Experiences and Perceptions of Great Lakes Water Level Change

A survey of shoreline property owners

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Abstract:
This report presents findings of an online survey of 1,815 Great Lakes property owners, managers, and other interested stakeholders. The survey was administered between September and November 2014 following a period of extremely low Great Lakes water levels in 2013 and the rapid rebound to average-above average water levels in 2014. The purpose of the survey was to inform the University of Michigan Graham Sustainability Institute's Integrated Assessment of Water Levels in the Great Lakes. The results of the survey indicate that property owners and managers surveyed are highly concerned about water levels in the Great Lakes. Some key impacts that respondents have experienced include a decrease in recreational opportunities due to low water levels, an increase in operating expenses due to low water levels, a decrease in water quality due to low water levels, and property damage due to erosion. The most popular forms of information for obtaining knowledge about water levels among respondents are personal contact with friends, family members, and neighbors, websites of organizations dealing with water levels, news media, and email updates/alerts. The greatest number of respondents reported wanting to know more about the causes of water level change, what water levels will be like in the future, and adaptation strategies for dealing with low water levels. The most common barriers to obtaining knowledge among respondents are difficulty finding or accessing information and not looking for information.

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Contents

Executive Summary

This report presents findings of a survey of Great Lakes property owners and managers. The purpose of the survey was to inform the University of Michigan Graham Sustainability Institute's Integrated Assessment of Water Levels in the Great Lakes.

The results of the survey indicate the following:

- **Level of concern:** generally, property owners and managers surveyed are highly concerned about water levels in the Great Lakes
- **Impacts experienced:** the impacts that the greatest number of respondents report experiencing are a decrease in recreational opportunities due to low water levels, an increase in operating expenses due to low water levels, a decrease in water quality due to low water levels, and property damage due to erosion
- **Cost of water level-related problems:** among those respondents who reported non-zero values for expenditures on protecting property from water level damage, expenditures on repairing water level-related property damage, or loss of business revenue, the most common level of expenditure/loss was $1,000-$10,000
- **Forms of information used:** the most popular forms of information for obtaining knowledge about water levels among respondents are personal contact with friends, family members, and neighbors, websites of organizations dealing with water levels, news media, and email updates/alerts
- **Trust of institutions:** academic institutions, property owners' associations, and environmental organizations are the institutions most trusted by respondents, and the industry associations are the least trusted.
- **Knowledge gaps and barriers to obtaining knowledge:** the greatest number of respondents reported wanting to know more about the causes of water level change, what water levels will be like in the future, and adaptation strategies for dealing with low water levels. The most common barriers to obtaining knowledge are difficulty finding or accessing information and not looking for information.

However, it is critical to account for key problems present in the sample which may limits its generalizability to the general Great Lakes shoreline property owner/manager population, including:

- Differences between respondents recruited through postal mail and respondents recruited through email
- Lack of representative distribution across lakes of interest
- Respondents from certain organizations dominate the sample
- Response bias and potential misunderstanding of survey questions

Regardless, hopefully this survey will be a useful tool to guide the IA analysis teams moving forward.

I. Introduction

In 2013, Great Lakes water levels hit record lows, sparking economic problems, media attention, and public and decision maker concern. In 2014, water levels rebounded to average-above average levels in large part due to unusually high levels of precipitation.[1] In response, the Graham Sustainability Institute (Graham) began exploring the feasibility of conducting an Integrated Assessment on Great Lakes water levels (IA). In preparation for the IA Graham wanted to explore stakeholder concerns and perceptions regarding water levels. One of the key goals of the IA is to promote the notion of living with the inherent variability of the Great Lakes, which fluctuate over a six-foot range on seasonal, yearly, and decadal timescales.[2] Understanding current concerns and perceptions is key to determining how to address variability and uncertainty.

The initial stated purpose of the IA was to provide a menu of environmentally, socially, economically, and politically feasible options to help shoreline property owners adapt to water level changes.[3] Being that Graham's IA process is stakeholder-driven, Graham staff wanted to collect baseline data on property owners' perceptions and experiences of the causes and consequences of water level change before beginning the IA. Also, as part of the purpose of any Graham IA is to educate stakeholders, Graham staff also wanted to know what forms of information might best reach stakeholders who are concerned about the issue of Great Lakes water level change.

With this in mind, I developed an online survey that was sent to shoreline property owners and managers, as well as additional interested people in the region. The central goal of the survey was to help guide the direction and scope of the IA and ensure that the IA is responsive to the needs of shoreline property owners and managers. A secondary goal was to collect baseline data about how people perceive the issue of water level change, giving Graham the option of sending a follow-up survey at the end of the IA to see how these perceptions changed over the course of the assessment.

The first section of this report covers the methodology I used to develop the survey, including designing the survey instrument, selecting the population of interest, and recruitment. I then report the results of the survey, covering respondents' level of concern about water levels, the impacts they have experienced, their perceptions of factors contributing to water level change, the reported cost of water level impacts, forms of information respondents use, their trust of institutions, the gaps in their knowledge and barriers to filling those gaps, and respondent demographics. I then discuss preliminary statistical analysis on the survey data, particularly looking at differences

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[1] Great Lakes Environmental Research Laboratory. "Water Levels of the Great Lakes: September 2014," http://www.glerl.noaa.gov/pubs/brochures/lakelevels/lakelevels.pdf [10 Dec 2014].
[2] Great Lakes Information Network. "Water levels on the Great Lakes: 3 types of water level fluctuations." http://www.great-lakes.net/teach/envt/levels/lev_2.html [10 Dec 2014].
[3] This statement based on informal conversations with Graham staff. The stated purpose of the IA has changed slightly since the period of time referenced in this statement. More information on the IA can be found at: http://graham.umich.edu/knowledge/ia/water-levels

between recruitment samples and potential drivers of respondents' perceptions about the causes of water level change. I conclude with some suggestions for future analysis and research.

II. Methods

Survey Instrument

The first step in developing the survey instrument was to brainstorm with Graham staff to create an initial list of survey constructs and subsequent questions. I then consulted with experts in the field and reviewed existing related survey instruments to further refine the language and scope of the instrument. I sent a draft survey instrument to eight beta testers who had some knowledge of Great Lakes water level issues, and two individuals who had little to no knowledge of Great Lakes water level issues. I also conducted a cognitive interview with one of the latter beta testers to understand how uninformed respondents might interpret the survey questions. After incorporating feedback from beta testers and making modifications based on the results of the cognitive interview, I designed the final survey instrument via the Qualtrics web platform. See Appendix A for final survey instrument.

Population of Interest

As described previously, shoreline property owners and managers were the original target population for the IA, and therefore the target population for the survey. Within the category of shoreline property owners, Graham specifically wanted to look at the states of Michigan, Ohio, and Wisconsin and the province of Ontario (territories of interest), along the shores of lakes Michigan, Huron and Erie.[4] Graham wanted to look at those territories because they perceived shoreline ownership, management, and use to be similar across them. Illinois and Indiana were not included because those shorelines are either completely hardened and therefore not subject to the same impacts as the shorelines in the territories of interest, or conservation land owned by the Federal government, and therefore would not benefit from the same types of policy recommendations as the territories of interest. They chose to exclude lakes Superior and Ontario because the International Joint Commission (IJC) maintains water level control structures that govern the levels on those lakes, and therefore strategies for adapting to fluctuating water levels are not as salient there. While others were not excluded from taking the survey, survey recruitment efforts were designed to get respondents from this population.

[4] The Huron-Erie Corridor, the connecting channel between lakes Huron and Erie which includes the St. Clair Rivers, Lake St. Clair, and the Detroit River was included as well.

Figure 1: Geographic area of interest[5]

Recruitment

The survey utilized two modes of recruitment: postal mail and email. To construct a sample for the postal mail recruitment, I conferred with water levels experts to determine an impact designation for each of the 67 shoreline counties in the territories of interest. Counties primarily impacted by high water levels received a designation of "high," counties primarily impacted by low water levels received a designation of "low" and counties impacted by both high and low water levels received a designation of "both." I then constructed a random sample of 10 counties, stratified by impact designation (Table 1).

Table 1: Counties included in postal mail recruitment

County	State/Province	Country	Lake	Impact
Marinette	Wisconsin	U.S.	Michigan	both
Brown	Wisconsin	U.S.	Michigan	both
Oceana	Michigan	U.S.	Michigan	high
Benzie	Michigan	U.S.	Michigan	high
Ashtabula	Ohio	U.S.	Erie	high
Bruce	Ontario	Canada	Georgian Bay, Huron	high
Iosco	Michigan	U.S.	Huron	low
Bay	Michigan	U.S.	Huron	low
Sudbury	Ontario	Canada	Georgian Bay	low
Essex	Ontario	Canada	Huron-Erie Corridor, Erie	low

[5] Basemap Source: Great Lakes Information Network. "Introduction to the Great Lakes." http://www.great-lakes.net/teach/geog/intro/intro_2.html. [9 Dec 2014].

Figure 2: Location of counties included in postal mail recruitment[6]

A letter was sent to all 2,911 shoreline property owners in the U.S. counties listed in Table 1 (see Appendix C: Postal Mail Recruitment Letter). Unfortunately, property ownership information for the Canadian counties was unable to be obtained, and therefore the postal mail recruitment was restricted to the U.S. For more information on postal mail recruitment methods, see Appendix B: Postal Mail Recruitment Sampling and Address Collection Protocol

For the email recruitment, I identified several organizations whose member bases matched the population of interest. Graham has preexisting relationships with most of these organizations. I emailed organization directors or other preexisting contacts to request that they send the survey link to their members via email. Twelve of the organizations I identified sent the survey link to their members via email, and a few posted the link on social media sites. Some organizations used sample text provided by the researchers for the email; others used their own emails (see Appendix D: Email Recruitment Sample Text). Some of the members of these groups were affiliated with organizations that I had not originally contacted, and the sample snowballed as those individuals forwarded the survey link to additional membership lists. Table 2 lists the organizations that sent out the survey link.

[6] Basemap Source: Great Lakes Information Network. "Introduction to the Great Lakes." http://www.great-lakes.net/teach/geog/intro/intro_2.html. [9 Dec 2014].

Table 2: Organizations that sent survey link to members, and number of members reached

Organization	Members reached (approx.)
Great Lakes Coalition	317
Council of Great Lakes Industries	50-60
Tip of the Mitt Watershed Council	226 via email/unknown via social media
Emmet County Lakeshore Association	unknown
Wisconsin Harbor Towns Association	~30
West Michigan Sustainable Business Forum	unknown
Georgian Bay Forever	909
Stop the Drop	18000
Restore our Waters International	unknown
Sierra Club Ontario	unknown
Freshwater Future	1000
Georgian Bay Association	3200-18000[7]

Results Reporting and Statistical Analysis

To conduct results reporting, I downloaded the survey response data from Qualtrics in .csv format and imported it into a Microsoft Excel workbook. The postal mail and email responses were collected in two different surveys in Qualtrics, so I downloaded both datasets and combined them in Excel. I used Excel to recode variables, calculate descriptive statistics, and create charts and tables to illustrate results (see Results section). I then imported select variables into Stata to conduct a more targeted statistical analysis (see Analysis section).

[7] "20 member organizations sent the link out through us; collectively 3,200 properties who pay dues to the GBA (through their local association) but given family sizes and multiple users of individual cottages our collective reach is closer to 18,000 individuals." (email communication with GBA contact)

III. Results

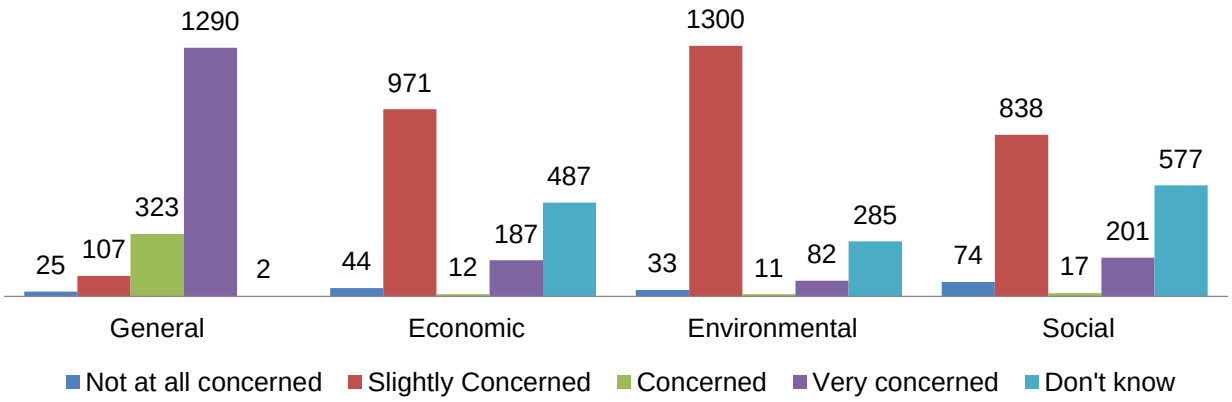
In total, 1,815 people responded to the survey. Of these, 1,527 respondents were recruited through email and 288 respondents were recruited through postal mail. The response rate for the postal mail recruitment was 9.89%. However, there were 293 returned postal mail letters, corresponding to an 11% response rate for received letters. The response rate for the email recruitment is currently unknown, as I am still waiting to hear back from a few organizations with the total number of people to whom they sent the survey link. Since the sample for the email recruitment became a snowball sample, it may not be possible to obtain an accurate response rate.

The following sections contain descriptive statistics for each survey question.

Level of Concern

As described previously, a key objective of the survey was to help identify stakeholder concerns and perspectives regarding water levels to inform the IA. Figure 3 shows the levels of concern respondents reported for water level changes generally, economic problems caused by water level changes, environmental problems caused by water level changes, and social problems caused by water level changes. For each of those categories, respondents were ask to indicate whether they were "not at all concerned", "slightly concerned", "concerned", "very concerned", or if they weren't sure via the "don't know" option.

Figure 3: Level of concern by type of problem



These numbers indicate a high level of general concern about water levels, but a lower level of concern for particular categories of problems associated with water levels. Perhaps this is due to the fact that respondents are concerned about different categories of problems than those represented in the question, or perhaps respondents do not conceptualize their concern based on particular categories of problems. In any event, these results demonstrate that that the public is concerned, at least generally, about water levels.

Impacts Experienced

I asked respondents what impacts they had experienced for two main reasons. One was to help guide the IA analysis teams toward impactful projects that will garner public support, under the

assumption that if a respondent has experienced an impact that it will be something they want support addressing in the present or future. Second, I wanted to see whether the types and number of impacts that a respondent has experienced correspond with other factors, such as a respondent's expenditures dealing with water levels. For this question, respondents were asked to check a box to indicate whether or not they had experienced each of the negative impacts listed in Table 3. Respondents were given the text listed under "'impact type"; "impact category" was added during the data analysis phase.

Table 3: Response options for negative water level impacts experienced with high/low designations added

Impact type	Impact category
Property damage due to flooding	High
Property damage due to erosion	High
Decrease in recreational opportunities due to low water levels	Low
Decrease in recreational opportunities due to high water levels	High
Decrease in water quality due to low water levels	Low
Decrease in business revenue due to low water levels	Low
Decrease in business revenue due to high water levels	High
Increase in operating expenses due to low water levels	Low
Increase in operating expenses due to high water levels	High

1307 respondents reported experiencing negative impacts related to high water levels, 662 respondents reported experiencing negative impacts due to high water levels, and 442 respondents reported experiencing negative impacts due to both high and low water levels. The figures below illustrate the number of respondents who reported experiencing each type of negative impact.

Figure 4: Number of respondents who reported experiencing negative high water level impacts, by impact type

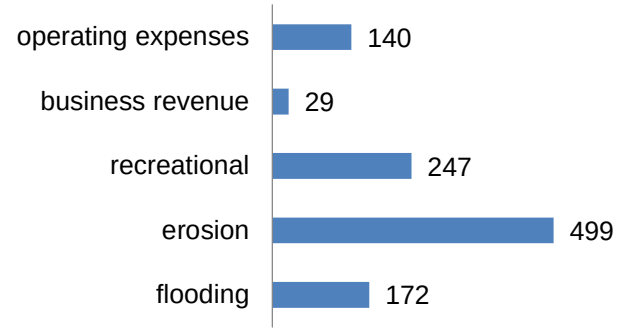
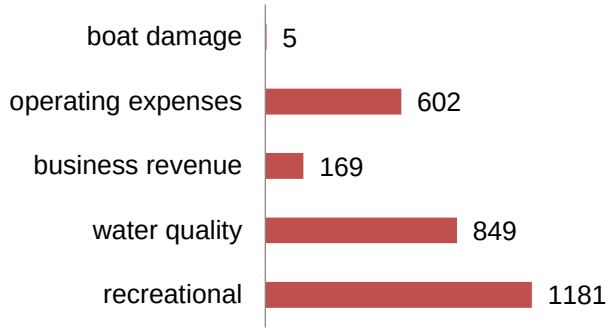


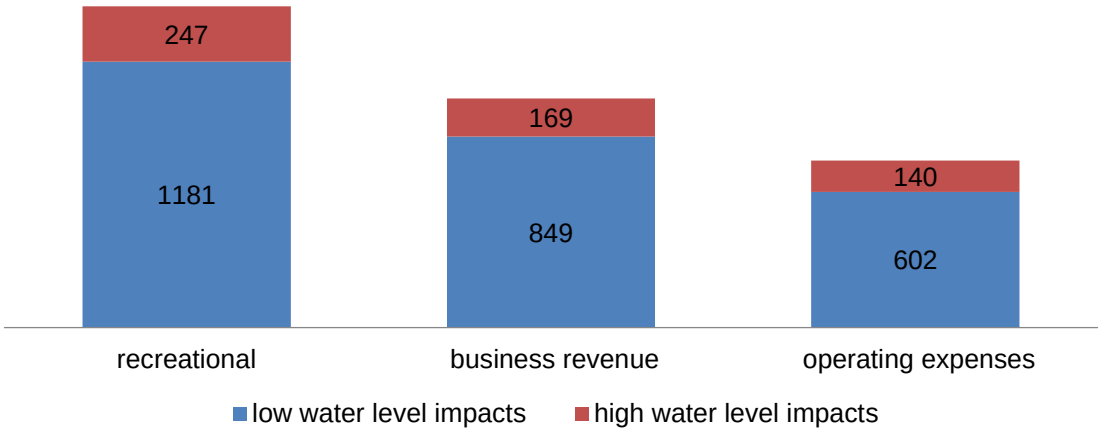
Figure 5: Number of respondents who reported experiencing negative low water level impacts, by impact type



The data shows that the impacts which have affected the greatest number of respondents include decreases in recreational opportunities due to low water levels, increases in operating expenses due to low water levels, decrease in water quality due to low water levels, and property damage due to erosion. Therefore, Graham might encourage IA analysis teams to focus on these impacts.

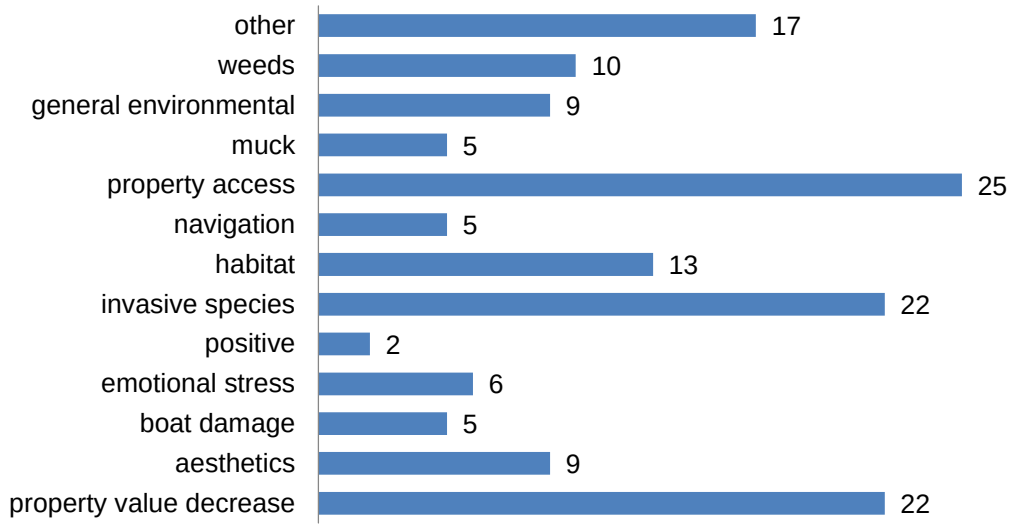
Because respondents were explicitly asked whether they had experienced a decrease in recreational opportunities, decrease in business revenue, or increase in operating expenses due to each of high and low water levels, comparing across these three categories may give a clearer picture of whether more respondents have experienced high or low level impacts. As Figure 6 shows, more respondents have experienced loss in recreational opportunities and business revenue and increase in operating expenses due to low levels than due to high. It is important to mention that the fact that low level-related impacts are likely freshest in respondents' memories may be biasing this data.

Figure 6: Number of respondents who reported experiencing negative impacts to recreational opportunities, business revenue, and operating expenses, by high and low water levels



As mentioned above, respondents were also given the option of typing a qualitative response to explain other impacts they have experienced. 190 respondents provided qualitative responses. I coded those responses using the categories in Figure 7, creating categories for most responses that were described by more than one respondent, and maintaining an "other" category for those that only one respondent wrote about.

Figure 7: Impact categories based on qualitative responses

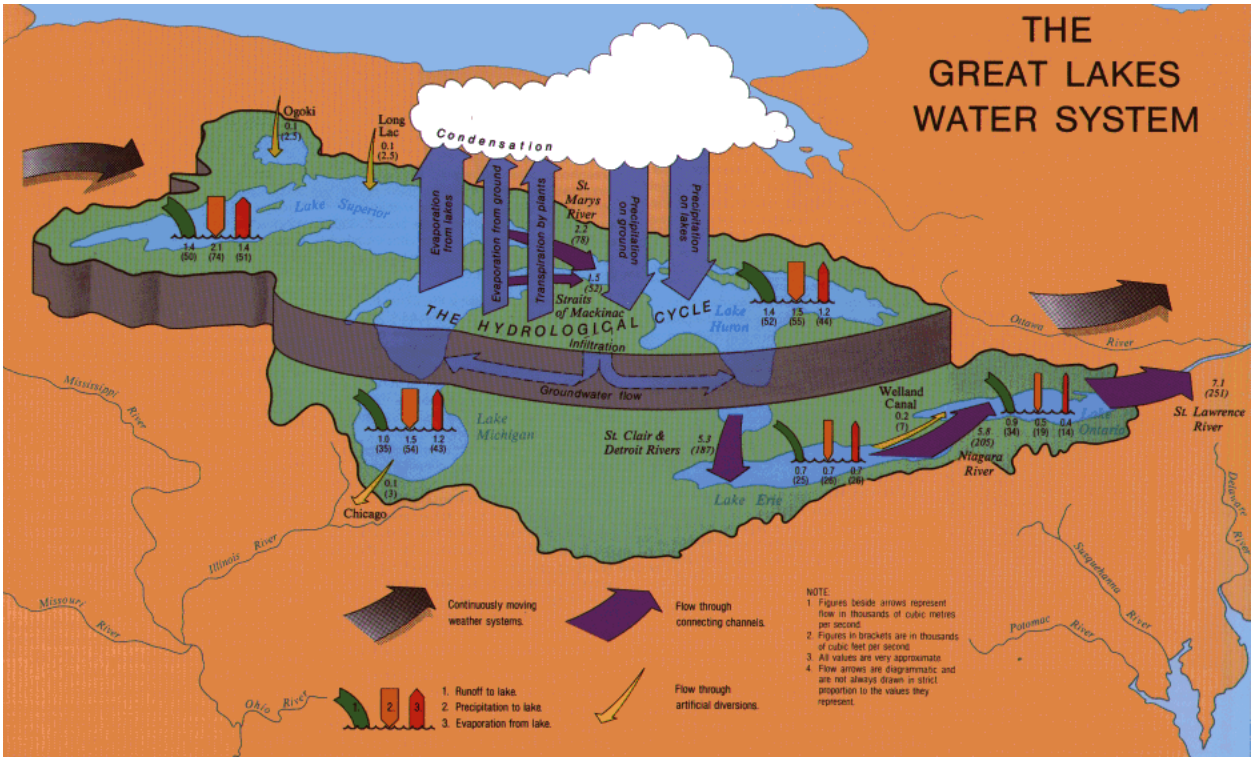


The qualitative responses shed light on some of the biases of the survey. First, a few respondents picked up on the fact that all of the predetermined impact types were negative in nature. Since the survey design, the Graham Institute has incorporated consideration of positive impacts of water level change into the IA plan. However, the survey did not reflect this, and therefore missed an opportunity to better understand some of the positive impacts of water level change. Second, although the predetermined impact categories included erosion and flooding, they were phrased as "property damage due to erosion" and "property damage due to flooding." During survey design, I conceptualized property damage as structural property damage. It became clear through the qualitative responses that many respondents have experienced erosion and flooding impacts that do not necessarily lead to structural property damage, though may still be considered damage to property or at the very least an impact due to erosion or flooding. Third, because the impact question was focused on impacts to property owners/managers, the predetermined impact types did not include environmental impacts. However, the qualitative responses revealed that many respondents are concerned about environmental impacts, in particular fish habitat. It seems as if, for many respondents, the concern about fish habitat stems from a decrease in recreational fishing opportunities, a problem that respondents could have described using the "decrease in recreational opportunities due to low water levels" option. However, the fact that they found it necessary to explain may indicate that they do not conceive of the impact in that way.

Perceptions of Factors Contributing to Water Level Change

The next section of the survey asked respondents to indicate how much each of suite of factors contributes to water level change using a Likert scale. Essentially, this question asks respondents to determine their own approximation of the magnitude of a suite of factors influencing net basin supply. Actual net basin supply can be seen in Figure 8. This figure illustrates that precipitation (both directly over the lakes and indirectly through runoff of overland precipitation), and evaporation have the largest effects on net basin supply.

Figure 8: Actual contributions to net basin supply8



Respondents' perceptions of the magnitude of impact that each of a variety of factors has on water levels are illustrated in Figure 10 and Figure 11. Respondents were asked to rate each factor based on how much they think it contributes to water level change. Many of these factors are actually elements of other factors; for example, ice cover has an effect on precipitation and climate change has an effect on all of the other hydrometeorological factors . Therefore, it is not possible to directly map these responses to the scientific understanding of net basin supply. However, Graham can use this data to identify some of the potential misconceptions about the causes of water level change. For this purpose, it is useful to divide the response options into hydrometeorological factors and anthropogenic factors.[9]

[8] Environmental Protection Agency. "The Great Lakes Atlas: Natural Processes in the Great Lakes." www.epa.gov/greatlakes/atlas/glat-ch2.html. [9 Dec 2014].

[9] The classification of climate change as a hydrometeorological factor rather than an anthropogenic one is not a reflection of my beliefs regarding anthropogenic climate change. Rather, it simply makes more sense conceptually to look at climate change alongside the factors with which it is most closely associated.

Figure 9: Perceptions of hydrometeorological factors' contributions to water level change

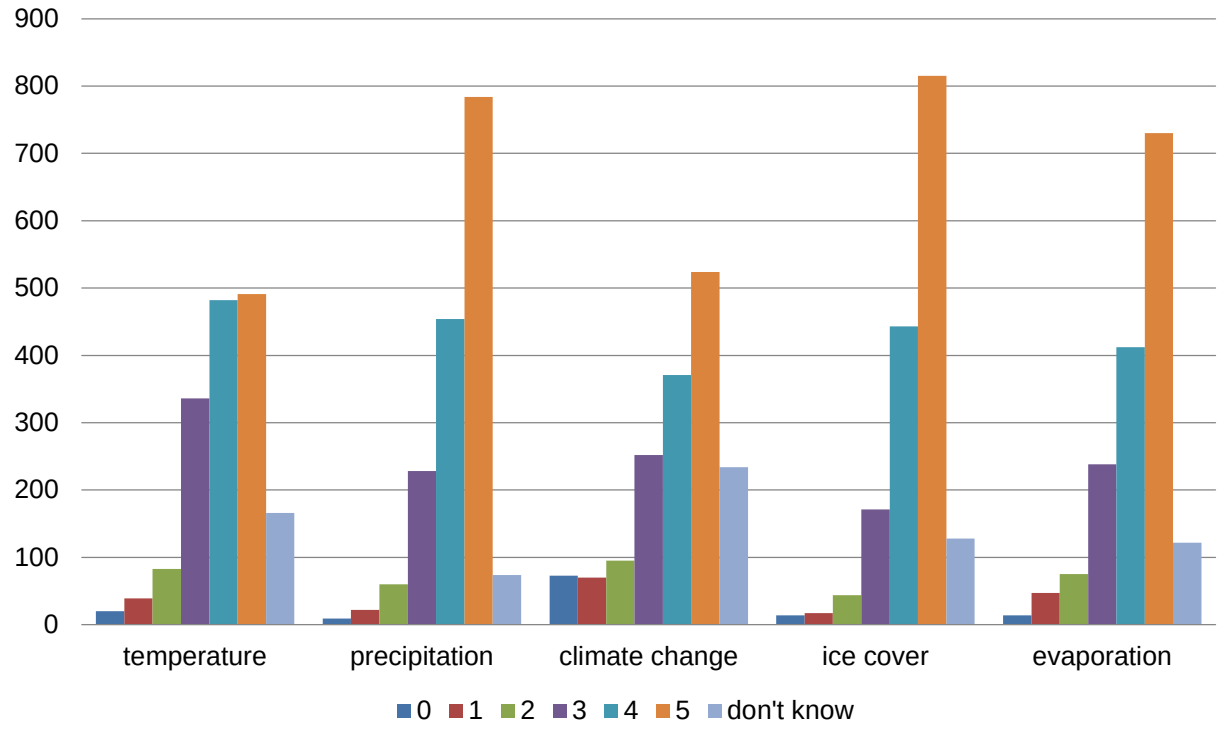
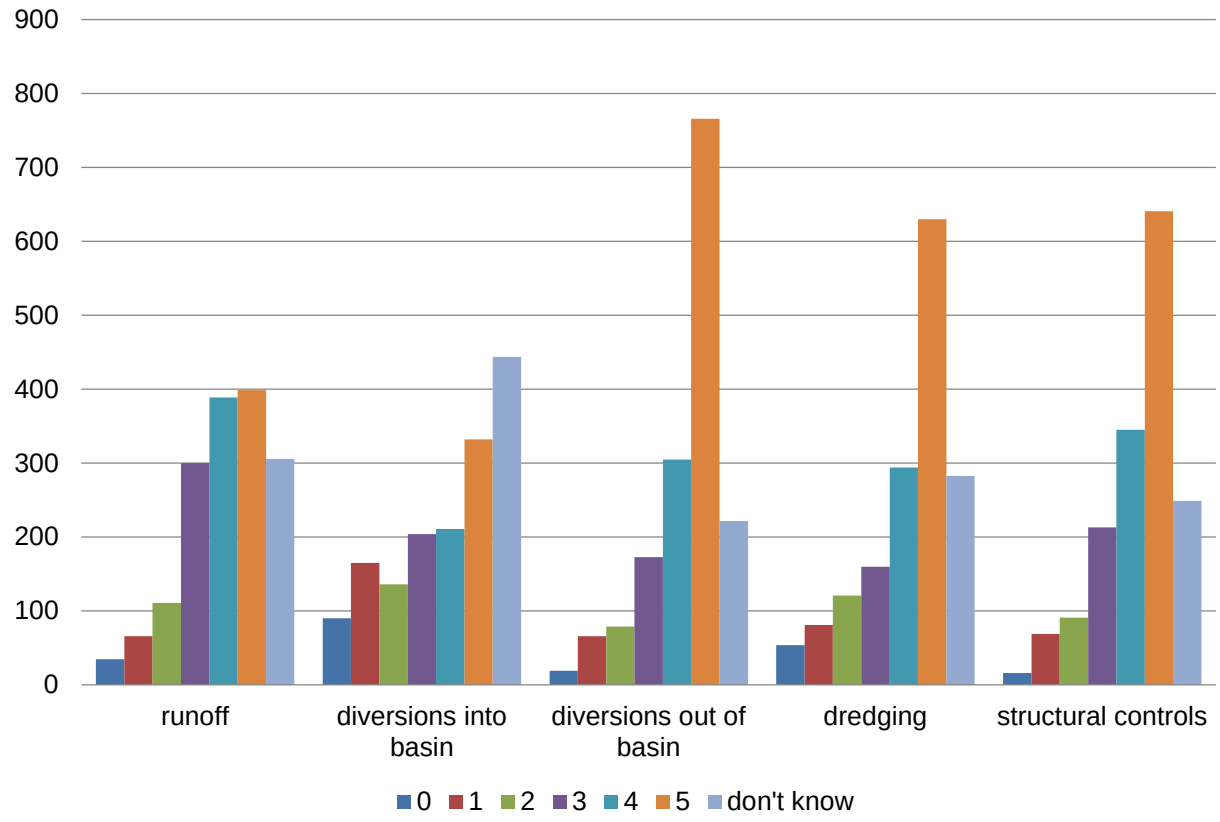


Figure 10: Perceptions of anthropogenic factors' contributions to water level change



Another impetus for this question was the fact that, during the recent period of extreme low levels, a vocal group of property owners attributed the problem, at least in part, to U.S. Army Corps of Engineers (the Corps) dredging on the St. Clair River. I included "dredging" on the list of response options with the intention of capturing that group of people, but I received many calls and emails from respondents and organizations who thought that I should have referenced the Corps or the St. Clair River explicitly. It is difficult to know how many respondents were thinking of that circumstance when they responded to the question. In qualitative responses, 43 respondents said that manipulation of the St. Clair River has an impact on water levels. 15 of those used the following verbatim text to describe it, "alterations to the St. Clair River as referenced by the IJC Advice to the US and Canadian governments in April 2013." All respondents who used that language received the survey link from Georgian Bay Forever, San Souci and Copperhead Association, or Georgian Bay Association, so it is possible that one of those organizations suggested, either in the recruitment email or in another communication, that members use that text.

The qualitative responses revealed some other information of note as well. Six respondents specifically mentioned diversions to the Mississippi as having an impact on water levels, four respondents reported that commercial water extraction has an impact on water levels, and eight respondents said that isostatic rebound has an impact on water levels.

Finally, it is important to consider one key way in which these responses might be biased. I designed the question thinking that respondents would indicate contribution of each factor relative to the others on the list. However, the large number of 5's indicates that respondents may not have interpreted the question that way. Therefore, it is difficult to know how to appropriately draw conclusions from the data from this question.

Property Ownership

While the survey targeted property owners and managers, it was designed so that others could respond to most questions regardless of whether they own or manage shoreline property. Figure 11 shows the breakdown of respondents based on whether or not they own or manage property on a Great Lakes shoreline. The majority are property owners or managers, but not all. This includes some Great Lakes shoreline property owners/managers outside of the geographic area of interest described in the Methods section, likely due to the fact that some of the organizations who facilitated email solicitation of the survey have members outside of that geographic area.

Figure 11: Percent of respondents who are Great Lakes shoreline property owners or managers

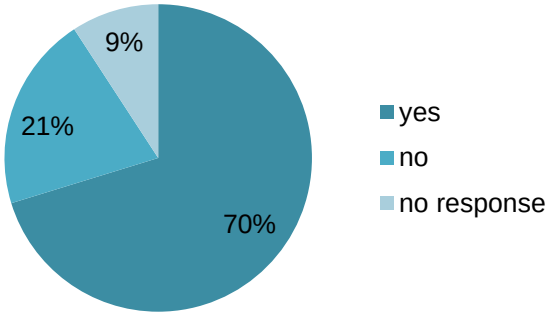


Figure 12: Breakdown of respondents who own or manage shoreline property by property type

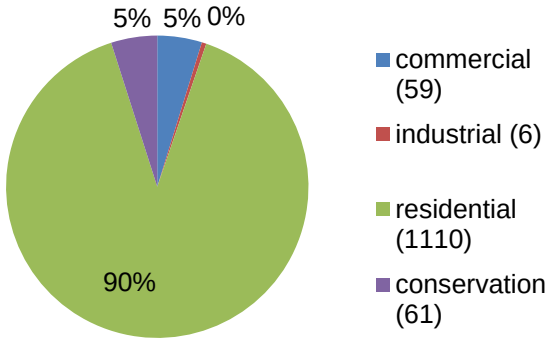


Figure 13: Breakdown of respondents who own or manage shoreline property by property location

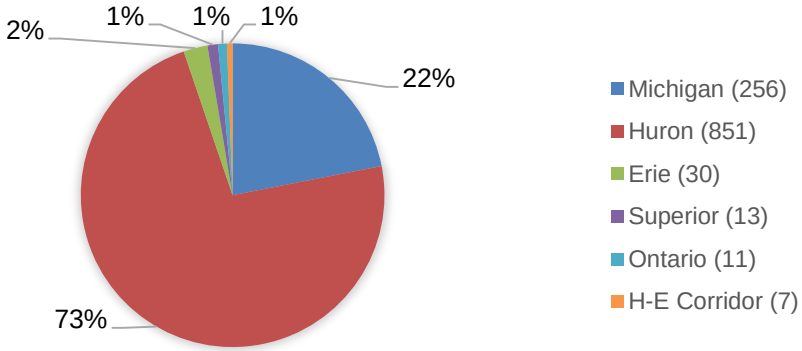


Table 4: Distribution of respondents who own or manage shoreline property, by number of properties

Number of properties	Number of respondents
1	914
2	176
3	32
4	13
5	6
6-10	6
11-100	9
101-500	0
501-1000	0
1001-11000	2

The most important observation from this data is that the sample is not evenly distributed across all of the lakes of interest. Lake Huron is over-represented and Lake Erie is under-represented. This is probably because the organization Stop the Drop sent out the greatest number of recruitment emails (~18,000) of any of the organizations I contacted, and this organization's membership is mainly based in Lake Huron. Two of the other organizations that sent recruitment emails also serve Lake Huron property owners: Georgian Bay Association and Georgian Bay Forever. None of the organizations I contacted specifically serve Lake Erie property owners. Additionally, Lake Huron property owners, and Georgian Bay property owners specifically, have been some of the most vocal members of the public to voice concern about low water levels. Therefore, it is likely that people in that area were more motivated to answer the survey than others were, creating response bias. As such, when analyzing the survey data, it is crucial to control for location of respondents' properties. It is probably also helpful to control for which organization respondents' received the survey link from. Respondents were also asked to describe, via several survey questions, the five properties that they deal with most often. In total, respondents described 1508 properties.

Figure 14: Properties by type

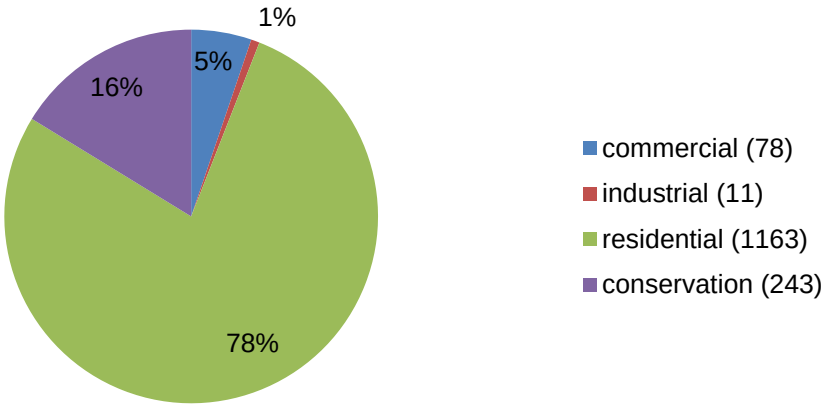
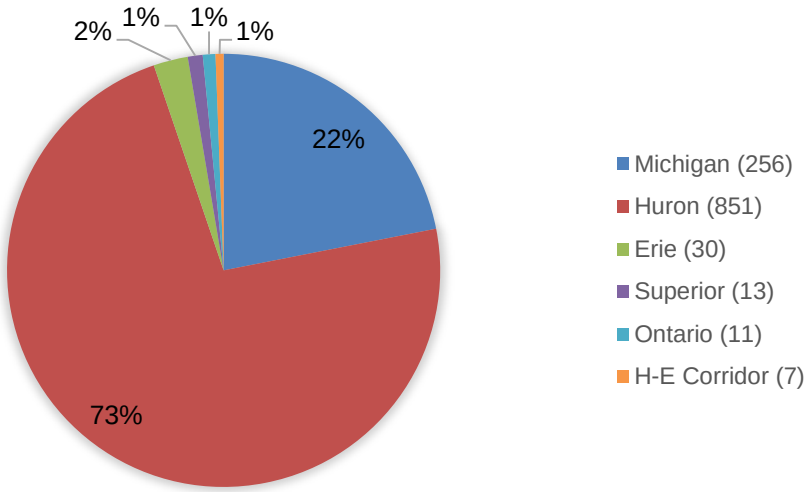


Figure 15: Properties by location



Cost of Water Level Impacts

One of the goals of the IA is to look at economic impacts of water levels, so the survey asked respondents to indicate, for the last five years, how much business revenue they have lost due to extreme water levels, how much money they have spent repairing property damage due to extreme water levels, and how much money they have spent protecting property from damage by extreme water levels. The distribution of those expenditures is illustrated in the tables below.

Table 5: Revenue lost due to extreme water level impacts

USD	Number of respondents
0	796
1-100	0
101-500	3
501-1k	3
1001-10k	21
10001-50k	12
50001-100k	1
100001-1M	6
1000001-20M	1

Table 6: Expenditures on repairing property damaged by extreme water levels

USD	Number of respondents
0	621
1-100	17
101-500	67
501-1k	54
1001-10k	155
10001-50k	38
50001-100k	3
100001-1M	6
1000001-20M	0

Table 7: Expenditures on protecting property from damage by extreme water levels

USD	Number of respondents
0	454
1-100	24
101-500	98
501-1k	92
1001-10k	276
10001-50k	82
50001-100k	11
100001-1M	5
1000001-20M	2
20000001-50M	1

Table 8: Total expenditures

USD	Number of respondents
0	1100
1-100	24
101-500	101
501-1k	99
1001-10k	322
10001-50k	123
50001-100k	23
100001-1M	18
1000001-20M	3
20000001-50M	1
50000001-100M	1

The mean amount of reported lost revenue from extreme water levels is $26,971.39, the mean reported expenditures on protecting property from damage by extreme water levels is $81,533.88, the mean reported expenditures on repairing property damaged by extreme water levels is $3,542.02, and the mean reported total expenditure is $61,404.20. However, it should be noted that a few respondents reported extremely high expenditures, and therefore the mean may not be the best statistic to describe this data.

Forms of Information

Graham plans for the IA to build on and compliment existing resources and tools that governments, non-profits, and academic institutions currently provide to the public. Additionally, Graham ultimately hopes to effectively communicate the knowledge generated by the IA to shoreline property owners and other stakeholders. Therefore, it is important to know what forms of information stakeholders are currently using to obtain information about water levels. The charts below show that personal contact with friends, family members, and neighbors is the most popular source of information, followed by websites of organizations dealing with water levels, news media, and email updates/alerts. The greatest number of respondents indicated that, in the future, they prefer to obtain information about water levels through email updates/alerts and websites, not through contact with friends, family members, or neighbors. Perhaps this is because respondents want to get information from sources they perceive as more authoritative or sources with more consistent quality or content.

Figure 16: Number of respondents who use a form of information sometimes or often, by form of information

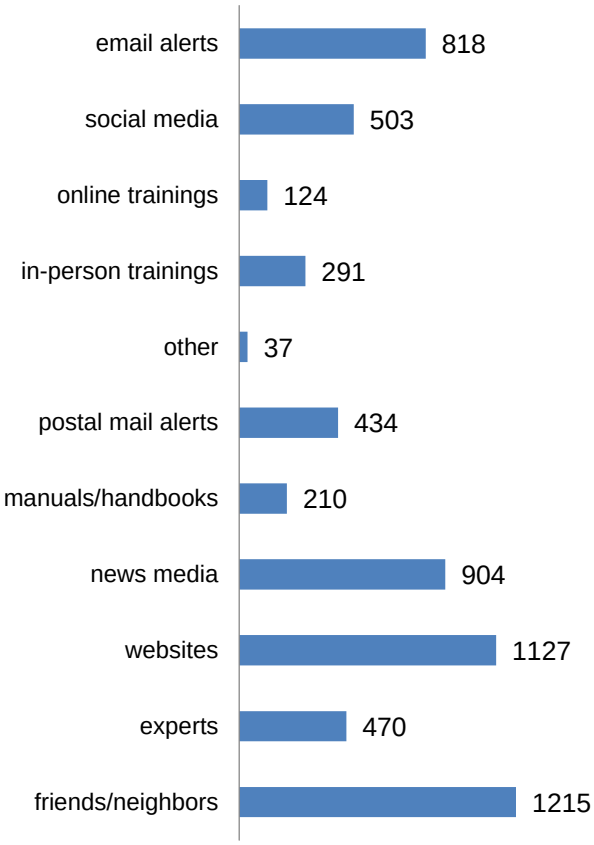
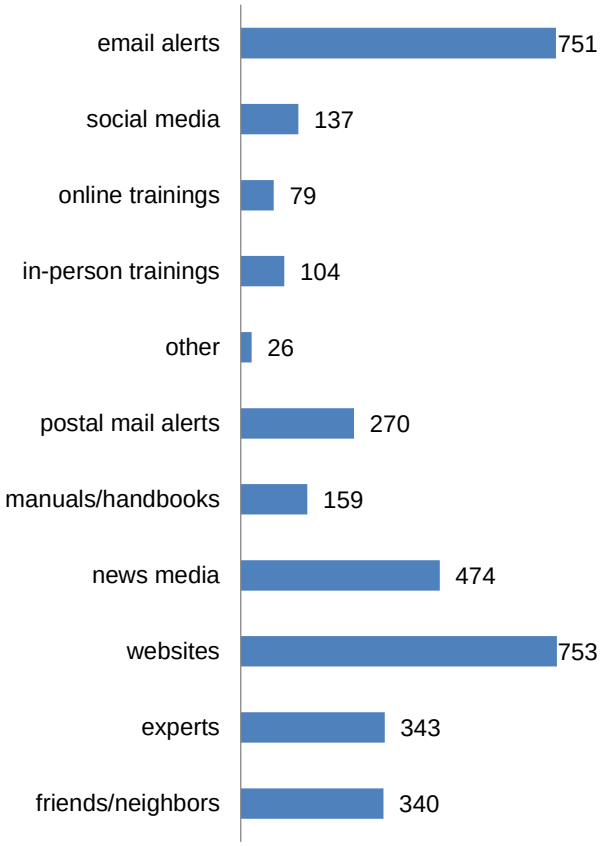


Figure 17: Number of respondents who would like to use a form of information in the future, by form of information



In addition to knowing what forms of information respondents are using, it is helpful to know what specific organizations are providing information about water levels that respondents find useful. Table 9 shows the approximate number of respondents who indicated that a specific organization has provided information on water levels that has been particularly useful to them. This is based on preliminary analysis of qualitative responses, and includes only select responses.

Table 9: Specific sources of information respondents have found useful (preliminary data)

Source	Approximate number of respondents
U.S. Army Corps of Engineers	111
Stop the Drop	500
National Oceanic and Atmospheric Administration	68
Canadian government	95
Georgian Bay Association	175
Georgian Bay Forever	161
San Souci and Copperhead Association	49

Trust of Institutions

Knowing which organizations respondents trust can help Graham determine which types of partners might be most effective in helping disseminate information produced through the IA. It can also help guide IA analysis teams in choosing collaborators that will be good intermediaries between themselves and stakeholders, or in deciding which sectors to focus on.

The table below shows the level of trust respondents have for each of eight institution types.

Table 10: Distribution of level of trust, by institution type

Type of institution	Level of Trust					
	0	1	2	3	4	5
Federal government	204	216	272	398	286	105
State/provincial government	134	168	271	502	322	73
Local government	71	138	236	490	423	111
Environmental organization	70	73	148	352	579	250
Academic institution	34	55	137	324	584	312
Industry association	226	285	349	359	154	34
News media	74	198	389	566	222	28
Proper owners' association	38	54	176	389	550	253

Table 11 shows, for each institution, the proportion of respondents who reported a trust level of 3, 4, or 5. The most trusted institutions seem to be academic institutions, environmental organizations, and property associations.

Table 11: Trust of institutions (proportion of respondents)

Source	Proportion
Academic institution	0.84
Proper owners' association	0.82
Environmental organization	0.80
Local government	0.70
State/provincial government	0.61
News media	0.55
Federal government	0.53
Industry association	0.39

Knowledge Gaps and Barriers to Obtaining Knowledge

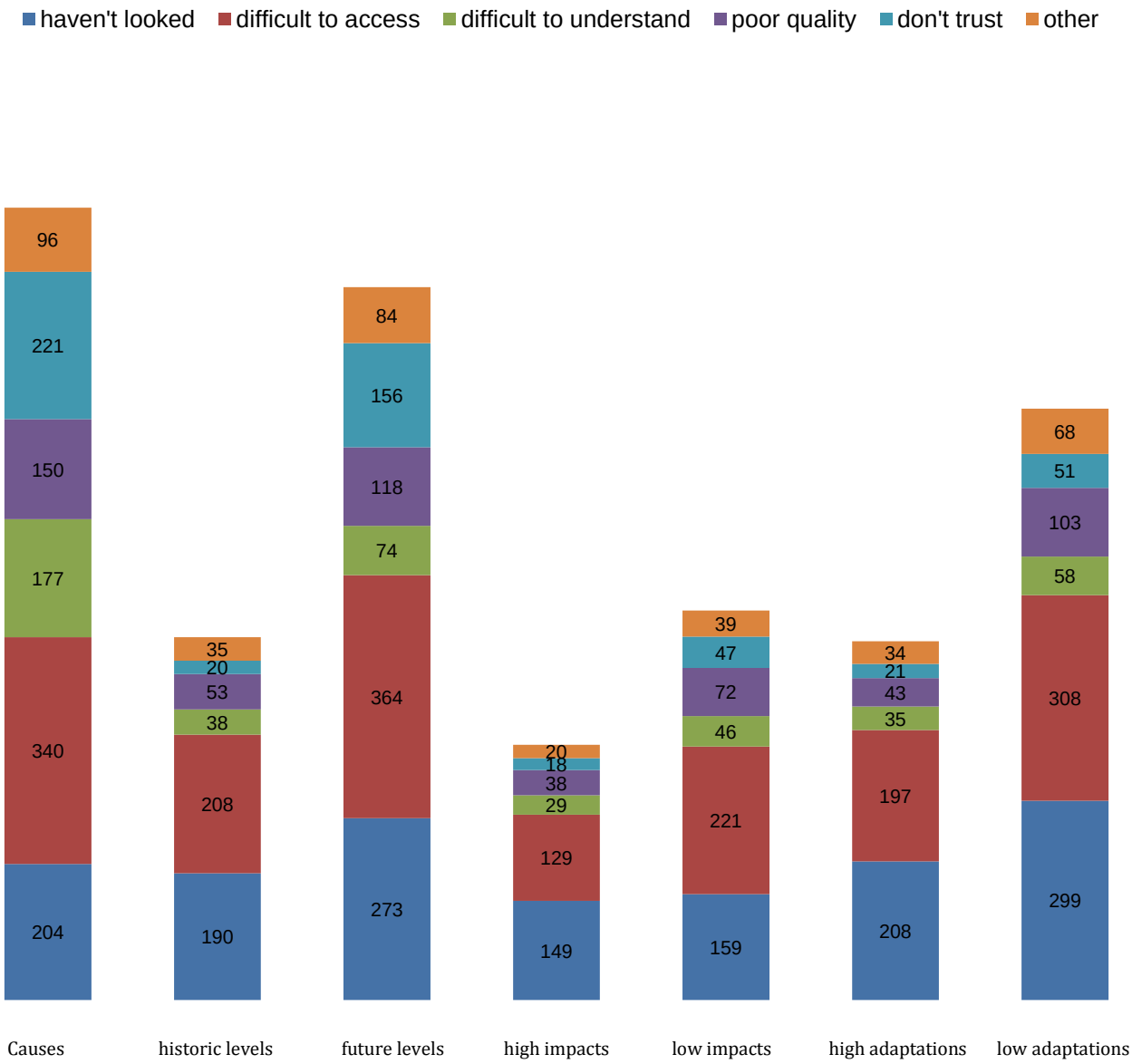
To determine which topics Graham might consider addressing through the IA, I asked respondents to indicate topics about which they wished to know more (knowledge gaps) from a pre-determined list, as well as the reasons why they felt they had been unable to learn about those topics (barriers to obtaining knowledge), also from a pre-determined list. Response options appear below.

Table 12: Response options for knowledge gaps and barriers to obtaining knowledge

Knowledge gaps	Causes of water level change	Historic water levels	Future projected water levels	Impacts to property from high water	Impacts to property from low water	Strategies for adapting to high water	Strategies for adapting to low water
Barriers to obtaining knowledge	Haven't looked for information	Information difficult to find/access	Information difficult to understand	Information of poor quality	Do not trust available information	Other	

The chart on the next page illustrates the number of respondents who wanted to know more about each topic, broken down by the barriers to obtaining knowledge.

Figure 18: Knowledge gaps, by barriers to obtaining knowledge



The greatest number of respondents reported wanting to know more about the causes of water level change, what water levels will be like in the future, and adaptation strategies for dealing with low water levels. Barriers to obtaining knowledge seem to be similar across all knowledge gaps, and the most common barriers among respondents are difficult finding or accessing information, following by not looking for information. However, it is important to note that those two barriers were listed first on the survey when reading left to right, and so there may have been some bias in how respondents filled out the form.

Demographics

The following tables show distributions for the demographic questions asked in the survey: age, employment status, education, household income, and gender. The results reveal that, compared to the general population, the sample is skewed towards older males of high socioeconomic status and education level. The latter three characteristics are not entirely surprising, since once might expect that shoreline property is more expensive and thus those who own it would be of a higher socioeconomic status. Since socioeconomic status is correlated with education level, this result would fit with that trend. However, it is unclear why the sample is skewed so heavily towards males, and this warrants further exploration. Finally, I was unable to find or construct a dataset giving the corresponding demographics of Great Lakes shoreline property owners in the population as a whole, so it is not possible at this time to definitively say whether this sample is representative of that population.

Table 13: Age distribution

Age	Frequency
18-24	8
25-34	39
35-44	99
45-54	255
55-64	517
65+	564

Table 14: Employment status distribution

Employment status	Frequency
employed full time	643
employed part time	98
unemployed	13
retired	680
student	8
other	37

Table 15: Gender distribution

Gender	Frequency
female	480
male	977
Other	6

Table 16: Household income distribution

Income level	Frequency
Less than $25,000	31
$25,000-$34,999	38
$35,000-$49,999	67
$50,000-$74,999	204
$75,000-$99,999	211
$100,000-$149,999	313
$150,000-$199,999	142
$200,000+	300

Table 17: Education level distribution

Education level	Frequency
some high school	18
high school degree	62
some college	150
trade/technical/vocational training	92
college degree	495
some postgraduate work	149
postgraduate degree	496

IV. Analysis

The results presented above should go a long way towards helping guide the IA in a direction that will address stakeholder needs and preferences. However, they tell us little about what is driving those needs and preferences. In the analysis below, I address a key question about the sample and begin constructing and analyzing regression models that can be used to form the basis for future statistical analysis of the survey results.

Because respondents in both the postal mail recruitment sample and the email recruitment sample were asked the same questions, it made sense to combine them into one dataset (super-sample) to report on the survey results.[10] However, it is important to explore what differences exist between the two recruitment groups in order to better understand what bias might exist in the super-sample. I calculated the significance of difference between the postal mail and email recruitment groups for several variables using the two sample t-test with equal variances (for continuous dependent variables) and the chi^2 test (for categorical dependent variables) in Stata. The results show that there are statistically significant[11] differences across the two recruitment groups for the following variables:[12]

- Type of impacts experienced
- Ownership status (yes/no)
- Ownership of property on lakes Michigan, Huron, Erie, and Superior
- Aggregate attribution of water level change to hydrometeorological factors
- Aggregate attribution of water level change to anthropogenic factors[13]
- Use of the following sources to obtain information about water levels:
    - experts in the field, websites of organizations dealing with water level change, in-person training, social media, and email updates/alerts to obtain information about water levels
- Trust of the following institutions:
    - property owners associations, federal government, state/provincial government, and environmental organizations
- Average number of knowledge gaps
- Gaps in knowledge for the following topics:
    - high water levels, water level impacts (high+low combined), and water level adaptation strategies (high+low combined)
- Identification of the following barriers to obtaining knowledge about water levels:
    - "haven't looked" and "information difficult to find or access"
- Education level, age, and gender

[10] Consultants at the University of Michigan Center for Statistical Consultation and Research confirmed that this decision was methodologically sound.
[11] At the 0.05 level
[12] See Appendix E for tables of results with P-values
[13] These variables were created by adding together all of the attribution factors that a respondent reported for each group. For example, if the respondent report a 4 for ice cover, a 5 for climate change, a 4 for precipitation, a 6 for evaporation, and a 6 for temperature, then the aggregate attribution to hydrometeorological factors would be 25.

As mentioned previously, prior to Graham beginning the IA scoping process there had been much public concern over the impact of U.S. Army Corps of Engineer dredging of the St. Clair River on water levels in Lake Huron. Graham and its partners perceived much of that concern to be coming from property owners on Lake Huron. I wanted to test this perception, and so developed a linear regression model to see if there is a correlation between aggregate attribution of water level change to dredging and lake location (model 1). I also looked at whether there is a correlation between aggregate attribution of water level change to anthropogenic factors as a whole and lake location (model 2).

The adjusted R^2 for model 1 was 0.2726, and it showed that the following variables have statistically significant correlations with aggregate attribution of water level change to dredging:

Variable	Sign	P-value
Email recruitment	+	0.000
Experienced low water level impacts	+	0.000
Experienced both high and low water level impacts	+	0.000
Ownership of property on Lake Michigan	-	0.001
Age	+	0.029
Gender	-	0.009

The only information about the association between property location and aggregate attribution of water level change to dredging that we learn from these results is that being a property owner on Lake Michigan is correlated with a decreased average attribution of water level change to dredging compared with not being a property owner on Lake Michigan. This model reveals that experiencing low water level impacts (either in isolation or together with high impacts), however, is correlated with an increased average attribution of water level change to dredging compared with those who do not experience any impacts or experienced high water level impacts in isolation. We see that being in the email recruitment group is also correlated with an increased average attribution of water level change to dredging compared with being in the postal mail recruitment group. This suggests the need for additional analysis of the breakdown of the email recruitment group to determine what is driving this difference, perhaps by impacts experienced, membership organization, or county of residence. It is important to note that the adjusted R^2 for this model is not particularly high, and therefore its predictive power is questionable.

The adjusted R^2 for model 2 was even lower, at 0.0681. It showed that the following variables have statistically significant correlations with aggregate attribution of water level change to dredging:

Variable	Sign	P-value
Email recruitment	+	0.000
Experienced low water level impacts	+	0.000
Experienced both high and low water level impacts	+	0.000
Ownership of property in the Huron-Erie Corridor	-	0.046
Income	-	0.036

These results underscore the aforementioned need to further examine differences between the two recruitment groups.

V. Conclusion

The survey results confirm Graham and its partners' perceptions that the IA will address salient concerns of shoreline property owners, shoreline property managers, and other stakeholders in the region. Ideally, the results can be operationalized into guidance for IA analysis teams or other IA affiliates in order to ensure that the assessment is as relevant and impactful as possible.

There are several additional areas of analysis and research that could make this survey more useful. First, it would be helpful to construct a dataset with the demographics of shoreline property owners/managers in the territories of interest in order to determine the external validity of the results. Second, there is a wealth of qualitative data from the survey, most of which has yet to be analyzed. From cursory review of that data it seems to illustrate some diverse and surprising perspectives. For example, several respondents mention the importance of living with the variability of Great Lakes water levels, whereas my perception going into this research was that this is not a common perspective, at least amongst property owners. Additionally, many more respondents mentioned environmental conservation and ecosystem concerns than I would have thought. Finally, I did not incorporate a literature review into this research, and it would be interesting to take a targeted look at any other surveys of Great Lakes shoreline property owners that have been completed in the past.

Appendix A: Survey Instrument

Default Question Block

Thank you for taking the time to respond to this survey about Great Lakes water level changes. We greatly value your input.

The survey is completely anonymous, and should take a maximum of 15 minutes to complete. You will be asked about your experiences with, concerns about, and knowledge of Great Lakes water level changes. You will also be asked about yourself and any properties you own/manage. Your participation is completely voluntary, and you may stop taking the survey at any time. We recommend that you complete this survey from a computer, as it may be difficult to read some of the questions on your mobile device.

Again, thank you for your willingness to help with this project. If you are interested in being involved with the overarching Great Lakes water levels assessment, or if you have any questions about the survey or the assessment, please contact Rachel Jacobson at rijacob@umich.edu.

1. Generally, how concerned are you about water level changes in the Great Lakes?

not at all concerned	slightly concerned	concerned	very concerned	don't know
○	○	○	○	○

2. How concerned are you about each of the following?

	not at all concerned	slightly concerned	concerned	very concerned	don't know
Economic problems associated with changing water levels (e.g. property damage, decreased business revenue, increased operating expenses, etc.)	○	○	○	○	○
Environmental problems associated with changing water levels (e.g. invasive species, wetland loss, etc.)	○	○	○	○	○
Social problems associated with changing water levels (e.g. affects on neighboring properties from others' shoreline management activities, unevenly distributed costs and benefits of shoreline management activities, changes to the culture/feel of a community, etc.)	○	○	○	○	○

3. Which of the following impacts have you experienced while using the Great Lakes shoreline or nearshore areas? (please choose all that apply)

- ☐ Property damage due to flooding
- ☐ Property damage due to erosion
- ☐ Decrease in recreational opportunities due to low water levels
- ☐ Decrease in recreational opportunities due to high water levels
- ☐ Decrease in water quality due to low water levels
- ☐ Increase in operating expense due to low water levels
- ☐ Increase in operating expense due to high water levels
- ☐ Decrease in business revenue due to high water levels
- ☐ Decrease in business revenue due to low water levels
- ☐ None
- ☐ Other (please describe)

4. On a scale of 0-5, with 0 being "not at all" and 5 being "a great deal", how much does each of the following factors contribute to changes in Great Lakes water levels? If you don't know what a particular item is, or do not have knowledge of how it affects water levels, please check "don't know".

	0	1	2	3	4	5	don't know
Dredging	○	○	○	○	○	○	○
Evaporation	○	○	○	○	○	○	○
Diversions of water into the Great Lakes basin	○	○	○	○	○	○	○
Diversions of water out of the Great Lakes basin	○	○	○	○	○	○	○

Human-built structures controlling water flow	○	○	○	○	○	○	○
Runoff	○	○	○	○	○	○	○
Temperature	○	○	○	○	○	○	○
Precipitation	○	○	○	○	○	○	○
Climate change	○	○	○	○	○	○	○
Ice cover	○	○	○	○	○	○	○
Other (please describe)	○	○	○	○	○	○	○

5. Do you own or manage property along the Great Lakes shoreline?

- ○ yes (please enter number of properties)
- ○ no

6. In the past five years, what has been the cost to you of each of the following? If the cost to you has been $0, please enter "0". If you do not know what the cost has been, please enter "DK".

	please enter an approximate dollar amount in USD
Protecting property from anticipated water level impacts (e.g. lengthening water intake pipe, hardening shoreline, dock expansion etc.)	
Lost business revenue due to high or low water levels (e.g. due to decreased recreational opportunities)	
Repairing property damage due to high or low water levels (e.g. due to flooding, erosion, etc.)	

7. Please tell us about the Great Lakes shoreline properties you own or manage. If you own or manage more than five Great Lakes shoreline properties, please choose the five you deal with most frequently.

	Property Type (You may choose more than one option if a single property serves multiple functions.)				**Facility Type:** If the property is commercial or industrial, please indicate a facility type	**Lake Location:** Use drop down menu to choose the lake on which your property is located. Click here for map of the Huron-Erie Corridor.	**County Location**
	Commercial	Industrial	Residential	Conservation	(wastewater treatment plant, restaurant, marina, etc.)		Please enter a U.S. or Canadian county.
Property #1	☐	☐	☐	☐			
Property #2	☐	☐	☐	☐			
Property #3	☐	☐	☐	☐			
Property #4	☐	☐	☐	☐			
Property #5	☐	☐	☐	☐			

8. Information about water levels comes in a variety of forms. How often do you currently receive information about water levels in each of the following forms? In what form(s) would you prefer to receive this information in the future?

	How often do you currently receive information about water levels in each of the following forms?				**In what form(s) would you prefer to receive information about water levels in the future?**
	never	rarely	sometimes	often	check all that apply
Personal contact with friends/family members/neighbors	○	○	○	○	☐

Personal contact with experts in the field	○	○	○	○	☐
Websites of organizations dealing with water levels	○	○	○	○	☐
News media (online, television, radio, or print)	○	○	○	○	☐
Social media (Facebook, Twitter, Instagram, etc.)	○	○	○	○	☐
Guides/manuals/handbooks	○	○	○	○	☐
Updates, alerts, or newsletters via postal mail	○	○	○	○	☐
Updates, alerts, or newsletters via email	○	○	○	○	☐
In-person training sessions	○	○	○	○	☐
Online courses	○	○	○	○	☐
Other (please specify)	○	○	○	○	☐

9. Please name any sources of information about Great Lakes water levels that have been particularly useful to you (Name of individual, name of organization, URL, title of guide/manual, title of online course, etc. 2,000 character limit.)

10. On a scale of 0-5, with 0 being "do not trust at all" and 5 being "trust completely", how much do you trust information about Great Lakes water levels from each of the following sources?

	0	1	2	3	4	5
local government (city/county/conservation authority)	○	○	○	○	○	○
property owners association	○	○	○	○	○	○
news media	○	○	○	○	○	○
state/provincial government	○	○	○	○	○	○
environmental organization	○	○	○	○	○	○
academic institution	○	○	○	○	○	○
federal government	○	○	○	○	○	○
industry association	○	○	○	○	○	○

11. About which topics do you wish you knew more?

- ☐ Causes of Great Lakes water level changes
- ☐ What Great Lakes water levels were like in the past
- ☐ What Great Lakes water levels will be like in the future
- ☐ Impacts to property resulting from high water levels
- ☐ Impacts to property resulting from low water levels
- ☐ Strategies for adapting to high water level impacts
- ☐ Strategies for adapting to low water level impacts
- ☐ Other (please specify)
- ☐ None

12. Which of the following are reasons why you have not been able to learn about these topics? Check all that apply.

	I have not looked for information	information is difficult to find or access	information is difficult to understand	information is of poor quality	I do not trust the information	other
» Causes of Great Lakes water level changes	☐	☐	☐	☐	☐	☐
» What Great Lakes water levels were like in the past	☐	☐	☐	☐	☐	☐
» What Great Lakes water levels will be like in the future	☐	☐	☐	☐	☐	☐
» Impacts to property resulting from high water levels	☐	☐	☐	☐	☐	☐
» Impacts to property resulting from low water levels	☐	☐	☐	☐	☐	☐
» Strategies for adapting to high water level impacts	☐	☐	☐	☐	☐	☐
» Strategies for adapting to low water level impacts	☐	☐	☐	☐	☐	☐
» Other (please specify)	☐	☐	☐	☐	☐	☐
» None	☐	☐	☐	☐	☐	☐

Please answer the following questions about yourself so that we will have a better idea of who answered this survey. Remember that your answers to these questions are completely anonymous.

13. How old are you?

- ○ 18-24
- ○ 25-34
- ○ 35-44
- ○ 45-54
- ○ 55-64
- ○ 65+

14. Which of the following best describes your employment status?

- ○ employed full time
- ○ employed part time
- ○ unemployed
- ○ retired
- ○ student
- ○ other

15. What was your total household income before taxes during the past 12 months?

- ○ Less than $25,000
- ○ $25,000-$34,999
- ○ $35,000-$49,999
- ○ $50,000-$74,999
- ○ $75,000-$99,999
- ○ $100,000-$149,999
- ○ $150,000-$199,999
- ○ $200,000+

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

- ○ some high school
- ○ high school degree
- ○ some college
- ○ trade/technical/vocational training

- ○ college degree
- ○ some postgraduate work
- ○ postgraduate degree

17. What is your gender?

- ○ female
- ○ male
- ○ Other

18. In what U.S. or Canadian county do you primarily reside?

19. From what organization(s) did you receive the link to this survey? Select all that apply.

- ☐ Council of Great Lakes Industries
- ☐ Emmet County Lakeshore Association
- ☐ Freshwater Future
- ☐ Georgian Bay Association
- ☐ Georgian Bay Forever
- ☐ Great Lakes Goalition
- ☐ Restore Our Water International
- ☐ Sierra Club Ontario
- ☐ Stop the Drop
- ☐ Tip of the Mitt Watershed Council
- ☐ West Michigan Sustainable Business Forum
- ☐ Wisconsin Harbor Towns Association
- ☐ Other
- ☐ None

Block 1

20. Optional-- provide any additional information you think may be useful as the Graham Institute and Water Center move forward with the Great Lakes water levels assessment. (2,000 character limit.)

Appendix B: Postal Mail Recruitment Sampling and Address Collection Protocol

County selection

In the U.S., real estate records are typically provided by counties, so the first step in sampling subjects in U.S. states was choosing counties. I assigned each shoreline county in the geographic region of interest an impact designation based on whether it is more acutely impacted by high water levels, more acutely impacted by low water levels, or equally impacted by high and low water levels. The designations were made by three experts in the field: Jennifer Read, Water Center Director at the University of Michigan Graham Sustainability Institute; Scudder Mackey, Coastal Zone Management Chief at the Ohio Department of Natural Resources; and Gene Clark, Coastal Engineering Specialist at Wisconsin Sea Grant. Jennifer Read provided blanket designations for several broad areas of shoreline in the study area. Scudder Mackey provided individual county designations for several counties throughout the study area. Gene Clark provided blanket designations for broad areas of Wisconsin's Lake Michigan shoreline. This left seven counties without a designation, and those counties were not considered for the sample. It also left a few counties with two conflicting designations, each conferred by a different expert. For Ohio counties and counties where Scudder Mackey's designation conflicted with Jennifer Read's designation, I used Scudder Mackey's designation. This is because Scudder Mackey is based on Ohio and has the most experience in that area of any of these experts. For Wisconsin counties I used Gene Clark's designation, since Gene is based on Wisconsin and has the most experience in that area of any of these experts.

Next, I determined the percentage of counties with each impact designation, and found the following:

	total	proportion
both	10	0.167
high	26	0.433
low	24	0.400

I decided to sample ten counties, and to round to the nearest whole number to determine how many counties I would sample from each designation category, which translated to two from "both," four from "high", and four from "low." Within each category, I assigned each county a number. I then used the randombetween function in excel to generate random numbers, and chose the counties corresponding to the first two, four, and four numbers that I generated for the both, high and low categories, respectively.

Address Collection

I wanted to collect all of the shoreline addresses in each county selected for the sample. A research assistant used Google Maps/Google Earth to find the street names and house numbers of each property in a given county. The researcher recorded all of the addresses for shoreline property on streets that met either of the following criteria:

a) streets of any length running parallel to the shoreline and within approximately 1,000 feet of the shoreline, or
b) short (approximately 2,000 feet or less) streets running perpendicular to the shoreline and ending within approximately 1,000 feet of the shoreline.

"Shoreline" was defined as the line of color change between land and water, as noted on Google Maps by the color change between blue (water) and any other color (land). In cases where Google data was suspect, the researcher cross-referenced it with Zillow.com.

The researcher then used the county's property database to find property owner addresses via tax records. Where property owner address was unavailable, researcher used the address of the shoreline property. In cases where the property owner name and mailing address were identical for multiple properties, only one entry was kept.

As mentioned in the main body of the report, we were unable to collect property owner information for the Canadian counties sampled. I contacted several people at Teranet, the organization that manages Ontario parcel data, but was told that only licensed Canadian real estate agencies and select Canadian businesses were able to obtain that data. We also attempted to partner with a Canadian university to obtain the data, but our connection unfortunately fell through.

Appendix C: Postal Mail Recruitment Letter

GRAHAM SUSTAINABILITY INSTITUTE
UNIVERSITY OF MICHIGAN

WATER CENTER
UNIVERSITY OF MICHIGAN

FusionPro Text

September 16, 2014

FusionPro Text

As a property owner or property manager near the Great Lakes shoreline, you have likely experienced some of the impacts caused by low or high water levels. These impacts are felt across the region, and they create challenges for protecting our homes, businesses, and lifestyles.

The University of Michigan's Graham Sustainability Institute and the U-M Water Center are launching an assessment of the causes, consequences, and options for adapting to water level changes on the Great Lakes. The central goal of this water levels assessment is to help shoreline communities, residents, and businesses make informed decisions about dealing with these changes, contributing to economic and environmental prosperity in the Great Lakes region.

We invite you to contribute to the water levels assessment by participating in a 15-minute online survey, through which you will have the opportunity to share your experiences with, concerns about, and knowledge of Great Lakes water level changes. Your input is crucial for us to better understand the needs of residents and business owners impacted by water-level changes, and it will ensure that the water-levels assessment addresses those issues that are most important to property owners and managers in our region. To access the survey, please type the following link into your web browser:

http://www.graham.umich.edu/water-levels-survey

Please complete the survey by October 15, 2014. If you have any questions about the survey or about the water levels assessment, please contact Rachel Jacobson via email at rijacob@umich.edu or phone **(734) 763-0747**. Thank you in advance for contributing to this project.

John Callewaert
Director, Integrated Assessment Center
U-M Graham Sustainability Institute

Rachel Jacobson
Graduate Student Researcher
U-M Graham Sustainability Institute

Appendix D: Email Recruitment Sample Text

As someone who cares about the Great Lakes shoreline, you have likely heard about or experienced some of the impacts caused by low or high water levels. These impacts are felt across the region, and they create challenges for protecting our homes, businesses, and lifestyles.

The University of Michigan's Graham Sustainability Institute and the U-M Water Center are launching an assessment of the causes, consequences, and options for adapting to water level changes on the Great Lakes. The central goal of this water levels assessment is to help shoreline communities, residents, and businesses make informed decisions about dealing with these changes, contributing to economic and environmental prosperity in the Great Lakes region.

We invite you to contribute to the water levels assessment by participating in a 15-minute online survey, through which you will have the opportunity to share your experiences with, concerns about, and knowledge of Great Lakes water level changes. Your input is crucial for us to better understand the needs of the residents, communities, and business owners impacted by water-level changes, and it will ensure that the water-levels assessment addresses those issues that are most important to people in our region.

CLICK HERE to access the survey.

Please complete the survey by November 2, 2014, and feel free to forward the survey link to others in your network. If you have any questions about the survey or about the water levels assessment, contact Rachel Jacobson at the Graham Institute via email at rijacob@umich.edu or phone at (734) 763-0747. Thank you in advance for contributing to this project.

Appendix E: Results of Recruitment Groups Analysis

Variables for which there is a statistically significant[14] different between the postal mail and email recruitment groups are highlighted in green.

Impacts Experienced

	Average number of impacts experienced	No impacts experienced (count of respondents)	Experienced low water level impacts (count of respondents)	Experienced high water level impacts (count of respondents)	Experienced both low and high water level impacts (count of respondents)	Average total expenditures (USD)
Postal mail	2.25	29	81	92	78	$8497.92
Email	2.41	148	784	128	364	$71382.60
P-value	0.0791	0.000				0.477[15]

Property ownership (counts of respondents unless stated otherwise)

	Ownership status (yes; % of respondents)	Commercial	Industrial	Residential	Conservation	
Postal	98.21%	12	2	252	8	
Email	73.23%	45	3	858	53	
P-value	0.000	0.683	0.524	0.436	0.071	
	Lake Michigan	Lake Huron	Lake Erie	Lake Superior	Lake Ontario	Huron-Erie Corridor
Postal	123	120	16	0	0	0
Email	133	731	14	13	11	7
P-value	0.000	0.000	0.000	0.050	0.072	0.152

Attribution of factors to water level change

	Average aggregate attribution of water level change to hydrometeorological factors	Average aggregate attribution of water level change to anthropogenic factors
Postal	16.20	12.72
Email	16.56	13.77
P-value	0.029[16]	0.026

Forms of information used sometimes or often (counts of respondents)

	family/friends /neighbors	experts	websites	news media	guides/manuals /handbooks	postal mail alerts	in-person training	online training	social media	email alerts
Postal	97	9	45	36	2	18	10	2	23	41
Email	499	98	479	159	22	119	87	12	231	830

[14] At the 0.05 level

[15] Wilcoxon rank sum test used here due to non-normal distribution of average total expenditures

[16] Wilcoxon rank sum test used here due to non-normal distribution of average attribution to hydrometeorological factors

P-value	0.141	0.005	0.000	0.913	0.199	0.098	0.025	0.66	0.000	0.000

Trust of institutions (counts of respondents)

	Property owners association	Federal government	state/provincial government	local government	environmental organization	academic institution	industry association	news media
Postal	194	159	188	184	168	218	100	145
Email	998	630	709	840	1013	1002	447	671
P-value	0.005	0.028	0.000	0.834	0.000	0.296	0.772	0.733

Gaps in knowledge (counts or respondents)

	High water levels	Low water levels	Impacts	Adaptation strategies	Average number of knowledge gaps
Postal	108	103	78	77	
Email	235	432	188	200	
P-value	0.000	0.461	0.000	0.000	0.001

Barriers to obtaining knowledge (counts of respondents)

	Haven't looked	Information difficult to access	Information difficult to understand	Information of poor quality	Don't trust information
Postal	140	72	28	47	30
Email	423	414	124	241	204
P-value	0.000	0.009	0.441	0.725	0.177

Education level distribution (percent of respondents)

	Some high school	High school degree	Some college	Trade/technical/ vocational training	College degree	Some post-graduate work	Post-graduate degree
Postal	0.00%	4.10%	6.72%	5.22%	30.22%	9.33%	44.40%
Email	1.51%	4.28%	11.07%	6.54%	34.73%	10.32%	31.54%
P-value	0.002						

Age distribution (percent of respondents)

	18-24	25-34	35-44	45-54	55-64	65+
Postal	0.00%	0.00%	7.38%	12.55%	40.22%	39.85%
Email	0.66%	3.23%	6.53%	18.28%	33.75%	37.55%
P-value	0.003					

Income distribution (percent of respondents)

	Less than $25k	$25k-$34,999	$35k-$49,999	$50k-$74,999	$75k-$99,999	$100k-$149,999	$150k-$199,999	$200k+
Postal	1.71%	2.56%	6.41%	13.25%	14.96%	23.50%	11.54%	26.07%
Email	2.52%	2.99%	4.86%	16.17%	16.45%	23.93%	10.75%	22.34%
P-value	0.762							

Gender distribution *(percent of respondents)*

	Female	Male	Other
Postal	12.82%	85.29%	1.89%
Email	21.25%	78.30%	0.46%
P-value	0.000		