Climate Considerations

for the

Little Rapids Habitat Restoration Project

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Prepared by

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Project Partners:

Eastern U.P Regional Planning & Development Commission
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Climate Considerations for the Little Rapids Habitat Restoration Project

Project Description

The Little Rapids project aims to restore 70 acres of rapids habitat in the St. Marys River Area of Concern. The project will include the following pre-construction elements: hydraulic flow modeling to predict the effects of the proposed restoration on water levels in the St. Marys River navigation channel and impact on ice formation in the Sugar Island Ferry lane; engineering design; an environmental assessment to examine the effects of the restoration on the current ecosystem; environmental monitoring plan; stakeholder relations and outreach and education. Once completed, implementation could begin by spring 2013. Restoring the rapids will lead to increased habitat for fish and invertebrates, representing 50% of the delisting target for the fish and wildlife related Beneficial Use Impairments in the Michigan waters of the St. Marys River Area of Concern.

These climate considerations are based on climate adaptation planning steps taken from *Restoring the Great Lakes Coastal Future: Technical Guidance for the Design and Implementation of Climate-Smart Restoration Projects.*

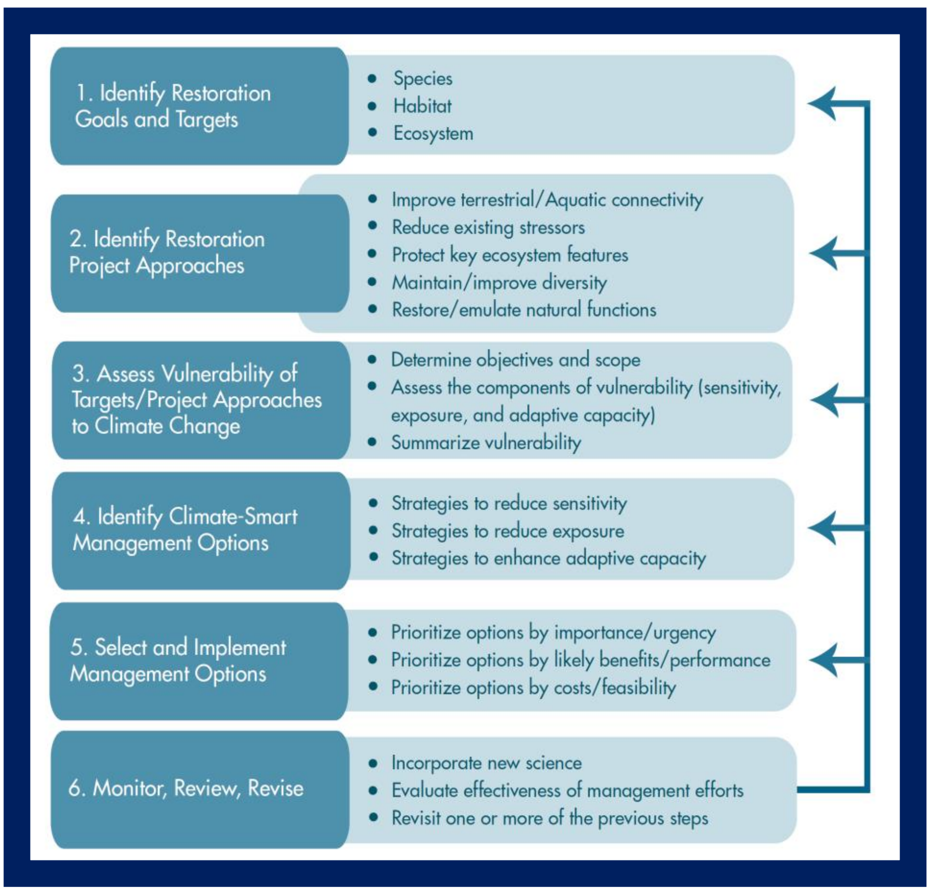

Figure 1. Six Step Process outlined in Restoring the Great Lakes Coastal Future.

The document provides guidance to restoration projects that will be impacted by climate change. Climate considerations outlined in this report provide more information on step three: Assessing Vulnerability of Targets/Project Approaches to Change. As the project progresses, project planners will run through steps four and five in order to decide which aspects of the project will need to be modified because of climate change. The information in this document is not intended to provide recommendations to the Little Rapids project, but to inform it of the effects of climate change in the Great Lakes that may be relevant to project plans.

Steps One and Two: Identify Restoration Goals, Approaches, and Targets

The goals and targets of a restoration project are its "why" and "what," while the project approaches are considered the "how," that is *how* the project will achieve these broader goals. Most current restoration projects in the Great Lakes fall under the broad, federally mandated, goals and priorities of the Great Lakes Restoration Initiative, i.e., improving aquatic ecosystem resiliency, enhancing wetlands, and improving and maintaining populations of native species, and the Little Rapids project is no exception. This report will focus on the vulnerability to climate change of the targets and approaches for the Little Rapids project – the targets being the rapids habitat for fish and invertebrate species, and the project approaches being hydrologic reconnection and restoring foraging, spawning, and nursery habitat for fish and invertebrates in the St. Marys River Area of Concern through removal or alteration of the current Sugar Island causeway.

Step Three: Assessing the Vulnerability of Targets/Project Approaches to Climate Change

To assess the vulnerability of these project targets and approaches to climate change, we look at the three main components of vulnerability, outlined below:

> **Sensitivity**: The extent to which project approaches and targets will be adversely affected by an aspect of climate change. For example, a target fish species with a narrow temperature tolerance is highly sensitive to changes in water temperature due to climate change.
>
> **Exposure**: The extent to which project approaches and targets will feel the character, magnitude, and rate of the effects of climate change. For example, a species may be highly sensitive to drought, but unless climate models predict increased drought in that species habitat, its exposure is low.
>
> **Adaptive Capacity**: The extent to which targets and approaches are able to accommodate to or cope with changing conditions. Adaptive capacity may reflect both internal traits, such as mobility, or external conditions, such as structural barriers, pre-existing stressors, and institutional or financial restrictions.

Assessing Sensitivity: Project Targets and Approaches

The project approaches and targets for the Little Rapids project have a broad range of sensitivities to climate change. The target fish species may have diminished habitat due to changing water temperatures or ice cover, and there are local concerns over changes in water flow and ice cover that may be exacerbated by climate change.

Target Sensitivities

Specifically, some of the fish species targeted for foraging, spawning and nursery habitat could be sensitive to increases in water temperatures. Four of the main target species are covered in the table below, to give an idea of the spawning temperature ranges these species prefer – fish with a lower optimal spawning temperature are likely to be more sensitive to increases in water temperature due to climate change. Additionally, Lake Whitefish are sensitive to changes in ice cover, as they prefer ice cover for spawning.

Target Fish Species	**Optimal Spawning Temperature**	**Sensitivity**
Lake Whitefish (Coregonus clupeaformis)	3.05° C	High
Lake Herring (Coregonus artedi)	3.3° C	High
Walleye (Sander vitreus)	7.73	Medium
Lake Sturgeon (Acipenser fluvenscens)	15° C	Low

Table 1: Little Rapids target fish species' optimal spawning temperatures (Christie et al. 1988)

Approach Sensitivities

Due to the nature of this project's approach, i.e. hydrologic reconnection that intends to restore habitat and improve an ecosystem, the approach is not highly sensitive to climate change, however, the proximity of residential property and residential water intake pipes may be sensitive or become more sensitive to the effects of climate change due to alterations to the causeway. Sugar Island residents have expressed concerns over changes in water level, flows, and ice cover with respect to their ability to intake water, walk on ice between islands, and have open water to take the ferry back to the mainland.

Assessing Exposure: Climate Considerations

Water Levels: Climate projections show that Great Lakes water levels may go either up or down, and that they will likely be more variable than they have in the past. While precipitation and lake evaporation does have some impact on water levels in the Great Lakes, water levels in the St. Marys River are heavily controlled by the locks and compensating gates, and so will be less affected by overall lake changes. However, the St. Marys River does ultimately flow into Lake Huron, and so is more affected by Lake Huron's levels[1]. The environmental assessment and hydrologic flow modeling will take into account more water level variability.

Ice Cover: With warmer air and water temperatures, Great Lakes ice cover may be decreasing in coming years. Residents of Sugar Island are worried that removing the causeway may divert enough water flow from the current channel to slow the current, allowing more ice to form and preventing the ferry from crossing the channel. Less ice cover due to climate change may, in fact, eliminate one challenge in removing the causeway. However, many island residents enjoy having ice between the smaller islands, as bought up in a public meeting with residents concerning the Little Rapids project.

Water Temperatures: Since one of the main goals of this project is to re-establish rapids for fish spawning and habitat, we will have to consider if anticipated changes in water temperatures will have an effect on the types of fish who will be using the rapids.

Relevant Climate Science

Water Levels

As water levels in the St. Marys river are strictly controlled , changes in Great Lakes water levels will not effect the Little Rapids project as much as they would in another location. However, the river does flow to meet the level of Lake Huron, so the hydrologic flow modeling and environmental assessment should take higher water level variability into account. Studies and models of show that Great Lakes water levels may fall up to 3 meters or rise up to 1.5 meters over the next hundred years. These are based on the balance between the increased precipitation expected under climate change and increased lake surface evaporation due to higher air temperatures and less winter ice cover. Because both are expected to happen in the coming decades, it is difficult to predict whether lake levels will go up or down, only that they will be more variable than in the past.

[1] For example, if water levels on Lake Huron drop dramatically, the St. Marys River outflow will drop as well, lowering water levels for the entire river.

Selected Climate Change Projections (Variability Extremes)	**All taken from Lynch et al, (2010)**
Declines from −3 m to increases of +1.5 m in lake level for all lakes using 23 GCMs and three IPCC emission scenarios	Angel & Kunkel (2010)
Significant decreases (1–1.5 m) or slight increases in Lakes Michigan, Huron and Erie water level using two GCMs with 2× CO_2	Lofgren et al. (2002)
Declines from −0.23 to −2.48 m in water level for all lakes with most scenarios using four GCMs and 2× CO_2	Mortsch & Quinn (1996)
Under Higher emissions scenario, drop in lake levels of 0.45 m	Hayhoe et al 2010
Decadal variations on the order of several feet	Hayhoe et al 2010

Table 2: Selected climate change projections for Great Lakes water levels

The following graphic, from Hayhoe et al: (2010), shows the projected change in average lake levels for all Great Lakes over the next hundred years. Because lake levels depend on the balance between precipitation and evaporation, climate change could have varying effects on lake levels. This figure uses a higher emissions scenario, assuming that fossil fuels continue as the predominant energy source in the future.

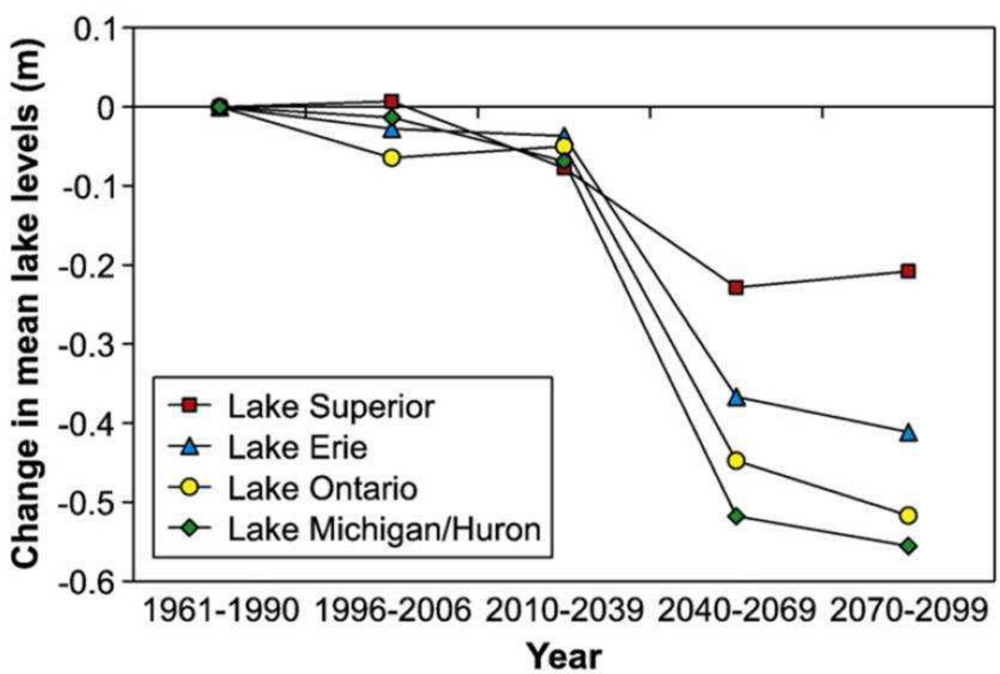

Figure 2: (Hayhoe et al, 2010). Projected change in average lake levels for the Great Lakes over the next century.

This graphic from NOAA's Drew Gronewold elaborates on the previous graphic by including historic water level data and multiple emissions scenarios (SRES B1 – low emissions, and SRES A1 – high emissions).

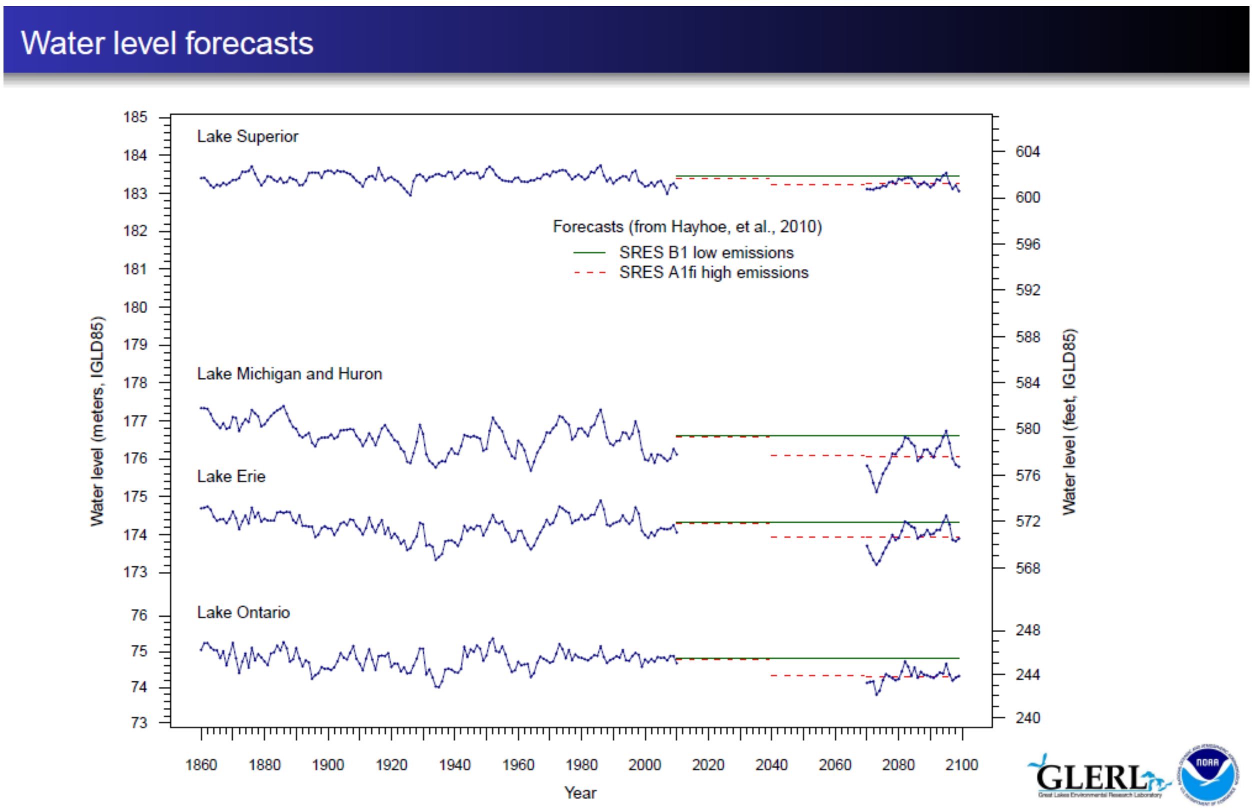

Figure 3: Water level forecasts for the next century.

Ice Cover

There is scientific evidence for the Great Lakes that backs up the local anecdotes of reduced ice cover in recent years. At a public meeting for the Little Rapids project, one resident recalled using ice breaking structures in past year to prevent ice from blocking the Sugar Island Ferry's path, but noted that these have not been necessary in recent years. Since 1974, ice cover across the great lakes has decreased more rapidly than during the past 250 years (Jensen et al. 2007, from Hayhoe et al. 2009). This trend is expected to continue – as both air temperatures and water temperatures warm – could have positive or negative implications for the Little Rapids project. On one hand, less ice cover would eliminate concerns over changes in water flows causing ice to form and block the path of the Sugar Island Ferry, but on the other hand, it could cause problems for residents who like to walk among islands on the ice. Ice cover can also have implications for fish habitat, however, with the exception of Lake Whitefish, the fish targeted by the Little Rapids project are thought to be largely unaffected by projected changes in ice cover.

Selected Climate Change projections	From Lynch et al, 2010
Ice cover virtually absent in Lake Erie's central and eastern basins and reduced from 4 months to 1 to 1・5 months in Lake Superior using three GCMs with 2× CO_2	Assel (1991)
Ice-free winters between 0 and 17% of simulated years for Lake Erie and between 7 and 43% of simulated years for Lake Superior using four GCMs and multiple emission projections	Magnuson *et al*. (1997)
From 1973 to 2010, annual average ice coverage on the Great Lakes declined by 71%. Will likely continue to decrease	GLISA – Climate Change in the Great Lakes Region

Table 3: Selected climate change projections for Great Lakes ice cover

Water Temperature

Air temperatures throughout the Midwest are predicted to increase, on average, with later fall freezes and earlier spring last frost dates. With warmer air comes warmer water temperatures, which could have implications for fish habitat, as warm water fish are expected to become more abundant and cold water fish populations are expected to decline. Readings taken in Sault Ste. Marie (near the locks and in the canal) from the past hundred years show that the water temperature has increased 0.1° C per decade. This small change may seem inconsequential, but can add up over time and may have severe implications for fish with limited habitat ranges, and may be detrimental to fish using the Little Rapids for habitat.

Selected Climate Change projections	From Lynch et al, 2010
As much as 5◦ C increase (bottom temperature) by the end of the 21st century using two GCMs with 2× CO_2	Lehman (2002)
As much as 6◦ C increase (summer surface temperature) by the end of the 21st century using one GCM and two emission projections	Trumpickas *et al*. (2009)

Table 4: Selected climate change projections for Great Lakes water temperatures

Assessing Project Adaptive Capacity

The project is already adapting to climate change more than similar restoration projects by incorporating climate considerations into the planning stages. By providing all parties involved in this project the opportunity to think about the potential effects of climate change on the Little Rapids, the project has already taken important steps towards adapting to climatic changes. In the future, the institutional ability to change project aspects as we understand more and have more certainty regarding the effects of climate change in the Great Lakes will be important.

Water Levels

Because water levels in the St. Marys River are highly controlled, the adaptive capacity in regards to water level at the Little Rapids is relatively high – the river can more easily respond to changes in lake levels than other areas, however, dramatic drops in Lake Huron may be problematic.

Ice Cover

Again, reduced ice cover is not likely to be problematic for fish targeted by this project, with the exception of Lake Whitefish. Winter residents who depend on the Sugar Island ferry in the winter could in fact benefit from less ice cover, but some residents may be upset at the potential loss of walkable ice between islands.

Water Temperature

Fish species, in general, have a higher adaptive capacity than many other, less mobile, flora and fauna, because they have the ability to swim elsewhere. However, they are still sensitive to changes in water temperature; the table below summarizes the adaptive capacity of some target fish species based on optimal spawning temperatures.

Target Fish Species	Optimal Spawning Temperature	Projected water temperature increase based on historic rate of change (Year 2100)	Projected water temperature increase based on current climate change predictions (year 2100)	Predicted Adaptive Capacity
Lake Whitefish (Coregonus clupeaformis)	3.05° C	1°C	5-6° C	Low
Lake Herring (Coregonus artedi)	3.3° C	1°C	5-6° C	Low
Walleye (Sander vitreus)	7.73	1°C	5-6° C	Medium
Lake Sturgeon (Acipenser fluvenscens)	15° C	1°C	5-6° C	High

Table 5: Target Species adaptive capacity to projected water temperature changes

Step Four: Identify Climate-Smart Management Options

Climate-smart management actions will reduce sensitivity, exposure, or adaptive capacity of project targets and approaches, or in short: they will reduce a projects vulnerability to climate change over time. These options may be within or outside of the scope of the project but are included nonetheless as options that will make the project less vulnerable to climate change.

Little Rapids Site Specific: As the biggest stressors for project targets and approaches are likely to be water temperature increases and changes in ice cover, it may be beneficial to keep water temperatures cooler by increasing or maintaining riparian vegetation near the rapids. Furthermore, removing the length of the causeway that leads to most restored rapids habitat will lead to a more resilient habitat in the face of climate change.

Broader options: Restoring more habitat throughout the Great Lakes Basin is one of the most basic ways to make the ecosystem more climate-smart. Restoration in general makes ecosystems more resilient to all stressors, be it climate change, pollution, land use change, or invasive species. Specifically, more restoration projects within the St. Marys River Area of

Concern will provide more habitat for fish and other species that will be adversely affected by climate change.

Next Steps:

Steps Four and Five: Select and Implement Climate-Smart Management Options

This report of climate considerations will provide information concurrent with the engineering and design phases of the project. Project planners will determine if any climate-smart management options are necessary as the project moves forward, depending on factors including costs and benefits, feasibility, and urgency. Because of the iterative nature of climate change research, it is important that new climate information and research is taken into consideration as this project progresses. Ongoing monitoring, as part of the environmental monitoring plan, will be important once this project is completed, to evaluate predicted and unpredicted effects of climate change on the project goals and targets.

Step Six: Monitor, Review, Revise

Climate change has fundamentally changed how we must go about restoration projects. Instead of simply restoring an area to previous conditions, we must now take into account a changing climate and revisit restoration projects to be sure they are still effective. It will be more necessary than ever to regularly monitor a project's outcomes and conditions, review updated climate science, and use this information to revise project goals and approaches to be the most beneficial. We are still learning the severity of climate change in the Great Lakes, and it will be critical to Great Lakes restoration to continue to learn from and improve our projects.

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