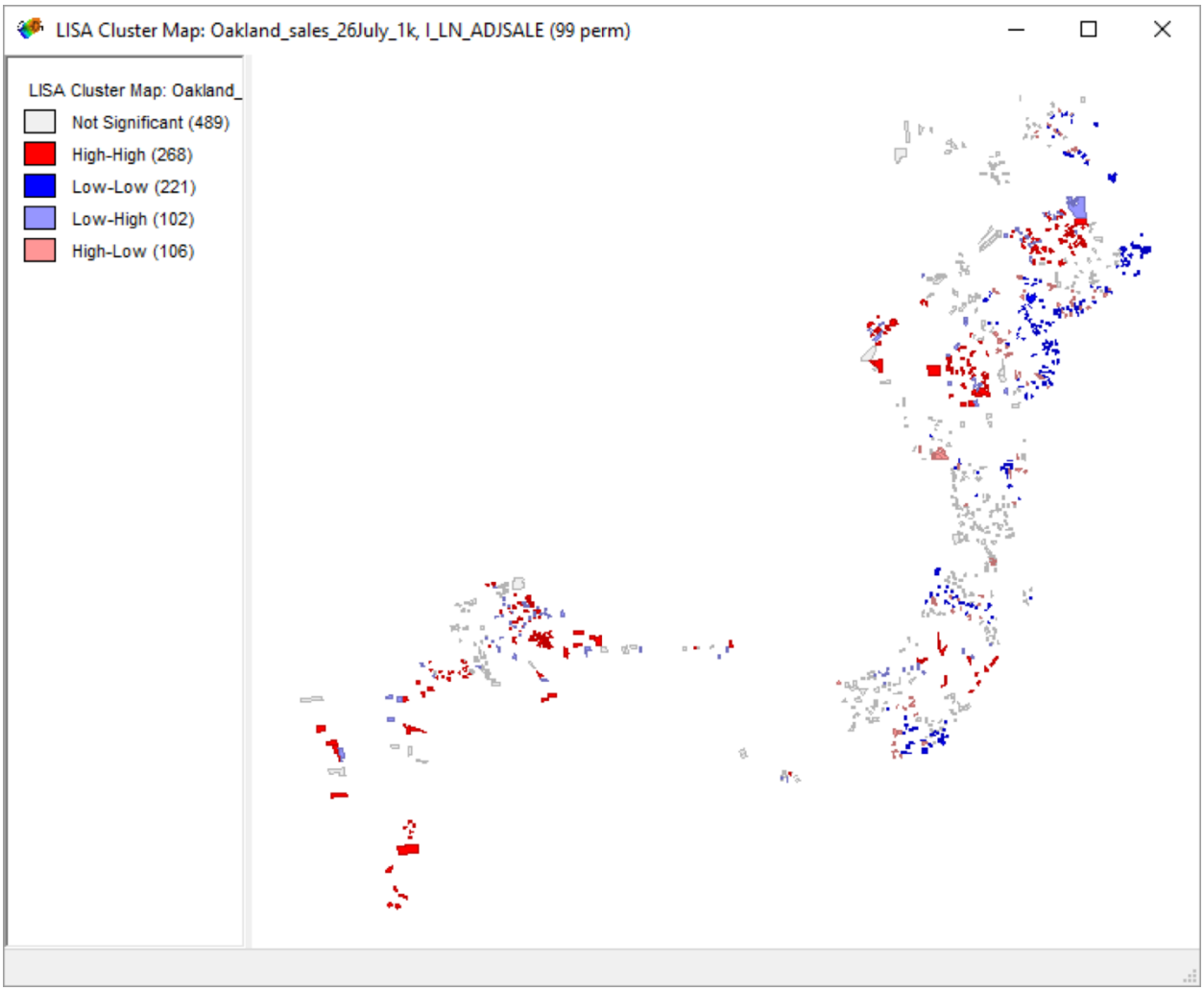

Figure 16: LISA clustering map of Oakland County home sales

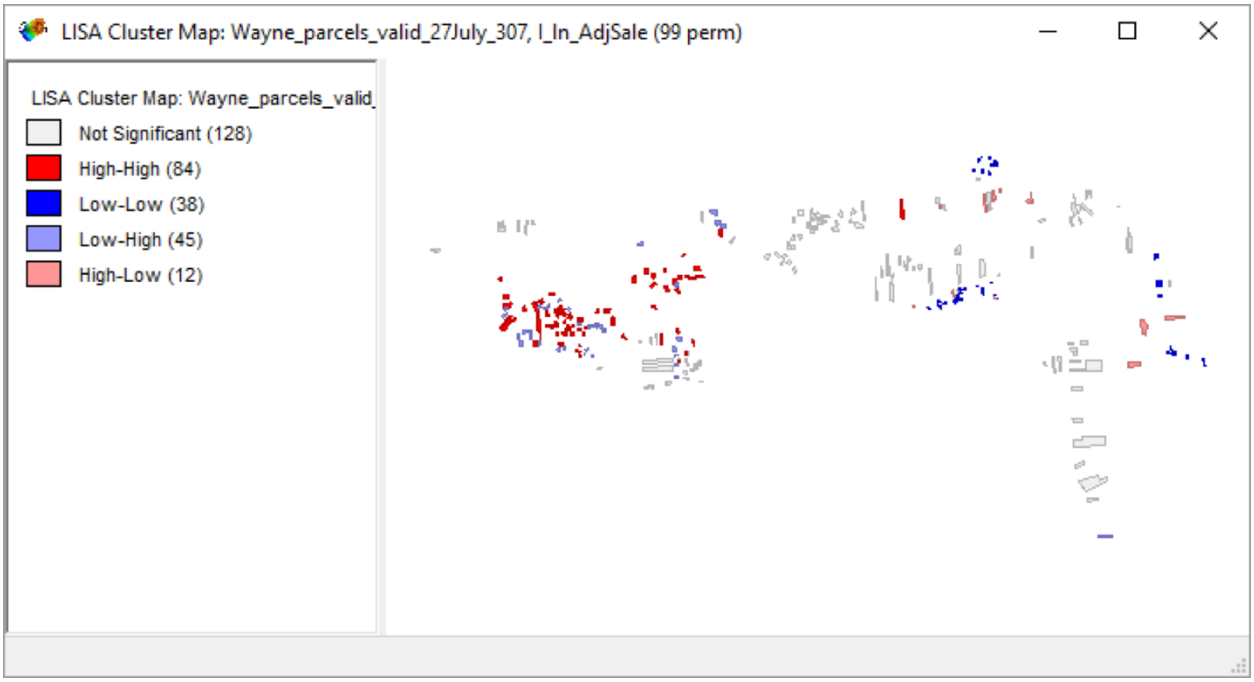

Figure 17: LISA clustering map of Wayne County home sales

ii. Benefit transfer

Benefit transfer is often used when there is a demand for environmental valuation information, but original research is not possible for logistical or financial reasons. Freeman (Freeman 2003, 453) defines benefit transfer as "the practice of applying nonmarket values obtained from primary studies of resource or environmental changes undertaken elsewhere to the evaluation of a proposed or observed change that is of interest to the analyst." The location presently under investigation is commonly called the "policy site", and the location from which the values are drawn is the "study site."

In this case, the policy site is the Huron River in southeast Michigan. The study sites were chosen from the literature based on geography and ecosystem similarity. Values from the study sites were adjusted to reflect the wages, land values, and other costs in the southeast Michigan region using the US Bureau of Labor Statistics' Consumer Price Index.

Three benefits were analyzed by estimating affiliated ecosystem services using benefit transfer: biodiversity from the Huron River; flood mitigation from wetlands; and waste assimilation from the Huron River (Table 9).

C. Biodiversity preservation

Whitehead et al. (2009) estimated the economic benefits of freshwater coastal marshes in Saginaw Bay, Michigan. The authors used the travel cost method to analyze the benefits of recreation activities and contingent valuation to estimate the willingness-to-pay for coastal marsh protection which includes non-use values like biodiversity. The latter was used for benefit transfer in this project. The general population and sport license-holders were surveyed about their willingness to pay for the hypothetical purchase and protection of up to 18,000 acres of Saginaw Bay coastal marsh. Geographically, the area of interest included five counties: Iosco, Arenac, Bay, Tuscola, and Huron. Both direct users of the resource (those with a hunting and fishing license) and non-users were included in the survey.

The combined user and non-user willingness-to-pay was $1,150/acre ($1,419/acre in 2016 dollars) to preserve wetlands up to 1,125 acres. Beyond that limit, the willingness-to-pay for additional preserved acres was $288/acre ($355 in 2016 dollars). The average median household income for the five Saginaw Bay counties was $41,216 in 2014 dollars. The household incomes for the Huron River counties were substantially higher. Willingness to pay is constrained by household income. Therefore the willingness-to-pay for wetland protection in each Huron River county was adjusted from the Whitehead et al. estimate in proportion to the higher household income in each county. The aggregate value of preserved wetlands was calculated by applying the price per acre to the area of wetlands within 800 m (0.5 mile) of the Huron River in the respective counties.

Table 14: Adjusted willingness-to-pay (WTP) for wetland preservation in 2016 dollars

Calculated from a baseline estimate of $680/acre in Saginaw Bay counties.

County	Median household income (2014)	Ratio to Saginaw Bay income	Adjusted WTP per acre up to 1,125 acres	Adjusted WTP for acres >1,125
Livingston	$73,694	1.79	$1,216	$635
Monroe	$54,911	1.33	$906	$473
Oakland	$66,436	1.61	$1,096	$572
Washtenaw	$60,805	1.48	$1,003	$524
Wayne	$41,421	1.00	$683	$357

Wetland data were downloaded as spatially-explicit shapefiles for analysis in ArcGIS. The shapefiles were obtained from the Michigan Geographic Data Library, a repository of public spatial data maintained by the State of Michigan. The "Final Wetland Inventory" dataset was downloaded for each of the five Huron River counties. Wetlands were selected for analysis in two stages: those that are adjacent to the Huron River and those that are within 800 m (0.5 mile) of the river. The original wetland shapefile polygons were "multipart" – that is, one wetland element consisted of several distinct, non-adjacent polygons. The

"multi-part to single-part" tool in ArcGIS 10.1 was used to break apart polygons that were within 800 m of the river. Some of these polygons were quite large. In one case the polygon took up most of the county and was 305,000 acres. In order to identify the portions of those polygons that are directly connected, both hydrologically and socially, to the Huron River, the wetland polygons were clipped at the extent of the 800 m buffer around the Huron River. In the first scenario, adjacent polygons were those that intersect with the Huron River shapefile. In the second, polygons that intersect the river within 800 m were selected.

D. Flood mitigation

Wetlands also reduce the risk of floods by absorbing excess water and discharging more slowly. The five counties that include the Huron River contain considerable areas of wetlands (Table 15). A reasonable assumption is that these wetlands could absorb three feet of flood water.

The Huron River most recently flooded at Ann Arbor, a Huron River Trail Town, in 2011 with a crest of 16.59 feet. This corresponds to a flow of 122 ft^3 per second (cfs) above the minor flood stage of 16.0 feet. Assuming that the river was at 90% of its peak for the entire day, the total water flooding Ann Arbor was 9.5 million ft^3 in a single day. Grand Rapids, Michigan, experienced a major, but not record-setting, flood in 2013. The flood, which had a total volume of 3.9 billion ft^3, caused an estimated $450 million in damages. Nordman et al. (in press) estimated the damage from the event at $0.11/$ft^3$. At that rate, damage from the 2011 Ann Arbor flood would be roughly $1.04 million. Nordman et al. estimated that the expected damage of flood water, with a 25-year recurrence time, to Grand Rapids, Michigan, would be $0.005/$ft^3$.

Table 15: Wetland areas along the Huron River

	Wetland area - adjacent	
County	**m^2**	**Acres**
Livingston	21,923,645	5,418
Monroe	8,464,488	2,091
Oakland	31,652,179	7,822
Washtenaw	16,551,391	4,090
Wayne	18,049,311	4,460
Total	96,641,014	23,881

E. Waste assimilation

Aquatic ecosystems like the Huron River absorb and process wastes from human-dominated landscapes. Examples of this include runoff from impervious surfaces like roads, parking lots, and building roofs; runoff from farms and other rural land uses; or direct discharge of wastewater from industrial facilities and wastewater treatment plants. This analysis focuses only on assimilating runoff from impervious surfaces and as such should be considered a conservative estimate of the total waste assimilation services provided by the river.

An analysis of the economic costs of stormwater runoff for Grand Rapids, Michigan, showed that pollutants like total suspended solids (TSS) and total phosphorous (TP) are carried into water bodies that receive stormwater discharge. One way to estimate the value of the waste assimilation service is to look at the avoided cost of removing the pollutants through a treatment system.

The unit cost of treating the pollutants, derived from a literature review and adjusted for local conditions, was $5.93/lb for TSS and $251.25/lb for TP in 2015 dollars. Because the pollutants are carried by stormwater at typical concentrations, the treatment cost per volume of stormwater is $0.049/ft^3 for TSS and $0.009/ft^3 for TP. There was virtually no inflation from 2015 to 2016, and the 2015 estimates are basically identical to the 2016 adjusted numbers. These can be taken as rough approximations of the per-unit value of waste assimilation services of the Huron River ecosystem.

To calculate the aggregate value, one needs to know the total volume of stormwater runoff each year entering the Huron River. The stormwater runoff volume is a function of the amount of impervious surface in the watershed. The NOAA Coastal Change Analysis Program (C-CAP) provides time series land cover datasets for U.S. coastal areas, including all of Michigan. The latest available land cover data was based on imagery collected in 2010.

The land cover data includes three categories of developed land. High-intensity developed includes land covered by 80-100% constructed materials such as roofing, metal, concrete, or other impervious surfaces. Medium-intensity developed includes land with 50-79% constructed materials and low-intensity developed includes 21-49% constructed materials. This analysis focused on the main body of the Huron River and its directly-associated wetlands and tributaries. Though the entire Huron River watershed contributes runoff and pollutants to the system, some of those pollutants are processed by upstream creeks and wetlands.

We limit our analysis, therefore, to an 800 m (0.5 mile) buffer around the Huron River. The number of pixels in each of the three developed land cover classes within the 800 m buffer was calculated for each county. Each pixel has an area of 900 m^2 (each pixel is 30 m by 30 m). The lower end percentage of constructed materials, which we interpreted as impervious surface, was used for each category (80%, 50%, and 21%) and applied to the area to estimate the total amount of impervious surface in each county. The total area and the area of impervious surface for each county were used to calculate the volume of runoff, also called water quality volume (WQv) in the New York State Construction Stormwater Toolbox.

The toolbox consists of pre-formatted Excel spreadsheets. The formula for calculating WQv is:

[Equation]

Where:

WQv = water quality volume (acre feet)

P = the 90% rainfall event number (1.0 inches)

Rv = 0.05 + 0.009(I) where I is percent impervious cover

A = contributing area (acres)

The Construction Stormwater Toolbox automatically converts acre-feet into cubic feet. The total WQv per year for each county was then multiplied by the unit cost of pollution to arrive at the aggregate value of the Huron River's pollution assimilation services in each county.

V. RESULTS

A. Hedonic model

The models explain a substantial proportion of the observed variation in sale price. The Oakland County OLS and spatial lag models had R^2 values higher than 0.70 (Table 16, Table 17). The R^2 values were lower in the Wayne County OLS and spatial lag models (0.62 and 0.65, respectively) (Table 18, Table 19). In both counties, the spatial lag model had a higher goodness-of-fit than the non-spatial OLS model. Correcting for spatial autocorrelation not only improved the goodness-of-fit but also affected the statistical significance of some of the variables. In both models, location within the school district (HURONVALLE or VAN_BUREN_SD) was statistically significant in the OLS model but not in the spatial lag model. The marginal willingness to pay (MWTP) was calculated by exponentiating the regression coefficient. The MWTP is expressed as a percentage of the geometric mean of the sales price (Table 20).

Most variables had the expected signs with the notable exception of ACRES in the Oakland County models. In this case, parcel size had a negative regression coefficient. The coefficient, however, was not statistically significant in either the OLS or spatial lag models. The interaction variable (Mil_X_ACR) was also insignificant. ACRES was statistically significant in the Wayne County models. At the exponentiated geometric mean level of ln_AdjSalePri, one additional acre of parcel size adds 4.55%, or $8,574, to the sale price. This is reasonably consistent with prices for vacant land currently listed on Zillow.com.

In the spatial lag models for both counties, an additional square foot of floor space (RESB_FLOOR) added 0.04% to the geometric mean sale price. In Oakland County, that is a marginal implicit price of $85.09/ft^2; in Wayne County, it is $75.38/ft^2.

RIVERFRONT was the primary variable of interest. The spatial lag models suggested a MWTP of 39% ($82,767) and 65% ($123,380) for the Oakland and Wayne county models, respectively, at the geometric mean sale price. Location within the Village of Milford, a designated Huron River Trail Town, increased sale prices by an average of almost 20% ($41,607).

The GIS analysis identified a total of 2,312 residential parcels in Oakland County that intersect (within 15 m) with a Huron River-related hydrological feature. At the MWTP of $82,767 per parcel, the total amenity value of location along the Huron River in Oakland County is $191,357,304. The Wayne County analysis was limited to zoned residential properties in Belleville and Romulus (essentially Van Buren Township). These communities contain 478 residential parcels adjacent to a Huron River hydrological feature. At the MWTP of $123,380 per parcel, the total amenity value is $58,975,640.

The amenity value per mile can be used to extrapolate the results to the rest of the river. The length of the Huron River was measured in each county in ArcGIS by manually tracing the main branch of the river at a scale of 1:150,000. This broad scale captures the basic length of the river but does not include the fine-scale meanderings. The aggregate value for Oakland County was divided by the length of the Huron River in the county. The same procedure was used to calculate the value per mile in Wayne County's Van Buren Township. The Huron River length was measured in Wayne County outside of Van Buren Township as well as in Livingston, Washtenaw, and Monroe Counties. Monroe County shares its entire Huron River length with Wayne County. Because Monroe County properties are only on one side of the river, its effective river length was divided by two. The corresponding correction was applied to Wayne County's side of the shared river length. Wayne County's lower per-mile value was then applied to the respective river lengths to arrive at a rough estimate of the Huron River's amenity value in all five counties (Table 21). The total amenity value for the entire region was estimated at $628,326,183.

Table 16: Oakland County - OLS semi-log model

Variable	Coefficient	Std. Error	t-Statistic	Probability
CONSTANT	-130.0228	10.1762	-12.78	0.00
Structural				
ACRES	-0.0070	0.0074	-0.95	0.34
RESB_FLOOR	0.0004	0.0000	28.93	0.00
RESB_GARAG	0.0002	0.0000	7.68	0.00
AgeAtSale	-0.0022	0.0004	-5.97	0.00
STYLE_COL	0.0289	0.0199	1.45	0.15
SALEYEAR	0.0702	0.0051	13.89	0.00
Neighborhood				
HURONVALLE	0.0626	0.0212	2.96	0.00
MILFORD	-0.0022	0.0297	5.93	0.00
MIL_X_ACR	-0.0033	0.0289	-0.11	0.91
Environmental				
RIVERFRONT	0.3214	0.0187	17.22	0.00
Number of observations		1186		
Degrees of freedom		1175		
R^2		0.706		
Adjusted R^2		0.704		
F-statistic		282.668	$p<0.05$	
Sum of squared residuals		88.125		
Log likelihood		-141.310		
Akaike info criterion		304.620		

Table 17: Oakland County - Spatial lag semi-log model

Variable	Coefficient	Std. Error	z-value	Probability
CONSTANT	-130.4770	9.9293	-13.14	0.00
W_LN_ADJSALE	0.3427	0.0480	7.14	0.00
Structural				
ACRES	-0.0119	0.0072	-1.65	0.10
RESB_FLOOR	0.0004	0.0000	26.93	0.00
RESB_GARAG	0.0002	0.0000	7.53	0.00
AgeAtSale	-0.0021	0.0004	-5.84	0.00
STYLE_COL	0.0481	0.0195	2.46	0.00
SALEYEAR	0.0684	0.0049	13.87	0.00
Neighborhood				
HURONVALLE	0.001	0.0230	0.04	0.96
Milford	0.1786	0.0290	6.16	0.00
Mil_X_ACR	0.0048	0.0282	0.17	0.86
Environmental				
RIVERFRONT	0.3287	0.0182	18.06	0.00
Number of observations		1186		
Degrees of freedom		1174		
R^2		0.718		
Log likelihood		-118.257		
Akaike info criterion		260.514		

Table 18: Wayne County - OLS semi-log model

Variable	Coefficient	Std. Error	t-Statistic	Probability
CONSTANT	-82.5750	21.5269	-3.84	0.00
Structural				
ACRES	0.0438	0.0157	2.79	0.01
RESB_FLOOR	0.0004	0.0000	16.52	0.00
SALEYEAR	0.0463	0.0107	4.34	0.00
Neighborhood				
VanBuren_SD	0.3745	0.1144	3.27	0.00
Environmental				
RIVERFRONT	0.5036	0.0419	12.02	0.00
Number of observations		307		
Degrees of freedom		301		
R^2		0.627		
Adjusted R^2		0.621		
F-statistic		101.368	$p<0.05$	
Sum of squared residuals		29.984		
Log likelihood		-78.545		
Akaike info criterion		169.090		

Table 19: Wayne County - Spatial lag semi-log model

Variable	Coefficient	Std. Error	z-value	Probability
CONSTANT	-94.4022	20.5011	-4.60	0.00
W_ln_AdjSale	0.4803	0.0995	4.83	0.00
Structural				
ACRES	0.0445	0.0151	1.501	0.00
RESB_FLOOR	0.0004	0.0000	16.98	0.00
SALEYEAR	0.0494	0.0108	4.86	0.00
Neighborhood				
VanBuren_SD	0.1726	0.1150	1.50	0.13
Environmental				
RIVERFRONT	0.5036	0.0419	12.02	0.00
Number of observations		307		
Degrees of freedom		300		
R^2		0.655		
Log likelihood		-68.120		
Akaike info criterion		150.239		

Table 20: Marginal willingness-to-pay (MWTP) for various home characteristics

	Oakland County model			Wayne County model		
Variable	**Coefficient**	**Exponentiated coefficient**	**MWTP**	**Coefficient**	**Exponentiated coefficient**	**MWTP**
ACRES	*	*		0.0445	1.0455	4.55%
RESB_FLOOR	0.0004	1.0004	0.04%	0.0004	1.0004	0.04%
RESB_GARAGE	0.0002	1.0002	0.02%	**	**	**
AgeAtSale	-0.0021	0.9979	-0.21%	**	**	**
STYLE_COL	0.0481	1.0492	4.92%	**	**	**
SALEYEAR	0.0684	1.0707	7.07%	0.0494	1.0506	5.06%
Milford	0.1786	1.1956	19.56%	**	**	**
RIVERFRONT	0.3287	1.3891	38.91%	0.5036	1.6547	65.47%

*coefficient not statistically significant

**not included in model

Table 21: Aggregate amenity value of Huron River in each county

County	Measured MWTP	Number of properties	Huron River length (miles)	Value per mile	Aggregate value
Oakland	$82,767	2,312	29.30	$6,530,966	$191,357,304
Wayne (Van Buren)	$123,380	478	10.31	$5,720,237	$58,975,640
Wayne (outside Van Buren)			13.96		$54,942,873*
Livingston			17.44		$99,760,927*
Washtenaw			34.68		$198,377,807*
Monroe			8.71		$24,911,631*
Total					**$628,326,183***

*Extrapolated based on Wayne County (Van Buren Township) value per mile

B. Benefit transfer

i. Biodiversity

The aggregate value of wetland preservation is the price ($/acre) of preservation, estimated from the Whitehead et al. analysis, multiplied by the total acres of Huron River wetlands in each county. The aggregate value was estimated for wetlands directly adjacent to the Huron River and for wetlands within 800 m (0.5 mile) of the river (Table 22). Oakland County had the highest area of Huron River wetlands as well as a relatively high marginal price for those wetlands which resulted in it having the highest aggregate value ($6.4 million-9.0 million). Monroe County had the smallest area of wetlands (2,091 acres) and a relatively low marginal price resulting in an aggregate value of around $2.6 million. The total value of preserved wetlands along the Huron River corridor is $21.3 million-27.8 million.

Table 22: Area and aggregate value of wetland ecosystem service

	Wetland area - adjacent				Wetland area – within 800 m		
County	**m²**	**Acres**	**Value**		**m²**	**Acres**	**Value**
Livingston	21,923,645	5,418	$5,578,984		31,256,489	7,724	$7,042,849
Monroe	8,464,488	2,091	$2,584,010		9,027,798	2,231	$2,649,846
Oakland	31,652,179	7,822	$6,405,163		50,144,441	12,391	$9,020,023
Washtenaw	16,551,391	4,090	$3,907,960		27,073,855	6,690	$5,269,755
Wayne	18,049,311	4,460	$2,794,201		29,488,052	7,287	$3,802,650
Total	**96,641,014**	**23,881**	**$21,270,318**		**146,990,635**	**36,323**	**$27,785,123**

ii. Flood mitigation

Assuming that wetlands can retain three feet of flood water, wetlands in the five Huron River counties can store between 273-1,022 million ft^3 of flood water. At a price of $\$0.005/ft^3$, this results in a flood mitigation value that ranges from $1.37 million per year for Monroe County to $5.11 million for Oakland County. The total value of flood mitigation is $15.60 million per year (Table 23).

Table 23: Value of flood mitigation in Huron River counties

	Wetland area - adjacent			
County	**m²**	**Acres**	**Water storage volume**	**Annual value**
Livingston	21,923,645	5,418	707,965,684	$3,539,828
Monroe	8,464,488	2,091	273,338,080	$1,366,690
Oakland	31,652,179	7,822	1,022,122,761	$5,110,614
Washtenaw	16,551,391	4,090	534,483,060	$2,672,415
Wayne	18,049,311	4,460	582,854,394	$2,914,272
Total	**96,641,014**	**23,881**	**3,120,763,979**	**$15,603,820**

iii. Waste assimilation

The Huron River's waste assimilation services have a conservative annual value of $1.4 million (Table 24). The value is highly variable among counties ranging from $38,234 in Monroe County to $540,781 in Washtenaw County. These are conservative values because we assumed that the percentage of constructed materials, (i.e., impervious surface) was at the low end of the range for each developed land cover type. It also only includes runoff from developed areas and does not include agricultural land.

Table 24: Value of the Huron River's waste assimilation services

County	Impervious area (acres)	WQv (ft^3)	Value of TSS and P pollution assimilation
Livingston	419.38	1,645,443	$95,436
Monroe	170.89	659,210	$38,234
Oakland	1,278.70	4,942,381	$286,658
Washtenaw	2,496.97	9,323,817	$540,781
Wayne	1,990.32	7,524,004	$436,392
Total	**6,356.26**	**9,980,019**	**$1,397,502**

C. Recreation

Individuals have to value an activity more than the money that they spend while engaging in it, or they will not do it. The direct spending of $24M is the minimum value these recreational users place on their Huron River experience. Another question to ask is, "Just how valuable is the Huron River experience to the user compared to other choices?"

While an approach to answering this question could be to implement the *travel cost* method, the number of completed surveys was insufficient to provide a reliable estimate of this value. As an alternative, similar Michigan-based travel cost estimates for these types of activities calculated in the last five years shows a value of $42 per visitor per day for people engaging in recreational activity. Applying this to the number of annual Huron River Water Trail users, the expenditures would be $108.2 million, or more than three times the amount actually spent by users. This three to one ratio of value to spending is consistent with similar studies in Michigan. More information on this estimate can be found in the benefits transfer section later in this report.

VI. DISCUSSION

As expected, waterfront properties in both counties, including those with frontage on the Huron River or its tributaries, sell for a considerably higher price than similar homes that are not adjacent to water. In Oakland County, waterfront homes have a 39% premium (spatial lag model). The effect is even larger in Wayne County where waterfront homes have a 65% premium (spatial lag model). This provides an indication of how much the scenic amenity provided by the river would increase the value. The much higher percentage for Wayne County reflects both a higher mean price for riverfront homes in Wayne County as well as substantially lower prices for non-riverfront homes compared to Oakland County.

The range of implicit prices for the Huron River amenity is consistent with other property value models. A 1995 study of waterfront property in central Texas estimated a premium of $79,000-$102,000, or $124,000-$161,000 in 2016 dollars (Lansford and Jones 1995). In Pensacola, Florida, where housing prices are substantially higher than Michigan, a one-meter reduction in distance to the shoreline increased property values by more than $1,000 (Hamilton and Morgan 2010). Closer to home, Colwell and Dehring (2005) studied sales of vacant lots along Lake Huron in northeastern Michigan. They found that lots located on a bluff that had lake frontage sold at a 200% premium compared to lots with similar views without lake frontage. These studies suggest that our estimates for the Huron River are reasonable.

The services provided by wetlands, as measured by willingness to pay for preservation, have an estimated value of $21 million to $27 million for the five-county Huron River corridor. While this is substantially less than the $628 million of residential amenity value, it does suggest that all residents, regardless of their location, value wetlands and the biodiversity they support.

Waterfront properties are at risk of floods, and those along the Huron River are no exception. The wetlands and topography of the floodplain allow for storage of flood waters. The estimate of three feet of flood water storage is a very coarse estimate and could be improved with hydrological modeling. However, using this rough number suggests that the Huron River's undisturbed wetland systems provide up to $15.6 million in flood risk reduction services. The Huron River assimilates wastes from urban runoff. This is the lowest-valued service analyzed in this paper, yet the river's waste assimilation services are still valued at almost $1.4 million each year.

A. Hedonic analysis summary

Researchers from Grand Valley State University collaborated with the Huron River Watershed Council to estimate the economic value of the Huron River ecosystem and its economic development impact. Six ecosystem services were evaluated using three methods: hedonic (property sale) model, travel cost model, and benefit transfer. The hedonic model assumes that homes are a bundle of attributes, such as the lot size, floor area, and,

important to this analysis, waterfront location. By looking at hundreds of home sales, an analyst can tease apart each attribute's contribution to the sale price.

Data on housing prices and attributes were provided by Oakland County and Wayne County. The data included parcels that were within 800 meters (one-half mile) of the Huron River, had a sale price of at least $10,000, and were sold between January 2010 and April 2016. Structural, neighborhood, and environmental characteristics were included in the models.

The hedonic real estate price model showed that location along the Huron River results in a sale price premium of 39% for Oakland County and 65% in Wayne County. At the geometric mean sale price, the premium translates to $82,767 and $123,380 in Oakland and Wayne counties, respectively. The total amenity value of all parcels with a location along the Huron River in Oakland County is $191,357,304. The Wayne County analysis was confined to Van Buren Township and the total amenity value is $58,975,640. The amenity value per mile can be used to extrapolate the results to the rest of the river. Wayne County's lower per-mile value was then applied to the respective river lengths to arrive at a rough estimate of the Huron River's amenity value in all five counties. The total amenity value for the entire region was estimated at $628,326,183.

Table 25: Aggregate amenity value of Huron River in each county

County	Measured MWTP	Number of properties	Huron River length (miles)	Value per mile	Aggregate value
Oakland	$82,767	2,312	29.30	$6,530,966	$191,357,304
Wayne (Van Buren)	$123,380	478	10.31	$5,720,237	$58,975,640
Wayne (outside Van Buren)			13.96		$54,942,873*
Livingston			17.44		$99,760,927*
Washtenaw			34.68		$198,377,807*
Monroe			8.71		$49,823,261*
Total					**$628,326,183**

*Extrapolated based on Wayne County (Van Buren Township) value per mile

B. Conclusion

Both private and societal values have been explored across this report. The private value in terms of spending and property values is less than half the value that is attributed to the region as a result of the Huron River. The societal values that result from environmental amenities show potential for even more economic development to take advantage of these natural areas. However, development that changes the natural area can lead to a reduction of societal value and eventually reduction in private value.

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D. Glossary of terms

Benefit transfer: A method of estimating the economic value of an ecosystem service using information from existing studies in other locations.

Ecosystem services: the components of nature, directly enjoyed, consumed, or used to yield human well-being (Boyd and Banzhaf 2007).

Functional form: the mathematical structure of the hedonic model. Variables may be transformed by the natural logarithm. In a semi-log form, only the dependent variable (sales price) is log-transformed.

GIS: geographic information system. A computer program that analyzes the spatial distribution of various resources. ArcGIS is a particular brand of GIS software.

Hedonic model: an analysis of property values that describes the home's sales price as a function of its characteristics, such as the structure (ex., number of bedrooms), neighborhood (ex., school district), and environment (ex., location along a scenic river).

Natural capital: an environmental asset that provides a stream of services over time. Analogous to financial capital that provides a stream of interest over time.

Regression analysis: a statistical approach that estimates the relationship between one attribute (dependent variable) and one or more related attributes (independent variables).

Scenic amenity: a pleasant view, especially of a natural ecosystem.

Spatial autocorrelation: a statistical concept in which the attributes of a class of objects are more similar at close distances. For example, expensive homes tend to be adjacent to other expensive homes – they are not randomly distributed through the landscape.

VII. APPENDIX A: SURVEY FORMS

A. Form 1: Economic survey

For the purposes of this survey about your recreational use of the Huron River Water Trail, a trip is the total time between leaving and returning to your home address. It includes all activities that you do in that time period.

1. Home Zip Code _____ Survey date/venue code:_____

2. Is the Huron River your primary reason for being at this location **TODAY**? Yes _____ No _____

3. Are you at least 18-years old? Yes _____ No _____ **(if 'No' stop here)**

4. Before being asked to take this survey, were you aware of the Huron River Water Trail? Yes _____ No _____

5. How many times in the past 12 months have you visited the Huron River for recreational purposes? _____

6. On **today's** visit, how many people are in your party (including yourself)? Adults ____ Children (17 & under) _____

7. How much does your party expect to spend as you are away from home and visiting the Huron River **TODAY**?

   $_____ Meals (including alcohol) $_____Shopping $_____ Lodging

   $_____ Transportation (gas, parking, bus etc.) $_____Gear Rental $_____ Other

8. What is your primary activity when you visit the Huron River? (**Choose one**)

   Canoeing/Kayaking___ Paddle Boarding___ Fishing___ Birding/Wildlife viewing___

   Motor boating/Jet Skiing___ Tubing___ Walking/Running/Hiking___ Biking___

   Other___ The Huron River was not my primary reason for visiting ___

9. What is your PREFERRED location when visiting the Huron River?

   Ann Arbor _____ Milford _____ Dexter _____

   Ypsilanti _____ Flat Rock _____ Other _____

10. How many times in the past 12-months have you visited the Huron River corridor for recreational purposes (kayaking, hiking, biking, etc.) from the following Trail Towns?

    a. Ann Arbor: Daily ____ Weekly ____ Monthly ____ Quarterly ____ Annually ____ Never ____
    b. Milford: Daily ____ Weekly ____ Monthly ____ Quarterly ____ Annually ____ Never ____
    c. Dexter: Daily ____ Weekly ____ Monthly ____ Quarterly ____ Annually ____ Never ____
    d. Ypsilanti: Daily ____ Weekly ____ Monthly ____ Quarterly ____ Annually ____ Never ____
    e. Flat Rock: Daily ____ Weekly ____ Monthly ____ Quarterly ____ Annually ____ Never ____

11. How satisfied are you with today's Huron River recreational experience (circle one)

    1 2 3 4 5 6 7

    Very dissatisfied Very satisfied

12. Do you use a smart phone (iPhone, Android, etc.) while using the Huron River Water Trail? Yes ____ No ____

-please complete other side-

This information will be used only to provide demographics of the users of the Huron River Water Trail

1. What is your annual household income?

   a. Less than $25,000 _____
   b. $25,000 - $60,000 _____
   c. $60,001 - $85,000 _____
   d. $85,001 – 100,000 _____
   e. $100,001 - $125,000 _____
   f. More than $125,000 _____

2. How much of your annual household budget do you spend on recreation in a year?

   a. Less than 5% _____
   b. 6% - 10% _____
   c. 11% - 15% _____
   d. 16% - 20% _____
   e. 21% - 25% _____
   f. 26% - 30% _____
   g. 31% - 35% _____
   h. More than 35% _____

3. MALE _____ FEMALE _____

4. What is your age?

   a. 18 – 25 _____
   b. 26 – 35 _____
   c. 36 – 45 _____
   d. 46 – 55 _____
   e. 56 – 65 _____
   f. 66 – 75 _____
   g. Over 75 _____

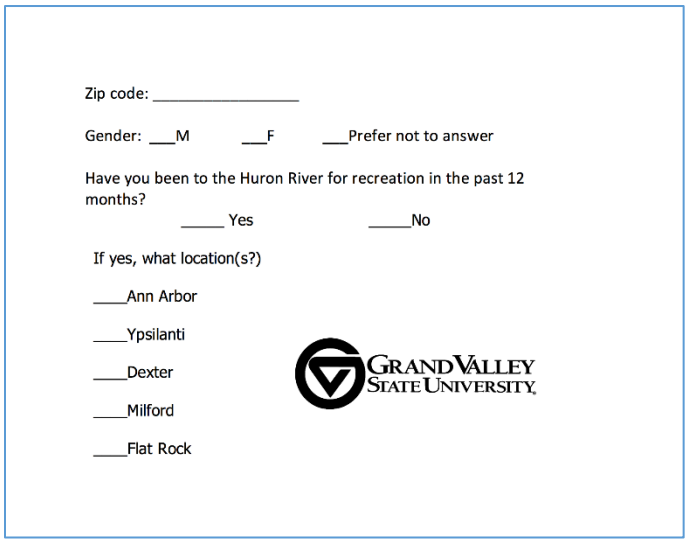
5. Do you own or rent your current home? _____OWN _____RENT

6. What is the highest level of education you have completed?

   a. Less than High School _____
   b. High School or GED _____
   c. Some college _____
   d. 4-year degree _____
   e. Masters degree _____
   f. Doctorate (including MD, JD) _____

7. Have you answered this survey more than once? No Yes (If Yes/How many times before today? ____)

B. Form 2: Downtown Ann Arbor survey



Zip code: _____

Gender: ___M ___F ___Prefer not to answer

Have you been to the Huron River for recreation in the past 12 months?

_____ Yes _____No

If yes, what location(s?)

____Ann Arbor

____Ypsilanti

____Dexter

____Milford

____Flat Rock

GRAND VALLEY STATE UNIVERSITY

C. Form 3: Local business survey

Question #1: How many employees are currently employed at your establishment?

Question #2: What year did you begin operating at your current location?

Question #3: Did the proximity to the Huron River influence your decision to operate out of your current location?

Question #4: Is your business seasonal or year-round?

Question #5: If you answered "Other" in Question 5, please provide the industry of your establishment.

Question #6: Approximately what percentage of your patrons are recreational users of the Huron River?

Question #7: On a scale from 1-10 (1 being low/10 being high), how confident are you in the percentage given in Question 6?

VIII. APPENDIX B: VISITOR DEMOGRAPHICS

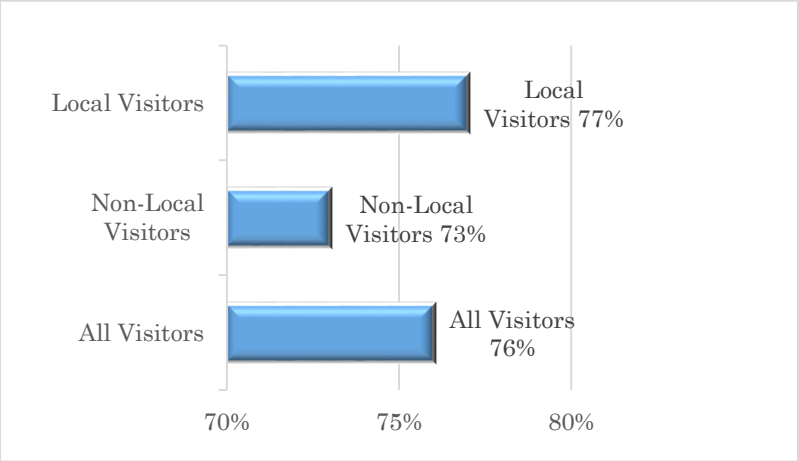


Figure B 1: Visitors for whom the river was the primary reason for visiting

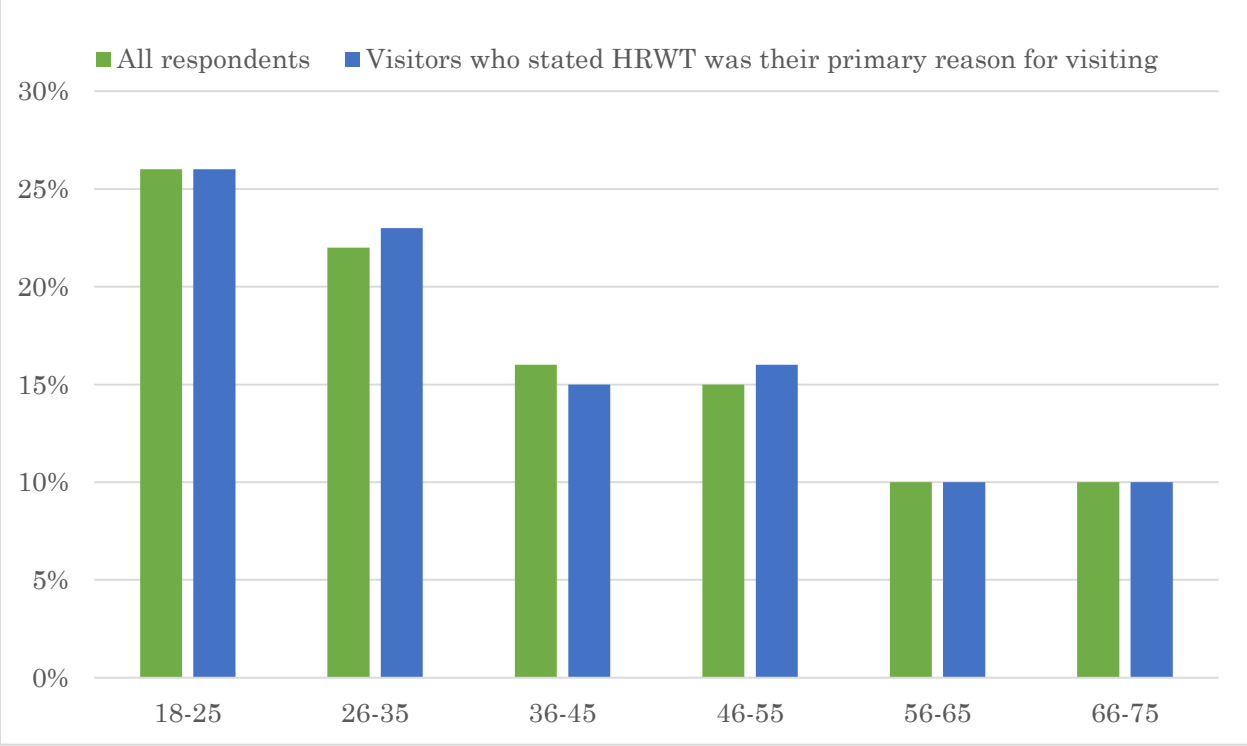


Figure B 2: Age of respondents

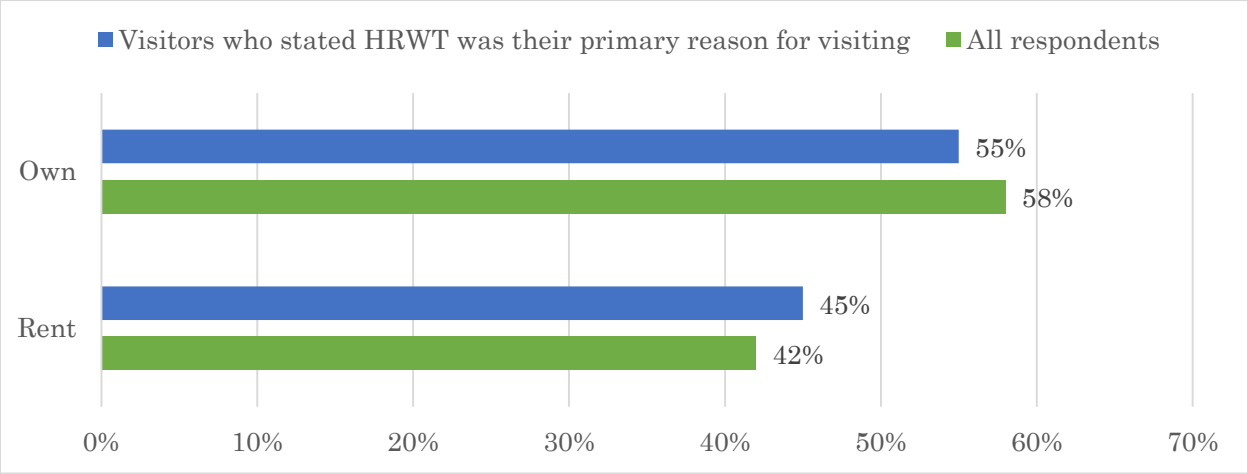


Figure B 3: Home ownership among respondents

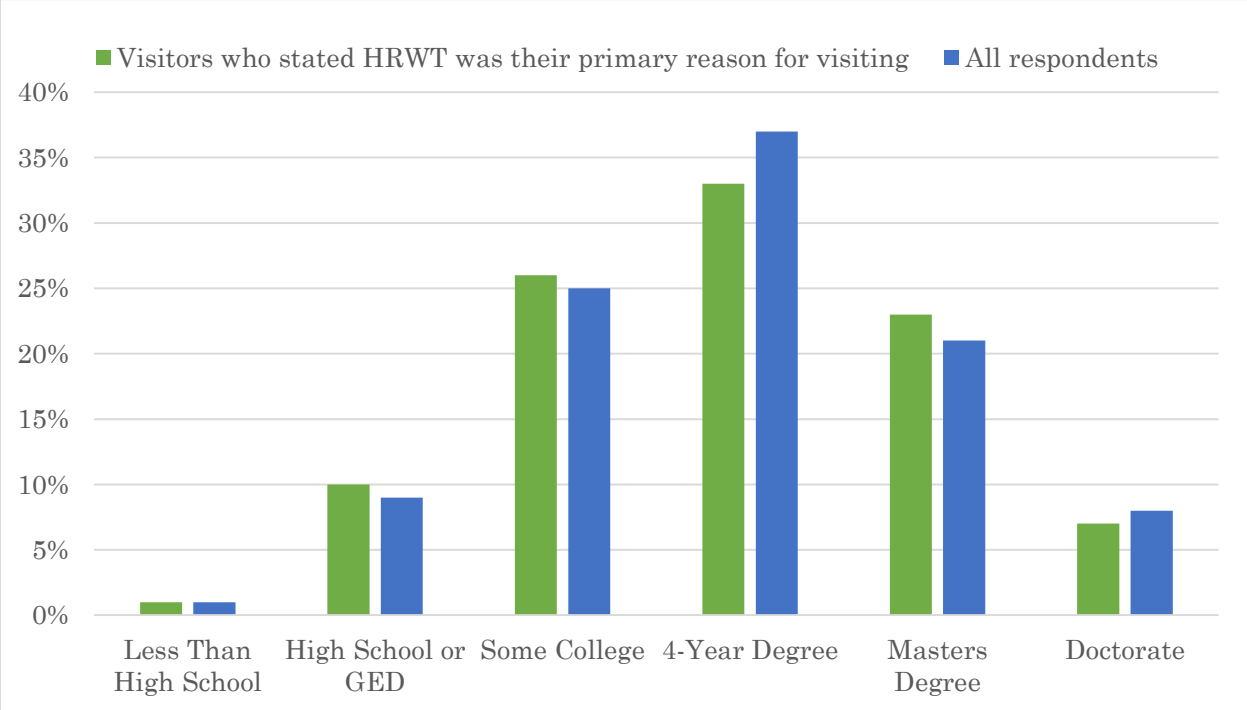


Figure B 4: Education level, respondents

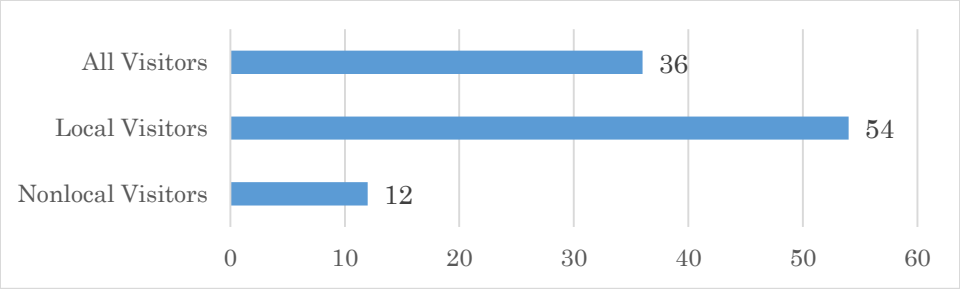


Figure B 5: Recreational visits to Huron River in previous 12 months

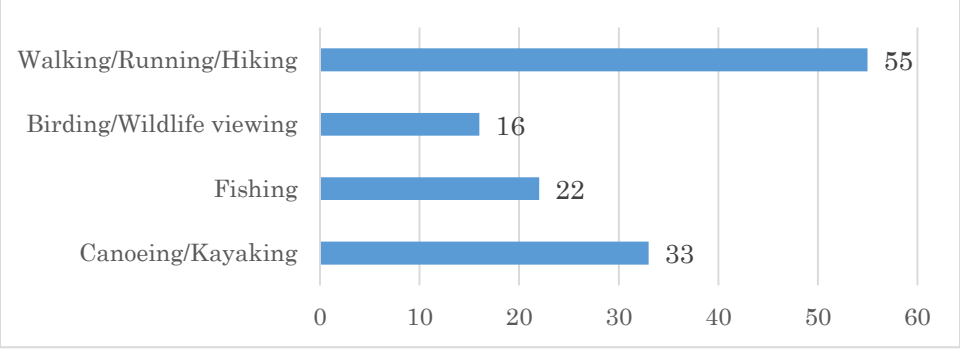


Figure B 6: Frequency of visits in past 12 months, by preferred activity

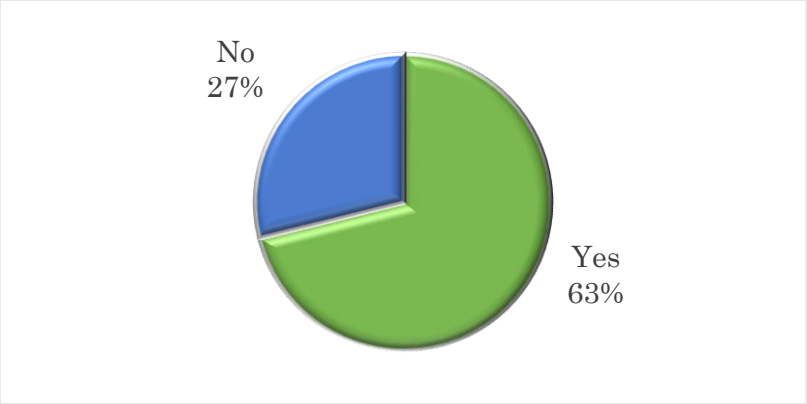


Figure B 7: Visitor use of smartphones while accessing the Huron River

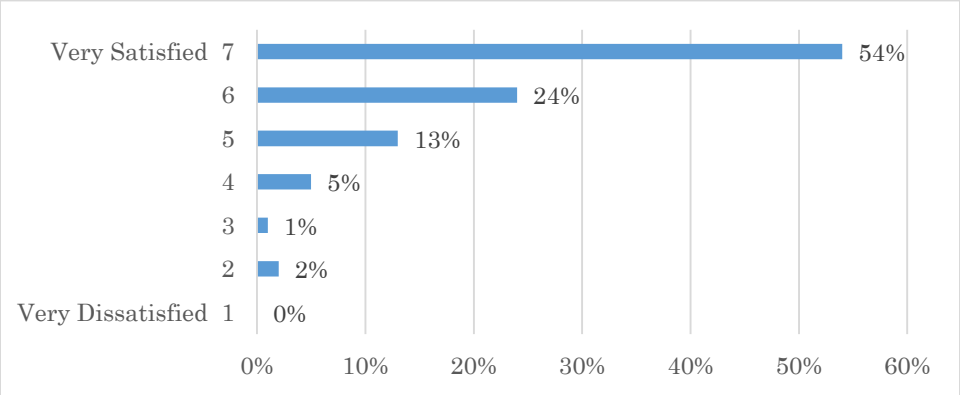
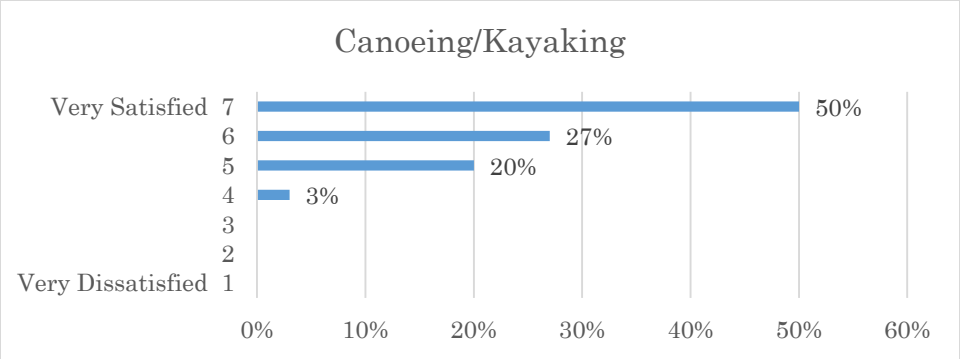
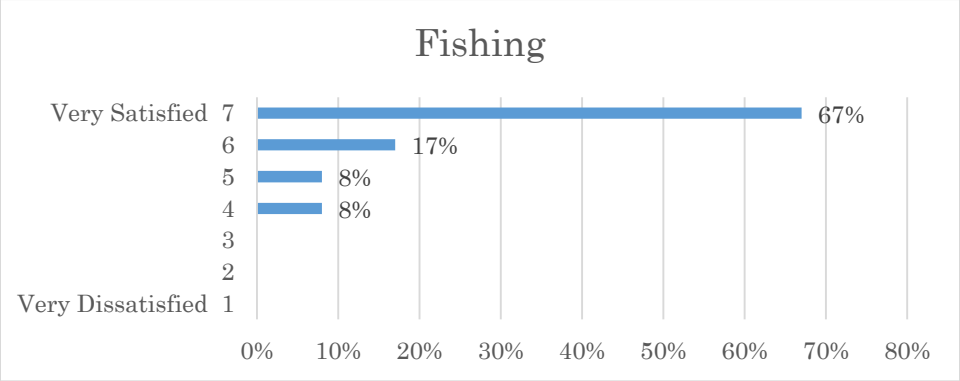
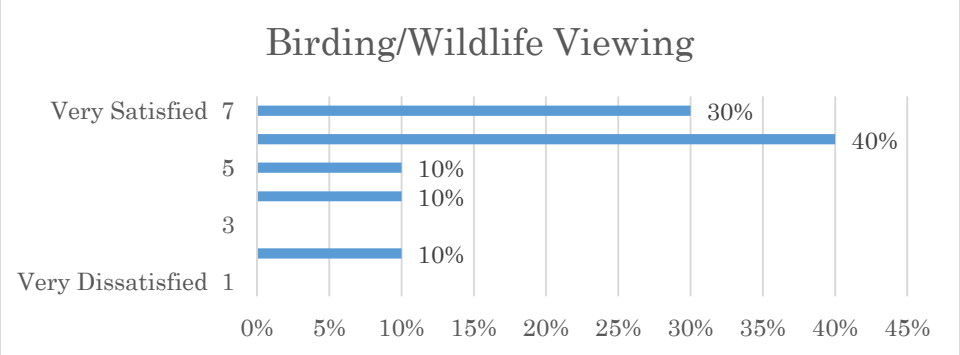


Figure B 8: Visitor satisfaction







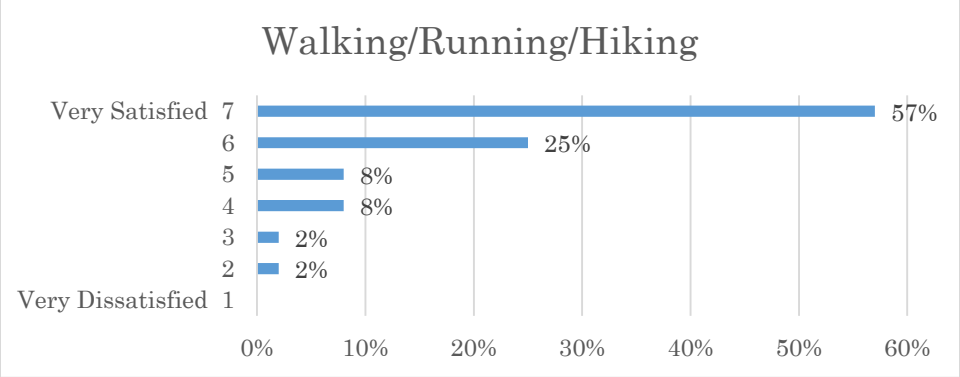


Figure B 9: Visitor satisfaction based on primary activity

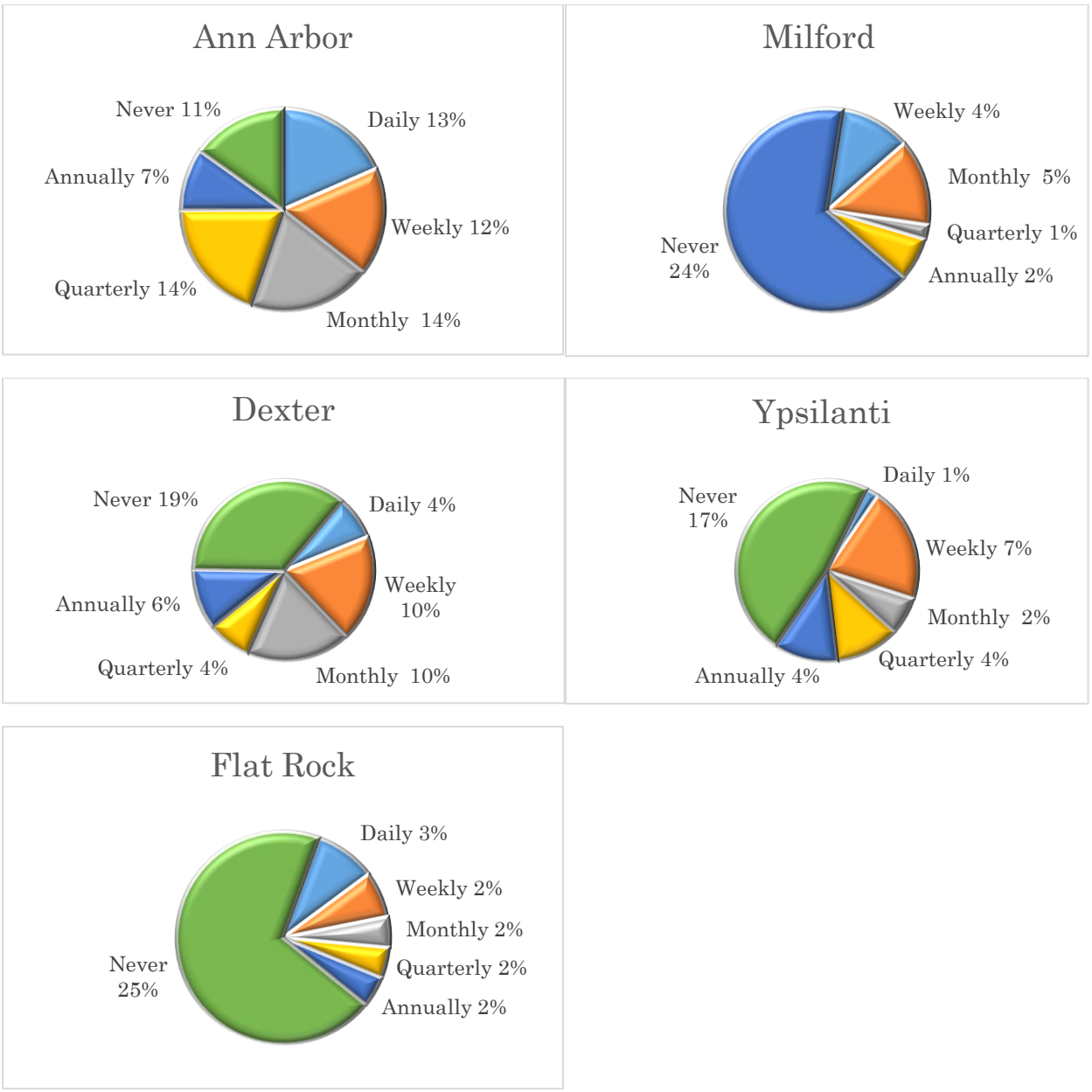


Figure B 10: Frequency of river access, by Trail Town

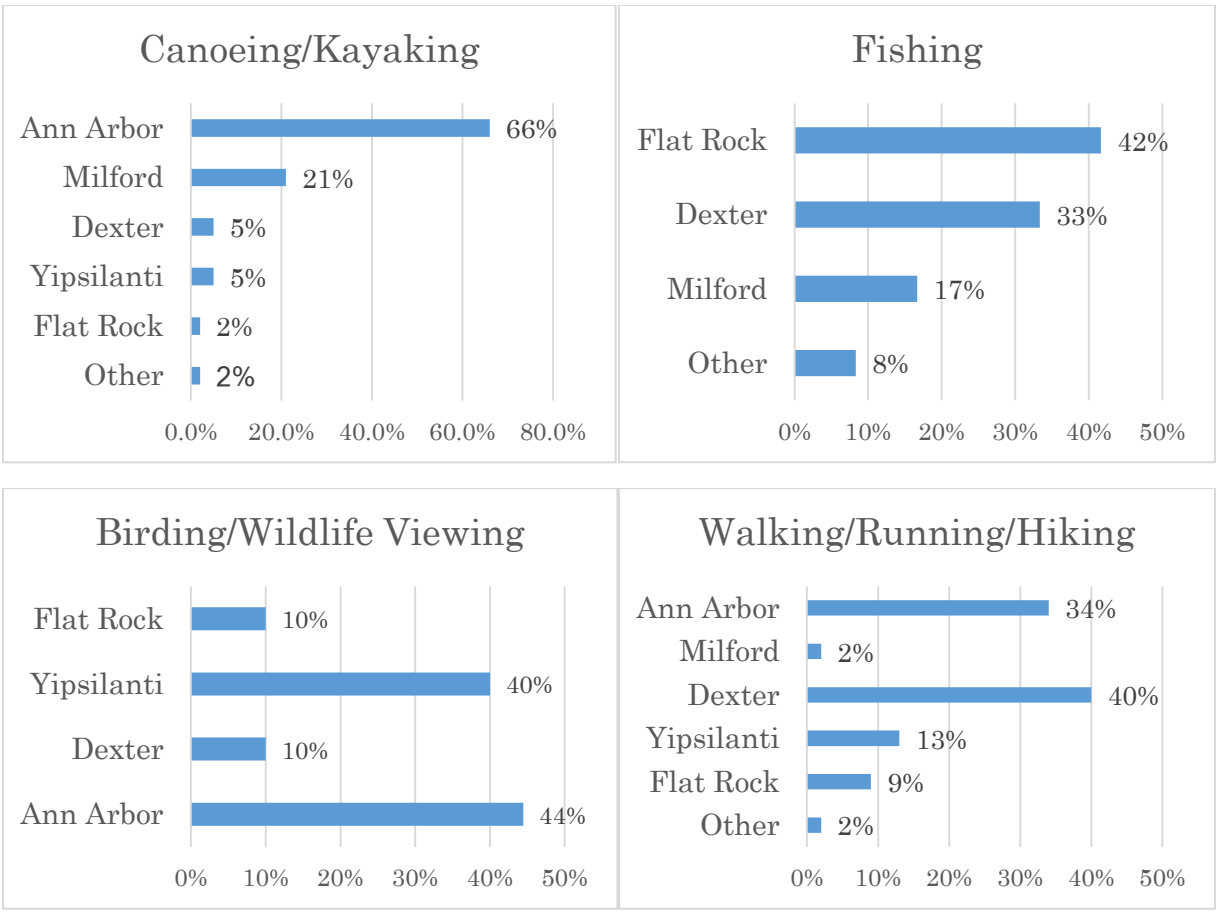


Figure B 11: Preferred location based on activity

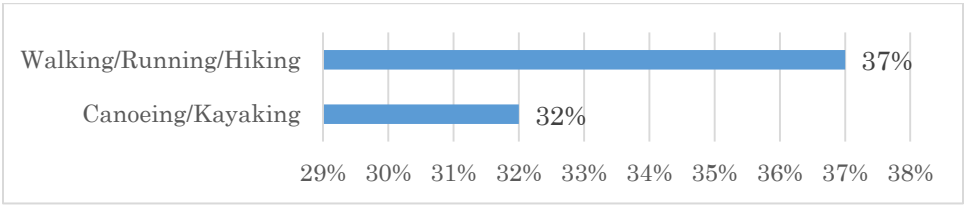


Figure B 12: Top two primary activities, local visitors

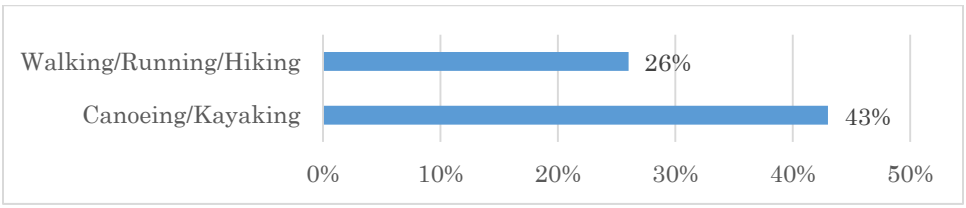


Figure B 13: Top two primary activities, non-local visitors

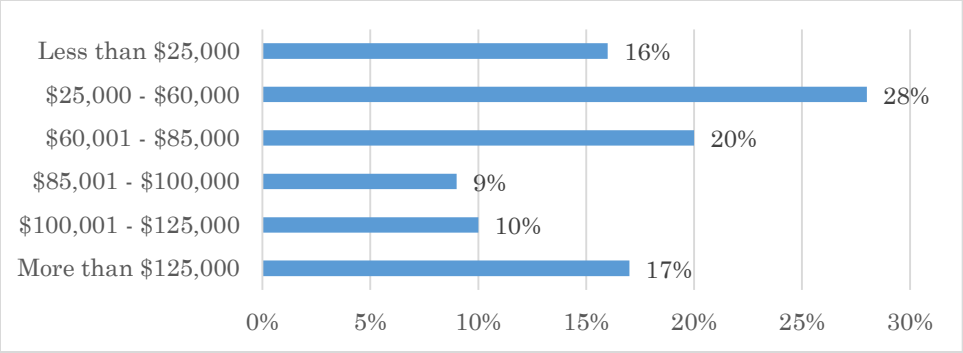
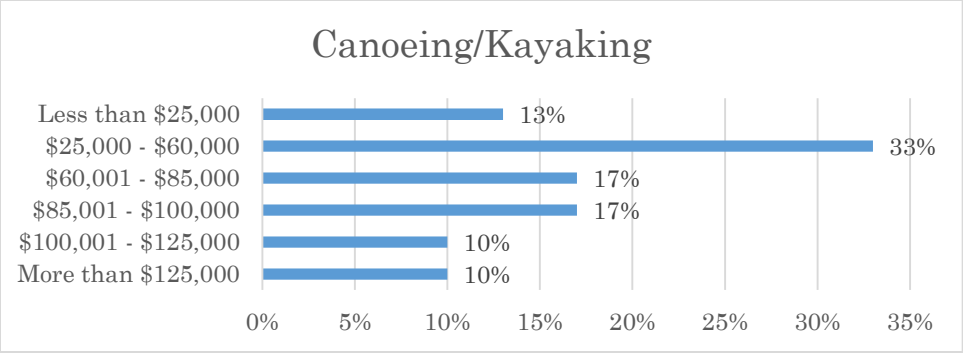
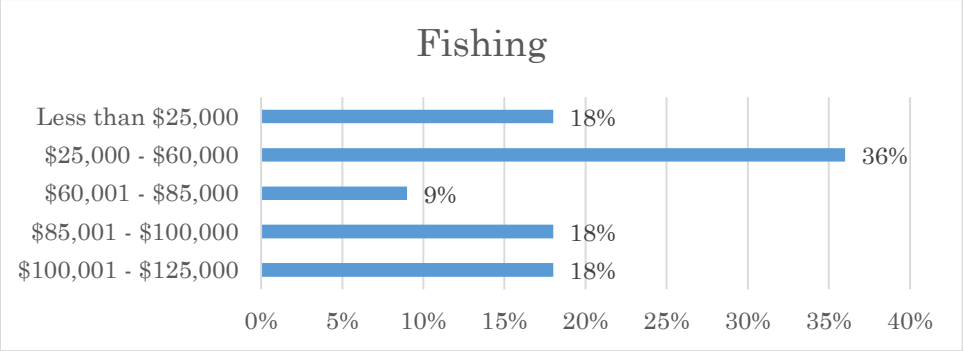
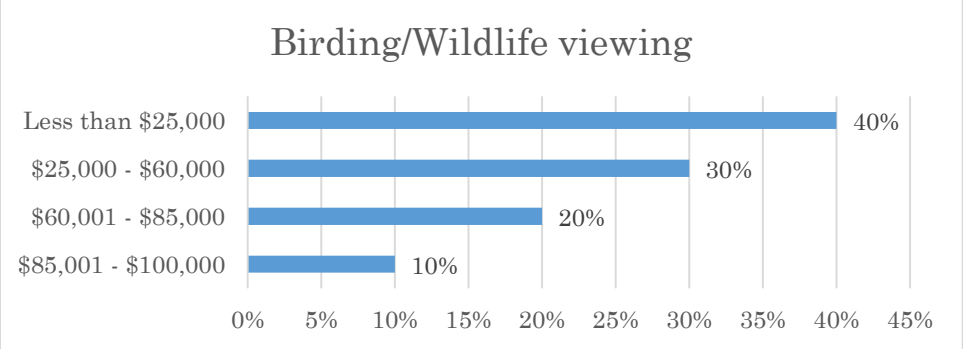


Figure B 14: Household income, all visitors







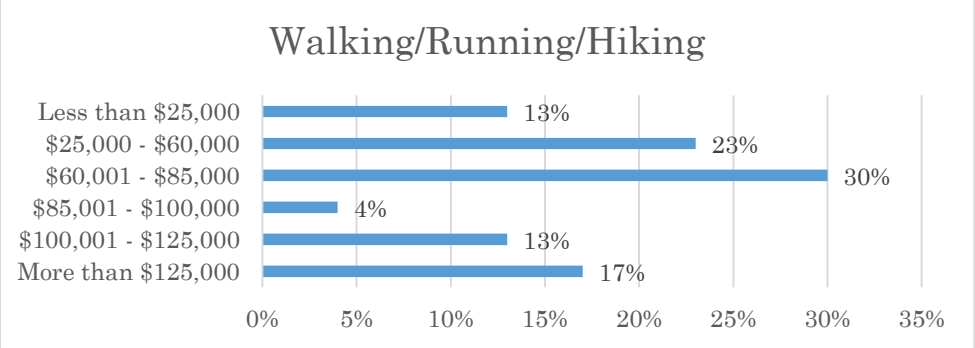


Figure B 15: Household income sorted by primary activity

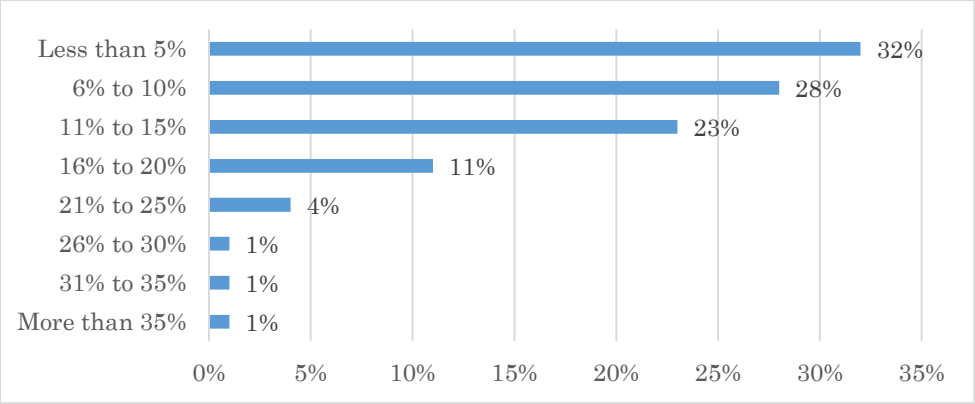
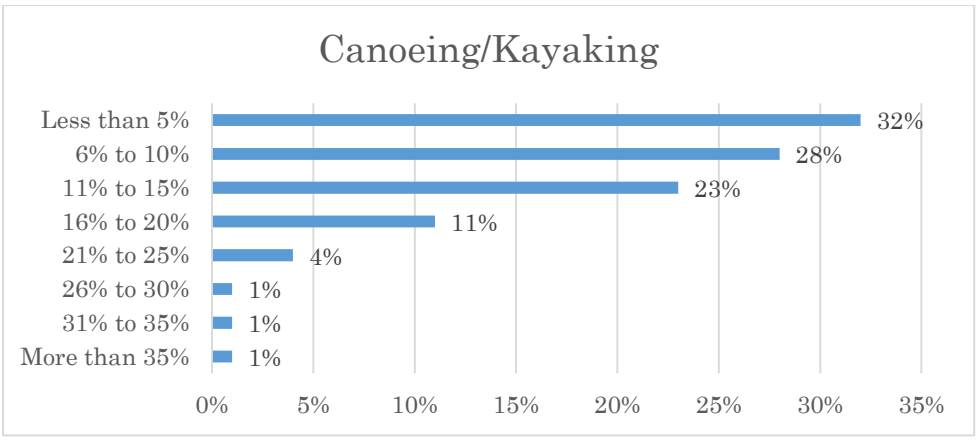
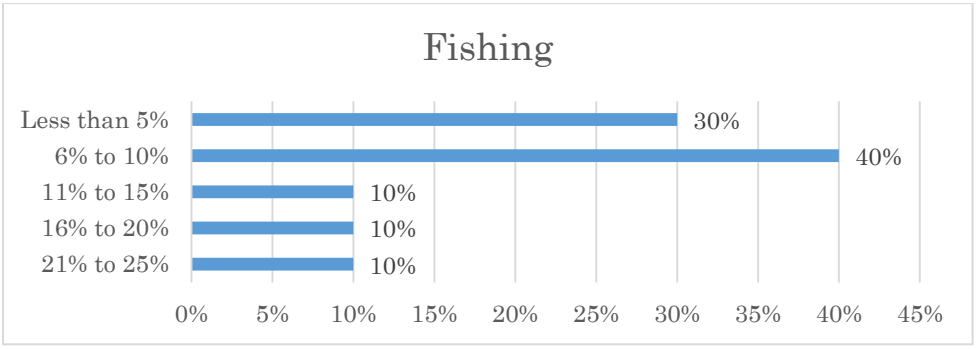
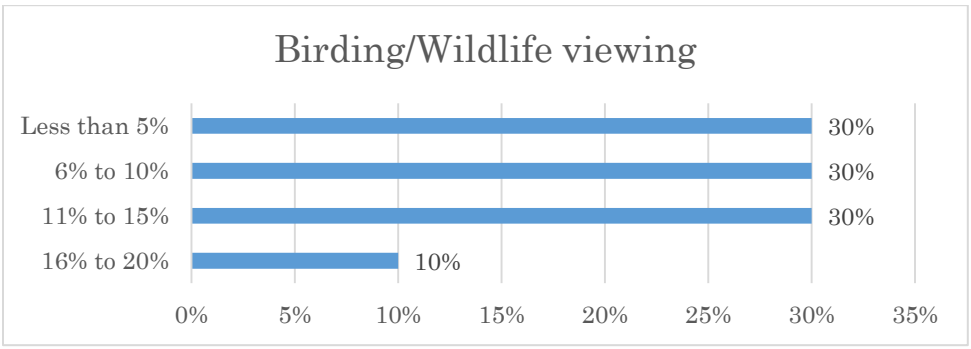


Figure B 16: Recreational spending as percentage of household budget







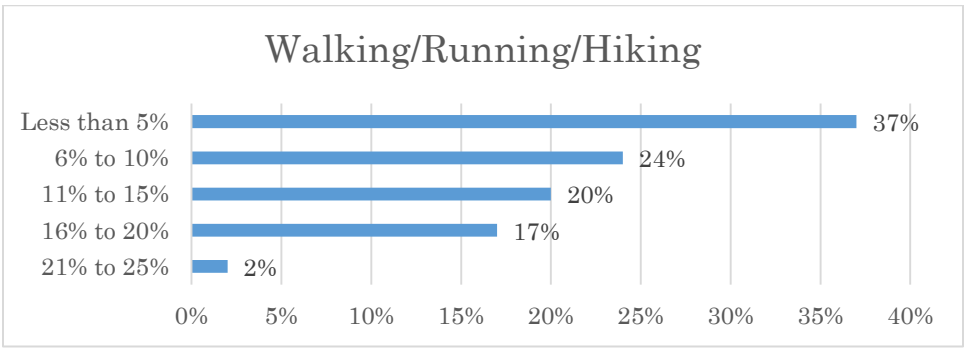
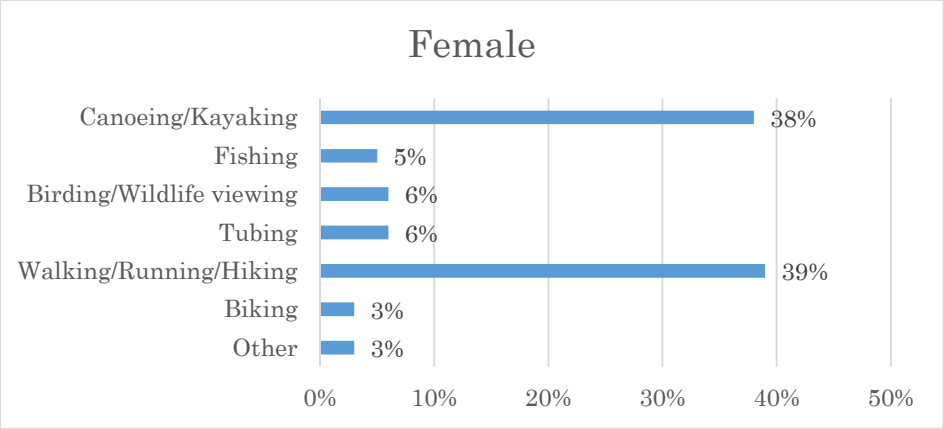


Figure B 17: Recreational spending as percentage of household budget, sorted by primary activity



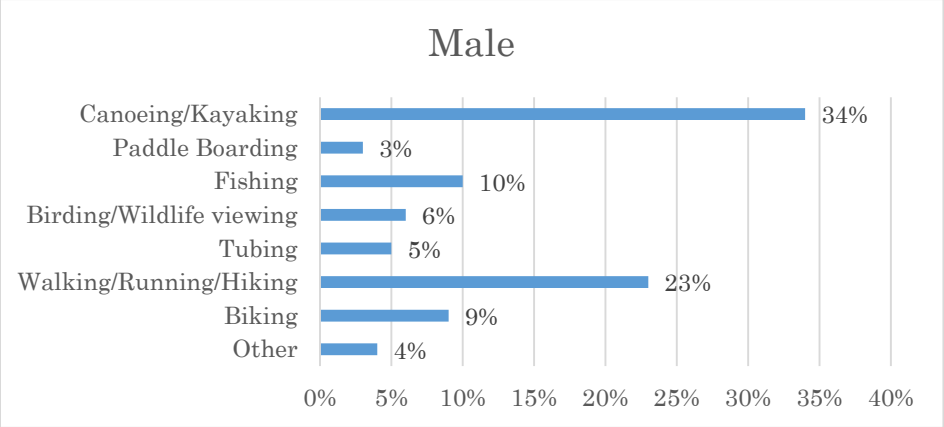


Figure B 18: Primary activity by gender

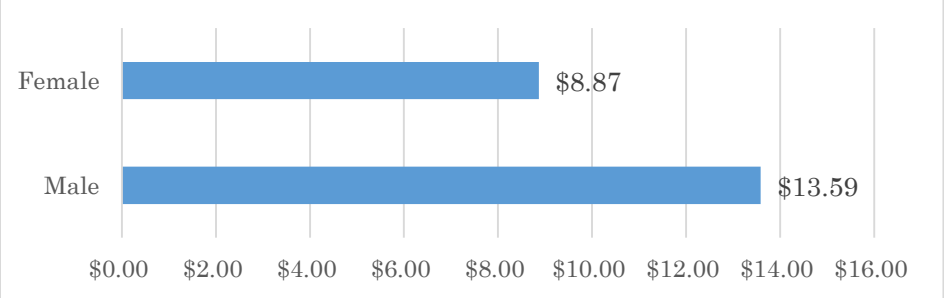


Figure B 19: Average spending, per person, by gender