

A Vision for the Head of
Chequamegon Bay & Fish Creek
Slough –
Notes from a December 20th, 2022
Meeting



Contents

Overview	2
Meeting Goals	2
Setting the Stage	2
What we know – Prior Research, Restoration Efforts, and Management Plans	2
Background on Proposed Dredging and the Dredge Material.....	2
Current Proposals and Future Opportunities	3
Key Takeaways from the Discussion	4
I. A Management Plan is Needed.....	4
II. Hydrodynamic Modeling is Needed.....	4
III. Nutrients and Sediments Are a Concern.....	5
IV. This is an Important Area for Birds and a Critical Stopover Area	5
V. This is an Important Fishery Area	6
VI. Climate Resiliency is a Priority	6
VII. U.S. Highway 2 Impacts the Wetland and Hydrodynamics in the Area	6
VIII. Invasive Species are a Concern	7
IX. Uses of the Dredge Material & Habitat Creation	7
X. The Area is Important to the Community	8
Next Steps	8
Appendix A. Attendee List.....	9
Appendix B. List of Resources	12
Appendix C. Action Steps Identified	14

These meeting notes were drafted on December 23, 2022. Final edits made on January 23rd, 2023. Any questions regarding the context of the meeting or what is included in the report can be directed towards:

Lacey Hill Kastern, Lake Superior Program Coordinator, WDNR, lacey.hillkastern@wisconsin.gov

Ellen Coffman, Lake Superior Sediment & Monitoring Coordinator, WDNR, ellen.coffman@wisconsin.gov

Overview

On December 20, 2022, a group of resource professionals gathered at the Northern Great Lakes Visitor Center (NGLVC) in Ashland, Wisconsin, and virtually to discuss current proposals, research needs, and opportunities for this important region in the Lake Superior Basin. A full list of attendees is in Appendix A. This document is a recap of those discussions.

Meeting Goals

1. Identify partner priorities for improving habitat and climate resiliency of Fish Creek slough and connected waters of Chequamegon Bay
2. Inform a future vision for the headwaters of Chequamegon Bay
3. Collect partner input on the potential reuse of dredged materials in Chequamegon Bay

Setting the Stage

What we know – Prior Research, Restoration Efforts, and Management Plans

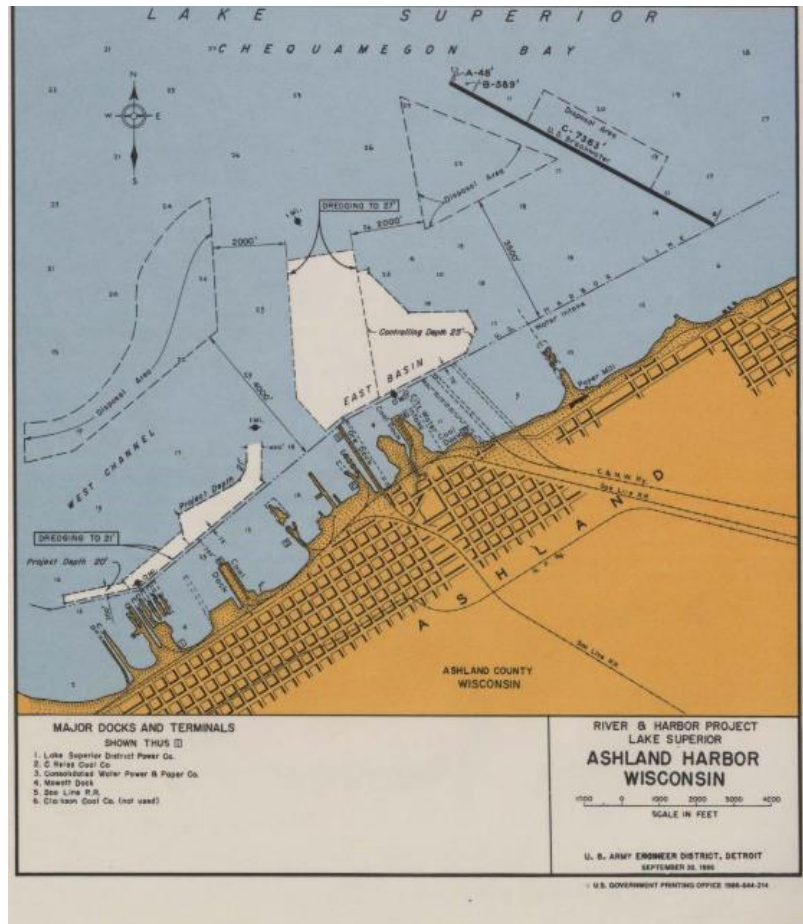
Before the meeting, a list of previous research papers, restoration efforts, and management plans was compiled. A hyperlinked list of those documents is located in Appendix B. This area is the head of Chequamegon Bay and has always been important to the region's culture and ecology. Early records tell us that this was a gathering place to many over the years for its abundance of fish and wildlife. However, human activities have dramatically altered this. For example, this area was a sluiceway to transfer logs to the mill in the logging era. Major upland and lowland vegetation changes started in the 1880s and continued through the 1920s when lumber mill spoils were dumped into the Prentice Park marsh area (Pratt, 1981). The city dump once was in this area and is now a capped landfill. There has also been dredging, filling, and rerouting of the water for a century (Bro and Fratt, 2011).

We also know that this area has numerous climate concerns, including warmer air and water temperatures, more frequent rain events, flooding, less ice cover on Lake Superior, increased wind speed from the Northeast, and increased wave action. There is also predicted to be increased bacterial and algal growth (Center for Rural Communities, 2018).

Background on Proposed Dredging and the Dredge Material

Dredging is being proposed by the U.S. Army Corps of Engineers (ACOE) in front of the Ashland Marina for routine maintenance of this site for navigation (see image on next page). Approximately 21,508 cubic yards of sediment were removed from this area in 1993 and placed upland at the Old Coal Dock in Ashland. Maintenance dredging is currently required. The current proposal is to remove around three feet of accumulated material (15,000-20,000 cu yds total). However, no suitable placement site for dredged material has been identified.

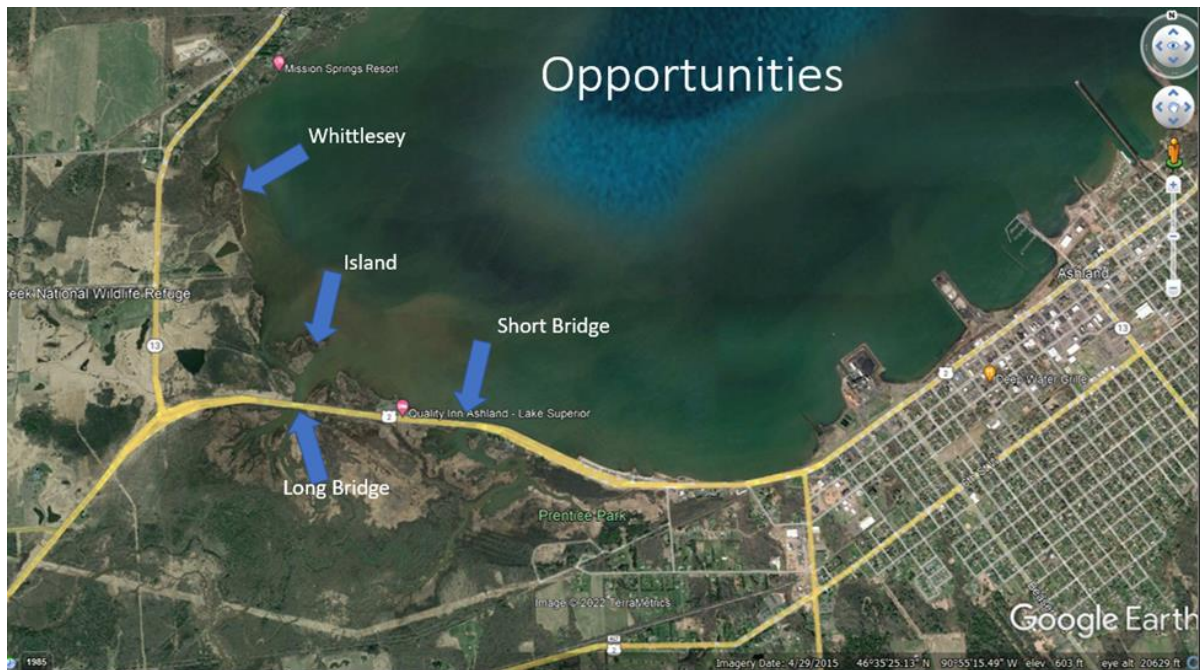
The project depth for the west basin area (the white area on the left side of the map), proposed for dredging, is 20-21ft. Sediment was sampled by the ACOE in 2010 and is considered to be chemically clean. The material ranges from 66-86% fine material. Two of the six total samples had slightly increased copper, iron, lead, and nickel concentrations from coal dock spillage. This is valuable information when considering the potential beneficial use of the material.



Current Proposals and Future Opportunities

ACOE fiscal year 2022 operation and maintenance (O&M) funds were approved for dredging work to be completed for Ashland harbor. An FY23 pre-proposal for the GLRI FA4 project was submitted by WDNR to scope the head of the Bay to determine the best way to enhance the migratory shorebird habitat. This discussion was intended to clarify what we know, what we need to know, and what is the long-term management vision of this area, including highway 2 (adjacent to the potential project area), the City of Ashland, and Whittlesey National Fish and Wildlife Refuge. One important question to remember through this process is: How do we build climate resilience in an area important to the community, fish, wildlife, and plants and maintain the high recreational value and access to this region?

To take a holistic approach, creating a vision for this area will need to include many partners and community members. This discussion was a starting point for the long-term planning efforts for this area.



Key Takeaways from the Discussion

I. A Management Plan is Needed

There has been a lot of research over the years in this area, and we know quite a bit about the Fish Creek Watershed and Chequamegon Bay. Ashland County released a Fish Creek Watershed Management Plan in 2011, but the development of an EPA-approved 9-key element plan has been identified as a priority in the Wisconsin Lake Superior Basin by partners. This 9-Key element plan will allow for additional funding to be accessed for watershed management projects. Currently, the Bayfield County Land and Water Conservation Department and the Wisconsin Department of Natural Resources have submitted an FY23 GLRI FA3 funding request to develop a 9-key element plan for this watershed.

II. Hydrodynamic Modeling is Needed

Hydrodynamic models are needed to properly assess how any changes we make may affect this region. We need to understand the history of the area to create these models. Important considerations include Traditional Ecological Knowledge (TEK), fisheries, wild rice, changing water levels, and physical and hydrological changes made by the construction, expansion, and maintenance of U.S. Highway 2. Historical aerial photos can also provide more context (i.e., the difference between the original outlet by Maslowski Beach and the channels created by the highway). Important to indicate although there have been several hydrodynamic modeling efforts by several partners in the bay, this area needs a very fine-scale sediment transport model. We need to identify the seiche's impacts and how more outflows will impact the flow dynamics. Past discussions have included upwelling impacts as important as well. There will also need to be a relative exposure index of wave energy in this portion of the Bay under different climate scenarios. Outstanding questions shared by meeting attendees included: Are there any safety concerns with climate change that the highway will need to consider? Is the highway protecting the wetland complex? We need to consult with coastal engineers and researchers with expertise in hydrodynamic modeling in the Chequamegon Bay area to answer these questions. First, there is a need to create a vision for this area or

multiple future scenarios to inform these models, and it was suggested the Cat Island Complex design in the Green Bay area could be used as a potential reference to learn more about the modeling needs.

III. Nutrients and Sediments Are a Concern

The Fish Creek Watershed has experienced sediment and nutrient issues for years, and this was amplified during extensive rainfall and flooding in 2018. During this meeting it was stated that the E. coli concern in the watershed is from human and bovine sources and needs to be addressed. Watershed land use changes over the years have altered the flow and sediment delivery dynamics in this watershed. The Bayfield County Land and Water Conservation Department, with partners, has been actively working in the headwaters of this watershed for many years to address these concerns. Armoring of the shoreline has altered the longshore transport of sediment, but the extent of this impact is still unknown.

IV. This is an Important Area for Birds and a Critical Stopover Area

This area of the Bay is a critical migration stopover site for shorebirds, waterfowl, and waterbirds, but extreme lake water levels and invasive cattails have eliminated the once-suitable and heavily-used habitat. Per WDNR avian expert Ryan Brady, many shorebird populations are down about 50% from historical numbers, partly due to the loss of stopover habitat (Pers. Comm. Ryan Brady, 2022). There was also a previous shrub planting efforts to help capture sediment near the mouth of Fish Creek that may have led to the reduction of mudflat habitat in this area.

Primary benefits of habitat enhancement will be aimed at spring and fall migratory stopover habitats for rare and declining shorebirds, including:

1. Piping Plover – SGCN, State endangered, federally endangered
2. Red Knot – SGCN*, State Special Concern, federally threatened
3. Marbled Godwit – MLI** Regional SGCN
4. Buff-breasted Sandpiper – MLI** Regional SGCN
5. Semipalmated Sandpiper – MLI** Regional Watchlist
6. In addition, the following species do not yet have any state or federal priority status but are experiencing concerning population declines:
 - a. Pectoral Sandpiper
 - b. Hudsonian Godwit
 - c. Lesser Yellowlegs
 - d. Black-bellied Plover
 - e. Short-billed Dowitcher
 - f. Dunlin
7. At least a dozen additional shorebird species will also use this enhanced habitat, including Semipalmated Plover, Sanderling, Greater Yellowlegs, Least Sandpiper, and more.

Secondary benefits, mostly as resting and roosting sites, will be provided to:

1. Black Tern – SGCN, state endangered, MLI** Regional SGCN
2. Common Tern – SGCN, state endangered
3. Forster's Tern – SGCN, state endangered
4. Caspian Tern – SGCN, state endangered

Other species likely to use this habitat include the American White Pelican, Bald Eagle, ducks (including the blue-winged teal), geese, swans, and gulls.

*SGCN = Species of Greatest Conservation Need

<https://dnr.wi.gov/topic/endangeredresources/Animals.asp?mode=listandGrp=7>

**MLI = Midwest Landscape Initiative <https://www.mlimidwest.org/>

**MLI = Midwest Landscape Initiative <https://www.mlimidwest.org/>

V. This is an Important Fishery Area

DNR Fisheries recognizes the sloughs as important habitat for natural reproduction of such species as Northern Pike and Yellow Perch, and also stresses the importance of maintaining an open corridor equal to or better than the existing condition for migratory Lake Superior salmonids that use Fish Creek for spawning and rearing. Whatever projects take place in this area should also include fisheries managers. More connectivity between the coastal wetland and the Bay would benefit the fishery. Increasing surface area of wetland would be a fisheries benefit – as long as good channels still exist to provide trout/salmon passage to the stream. The State of Wisconsin does netting surveys in the watershed and knows that sea lampreys are present.

Concern regarding the placement of fine grain sediment in the system was expressed by fisheries biologists, that the sediment may have an impact on spawning habitat. Negative impacts on spawning and juvenile nursery habitats (submerged vegetation) could occur in the area if the fine material is not stable – which is the concern. On the other hand – vegetated islands would likely have a positive fishery impact, if they are stable, slow flow, reduce sediment input, and provide more submerged vegetation. There are currently many efforts to reduce sediment loading to the Head of the Bay from Fish Creek. Would the benefits that the birds experience from habitat creation outweigh the potential negative consequences of additional fines in the system?

The traditional ecological knowledge of the historical fishery should be researched, and there need to be more biological inventories on the mussels, turtles, invertebrates, herptiles, dragonflies, damselflies, fish, and other co-species in this coastal wetland. We need to learn more about the nearshore population of organisms and their abundance.

VI. Climate Resiliency is a Priority

History shows this is a flashy watershed prone to flooding. Wind, waves, and seiche all influence the Sloughs area. Wind speeds are predicted to increase 5-10% per decade, increasing the wave energy in this area. There is a need for hydraulic modeling to fully understand the highway's impact and what opportunities exist to reduce channelization, slow the flow, and improve the coastal wetland's connectivity with Chequamegon Bay. Increased probability of storm surges could damage key habitats. Human and ecological health are important considerations when determining how to build resiliency.

VII. U.S. Highway 2 Impacts the Wetland and Hydrodynamics in the Area

A large part of the conversation focused on how significantly US2 has affected this coastal wetland complex and the Head of Chequamegon Bay. The US2 Causeway has drastically altered and restricted the water flow in this area. A concern that was brought up was, "How can we minimize the impacts of this manmade disturbance while still providing safe transportation?"

Two bridges were installed on U.S. 2 in Ashland in 1991. Both have a 50-year life expectancy before major work needs to be done. Questions posed on this topic were: What would an extended bridged highway cost and feasibility be in this area? Is that needed? What is the cost-benefit of the highway cutting through

this wetland right on the Lake? Would relocation be a feasible option? Most of the infrastructure in this watershed is undersized and unable to deal with current flood conditions, threatening the infrastructure and ecosystems in this area.

VIII. Invasive Species are a Concern

Overall, many invasive species are present within the Fish Creek Sloughs. Prentice Park has an overall species diversity concern and is dominated primarily by dense monotypic stands of hybrid cattails (*Typha x. glauca*).

Discussions regarding invasive species management centered on increased use of biocontrol to manage Purple Loosestrife, potential control of monotypic cattail stands (increasing interspersed and biodiversity), and preventing the further spread of Eurasian watermilfoil into the Fish Creek Sloughs area.

Current efforts related to invasive species include early detection monitoring efforts, control (Moneywort and Purple Loosestrife), and efforts in Prentice Park completed by the City of Ashland.

Species Currently Present:

- Hybrid Cattail (*Typha x. glauca*)
- Narrow Leaf Cattail (*Typha angustifolia*)
- Purple Loosestrife (*Lythrum salicaria*)
- Eurasian Water-Milfoil (*Myriophyllum spicatum*)
- Common Buckthorn (*Rhamnus cathartica*)
- Glossy Buckthorn (*Frangula alnus*)
- Moneywort (*Lysimachia nummularia*)
- Yellow Iris (*Iris pseudacorus*)
- Non-Native Honeysuckle's (*Lonicera* spp.)

Species of Concern (Not Present):

- Non-Native Phragmites (*Phragmites australis* subsp. *australis*)
- European Frogbit (*Hydrocharis morsus-ranae*)
- Reed mannagrass (*Glyceria maxima*)
- Curly Leaf Pondweed (*Potamogeton crispus*)

IX. Uses of the Dredge Material & Habitat Creation

Through discussions, we identified alternative uses for the dredge material. In Ashland and Bayfield counties, large manure pits are looking for fill. There was a lot of support and discussion regarding the creation of islands in the head of the Bay. A smaller version of the Cat Island complex in Green Bay will be a good example of design ideas for this area. Some additional research will be done to explore the feasibility of this idea. Wing dams at varying depths that could diversify the habitat at different lake water levels are also an idea to explore. We will present some of the ideas and modeling needs to the USACE for additional input and discussion.

Wave control structures could be added to this area to help create fish and waterfowl habitats. Rock weirs or dikes could help expand the wetland area past the highway and into the Bay, creating more habitat.

Wetland scrapes in the Sloughs area were also an idea that was presented: Here's the journal article referenced for the Halfway wetland scrapes and nutrient load reductions:

<https://access.onlinelibrary.wiley.com/doi/epdf/10.2134/jeq2012.0248>

X. The Area is Important to the Community

This area is important to the surrounding communities for many reasons. There are opportunities to increase this area's value by adding recreational opportunities that don't detract from current opportunities. There are currently two boat landings, one at Long Bridge and one at Short Bridge, that the WDNR maintains. Access for fishing, hunting, bird watching, kayaking, etc., should be maintained for the various user groups. The Long Bridge boat landing is for only small vessels, mostly canoes, kayaks, and small duck boats. The Short Bridge boat landing is where most fishing boats launch; they can be restricted by passage underneath the short bridge depending on the water level, seiche, and wave energy.

Duck hunters have expressed concern over the years about the deteriorating habitat for waterfowl and hunting opportunities within the Bay over the last few years of high water. Many people fish in this area, and there is an opportunity to create more rocky areas for walleye spawning; the Bay offers limited rocky spawning habitat. This area is also heavily used by birders and others that enjoy the connection. Business owners are also concerned about flooding, shoreline erosion, and wave energy in this area. There is a great opportunity to connect with the community and collaboratively enhance the opportunities in this area.

Next Steps

On January 24, 2023, there will be a discussion led by Matt Hudson from Northland College and Ben Lee from Fish Creek Restoration, LLC about the sediment reduction efforts in the North Fish Creek Watershed. At this meeting, there will be a discussion on the historical research that laid the scientific foundation for the ongoing streambank stabilization and sediment reduction efforts in this watershed. There will be a discussion on what the future of these efforts should be if a FEH study is prioritized in the watershed. There will also be a discussion on how these efforts can complement and align with a proposed nine-key-element plan for this watershed.

Nine key element plans provide a framework for improving water quality within a watershed. These plans help prioritize the efforts occurring. We also want to look at the overall habitat needs in the Fish Creek watershed and Head of Chequamegon Bay and also discuss how to build climate resiliency and enhance community use and opportunities. WDNR and the Lake Superior Collaborative will discuss with USFWS the possibility of a Landscape Conservation Design or Blueprint for this area that will complement the nine-key element planning and provide a framework for reaching the overall vision of this area.

WDNR will have continued discussions with USACE about the beneficial use of dredge material in the Chequamegon Bay Region and will also discuss the need for climate resiliency and coastal engineering with nature.

In 2023, there will be more discussions with partners and the community about this area's long-term needs and vision. Appendix C of this document provides a bulleted list of action steps assembled from this meeting. Not all actions have an identified lead. Please reach out if you have additional information, resources or can take the lead on any identified actions in this document.

This document provides the direction on what currently exists and what information is needed. Thank you for your contributions.

Appendix A. Attendee List

Name	Title	Affiliation	Email	
Aaron Gustafson	Northwest Region Technical Services Supervisor	WI DOT	aaron.gustafson@dot.wi.gov	Virtual
Alex Faber	Executive Director	SRWA	alex@superiorrivers.org	In Person
Alex Selle	Lake Superior AIS Coordinator	WDNR OGW	Alexander.Selle@wisconsin.gov	In Person
Allison Carl	Water Resources Program Manager	Red Cliff TNR Division	Allison.Rakowski@redcliff-nsn.gov	In Person
Andrew Edwards	Interim TNR Division Administrator	Red Cliff TNR Division	andrew.edwards@redcliff-nsn.gov	In Person
Ben Dufford	Land & Water Conservation Director	Bayfield County Land & Water	ben.dufford@bayfieldcounty.wi.gov	In Person
Ben Lee	Senior Water Resources Engineer	Fish Creek Consulting	ben@healthystreams.com	Virtual
Brian Glenzinski	Wisconsin Regional Biologist	Ducks Unlimited	bglenzinski@ducks.org	Virtual
Bridget Olson	Project Leader - Whittlesey & St Croix Wetland Management Districts	USFWS	bridget_olson@fws.gov	In- person
Chris Collier	Great Lakes Stream Restoration Manager	Trout Unlimited	Chris.Collier@tu.org	Virtual
Dave Grandmaison	St. Louis River Wild Rice Restoration & Habitat Project Coordinator	WDNR	david.grandmaison@wisconsin.gov	Virtual
Dray Carl	Lake Superior Fisheries Biologist	WDNR Fisheries	Dray.Carl@wisconsin.gov	In Person
Eddie Shae	Wildlife Biologist- Ashland & Bayfield Counties	WDNR Wildlife Management	Eddie.Shea@wisconsin.gov	Virtual

Ellen Coffman	Lake Superior Sediment & Monitoring Coordinator	WDNR OGW	ellen.coffman@wisconsin.gov	In Person
Erin Burkett	Lake Superior Collaborative Coordinator	Lake Superior Collaborative	erin.burkett@wisc.edu	In Person
Faith Fitzpatrick	Research Hydrologist - Hydrogeomorphology	USGS	fafitzpa@usgs.gov	Virtual
Ian Harding	Fisheries	Red Cliff TNR	Ian.Harding@redcliff-nsn.gov	In Person
Jessica Jacobson	Wetlands	Red Cliff TNR	Jessica.Jacobson@redcliff-nsn.gov	In Person
Kevin Brewster	Project Manager	SRWA	kbrewster@superiorrivers.org	In Person
Lacey Hill Kastern	Lake Superior Project Coordinator	WDNR OGW	Lacey.hillkastern@wisconsin.gov	In Person
Louis Lozinski	Ornithologist	Mashkiiziibii NRD	Ornithology@badriver-nsn.gov	In-Person
Matt Hudson	Associate Director - Great Lakes - Mary Griggs Burke Center for Freshwater Innovation	Northland College	mhudson@northland.edu	In Person
Matthew Cooper	PI Coastal Wetland Monitoring Program	Central Michigan University	Coope3mj@cmich.edu	Virtual
Mitchell Baalman	Whittlesey Creek National Wildlife Refuge Specialist	USFWS	mitchell_baalman@fws.gov	In-person
Paul Piszczek	Lake Superior Tributary Fisheries Biologist	WDNR Fisheries	Paul.Piszczek@wisconsin.gov	Virtual
Ryan Brady	Conservation Biologist	WDNR NHC	ryans.brady@wisconsin.gov	In Person
Sara Hudson	Director, Ashland Parks & Recreation	City of Ashland	shudson@coawi.org	In-person
Shawn Haseleu	Environmental Analysis Review Specialist	WDNR EAS	Shawn.haseleu@wisconsin.gov	Virtual

Sophie LaFond-Hudson	Wisconsin Sea Grant J. Philip Keillor Great Lakes Fellow	Wisconsin Sea Grant & WDNR OGW	sophie.lafondhudson@wisconsin.gov	Virtual
Tom Prestby	Wisconsin Conservation Manager	Great Lakes Audubon	thomas.prestby@audubon.org	Virtual

Appendix B. List of Resources

Fish Creek/Chequamegon Bay Research List

- Bayfield County Land and Water Conservation Committee and Department. 2010. Land and Water Resource Management Plan. <https://www.bayfieldcounty.wi.gov/DocumentCenter/View/1058/LWRMP-full?bidId=>.
- Blodgett, D.L. 2009. Modeling flood flow reduction for bluff erosion mitigation using upland runoff attenuation on north Fish Creek, Bayfield County, Wisconsin. Masters Thesis. Water Resources Engineering, University of Wisconsin-Madison.
- Bro, K. M., & Fratt, T. W. 2011. Fish creek watershed restoration and management plan. Ashland County Land and Water Conservation Department, Ashland, WI. https://drive.google.com/file/d/1pIIS31Kd7SLLMvIE3Cjv-XyeOIgvODL5/view?usp=share_link
- Center for Rural Communities. 2018. Chequamegon Bay Area Community Study. <https://www.northland.edu/wp-content/uploads/2018/08/CBA-Climate-Change-Study-2018.pdf>
- City of Ashland Source Water Protection Committee. 2021. City of Ashland Source Water Protection Plan. <https://www.coawi.org/DocumentCenter/View/1903/Final-City-of-Ashland-Source-Water-Protection-Plan-July-2021>.
- Fitzpatrick, F. A. 1998. Geomorphic and hydrologic responses to vegetation, Climate, and Base Level Changes, North Fish Creek, Wisconsin, Ph.D. Dissertation, Department of Geography, University of Wisconsin. Madison. <http://wi.water.usgs.gov/professional-pages/pdf/FitzpatrickDissertation1998.pdf>
- Fitzpatrick, F. A., Knox, J. C., & Whitman, H. E. 1999. Effects of Historical Land Cover Changes on Flooding and Sedimentation, North Fish Creek, Wisconsin. USGS Water-Resources Investigations, 2, 12. <https://pubs.usgs.gov/wri/1999/4083/report.pdf>
- Fitzpatrick, F.A., et. Al. 2004. Monitoring channel morphology and bluff erosion at two installations of flow-deflecting vanes, North Fish Creek, Wisconsin, 2000-03. USGS Publications. https://pubs.usgs.gov/sir/2004/5272/pdf/SIR_2004-5272.pdf
- Huff, A. and A. Thomas. 2014. Lake Superior Climate Change Impacts and Adaptation. Prepared for the Lake Superior Lakewide Action and Management Plan – Superior Work Group. Available at <http://www.epa.gov/glnpo/lakesuperior/index.html>
- Kemkes, R., A Tochtermann, and B. Hofstedt. 2018. Chequamegon Bay Area Community Climate Change Study: Ashland, Bayfield, Red Cliff, Washburn. <https://www.northland.edu/wp-content/uploads/2018/08/CBA-Climate-Change-Study-2018.pdf>
- Lake Superior Research Institute & Wisconsin DNR. 2019. Lake Superior Coastal Wetland Invasive Species Early Detection and Rapid Response (LS3) Project #: GI-00E01987_LS1603_ISEarlyDetection, Fish Creek Slough. https://drive.google.com/file/d/1rU4aXm8vf6ZJmU_6UTHyiRpps9tMgG-p/view?usp=share_link
- Lehr, R., & Hudson, M. 2019. Identifying Nutrient and Sediment Sources in Chequamegon Bay Area Tributaries.
- Meador, R. (2019). Water Quality Concerns on the South Shore of Lake Superior. <https://www.wpr.org/sites/default/files/ijc-white-paper-interactive.pdf>

- Northland College – Center for Rural Communities. 2019. Climate Change Adaptation Planning Guide for Chequamegon Bay Area. <https://www.northland.edu/centers/crc/data-visualizations/climate-change-database/>
- Peppler, M.C., 2006, Effects of magnitude and Duration of Large Floods on Channel Morphology: A Case Study of North Fish Creek, Bayfield County, Wisconsin, 2000-2005, M.S. Thesis, Department of Geography, University of Wisconsin-Madison. http://wi.water.usgs.gov/professional-pages/pdf/PepplerThesis061306_000.pdf
- Potter, K. W., D. S. Liebl, Z. Schuster, and V. Cottle. 2010. "Wisconsin Initiative on Climate Change Impacts Stormwater Working Group Report: Stormwater Management in a Changing Climate: Managing High Flow and High Water Conditions in Wisconsin." The University of Wisconsin-Madison. Madison, Wisconsin.
- Pratt, D.M. 1981. Environmental and Public Use Inventory of the Fish Creek Sloughs Project Area. Wisconsin DNR. https://drive.google.com/file/d/1sJQVMrPnm66PEVk1EpgKi4-PgM6VgKdi/view?usp=share_link
- Rose, W.J. & Graczyk, D.J. 1996. Sediment transport, particle size, and loads in North Fish Creek in Bayfield County, Wisconsin, water years 1990-91. <https://pubs.usgs.gov/wri/1995/4222/report.pdf>
- WDNR Water Quality Bureau. 2020. [South Fish Creek Targeted Watershed Assessment: A Water Quality Report to Restore Wisconsin Watersheds.](#)

Appendix C. Action Steps Identified

Below is a list of action items and the next steps

1. WDNR will continue to work with Bayfield County to pursue funding opportunities to kick off the Nine Key Element Planning process for the Fish Creek Watershed
2. There will be continued discussion with USFWS regarding the Headwaters to Coast Initiative and the role that the Initiative will play in these efforts moving forward
3. There will be discussions between Lake Superior Collaborative, WDNR, and USFWS to discuss a blueprint planning process similar to the approaches in the St. Louis River Estuary and Green Bay. Developing a Landscape Conservation Design for Chequamegon Bay will complement the Fish Creek Watershed's nine key element planning efforts and include more habitat and community components.
4. WDNR will continue conversations with the USACE regarding the beneficial use of dredge material, building coastal resiliency in the Head of Chequamegon Bay, looking at habitat improvements, and discussing coastal engineering with nature opportunities. Other ideas to explore include wing dams at varying depths that could diversify the habitat at different lake water levels.
5. WDNR will discuss with NOAA the scale of Bathymetry mapping completed in the Chequamegon Bay area and the additional data needs.
6. The possibility of a very fine-scale sediment transport model will be investigated. A lead will need to be identified.
7. An evaluation of the seiche's impacts and how more outflows will impact the flow dynamics is needed. There will also need to be a relative exposure index of wave energy in this portion of the Bay under different climate scenarios. A lead will need to be identified.
8. There is a need for hydraulic modeling to fully understand the highway's impact and what opportunities exist to reduce channelization, slow the flow, and improve the coastal wetland's connectivity with Chequamegon Bay.
9. Investigate how to complete more biological inventories on the mussels, turtles, invertebrates, herptiles, dragonflies, damselflies, fish, and other co-species in the coastal wetland.
10. Investigate how to gather more information about the lower trophic communities and abundance in the nearshore of this area.
11. WDOT will be involved in future conversations regarding this area's vision. We will continue to discuss the US2 causeway and how we can work together to build resiliency and improve this area.
12. Invasive species priorities identified include increased use of biocontrol to manage Purple Loosestrife, potential control of monotypic cattail stands (increasing interspersed and biodiversity), and preventing the further spread of Eurasian watermilfoil into the Fish Creek Sloughs area.