PUBLIC COMMENT DRAFT

St. Louis River Area of Concern

Beneficial Use Impairment Removal Recommendation for

Degraded Fish and Wildlife Populations

Date, 2022

Submitted to:

U.S. EPA-Region 5

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List of Acronyms

- AOC – Area of Concern
- BUI – beneficial use impairment
- CPUE – Catch per unit effort
- CWA – Clean Water Act
- DLC – Dioxin-like chemical
- FdL – Fond du Lac Band of Lake Superior Chippewa
- MA – management action
- MLT – Minnesota Land Trust
- MNDNR – Minnesota Department of Natural Resources
- MPCA – Minnesota Pollution Control Agency
- NRRI – Natural Resources Research Institute
- PIT – Passive Integrated Technology
- PSD – Proportional stock density
- AOC – Remediation to Restoration
- RAP – Remedial Action Plan
- RST – Restoration Site Team
- SEH – Short, Elliot, and Hendrickson
- SLRA – St. Louis River Alliance
- SLRAOC – St. Louis River Area of Concern
- SLRE – St. Louis River Estuary
- SR – Species Richness
- USACE – United States Army Corps of Engineers
- USFWS – United States Fish and Wildlife Service
- WDNR – Wisconsin Department of Natural Resources
- WLSSD – Western Lake Superior Sanitary District

Executive Summary

Background

The United States and Canada designated 43 Areas of Concern (AOC) across the Great Lakes in 1987, including the St. Louis River Area of Concern (SLRAOC). The AOCs were designated because significant environmental damage at those locations caused specific types of Beneficial Use Impairments (BUIs). At the time of AOC designation, the International Joint Commission identified 14 BUIs in the Great Lakes Water Quality Agreement that were to be assessed at each AOC to determine their applicability. Only nine BUIs applied to the SLRAOC. Once the BUIs were identified, removal targets for each were established and management actions (MAs) to achieve the targets for each BUI were identified.

Once the MAs for a BUI are completed and removal targets are met, a removal package is prepared for public review and, ultimately, concurrence by the U.S. Environmental Protection Agency.

This document provides the justifications supporting a removal recommendation for the Degraded Fish and Wildlife Populations BUI (BUI 2) for the SLRAOC. All six MAs that apply to BUI 2 are complete and the BUI 2 removal target has been met. The removal criteria and brief conclusions pertaining to the studies applicable to each are included in this executive summary. Detailed summaries of the studies and findings for each MA are included in the main body of this document, while the study reports prepared for each management action are included in the appendices.

The non-regulatory AOC program was established to address "legacy" issues. These were environmental problems that caused ecosystem impairments at the time of the AOC designation and largely occurred before modern environmental regulations were in place. Legacy issues significantly impacted geographically-defined sites rather than regional-scale stressors.

For the SLRAOC, examples of legacy issues are: unregulated discharge of industrial and municipal waste, dredging and filling in the estuary, wood waste deposited in the river, and extensive logging which exacerbated erosion and sedimentation problems. Since the time of these legacy impacts, the Clean Water Act (CWA) and other environmental regulations were enacted to protect the environment and human health from these types of large-scale problems.

The scope of the AOC program does not include "modern" issues that are the responsibility of variety of state, tribal, and federal agencies under existing natural resources, environmental, and public health program authorities. Some examples of modern issues are: contaminants of emerging concern, water-related climate change impacts, non-compliance with point source permits, and impairments identified and regulated under the CWA.

The Removal Target Has Been Met

The removal target will have been met when:

> *In consultation with their federal, tribal, local, and nonprofit partners, state resource management agencies concur that diverse native fish and wildlife populations are not limited by physical habitat, food sources, water quality, or contaminated sediments* (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2008).

Removal of BUI 2 will be justified when resource management agencies (Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, and Wisconsin Department of Natural Resources) concur that key native species populations of fish and wildlife are present and not limited by the legacy impairments referenced by the removal target. This is demonstrated by addressing the specific removal objectives for the fish and wildlife species listed below. Removal objectives were established to help identify key species, establish specific management actions, and guide AOC managers toward achieving the removal target. All removal objectives have been met except the Lake Sturgeon objective. Species monitoring has shown the Lake Sturgeon-specific removal objective metric has not yet been met, however resource managers have completed additional studies to justify BUI removal as described in the summary of Management Action 2.02 (p.25) and detailed in **Appendix D**.

Successfully completing management actions triggers a review to verify the removal objectives and target have been achieved. Removal is justified because the objectives and management actions identified as priorities for BUI 2 were successfully addressed. Removal is recommended while acknowledging that St. Louis River fish and wildlife populations may continue to face limitations caused by physical habitat, food sources, water quality, or contaminated sediments. Limitations caused by legacy contamination and habitat loss will be further addressed through remaining AOC management actions and natural resource improvements outside of the AOC program.

Fish

The following BUI 2 objectives were developed for target native and invasive fish species:

- Walleye gillnet catch per unit effort (CPUE) is maintained at or above 5.0 per lift with a proportional stock density between 30 and 60 in at least 50% of years surveyed since 2000.
- Muskellunge trap net CPUE is maintained at or above 1.0 per lift in at least 50% of years surveyed since 1997.
- Document an increasing trend of two to five year old Lake Sturgeon captured in summer index nets, with at least two index values greater than 2.0 per gillnet lift.
- An analysis of historical data that shows the Ruffe, an invasive species, is not inhibiting the native fish population.

CONCLUSION: Populations of Walleye and Muskellunge in the St. Louis River are meeting or exceeding the established objectives and invasive Ruffe are no longer inhibiting native fish populations. While Lake Sturgeon populations are not trending towards recovery goals, research indicates they are not accumulating legacy contaminants at levels that impact reproduction and are likely limited by factors outside of the AOC program's Degraded Populations focus.

Wildlife

The following BUI 2 removal objectives were established for target wildlife species:

- Piping Plover nesting habitat is created with the SLRAOC.

- Common Tern nesting habitat at Interstate Island is restored and state agencies continue to support habitat management and population monitoring there.
- Great Blue Heron and Bald Eagle presence is recorded during one or more nesting seasons since 1997.
- Wetland bird species are surveyed and compared with 1979 survey results.
- A survey of semi-aquatic mammals in the estuary verifies that the status of small mammal species in the St Louis River Area of Concern is sufficient to remove the beneficial use impairment.

CONCLUSION: Removal objectives for wildlife were achieved. Species including Great Blue Heron and Bald Eagle met numeric targets, while wetland bird species at Remediation to Restoration sites were surveyed and found to have greater abundance and similar species richness when compared to reference sites and similar species richness when compared to historical surveys. Four species of semi aquatic mammals were surveyed and found to be similar to reference populations. Habitat restoration projects targeting Piping Plover and Common Tern were implemented to address legacy habitat loss, which includes long-term monitoring and maintenance.

Developing the Removal Package

Multiple BUI Technical Teams of subject matter experts were established to evaluate the removal strategy and review the findings from each study and offer recommendations to address any deficiencies until the target and criteria were met.

A public information process was conducted to obtain input from interested parties on the information provided in the removal package.

The BUI 2 Removal Target requires concurrence from resource managers. This is accomplished by reviewing the final recommendation with the AOC Leadership Team, comprised of lead supervisors from the Fond du Lac Band of Lake Superior Chippewa and three state agencies (Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, and Wisconsin Department of Natural Resources.) Upon gaining concurrence from the AOC Leadership Team, the final recommendation is shared with the Interagency Manager's Team. Managers from the three state agencies comprise this team and provide final concurrence and authorization to submit the final BUI removal package to EPA.

Multiple lines of evidence support a removal recommendation for this BUI. The results of the BUI 2 studies, successful implementation of required restoration projects, along with support from the BUI 2 Technical Teams, SLRAOC partners, and stakeholders have resulted in this recommendation by the SLRAOC Coordinators, leaders, and executive managers to remove the Degraded Fish and Wildlife Populations BUI from the SLRAOC.

Purpose

The purpose of this document is to provide the information needed to support a recommendation to remove the Degraded Fish and Wildlife Populations Beneficial Use Impairment (BUI) in the St. Louis River Area of Concern (SLRAOC).

St. Louis River Area of Concern Background

The 1987 US-Canada Great Lakes Water Quality Agreement designated the SLRAOC as one of 43 areas with significant environmental degradation. The SLRAOC is spatially large and geographically complex, spanning the Minnesota and Wisconsin state line and including tribal interests (Figure 1).

The SLRAOC program is jointly managed by four implementing agencies: the Fond du Lac Band of Lake Superior Chippewa (FdL), the Minnesota Department of Natural Resources (MNDNR), the Minnesota Pollution Control Agency (MPCA), and the Wisconsin Department of Natural Resources (WDNR). MPCA and WDNR are the delegated authorities that manage official transactions with the U.S. Environmental Protection Agency - Great Lakes National Program Office. Dozens of stakeholder organizations are also involved in activities related to the SLRAOC.

Efforts to remove the BUIs are located primarily within the 12,000-acre St. Louis River Estuary (SLRE), where water from the St. Louis River and Lake Superior mix. The twin port cities of Duluth, MN and Superior, WI are located on either side of the estuary.

A Stage I Remedial Action Plan (RAP) identified these nine BUIs (MPCA and WDNR, 1992):

1. Restrictions on Fish and Wildlife Consumption
2. Degradation of Fish and Wildlife Populations
3. Fish Tumors or Other Deformities; removed in 2017
4. Degradation of Benthos
5. Restrictions on Dredging Activities
6. Eutrophication or Undesirable Algae (SLRAOC name: Excessive Loading of Sediment and Nutrients); removed in 2020
7. Beach Closings (SLRAOC name: Beach Closing and Body Contact Restrictions)
8. Degradation of Aesthetics; removed in 2014
9. Loss of Fish and Wildlife Habitat

A Stage II RAP was completed in 1995 and it was later superseded by the 2013 St. Louis River Area of Concern Implementation Framework: Roadmap to Delisting (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 1995). The 2013 RAP (Roadmap) was a comprehensive listing of the BUIs, their removal targets, and the management actions (MAs) needed to achieve those targets (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2013). The 2013 RAP has been updated annually thereafter to document progress and changes to the RAP implementation plan and schedule.

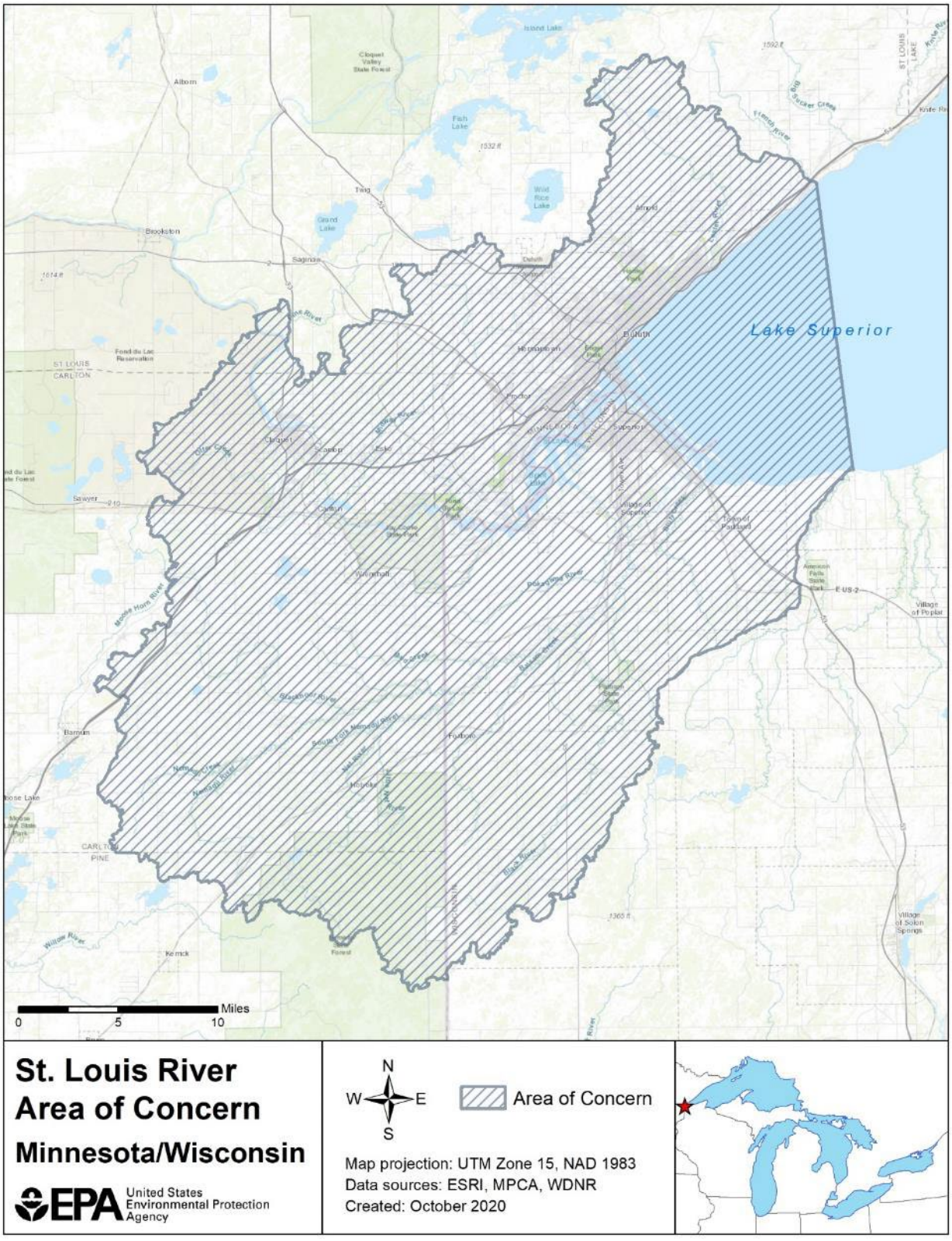
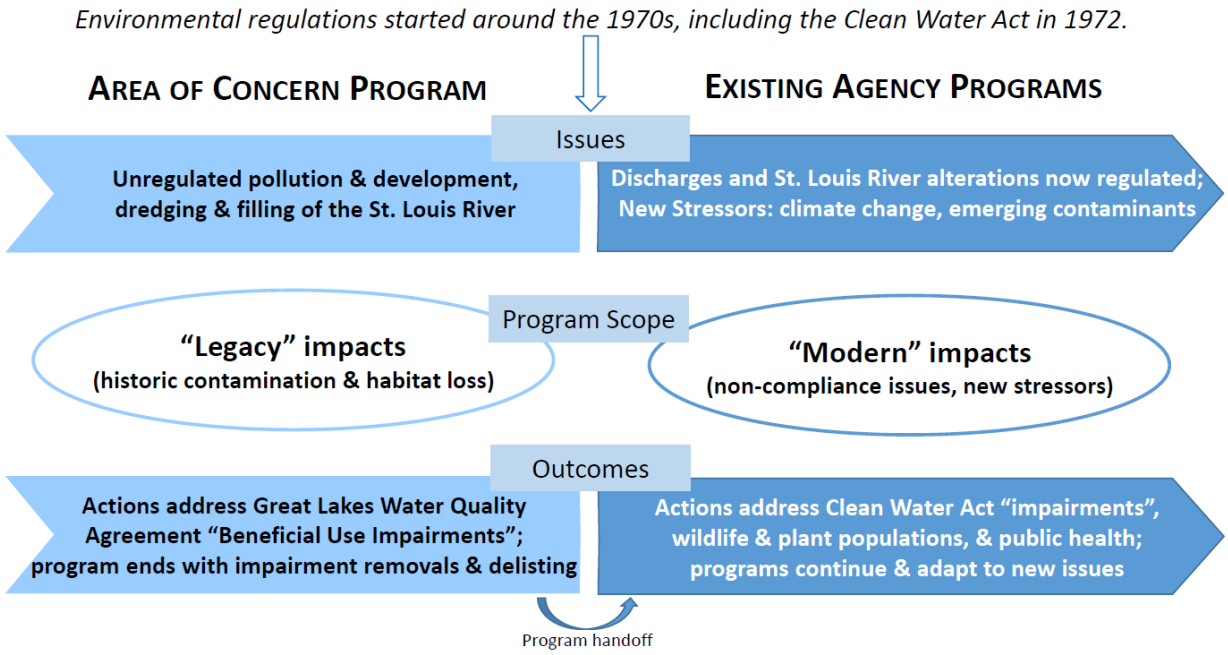


FIGURE 1. EXTENT OF THE ST. LOUIS RIVER AREA OF CONCERN

It is important to understand that the non-regulatory AOC program was created to address "legacy" issues or environmental problems that caused ecosystem impairments at the time of the AOC designation and largely occurred before modern environmental regulations were in place. Legacy issues addressed by the AOC program include stressors which significantly impacted specific, geographically-defined sites as opposed to regional-scale stressors.

For the SLRAOC, examples of legacy issues are unregulated discharge of industrial and municipal waste, dredging and filling in the estuary, wood waste deposited in the river, and extensive logging which exacerbated erosion and sedimentation problems. Since the time of these legacy impacts, the Clean Water Act (CWA) and other environmental regulations were enacted to protect the environment and human health from these types of large-scale problems.

The scope of the AOC program does not include "modern" issues that are the responsibility of a variety of state, tribal, and federal agencies under existing natural resources, environmental, and public health program authorities. Some examples of modern issues are: contaminants of emerging concern, climate change impacts, non-compliance with point source permits, and impairments identified and regulated under the CWA. Figure 2 depicts the differences between the AOC and existing agency programs.



The same environmental and natural resource agencies that implemented the Area of Concern Program will address ongoing issues after the Program has ended, but under different program authorities. This will include long-term monitoring and maintenance of remediation and habitat projects, species management, and regulatory enforcement.

FIGURE 2. "LEGACY VS MODERN"-THE PROGRAM SCOPE OF THE ST. LOUIS RIVER AREA OF CONCERN

Sustaining healthy populations of fish and wildlife in the St. Louis River requires actions to address both legacy and modern impacts. As it relates to the removal of the Degraded Fish and Wildlife Populations BUI discussed in this report, consider the successful nesting of Piping Plover, a federally listed bird species. Plover nest exclusively on unvegetated shoreline, a habitat type lost in the SLRE due to legacy development for industry and navigation. The SLRAOC program can be used to address this legacy impact by creating, restoring, and maintaining Piping Plover habitat. Other factors that influence successful Piping Plover nesting include disturbance by humans and dogs, predation, and regional population trends. These are modern impacts that must be addressed by public land managers and through community outreach and monitoring programs but is not the responsibility of the SLRAOC program. The Future Actions section of this document lists a variety of future needs to be addressed by other agency programs.

BUI Information and Background

Rationale for Listing (1992)

An impairment will be listed when fish and wildlife management programs have identified degraded fish or wildlife populations due to a cause within the watershed. In addition, this use will be considered impaired when relevant, field-validated, fish or wildlife bioassays with appropriate quality assurance/quality controls confirm significant toxicity from water column or sediment contaminants. SLRAOC partners worked together to develop the following rationale for the 1992 Stage 1 RAP (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 1992):

> *During the period of severe organic pollution before 1979, fish populations were degraded and fish kills were common. Fish populations have been recovering from that era because of improvements in wastewater treatment. However, fish populations are now adversely affected by the proliferation of the Ruffe, an exotic species first found in the AOC in 1987. Other exotics threaten fish populations. The potential effects of toxic substances on fish population health in the AOC is largely unknown. Continuing loss of physical habitat also threatens populations. The loss of wetland habitat and the infestation of the exotic plant, purple loosestrife, have the potential to cause declining fish and wildlife populations. Little population data are available for wildlife with the exception of colonial nesting birds in the AOC. Populations of the Common Tern and the Piping Plover (threatened and endangered species) have declined, probably due to a combination of local and regional factors.*

Since 1979, fish populations have been recovering because of improved water quality that resulted from more complete wastewater treatment after formation of the Western Lake Superior Sanitary District (WLSSD), construction of the WLSSD wastewater treatment plant, and improvement of City of Superior wastewater treatment. However, at the time of listing, fish populations remained adversely affected by alterations and loss of habitat, proliferation of exotic species, and possibly by exposure to toxic substances.

At the time of listing, little population data were available for wildlife except for colonial nesting birds, herons, and gulls. Populations of the Common Tern and the Piping Plover (threatened and endangered species) and Great Blue Heron had declined. Gulls and Mallards had experienced die-offs in the recent past. These problems were attributed to alteration or loss of habitat and possibly toxic contamination.

Early BUI Recommendations (1995)

Following the 1992 Stage I RAP, discipline-specific working groups were formed to systematically evaluate BUIs and develop recommendations for activities to address the impairments. The work groups followed a protocol, generating a list of 43 approved recommendations, which were presented in a 1995 RAP Progress Report

(Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 1995). Specifically, the Habitat Work Group generated the following recommendations related to fish, wildlife, and invasive species.

Fish

The 1995 RAP Progress Report identified three recommendations related to fish (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 1995). One ("Ruffe") is addressed in the BUI Removal objectives for fish in the 2013 RAP (see Section 4.3.1). Two others "Fish Stranding" and "Dam Relicensing" were addressed prior to 2013 through changed requirements to operation of the Fond du Lac Dam as part of the license issued in 1995 (United States Federal Energy Regulatory Commission 1995) by the United States Federal Energy Regulatory Commission (FERC) and by the updated five-year operating plans submitted by Allete Inc., the operator of the St. Louis River Hydroelectric Project (ALLETE, Inc. d.b.a. Minnesota Power 2018).

Walleye, including a major portion of western Lake Superior population, spawn in the St. Louis River below the Fond du Lac Dam (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 1992). Restricting the flow of water through the Fond du Lac Dam affected this spawning area and caused incidents of stranding of eggs and spawning adults. Through the 1995 license renewal process and the development of regular, updated operating plans, dam operations, equipment, and licenses have been modified to ensure more flow volume and more gradual rates of change (i.e., ramping rates) to flows through bypassed reaches of the St. Louis River. Article 407 of the current FERC license for the St. Louis River Project requires release of specified minimum flow rates, measured in cubic feet per second, from the Fond du Lac Dam for the protection and enhancement of fish and wildlife resources and riparian vegetation in the Fond du Lac bypassed reach (United States Federal Energy Regulatory Commission 1995). Ramping rates for walleye are required under normal operating conditions and applicable to both increasing and decreasing flows. Appropriate ramping rates were incorporated into required five-year operating plans (ALLETE, Inc. d.b.a. Minnesota Power 2018).

Wildlife

The 1995 RAP Progress Report identified five recommendations related to wildlife (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 1995). Four of these recommendations (Herons, Raptors, Piping Plovers, and Common Terns) are addressed by the removal targets established in the 2013 RAP. One, "Water Birds," was addressed prior to 2013 through an investigation conducted by MPCA on contaminant uptake by mallards at Stryker Bay and the Confined Disposal Facility (CDF) at Erie Pier (Ensor, Pitt and Helwig 1993). The results indicated that waterfowl exposed to dredged sediments at the CDF accumulated polychlorinated biphenyls at levels higher than control, but below Food and Drug Administration's tolerances. Since the 1993 report, contaminated sediments in Stryker Bay have been remediated and contaminated sediments in the Ponds behind Erie Pier will be cleaned up as a management action associated with the Restrictions on Dredging BUI. The Erie Pier CDF was overhauled as a processing and sorting facility in 2010 and now operates under a Management Plan that requires materials testing and regulation (Duluth Seaway Port Authority and Duluth-Superior Metropolitan Interstate Council 2021).

Invasive Species

Three recommendations from the 1995 RAP Progress Report addressed Aquatic Invasive Species (AIS): "Ballast Water," "Exotics Transport," and "Exotic Mussels (Zebra) Importation." Significant actions were taken outside the AOC program prior to the 2013 RAP update and in the intervening years. These include development of ballast water management protocols, international conventions on ballast water management, USCG discharge standards as well as state regulations to prevent introduction and spread of AIS (Great Lakes Commission 2016). Additionally, the 2012 renegotiated Great Lakes Water Quality Agreement, between the U.S. and Canada included ballast water management commitments to prevent the introduction and spread of AIS (Canada and the United

States of America 2012). The States of Minnesota and Wisconsin have, since 1995, established statewide AIS programs to manage both aquatic and terrestrial invasive species of concern. Together these State, Federal and international efforts have addressed the recommendations from the 1995 RAP Progress report and developed responses to emerging AIS threats.

Removal Target and Objectives (2008-13)

In 2008, the states of Minnesota and Wisconsin submitted a list of SLRAOC BUI removal targets to the USEPA (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2008). These targets were developed by the two states with input from local stakeholders. They established specific goals, objectives, and indicators to track progress and determine when BUIs can be removed. The removal target for BUI 2 is as follows:

> *"In consultation with their federal, tribal, local, and nonprofit partners, state resource management agencies concur that diverse native fish and wildlife populations are not limited by physical habitat, food sources, water quality, or contaminated sediments."*

The removal target describes a process that leads to delisting through concurrence between State resource management agencies (MNDNR, MPCA, and WDNR) in consultation with other AOC partners. Removal of BUI 2 will be justified when it is shown that key native species populations of fish and wildlife are present and not limited by the legacy impairments referenced by the removal target.

As written, the 2008 removal target does not explicitly state that limitations addressed by the AOC program must be from legacy sources (Figure 2). The AOC Program does not address modern limitations to fish and wildlife populations or limitations of any origin that exist outside of the SLRAOC boundary. The primary legacy sources identified in the SLRAOC are contaminated sediments and degraded habitats. There is significant overlap with other SLRAOC BUIs that are addressing these legacy impairments. With the scope of the AOC program in mind and an understanding of the significant role played by other BUIs, a team was assembled to translate this general target into "removal objectives" and corresponding "management actions" that provide a pathway to removing BUI 2.

Removal objectives are detailed activities or outcomes that are needed to meet the goals established by the removal target. During a multi-year effort, culminating in the completion of the 2013 Roadmap to Delisting, a team of resource managers developed a "Blueprint" for BUI 2. Using information contained in the Lower St. Louis River Habitat Plan as a starting point, the Blueprint Team created a document that evaluated the BUI 2 removal target and guided the selection of removal objectives (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2013).

The Blueprint Team acknowledged that there was little specific information in the 1992 Stage 1 RAP that definitively linked fish and wildlife population information to particular causes of decline or recovery. To address this information gap, the team developed a source-stressor model for SLRAOC fish and wildlife populations. The Blueprint Team used existing knowledge and expertise to define key sources and stressors affecting SLRAOC fish and wildlife populations.

The Blueprint Team stated that "impacts to the conservation targets by sources (threats) and resulting stressors have been reduced since the passing of the Clean Water Act and the establishment of the Western Lake Superior Sanitary District in 1979." There was a consensus that significant gains had resulted from improvements to wastewater treatment, agency-supported species rehabilitation programs, and migration from unimpaired reaches of the St. Louis River. This "resulted in the re-establishment of most species that were considered native to the Estuary" (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2013).

The Blueprint Team identified the following sources: legacy toxics (sediment/water), habitat alterations, industrial and municipal discharges, exotic species invasions, and hydrologic alteration. These sources are largely addressed

by modern day regulations and other BUIs (BUI 5: Restrictions on Dredging, and BUI 9: Loss of Fish and Wildlife Habitat).

After identifying sources and stressors and acknowledging overlap with other programs or BUIs, the Blueprint Team developed measurable status indicators that could be used to assess BUI condition. "It was determined by the team that, although most native fish and wildlife populations have been reestablished, there is a strong need for collection of baseline population information for some species" (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2013). Status indicators were evaluated to identify where information gaps existed relative to data collection, synthesis, or index development. The Blueprint provided a pathway by which AOC resource professionals and partners would identify key native, sensitive, and invasive species populations for further assessment and evaluation relative to the BUI. Through this process, specific removal objectives for fish, birds, and small aquatic mammals were developed and incorporated into the BUI removal process as described below.

Fish

The BUI removal objectives for fish are based on goals established in the MNDNR St. Louis River Estuary Lake Management Plan for three native indicator fish species: Walleye, Muskellunge, and Lake Sturgeon, and one invasive species, Ruffe (Minnesota Department of Natural Resources 2012). The objectives, which must be demonstrated with fish survey data, are listed below. *Italicized* text is quoted directly from the most recent RAP.

Walleye

"Gillnet catch per unit effort (CPUE) is maintained at or above 5.0 per lift with a proportional stock density (PSD) between 30 and 60 in at least 50% of years surveyed since 2000."

This objective identified an indicator of overall walleye abundance in the St. Louis River estuary and has evolved since first appearing in the 2013 Roadmap. The 2013 objective required a PSD greater than 50 in at least 50% of years surveyed since 2000. This objective was modified to its current form at the recommendation of the Fish Technical Team. The PSD objective identified an indicator of a size vs frequency distribution that suggests a sustainable, balanced population. While a PSD greater than 50 may very well reflect a balanced population in any given year, a PSD which remains greater than 50 most of the time may not reflect a balanced population (R. O. Anderson 1978). As recommended by the Technical Team, the PSD objective was replaced with a range between 30 and 60. This revised range was included in the 2017 RAP.

Muskellunge

"Trap net CPUE is maintained at or above 1.0 per lift in at least 50% of years surveyed since 1997."

Lake Sturgeon

"Document an increasing trend of two to five year old fish captured in summer index nets, with at least two index values greater than 2.0 per gillnet lift."

Invasive Species

"An analysis of historical data that shows the Ruffe is not inhibiting the native fish population is required to remove this BUI."

Wildlife

AOC resource managers selected the wildlife species and species groups represented in the BUI removal objectives below based on their importance for developing consensus among resource managers that wildlife species are no longer limited by physical habitat, food sources, water quality, or contaminated sediments.

The 2013 RAP established removal objectives for target wildlife species (Piping Plover, Common Tern, Great Blue Heron, Bald Eagle, wetland bird species, and semi-aquatic mammals.) The removal objectives below are quoted directly from the most recent RAP and are *italicized.*

Piping Plover

"Piping Plover populations have been limited by historical habitat losses and may be restricted by factors operating outside of the estuary; however, to support the U.S. Fish and Wildlife Service (USFWS) recovery goal of 150 breeding pairs for the Great Lakes Piping Plover population, efforts are being made to create suitable nesting habitat within the St. Louis River AOC. In order to remove this BUI, implementation of the Piping Plover habitat project (management action 2.05) in the RAP is necessary."

The location of management action 2.05 is shown on Figure 3. Though not stated in the RAP, a more detailed version of the USFWS Piping Plover recovery goals states that of the 150 breeding pairs in the Great Lakes, at least 50 pairs must reside outside of Michigan. The St. Louis River is at the far western edge of the Great Lakes Piping Plover's range, with the core population in Michigan.

Common Tern

"Common Tern populations have been limited by historical habitat loss and may be restricted by factors within the estuary such as ice cover, flood events, gull predation, competition for nesting and young rearing habitat by gulls, and by other regional factors outside the estuary. Wisconsin's Common Tern Recovery Plan (WI Recovery Plan) establishes a goal of a 10-year average of 200 nesting pairs with sufficient production of 0.8-1.1 young per breeding pair to maintain population stability in the St. Louis River Estuary (Matteson 1988)*. To support this goal, efforts are being made to maintain and enhance suitable nesting habitat within the SLRAOC. To remove this BUI, implementation of the Interstate Island restoration project (management action 2.06) in the RAP is necessary. In addition, the state agencies will continue to support habitat management and population monitoring at Interstate Island."*

This objective reflects significant changes adopted in the 2017 and 2019 RAPs upon recommendations from the Technical Team. The 2013 RAP objective required a target Common Tern colony size of 100 nesting pairs. According to data provided by the Technical Team, this objective was neither reflective of historic population size nor supportive of the WI Recovery Plan. The WI Recovery Plan established a goal of 200 nesting pairs in the SLRE as sufficient to maintain population stability; this goal was recommended for adoption by the Technical Team. The previous removal objective also did not include a target production rate, a metric suggested by the Technical Team as an important measure of population stability. Therefore, AOC Coordinators modified the objective in the 2017 RAP to include both the 200 nesting pair and 0.8-1.1 young per breeding pair goals from the WI Recovery Plan.

It is noteworthy that this objective requires support from state resource management agencies towards meeting Common Tern recovery goals, though meeting and/or sustaining the numeric goals is not required for BUI removal. The Technical Team indicated that the most critical support required to recover the SLRE Common Tern population was restoration of habitat at Interstate Island to mitigate for legacy loss of tern habitat in the estuary. AOC Coordinators and agency leaders concurred with this recommendation, including a new BUI 2 management action (2.06) requiring habitat restoration at Interstate Island in the 2019 RAP. See Figure 3 for the location of management action 2.06.

Though not stated as a potential population restriction within the estuary, emerging research conducted by Technical Team members independent of the AOC program indicates that mercury pollution may be an issue currently impacting the Interstate Island Common Tern population. This work is explained in the summary of Management Action 2.01 and recommendations to better understand this have been added to the Future

Actions section of this document. Separate BUIs; Fish Consumption Advisories and Restrictions on Dredging, are addressing legacy contamination and specifically legacy mercury in contaminated sediments in the St. Louis River AOC.

Great Blue Heron

"Removal of this BUI is not dependent on the establishment of a Great Blue Heron rookery, but the recorded presence of the species in the estuary during nesting season since 1997 will provide additional evidence for BUI removal."

Bald Eagle

"Recovery of the Bald Eagle and the recorded presence of the species in the estuary during nesting season since 1997 is an indicator for BUI removal."

Wetland Bird Species

"Removal of this BUI is not dependent on populations of wetland-associated wildlife species. An AOC-wide bird follow-up survey to compare to work done in 1979 is necessary evidence for BUI removal."

Semi-Aquatic Mammals

"Removal of this BUI is not dependent on specific semi-aquatic mammal population numbers. However, to support development of concurrence among state resource management agencies, a semi-aquatic mammal survey will be conducted in the estuary to verify that populations are not limited by physical habitat, food sources, water quality, or contaminated sediments."

Removal Strategy (2013-19)

The strategy for BUI 2 removal includes the six management actions listed in Table 1. These management actions were designed to address the specific removal objectives described above.

Management Actions 2.01 through 2.05 first appeared in the 2013 Roadmap to Delisting (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2013) and were developed through the combined efforts of numerous AOC partners/stakeholders in addition to the AOC coordinators and leaders who represent the agencies responsible for BUI removal and AOC delisting.

Management action 2.02 was expanded in 2018 to include a Lake Sturgeon study. Annual monitoring data showed that sturgeon recruitment was not trending towards BUI objectives. Fish Technical Team members made a formal recommendation to investigate factors limiting Lake Sturgeon recovery and determine whether limiting factors were influenced by legacy contamination. AOC Coordinators and agency leadership concurred with the recommendation, and the addition of the Lake Sturgeon study to management action 2.02 was formalized in the 2018 RAP (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2018).

Management action 2.06 was added in 2019 following a review of local Common Tern population data by the Avian Technical Team. With tern populations trending away from Wisconsin's Common Tern Recovery Plan goals and the increasing instability of Interstate Island due to rising lake levels, it was determined that restoration at this location was the most critical and cost-effective option to improve the tern population and mitigate legacy losses of shorebird habitat in the SLRE. In 2017 and 2018, the Technical Team recommended that restoration of Common Tern nesting habitat at Interstate Island be added as a required management action. AOC Coordinators and agency leadership concurred with the recommendation, and the addition of management action 2.06 was formalized in the 2019 RAP (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2019).

Completing management actions and meeting removal objectives triggers a review of BUI 2 for removal. A removal objective that is not met can be evaluated to determine whether limitations are outside of the scope of the AOC program or will be addressed by other BUIs. In these cases, a BUI 2 removal recommendation can proceed. While we acknowledge that on-going BUIs that remediate legacy pollution and/or restore degraded habitat will further aid in recovering historically degraded fish and wildlife populations, removing other BUIs is not required to remove BUI 2.

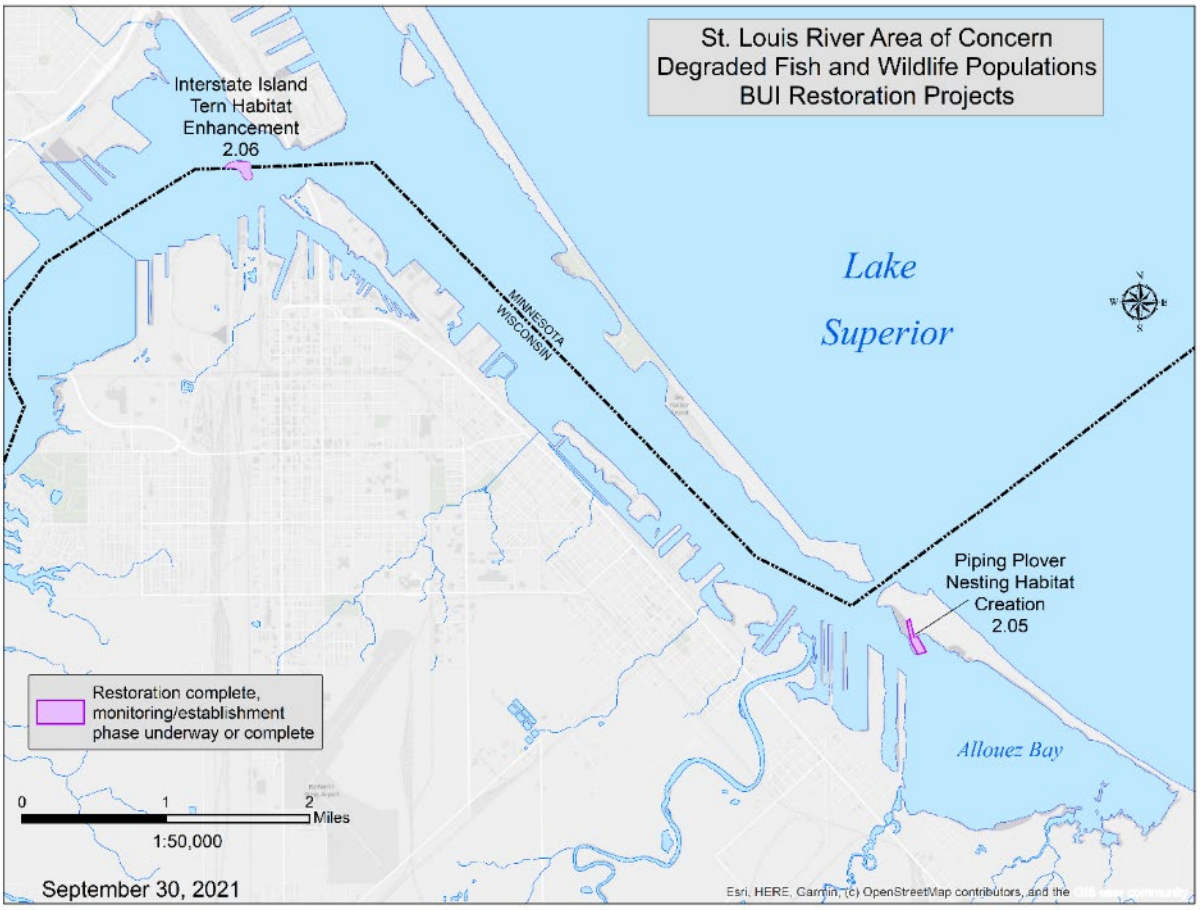


FIGURE 3. LOCATION OF DEGRADED FISH AND WILDLIFE POPULATIONS BUI HABITAT RESTORATION PROJECTS 2.05 AND 2.06

TABLE 1. MANAGEMENT ACTIONS NEEDED TO ACHIEVE BUI 2 REMOVAL

Mgmt Action	Project Name	Project Description	Year Completed
2.01	Bird Inventory and Assessment	Conduct an estuary-wide bird inventory for target species to be combined with existing inventory data available. Complete an AOC-wide assessment of bird population status using the combined dataset.	2016
2.02	Fish Population Monitoring and Assessment	Conduct regular MNDNR and WDNR fish population monitoring and evaluate to track status of target fish species against the BUI removal objectives. Conduct study of Lake Sturgeon tissue to assess adverse effects related to legacy contaminants on early life stage and adult fish.	2021
2.03	Ruffe Assessment	Document Ruffe populations in relation to native fish populations within the estuary.	2017
2.04	Semi-Aquatic Mammal Survey	Conduct an estuary-wide semi-aquatic mammal survey.	2016
2.05	Piping Plover Habitat / Beach Nourishment	Increase available nesting habitat within area designated critical habitat.	2020
2.06	Interstate Island Avian Habitat Restoration	Restore and protect critical nesting habitat for Common Tern and stopover habitat for Piping Plover.	2021

BUI 2 Technical Teams

BUI Technical Teams provide expertise and recommendations to AOC staff and leaders on BUI goals, removal strategies, and the scientific interpretation of BUI status. BUI Technical Teams were originally formed during the 2013 Roadmap development. Since then, these teams changed depending on staff turnover, technical expertise, and interest. BUI Leaders managed three Technical Teams for BUI 2 including Avian, Fish, and Mammal (Table 2). Technical Teams met as needed for their review and recommendations on particular BUI 2 actions.

TABLE 2. CURRENT BUI 2 TECHNICAL TEAMS (DOES NOT INCLUDE PAST TECHNICAL TEAM MEMBERS)

Avian Team

Name	Affiliation
Reena Bowman	US Fish and Wildlife Service
Annie Bracey	UMN Natural Resources Research Institute
Gaea Crozier	Minnesota Department of Natural Resources
Kris Eilers	St. Louis River Alliance
Rick Gitar	Fond du Lac Resource Management Division
Cherie Hagen (lead)	Wisconsin Department of Natural Resources
Sumner Matteson	Wisconsin Department of Natural Resources
Martha Minchak	Minnesota Department of Natural Resources
Alexis Grinde	UMN Natural Resources Research Institute
Fred Strand	Avian expert

Fish Team

Name	Affiliation
Brian Borkholder	Fond du Lac Resource Management Division
Deserae Hendrickson	Minnesota Department of Natural Resources
Joel Hoffman	US Environmental Protection Agency
Paul Piszczek	Wisconsin Department of Natural Resources
Henry Quinlan	US Fish and Wildlife Service
Amy Roe (BUI 2 Technical Review Lead)	US Fish and Wildlife Service
Melissa Sjolund (lead)	Minnesota Department of Natural Resources
Darren Vogt	1854 Treaty Authority

Mammal Team

Name	Affiliation
Shawn Crimmins	University of Alaska – Fairbanks (formerly Wisconsin Department of Natural Resources)
John Erb	Minnesota Department of Natural Resources
Rick Gitar (lead)	Fond du Lac Resource Management Division
Greg Kessler	Wisconsin Department of Natural Resources
Martha Minchak	Minnesota Department of Natural Resources
Tim Van Deelen	University Wisconsin - Madison

Management Actions Review

This section documents the successful completion of the six management actions required to achieve the BUI 2 target. Methods, findings, and conclusions are detailed for each management action.

Management Action 2.01: Bird Inventory and Assessment

The primary monitoring for this action item was completed in 2016 by the Natural Resources Research Institute (NRRI), University of Minnesota – Duluth under contract managed by the Minnesota Pollution Control Agency (Bracey, Chatterton and Niemi 2016). The goal of the 2016 NRRI study was to provide a contemporary assessment of bird use in the SLRE. The study also compared populations against a 1979 survey to identify positive or negative trends attributable to legacy impacts and/or contemporary restoration work. The complete 2016 NRRI report is included as **Appendix A**. Study objectives included:

> **Objective 1:** Summarize and compare contemporary baseline data gathered on bird use at sites planned for restoration and reference sites, and
>
> **Objective 2:** Synthesize and compare contemporary bird use data with similar data gathered for SLRE sites in the late 1970s.

In addition to the 2016 NRRI study, annual monitoring of the Common Tern colony at Interstate Island was completed to meet Objective 3, below. The colony has been monitored using consistent methodology since 1989.

This monitoring has been completed by various agencies over the years and is currently being led by MNDNR and WDNR with assistance from NRRI.

> **Objective 3.** Measure Interstate Island Common Tern colony size and reproduction rates; compare these metrics against regional population recovery targets.

Methods

Objective 1. NRRI selected ten contemporary AOC sites to compare against five reference locations (Table 3). NRRI sampled the sites during breeding and migration time periods between 2010 and 2015. During the breeding season, NRRI counted birds from a fixed point beginning at 0.5 hour before sunrise to 4.5 hour after sunrise. During each 15-minute count, all individuals seen or heard were recorded. Playback recordings helped elicit responses from hard-to-detect species. NRRI sampled each site two times during the breeding season.

TABLE 3. AOC AND REFERENCE SITES IN THE SLRAOC WHERE BIRD USE WAS DOCUMENTED

Corresponding Reference Site	AOC Site
Minnesota Point	Minnesota Slip
	Slip C
Little Pokegama Bay	21st Avenue West
	40th Avenue West
	Grassy Point
Spirit Lake East	Spirit Lake West
North Bay	Radio Tower (Cedar Yard) Bay
	Kingsbury Bay
Rask Bay	Mud Lake
	Perch Lake

Migration season counts lasted 10 minutes and occurred between sunrise and early afternoon from a fixed shoreline or boat location. All individuals seen or heard from the point were recorded. NRRI recorded the location of each observation, including flyovers, on aerial photo sheets which were digitized into Geographic Information System (GIS) format. Observations were classified into 16 unique species groups, with species of special concern (e.g. Common Tern and Piping Plover) also considered separately. NRRI sampled each site four times during each migration season (spring and fall).

Objective 2: NRRI also selected ten sites sampled from 1976-1979 to compare against the ten recent AOC sites. Historic sites were chosen based on their use of similar sampling techniques, objectives, and biological timing. NRRI digitized data from the 1970s data and aerial photo sheets. NRRI employed various statistical techniques to determine overall differences in community composition, species richness, and species of special interest or conservation concern between recent and historic surveys.

Objective 3: Since 1989, the Interstate Island Common Tern colony has been monitored by MN and WI wildlife biologists using a consistent methodology to estimate peak nest count and reproduction rates. Biologists visit the Common Tern nesting colony annually at least twice a week, beginning in mid-May. Active nests are counted and marked through peak nest count (mid- to late-June) to determine the number of nesting pairs. The fate of all marked nests is recorded during each visit to determine nest success (hatched or failed). Chicks are captured as soon as possible after hatching and banded. To calculate fledgling rates, chicks are recaptured during each visit

through mid-August, when most chicks have fledged. Fence maintenance and vegetation management are performed as needed.

Findings

Objective 1. A total of 117,235 individual bird observations of 177 species were recorded during the migratory and breeding seasons at all sites sampled from 2010-2015. Researchers performed a total of 11 surveys at each site. Observations were grouped into three categories of bird: waterfowl, shorebirds, and waterbirds.

For waterfowl, there were approximately 880 individuals per AOC site, compared to 288 individuals per reference site. Of the waterfowl species observed at AOC sites, 80% were Canada Geese and Mallards. For shorebird species, there were six individuals per AOC site and two individuals per reference site. Most shorebird species were observed at 40th Avenue West complex. There were more waterbirds observed at reference sites (386 individuals per site) than AOC sites (67 individuals per site). Most of the waterbird observations were American Coot. Rails and Wrens were observed in low numbers at both AOC and reference sites, and there were no differences between sites. Great Blue Heron (a BUI 2 indicator species) were observed at higher frequencies at AOC sites (mean 0.33, Range 0-7) as compared to Reference locations (mean 0.04, range 0-1).

Species observed in AOC sites only, included six species of shorebirds: Killdeer, Greater Yellowlegs, Dunlin, Least Sandpiper, White-rumped Sandpiper, and Semipalmated Sandpiper, most of which were observations of single individuals, five species of waterfowl: Gadwall, Northern Shoveler, Greater Scaup, Red-breasted Merganser and Ruddy Duck, and one Sedge Wren. There were two species of waterfowl observed in reference sites only (Trumpeter Swan and Northern Pintail) and one shorebird (Pectoral Sandpiper).

There were no statistically significant differences in cumulative species richness (SR) between AOC and reference sites when all sites were pooled. This included richness calculated for all species observations as well as for water-obligate species only (i.e., rails, waterbirds, waterfowl, and shorebirds.)

Site-specific SR results were mixed. When comparing AOC sites against reference, four sites showed significant differences in cumulative SR: Minnesota Slip, Slip C, Radio Tower (Cedar Yard) Bay, and 40th Avenue West. At sites where differences were significant, cumulative SR was higher in the reference site with the exception of 40th Avenue West. In general, the AOC and reference sites had substantial overlap in their respective bird communities, primarily because of the high variability in bird species.

Since the completion of the avian survey in 2015, remediation and restoration are either complete or in development at all of the AOC sites listed in Table 3. These projects are associated with the Restrictions on Dredging and Loss of Fish and Wildlife Habitat BUIs. With the exception of remediated slips, these sites are anticipated to provide improved habitat to estuary bird populations after a period of recovery.

Objective 2. A total 196 species were observed in the historical and recent surveys at the 10 sites sampled during both survey periods in the SLR. There were 16,911 individual bird observations of 133 species (historical) and 11,042 individual bird observations of 132 species (recent) included in the analysis.

Of the 196 total species, 29 were observed in recent surveys only and 31 were observed in historical surveys only. However, many of the species unique to either historical or recent surveys were observed in small numbers (less than 5 individuals). All of the water-obligate species observed in historical surveys only were uncommon, rare, or very rare in the SLR and, therefore, the lack of observation of many of these species was partly due to their rarity.

Similar with the AOC and reference comparisons, NRRI found no significant differences in species richness between historical and recent surveys when all sites were pooled. This included richness measured for all species observations as well as for water-obligate species only. However, comparisons of site-specific species richness indicated significant differences in cumulative SR for three sites: 20th Avenue West, 27th Avenue West, and Spirit

Lake West. For comparisons of water-obligate species, four sites had significant differences: 20th Avenue West, 27th Avenue West, 40th Avenue West, and Spirit Lake West. At each of these sites, with the exception of 40th Avenue West, cumulative SR was greater in historical surveys.

Findings specific to the BUI 2 indicator species are as follows:

- ***Great Blue Heron*** have declined in the SLRE relative to historical counts. Recent counts of Great Blue Heron at AOC sites produced a mean of 0.32 and range of 0-6 individuals. This shows a decline of approximately 1.73%/year when compared to a historical mean of 0.73 and range of 0-4. Great Blue Heron reductions may be associated with changes in the location of their colony site. During the historical surveys, Great Blue Herons nested near Kimball's Bay. This nesting site no longer exists, likely due to residential development and/or Bald Eagle predation. While researchers are unaware of the colony's current location, it is likely further from the SLRE, influencing their presence on the river. The Great Blue Heron specific removal objective has been met based on the report generated by management action 2.01, and therefore recorded presence, of Great Blue Herons within the AOC, which provide additional evidence for BUI removal.
- ***Bald Eagle*** populations have increased substantially in the SLRE compared with the historical period (1970s) when the species did not nest at all. Today, there are up to five nesting Bald Eagle pairs in the SLR, but no information on their overall nesting success. Researchers noted that recovery of the Bald Eagle is supportive of BUI removal, but its recovery has had little to do with changes in the SLRE. The species has recovered because of the banning of DDT, the focused management efforts to protect nest sites, the improvement in reduced contaminant loads in food supplies, and its increased tolerance to human disturbance. The Bald Eagle specific removal objective has been met based on the report generated by management action 2.01, and therefore recorded presence, of Bald Eagles within the AOC, which provide additional evidence for BUI removal
- ***Wetland Bird Species*** at AOC sites were surveyed and found to have greater abundance and similar species richness when compared to reference sites and similar species richness when compared to historical surveys. When comparing specific AOC-reference site pairs, results were mixed. When comparing historic and current species data, lower use by Wood Duck, Northern Pintail, and Common Loon were inconsistent with regional trends.

Objective 3. Peak nest counts at Interstate Island have been estimated annually, dating back to 1977. However, current monitoring methods have stayed consistent since 1989, making the 1989-2020 data set the most accurate for assessing population size and reproductive rates (**Appendix B**). 2014 was a significant year for Interstate Island, in that it marked the beginning of a sudden and sustained increase in Lake Superior water levels (Figure 4). This rise in water level flooded portions of Interstate Island, increasing pressure from co-nesting Ring-billed Gulls and threatening to inundate the tern nesting area.

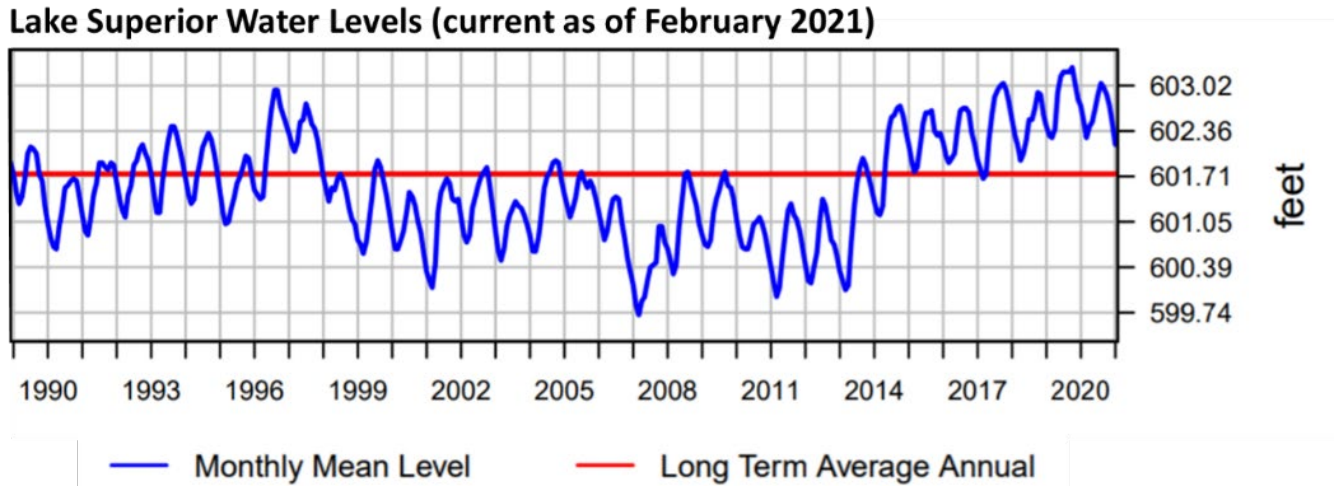


FIGURE 4. MONTHLY MEAN AND LONG-TERM AVERAGE ANNUAL LAKE SUPERIOR WATER LEVELS (1989 - 2021). USACE DATA AVAILABLE AT: HTTPS://LRE-WM.USACE.ARMY.MIL/FORECASTDATA/GLBASINCONDITIONS/LTA-GLWL-GRAPH.PDF

Common Tern Population Size

A summary of Common Tern population size metrics is presented in Table 4 and Figure 5. The Wisconsin recovery goal as referenced in the RAP is 200 nesting pairs (measured as a rolling 10-year average). Between 1989 and 2021, the average annual population size was 178 nesting pairs. During this time frame, the annual population count met or exceeded the 200-pair target in 11 years (33%). The 10-year average (calculated for years 1998-2021) met or exceeded the 200-pair target in nine years (38%).

Due to sudden and sustained high water levels, 2014 marked the beginning of a decline in the size of the tern nesting population. In 2015, the colony was only 101 nesting pairs, the lowest number since 1989 (Figure 5). The annual population count prior to 2014 averaged 194; after 2014, the average fell to 131. The 200 pair goal was met 11 times prior to 2014; since 2014, the 200 pair goal has not been met. Based on a rolling 10-year average (calculated for years 1998-2021), the 200 pair goal was met eight times prior to 2014, and only once since 2014 (Table 4 and Figure 5). Lower populations observed during recent counts were likely caused by habitat loss due to the high-water levels. Resource managers implemented emergency repairs in 2015 and eventually added a more comprehensive project, Interstate Island Avian Habitat Restoration, to the AOC program as Management Action 2.06.

Common Tern Reproductive Rate

Annual fledgling counts (number of young fledged per nest) were recorded annually at Interstate Island starting in 1989 (**Appendix B**). A summary of Common Tern reproductive rate metrics is presented in Table 5 and Figure 5. The RAP references a WI Common Tern recovery goal to have a minimum fledgling rate between 0.8 and 1.1 young fledged per nest. These two goals encompass a range in recommendations from various researchers studying Great Lakes Common Tern colonies (Matteson 1988). The 0.80 fledgling rate can be considered a "bare minimum," for recovery, while the 1.1 rate is more desirable to ensure long-term population stability.

TABLE 4. SUMMARY OF COMMON TERN ANNUAL NESTING PAIR COUNTS AT INTERSTATE ISLAND (1989-2021).

Years	Metric	Annual Nesting Pair Count	10-year Nesting Pair Average
1989-2021	**n**	33	24
	Average	178	194
	Years ≥ 200	11	9
	Percent ≥ 200	33	38
1989-2013	**n**	25	16
	Average	194	200
	Years ≥ 200	11	8
	Percent ≥ 200	44	50
2014-2021	**n**	8	8
	Average	127	183
	Years ≥ 200	0	1
	Percent ≥ 200	0	13

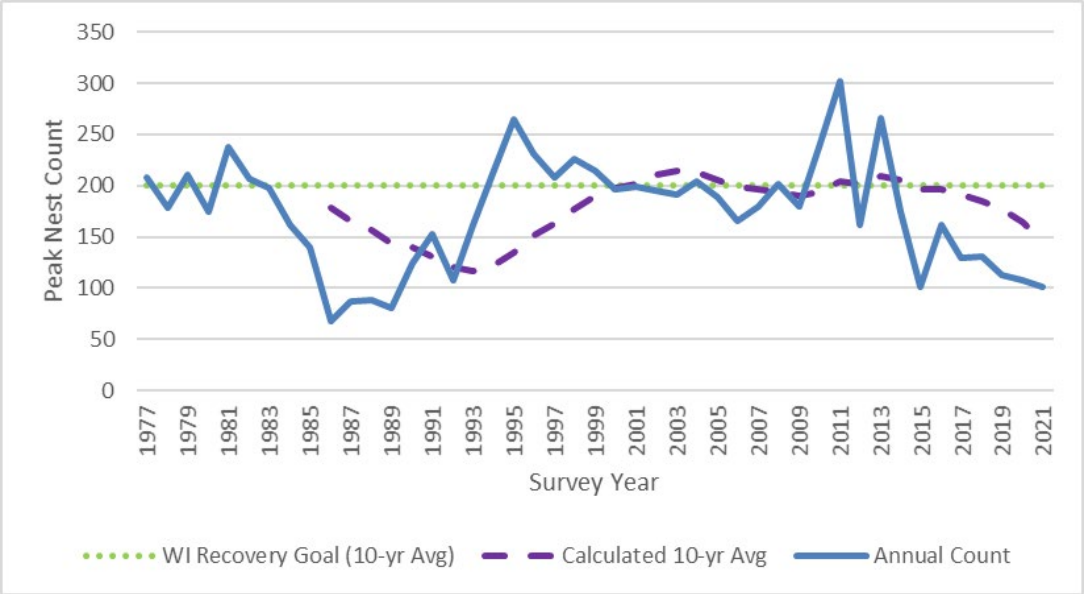


FIGURE 5. ESTIMATED NUMBER OF PAIRS OF COMMON TERNS NESTING IN THE ST. LOUIS RIVER ESTUARY (1989-2021). THE WISCONSIN RECOVERY GOAL IS 200 NESTING PAIRS (10-YR AVERAGE).

Between 1989 and 2021, the average annual fledgling rate was 0.87. During this time frame, the annual fledgling rate met or exceeded the 0.80 goal 18 times (55%) and met or exceeded the 1.1 goal 11 times (33%). The 10-year

rolling average (calculated for years 1998-2021) met or exceeded the 0.80 goal 13 times (54%) but did not ever meet the 1.1 goal. The rolling 10-year average shows oscillations around a slight, steady downward trend (Figure 6).

High water levels beginning in 2014 have had a less dramatic impact on fledgling rates at Interstate Island. Factors such as weather and mammalian/avian predation on chicks are important factors influencing fledgling success. The annual fledgling rate prior to 2014 averaged 0.88; after 2014, the average fell slightly to 0.81. Interestingly, 2013 was the last year that the rolling 10-year average was at or above the 0.80 goal, while the 1.1 goal has not ever been met based on a 10-year average (Figure 6).

TABLE 5. SUMMARY OF ANNUAL COMMON TERN FLEDGLING RATES AT INTERSTATE ISLAND (1989-2021).

Years	Metric	Annual Fledgling Rate (No. fledged per nest)	10-year Average Fledgling Rate (No. fledged per nest)
1989-2021	**n**	33	24
	Average	0.87	0.81
	Years ≥ 0.8	18	13
	Percent ≥ 0.8	55	54
	Years ≥ 1.1	11	0
	Percent ≥ 1.1	33	0
1989-2013	**n**	25	16
	Average	0.88	0.86
	Years ≥ 0.8	13	13
	Percent ≥ 0.8	52	81
	Years ≥ 1.1	8	0
	Percent ≥ 1.1	32	0
2014-2021	**n**	8	8
	Average	0.81	0.70
	Years ≥ 0.8	5	0
	Percent ≥ 0.8	63	0
	Years ≥ 1.1	3	0
	Percent ≥ 1.1	38	0

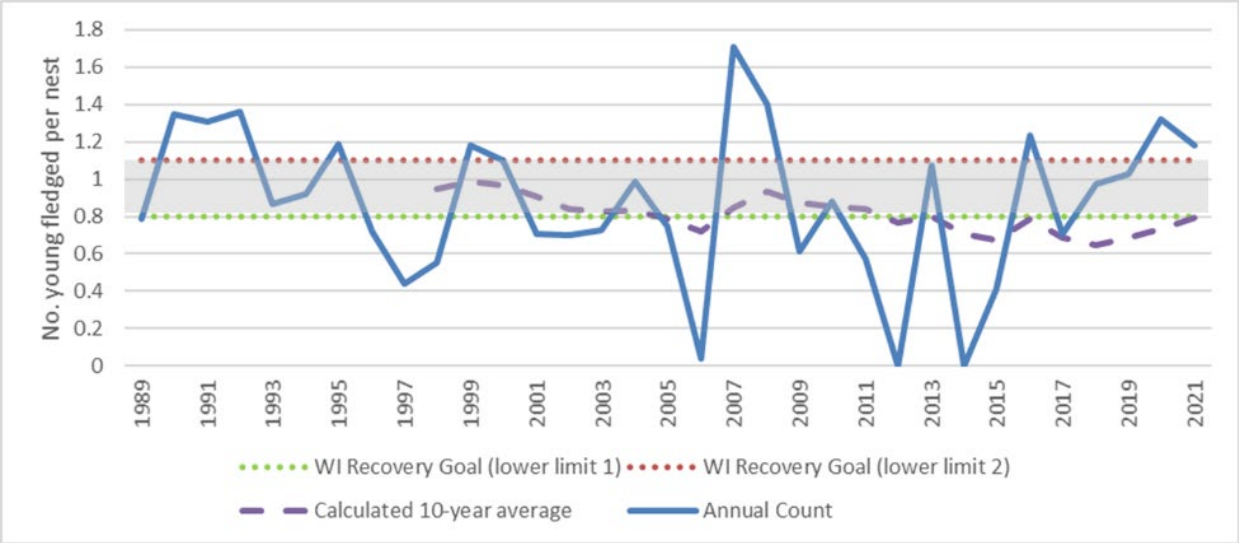


FIGURE 6. NUMBER OF COMMON TERN YOUNG FLEDGED PER NEST (1989-2021). THE WISCONSIN RECOVERY GOAL ESTABLISHES A MINIMUM RATE BETWEEN 0.8 AND 1.1 (SHADED AREA).

The extensive monitoring effort on Interstate Island has provided important information relative to the estuary's Common Tern population. The statewide and regional significance of the colony reinforces the value of maintaining this long-term effort. Until recently, about two-thirds of all the Common Terns breeding in the Lake Superior Basin nested on Interstate Island. With the success of the constructed nesting colony at Ashland, WI and continued loss of Interstate Island habitat, that proportion has fallen to less than half in recent years, though the long-term nesting pair average remains higher at Interstate Island (Strand 2020). With the Interstate Island tern colony trending away from regional recovery goals as described above, island restoration was determined necessary and incorporated into the BUI 2 removal strategy as management action 2.06 in (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2019).

In addition to the monitoring activities described above, area researchers have further studied the SLRAOC Common Tern population. Bracey et al. (2018) studied potential impacts to Common Tern populations during the nonbreeding season using geolocators. Researchers found the majority (70%) of the inland Common Tern colonies (including the Great Lakes) spending the nonbreeding season on the coast of Peru. Such aggregation could make the terns vulnerable to local negative effects, impacting population size and breeding success in the SLRAOC. Though population impacts occurring during the nonbreeding season are outside of the SLRAOC program influence, researchers emphasized the importance of continued colony management at sites such as Interstate Island.

Bracey et al. (2021) focused additional Common Tern research on patterns of dietary mercury (Hg) exposure. Measurements of Hg in blood and feathers indicated higher Hg accumulation in the summer (breeding season). Hg concentrations were also correlated with increased industrial influence and riverine-based diet. Mercury levels in chicks hatched on Interstate Island were often above published toxicological risk thresholds, whereas chicks hatched at the Ashland, WI colony were below the threshold, suggesting greater mercury exposure in the SLRE relative to Chequamegon Bay. Because chicks obtain most of their diet from the river, the study highlights the importance of identification and remediation of estuary contamination.

A 2021 study demonstrated that mercury is still actively cycling in the estuary food web and is present in sediments outside the boundaries of identified SLRAOC remediation and restoration projects at concentrations below remediation action levels (Janssen, et al. 2021). At each sampling location, inorganic mercury originated

from two or three of the following sources: industrial/legacy, watershed, and precipitation. The AOC program targets legacy sources of mercury, but not those from modern watershed and precipitation sources. A strategy is being implemented under other BUIs to identify and remediate hot spots (those sites where contamination exceeds state action levels), with the understanding that it is not feasible to remediate low levels of contamination in sediments elsewhere in the estuary. AOC restoration and remediation project sites are used as forage locations for Common Terns and an outcome of completed projects will be a reduction of mercury entering the food web. A lag between completion of AOC projects and observable food web impacts is likely and may be two or more years.

While Common Terns in the SLRE may continue to face contaminant exposures unique to the estuary, as well as beyond the estuary during the non-breeding season, the primary factor limiting colony stability is habitat suitability. Accordingly, habitat restoration and long-term management remained the primary BUI 2 management action targeting terns. While the findings of Bracey et al. (2021) did not prompt an additional BUI 2 management action, continued study of mercury's impacts on Common Tern chicks is included as a recommended future action. Separate BUIs, Fish Consumption Advisories and Restrictions on Dredging, are addressing the contribution of legacy mercury sediment contamination to the food web in the St. Louis River AOC.

Conclusions

Based on the results of the 2016 bird study and planned long-term monitoring and maintenance of the restored Interstate Island habitat, objectives for the chosen avian indicator species have been met and Management Action 2.01 is complete (Table 6). As described above, numeric objectives were set for some species, based on measured indicators of populations. These numeric objectives were met.

For other indicator species, action-based objectives such as studies or on-the-ground projects supportive of regional population goals were established. For both the Piping Plover and Common Tern, habitat was chosen as the most significant population limitation for the AOC program to address under BUI 2. Therefore, the objectives and associated management actions for these species are limited to restoring critical habitat and supporting long-term monitoring and maintenance. While achieving regional recovery goals for Piping Plover and Common Tern is desired by all involved it is not required for BUI 2 removal.

Successful completion of Management Action 2.02 supports a BUI 2 removal target focused on legacy impacts to key indicator species. Through implementation and review of these actions, resource managers, species experts, and researchers developed recommendations for future actions. These actions will provide continued support for avian populations in the SLRE and would take place outside of the AOC program and framework. See Section 6.0 for a summary of recommended future actions.

TABLE 6. SUMMARY AND STATUS OF BUI 2 AVIAN SPECIES OBJECTIVES

Objective	Status	AOC Objective Met?
Piping Plover: To remove this BUI, implementation of the Piping Plover habitat project (Project 2.05) is necessary.	Piping plover populations may be restricted by factors operating outside the estuary. The required restoration project was completed in 2020 (See action 2.05 for additional information.)	Yes
Common Tern: State agencies will continue to support habitat management and population monitoring at Interstate	Population metrics for the Common Tern are not currently meeting goals established by	Yes

Objective	Status	AOC Objective Met?
Island to support the following population goals established by Wisconsin's Common Tern Recovery Plan: A. 10-year average of 200 nesting pairs B. Production of 0.8-1.1 young per breeding pair *Achieving the numeric population goals is not required to remove BUI 2.*	Wisconsin's Common Tern Recovery Plan (Figure 5, Figure 6) though achievement of these goals is not necessary to meet the BUI removal objective for this species. State agencies restored habitat at Interstate Island (see management action 2.06). A long-term monitoring, maintenance, and management plan for the habitat is in place and supported by state resource management agencies.	
Great Blue Heron: Removal of this BUI is not dependent on the establishment of a rookery, but the recorded presence of the species in the estuary during nesting season since 1997 will provide additional evidence for BUI removal.	Between 0-6 Great Blue Herons were observed at AOC sites in the SLR during the study period, though no colonies have been located for many years.	Yes
Bald Eagle: Recovery of the Bald Eagle and the recorded presence of the species in the estuary since 1997 is an indicator for BUI removal.	Today there are up to five nesting Bald Eagle pairs in the SLR, but no information on overall nesting success. Recovery is supportive of BUI removal but has little to do with changes in the SLR.	Yes
Wetland Bird Species: Removal of this BUI is not dependent on populations of wetland-associated wildlife species. BUI removal requires an AOC-wide bird follow-up survey to compare to work done in 1979.	Site-specific comparisons produced mixed results. Overall, AOC sites had greater abundance and similar species richness when compared to reference sites and similar species richness when compared to historical surveys. Wetland habitat is targeted for restoration by many projects under the Loss of Fish and Wildlife Habitat BUI (BUI 9) and will benefit wetland bird species.	Yes

Management Action 2.02: Fish Population Monitoring and Assessment

Management Action 2.02 contains two components: annual fish population monitoring targeting key species, and a study of Lake Sturgeon to assess potential limitations to population recovery.

Fish Population Monitoring

Walleye historically was an important fish species in the St. Louis River for subsistence fishing by native people, early commercial harvest, and for recreational fishing (Kaups 1984). Declines in water quality from industrial and municipal discharges, hydrologic alteration from construction and operation of dams, and loss of aquatic habitat due to dredging and filling associated with port development all are cited as contributing to declines in Walleye populations in the estuary (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 1992).

Walleye and Muskellunge populations in the St. Louis River are monitored as part of routine fisheries assessments conducted by both Minnesota and Wisconsin Departments of Natural Resources. They were selected as a target species for BUI removal due to their historic subsistence harvest importance and their importance as recreational gamefish.

The Lake Sturgeon population in the SLR was extirpated in the early 1900s due to overfishing and habitat changes caused by dam construction and pollution. Since then, management actions such as stocking and spawning habitat restoration have helped reintroduce Lake Sturgeon to the St. Louis River. Fry, fingerlings, and/or yearlings were periodically stocked between 1984 and 2000 from two sources (Wolf River, WI and Sturgeon River in MI). Schram et al. (1999) reported that spawning habitat in the upper St. Louis River estuary "remained relatively unchanged and adequate." In 2009, rock riffles were constructed below the Fond du Lac dam, creating spawning cells and in 2015, additional spawning habitat was constructed at Chambers Grove. In 2011, the first documented naturally reproduced larval Lake Sturgeon were captured during a drift netting survey below the Fond du Lac dam on the St. Louis River, demonstrating that the stocking and habitat improvement efforts have been somewhat successful (Anselmo, Bogyo and Borkholder 2020). The successes realized in 2011 were translated by fisheries resource managers into population recovery metrics that appeared feasible at the time they were incorporated into the 2013 Roadmap. In 2019, the MNDNR completed a Lake Sturgeon Management Plan to document the history of Lake Sturgeon Management in the St. Louis River and guide future management.

All Lake Sturgeon captured in the SLR since 2007 by MNDNR or WDNR have been implanted with a Passive Integrated Technology (PIT) tags. Approximately 1,800 individuals have been PIT tagged with less than one percent of those being verified as females. Most of the Lake Sturgeon captured in the SLRE are captured during the spring near the known spawning habitat. The adult Lake Sturgeon population is monitored annually utilizing a variety of methods, including boom electrofishing, backpack electrofishing and hand dipping. River flow rates vary greatly in the spring on the St. Louis River and have a large impact on the number of Lake Sturgeon captured each year. Also, Lake Sturgeon do not spawn every year adding more variability to the number of Lake Sturgeon captured yearly. These factors contribute to making adult Lake Sturgeon captured during spring spawning surveys an unreliable metric for measuring the recovery of the Lake Sturgeon population. For this reason, metrics for adult Lake Sturgeon were not developed for BUI 2.

Despite past efforts to recover SLRAOC Lake Sturgeon populations via fingerling stocking, natural recruitment has not been observed at anticipated levels. Lake Sturgeon objective metrics were established during the period of fingerling stocking and considered the number of years since stocking was initiated and current age of the population. Since then, the population has not even approached the BUI objectives, though there is evidence that some natural reproduction is occurring. Spring surveys conducted by the 1854 Treaty Authority and Fond du Lac Resource Management Division between 2011-2020 have captured between two and 1,028 larval Lake Sturgeon in

drift nets. The number of larvae captured have been highly variable, likely due to many influencing factors including survey timing/methods, water levels, and number of spawning females. However, data suggest that Lake Sturgeon have continued to naturally reproduce in the St. Louis River to some degree. Larval survey methods were standardized in 2019, making future analysis of reproductive success easier (Anselmo, Bogyo and Borkholder 2020).

Methods

The Minnesota and Wisconsin Department of Natural Resources, together with the 1854 Treaty Authority and the Fond du Lac Band of Lake Superior Chippewa, monitor fish populations annually. Populations of Walleye, Muskellunge, and Lake Sturgeon were selected as objectives for assessing health of the fish population. Fisheries managers share monitoring efforts and reports; these data were compiled for this report by MNDNR Duluth Area Fisheries staff.

An annual summer gillnet assessment is completed by the MNDNR in late June/early July and used to monitor Walleye and Lake Sturgeon populations. These data were used to evaluate BUI 2 removal objectives for Walleye and Sturgeon. Experimental gillnets are set at the same locations and in the same orientation each year to make catch rates comparable. Data collected as part of this assessment are used to calculate CPUE, PSD and other metrics.

The Muskellunge population is monitored in spring using trapnet assessments that take place approximately every two to five years. Historically, when BUI 2 was written, assessments were completed only during the peak of Muskellunge spawning and at a limited number of locations with high quality spawning habitat. More recent assessments attempt to capture the entire spawning season by setting nets when water temperatures are near 44 degrees Fahrenheit and rising and continuing until Muskellunge are being captured in very low numbers post-spawn. Nets are also being set in more locations to look for additional potential spawning areas. These assessment changes would be reflected in the 2017 and 2018 sampling discussed in this document and in future assessments.

Findings

Based on monitoring results, BUI 2-specific removal objective metrics have been met for Walleye and Muskellunge, but not for Lake Sturgeon, triggering additional study (Table 7). Complete data sets for these indicator species are attached as **Appendix C**.

The specific removal objective metrics for Walleye included a gillnet CPUE greater than 5.0 and PSD between 30 and 60 in at least 50% of years sampled since 2001. Based on survey results, both metrics were met, with CPUE and PSD meeting the objectives in 81% and 59% of years sampled, respectively (Figure 7, Figure 9). For Muskellunge, the specific removal objective metric required trapnet CPUE greater than or equal to 1.0 in at least 50% of years surveyed since 1997. Based on survey results, this metric was met with CPUE meeting the objective in 75% of years (Figure 8).

The specific removal objective metrics for Lake Sturgeon included documenting an increasing trend in two to five year old fish captured in summer index nets (Figure 10), and measuring at least two index values greater than 2.0 fish per lift (Figure 11). Since 2002, the number of sturgeon age five or less has been close to zero with no increasing trend. Similarly, index values have also been below the 2.0 goal since 2002. Failure to meet established targets triggered an additional study detailed below to justify BUI removal.

TABLE 7. COMPARISON OF FISH POPULATION MONITORING AGAINST FISH SPECIES OBJECTIVES

Objective	Result	Objective Met?
Walleye: A. Gillnet catch per unit effort (CPUE) ≥ 5.0 in at least 50% of years surveyed since 2000 B. Proportional stock density (PSD) between 30 and 60 in at least 50% of years surveyed since 2000.	A. The objective is met in 13 of 16 years (81%) surveyed since 2000 (Figure 7). B. The objective is met in 10 of 17 years (59%) surveyed since 2000 (Figure 9).	Yes
Muskellunge: Trapnet CPUE ≥ 1.0 in at least 50% of years surveyed since 1997.	Muskellunge CPUE was 1.0 or greater in 4 of 6 years (75%) surveyed since 1997 (Figure 8).	Yes
Lake Sturgeon: A. Document an increasing trend of two to five year old fish captured in summer index nets. B. At least 2 index values greater than 2.0 per lift.	A. Populations of Lake Sturgeon under 5 years of age are not observed to be increasing (Figure 10). B. Lake Sturgeon index values have not been measured above 2.0 per lift since 2000 (Figure 11).	No – for this reason, a supplemental study was initiated in 2018.

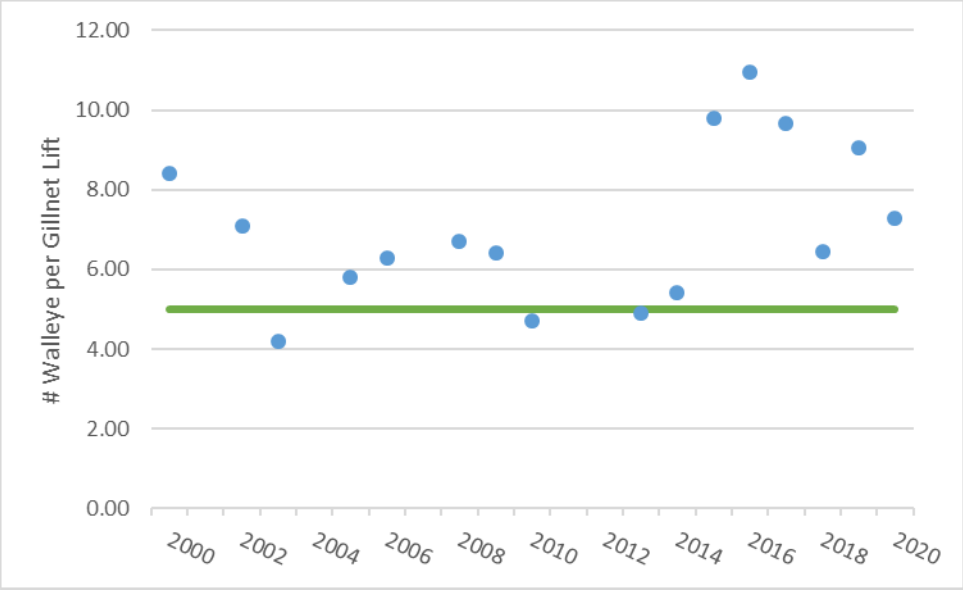


FIGURE 7. CPUE MONITORING DATA FOR WALLEYE. THE GREEN LINE INDICATES THE BUI 2 METRIC, THE OBJECTIVE BEING TO ACHIEVE THIS IN AT LEAST 50% OF YEARS.

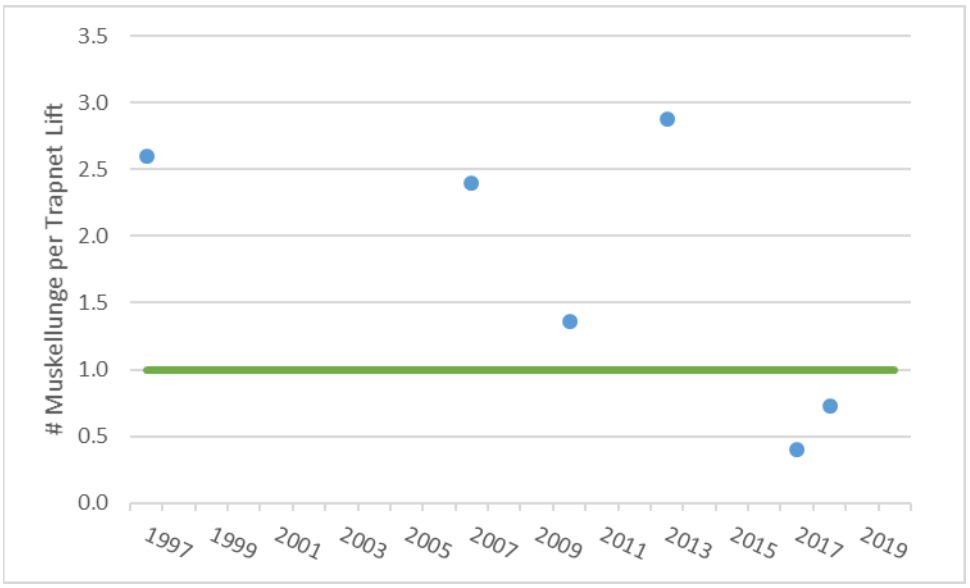


FIGURE 8. CPUE MONITORING DATA FOR MUSKELLUNGE. THE GREEN LINE INDICATES THE BUI 2 OBJECTIVE.

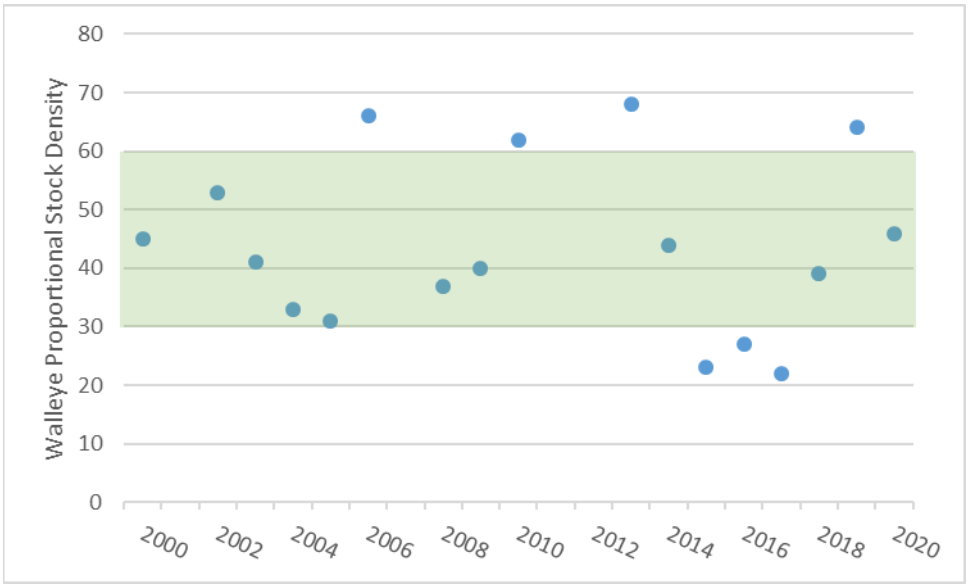


FIGURE 9. PSD MONITORING DATA FOR WALLEYE. THE CORRESPONDING BUI 2 OBJECTIVE RANGE IS SHADED IN GREEN

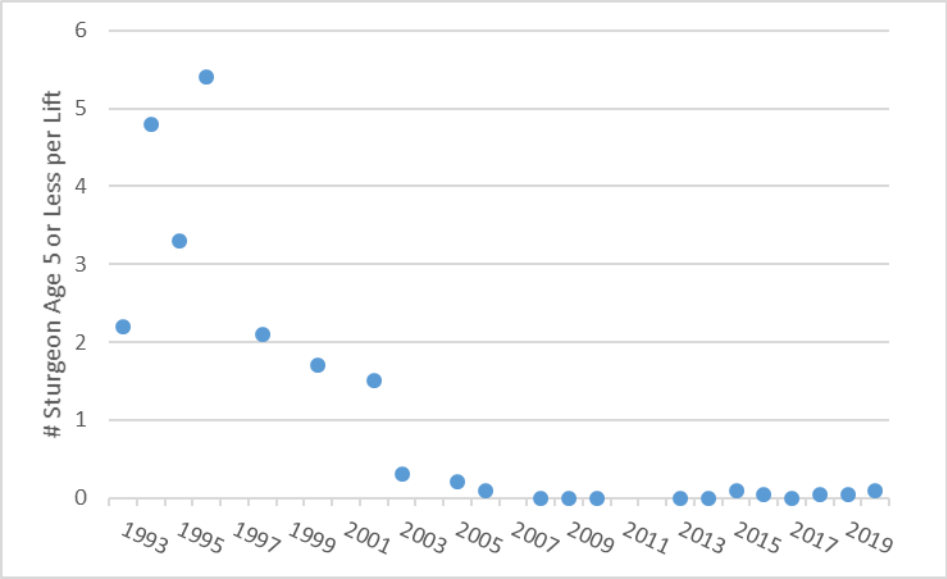


FIGURE 10. NUMBER OF LAKE STURGEON AGE FIVE OR LESS CAPTURED PER LIFT IN SUMMER INDEX NETS. THE CORRESPONDING BUI 2 OBJECTIVE IS TO DOCUMENT AN INCREASING TREND.

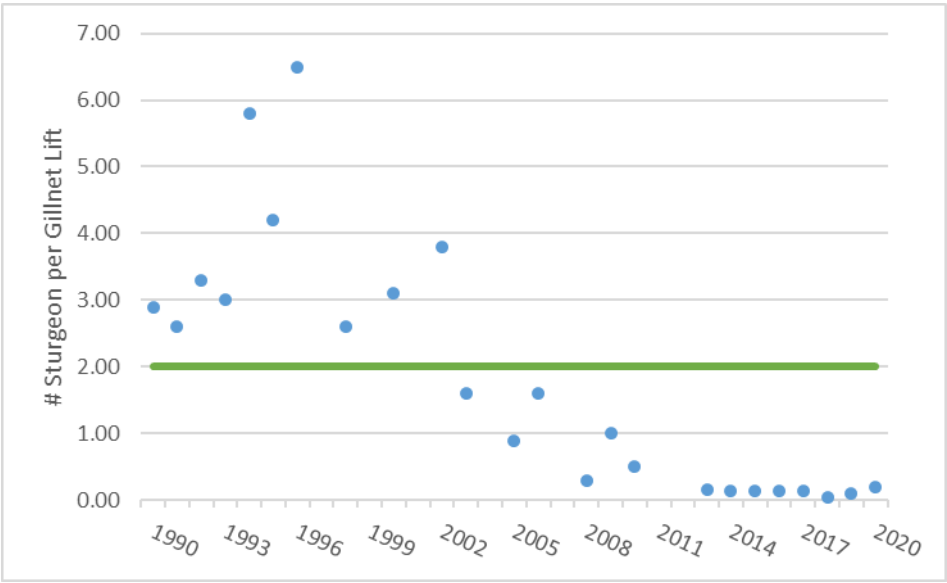


FIGURE 11. TOTAL NUMBER OF LAKE STURGEON CAPTURED PER LIFT. THE GREEN LINE INDICATES THE CORRESPONDING BUI 2 OBJECTIVE.

Conclusions

All removal objectives have been met except the Lake Sturgeon objective. In 2017, Fish Technical Team members concurred that population objectives for Walleye and Muskellunge had been met. Fisheries data collected since 2017 continues to support these objective metrics (Table 7).

Species monitoring has shown the Lake Sturgeon specific removal objective metric has not yet been met, however in 2017, Fish Technical Team members made a formal recommendation to assess potential factors limiting Lake

Sturgeon recovery and determine whether limiting factors were influenced by legacy contamination. This additional study to justify BUI removal was completed in 2021 is summarized below. A detailed report is included as **Appendix D**.

Lake Sturgeon Study

Despite past efforts to recover Lake Sturgeon on the SLRAOC via fingerling stocking, restoring habitat, and improving water quality, annual population measurements indicate that recruitment was not being observed at anticipated levels or trending towards BUI 2 removal targets. Resource managers and fisheries experts working in the SLRAOC identified a need to assess potential factors limiting Lake Sturgeon recovery and determine whether limiting factors are influenced by legacy contamination. Lake Sturgeon are particularly susceptible to bioaccumulation of legacy contaminants because it is an extremely long-lived, late-spawning, bottom-dwelling species that consumes organisms from the bottom sediments, where many contaminants occur in the St. Louis River. The Technical Team hypothesized that various legacy contaminants may accumulate in adult sturgeon and maternally transfer to their developing embryos, potentially leading to decreased survival of early life-stage fish. This prompted a study in 2018, led by Dr. Jon Doering (former EPA GL-TED researcher), to determine the effects of legacy contaminants on early life stage and adult Lake Sturgeon. The study suggested low likelihood of adverse impacts (see final report in **Appendix D**).

Methods

During the springs of 2017, 2018, and 2019, resource managers captured spawning Lake Sturgeon in the SLRE between the Fond du Lac dam and Highway 23. Captured sturgeon were measured, weighed, and their sex determined. Samples collected included blood, eggs (if female), and pelvic fin clips (for genetic stock identification purposes). A total of seven egg samples were collected from captured females between the three sampling efforts.

The egg and plasma samples were analyzed for concentrations of contaminants known as dioxin-like chemicals (DLCs). DLCs are known to have great toxicity to wildlife, producing a range of issues from wasting disease to deformities and early life mortality. To express the total toxicity of a mixture of compounds as a single number, the suite of DLCs measured in eggs and plasma were converted to toxic equivalents (TEQs). The summed potency for each egg sample, in terms of TEQs, were compared to a mortality curve which predicts the percent mortality of Lake Sturgeon as a function of TEQs present in eggs. TEQs measured in St. Louis River sturgeon were also compared to a healthy reference population.

Due to field sampling yielding only seven egg samples, plasma samples from a larger population of females, males, and immature individuals were analyzed to get a broader scope of DLC exposure and bioaccumulation.

Findings

DLCs were detected in egg samples collected from all seven female Lake Sturgeon caught in the SLRE. DLC concentrations in St. Louis River sturgeon eggs were generally at levels higher than the reference population. However, the resulting TEQs were all below the level predicted to cause early life stage mortality. Further, all TEQs were below levels predicted to cause developmental anomalies.

Plasma samples were collected in 2018 and 2019 from a total of six female, two male, and ten immature SLRAOC Lake Sturgeon. DLCs were detected in plasma collected from all but two of the females. Of the 19 DLCs analyzed, individual plasma samples had between one and seven DLCs measured at detectable levels.

TEQs in SLRAOC Lake Sturgeon plasma were greater than EQs in eggs. However, TEQs in plasma remained well below the calculated threshold corresponding to sublethal or lethal effects in adults. This suggests that neither lethal nor sublethal adverse effects would be expected to occur in female, male, or immature adult individuals because of bioaccumulated DLCs.

Long-term exposures to DLCs in Rainbow Trout have shown that effects on adults, such as decreased survival, altered behavior, and impaired reproduction, begin to occur at body burdens that result in maternal transfer of doses that cause toxicities in early life stages. Because adult Lake Sturgeon in the SLRAOC are not accumulating DLCs at levels known to cause lethal or sublethal effects, body burdens are such that females likely are not transferring DLCs to eggs at concentrations known to cause mortality.

Conclusions

The study demonstrates that DLCs are present in SLRAOC Lake Sturgeon and are bioaccumulating to levels greater than the reference population. However, DLC concentrations being maternally transferred from adult fish to embryos are well below concentrations known to cause lethal or sublethal effects. In addition, concentrations measured in adult fish suggest that neither lethal nor sublethal effects are expected. Therefore, bioaccumulated or maternally transferred DLCs are unlikely to be a contributing factor to the failed recruitment of Lake Sturgeon in the SLRAOC (Figure 9 and Figure 10). See **Appendix D** for the complete study report.

Females Lake Sturgeon may live from 80 to 150 years. The do not reach sexual maturity until 18 to 27 years of age, and even then will spawn intermittently. Data from the Bad River Lake Sturgeon population suggests that Lake Sturgeon inhabiting the relatively colder waters of Lake Superior mature later than most other populations and spawn less frequently (Schloesser and Quinlan 2019). It is likely that too few female Lake Sturgeon in the St. Louis River have reached sexual maturity and spawned for fishery assessment to detect a change in abundance of age two-to-five-year-old fish. It is even less likely that females have spawned multiple times and first-time spawners are less fecund or successful. Larval sturgeon were first captured in 2011 and numbers have been steadily increasing. It is evident from increasing captures during the spring spawning run that spawning stock biomass is continuing to increase which should result in an increase in larval and age 2-5 fish over the next decade.

While the BUI removal objective targets for Lake Sturgeon have not been reached, findings from the Lake Sturgeon study indicate that legacy contaminants associated with the SLRAOC are not contributing to slow sturgeon recruitment. Historic habitat loss associated with the SLRAOC has been addressed via restoration of Lake Sturgeon spawning habitat at multiple locations in the estuary and restoration of fish habitat at multiple sites associated with the Loss of Fish and Wildlife BUI (BUI 9). While it is likely that patience is still required for Lake Sturgeon recovery, the SLRAOC program has completed the key actions needed to address legacy impacts to the species and BUI removal is justified despite failure to meet removal targets.

Management Action 2.03: Ruffe Assessment

The Eurasian Ruffe was first identified by Wisconsin DNR in the St. Louis River Estuary in 1987, likely introduced via ship ballast water discharged by a vessel arriving from a Eurasian port. By 1993, it was considered the most abundant of the 60 species found in Duluth Harbor.

Ruffe exhibit rapid growth and high reproductive output and adapt to a wide range of habitat types. There was concern that ruffe may have a detrimental effect on native species in the St. Louis River, such as Yellow Perch and Walleye, by feeding on the young of these species, or by competing for food.

Subsequent analysis demonstrated “that it is not possible to implicate ruffe for decreasing densities of native fishes in the St. Louis River during the study period” (Bronte, et al. 1998). The researchers reported that the variability in abundance and distribution of Ruffe in the SLRE did not negatively impact recruitment of other species in the estuary.

Despite an intense focus on Ruffe during the 1990s, and its subsequent spread to other Great Lakes, resource managers knew little of how its abundance has since changed in the St. Louis River over the last two decades (Gutsch 2017). To better understand the dynamic between Ruffe and native Lake Superior fish, management action 2.03 was created.

Methods

University of Minnesota PhD candidate Michelle Gutsch addressed this action item by completing an analysis of historical fish population data to confirm that Ruffe are not currently inhibiting native fish populations (Gutsch 2017). A complete copy of Ms. Gutsch's dissertation is included as **Appendix E,** noting that the research specific to this action item is captured in *Chapter 2: Population change of an invasive fish, Ruffe, thirty years post-introduction: boom or bust?*

The study's purpose was to determine if Ruffe populations in the St. Louis River conform to typical invasive species "boom-bust" patterns and to identify interactions between Ruffe and native prey and predatory fishes.

Annual St. Louis River fisheries data were available between 1993 and 2015. Bottom trawl surveys were used to sample the fish community. Ruffe invasions in other systems were found to directly compete with species such as Round Goby, Trout Perch, Yellow Perch, Spottail Shiner, Emerald Shiner, and Johnny Darter. These other species were classified as "competitor species" for analysis. Gill net and creel surveys were used to sample the predator fish community. Predator fish are those large enough to consume Ruffe and included Walleye, Northern Pike, Smallmouth Bass, and Muskellunge.

Determining CPUE

CPUE was calculated separately for trawl, gill net, and creel survey data. Trawl CPUE data were standardized to account for variations in trawl width, tow duration, and vessel speed. Trawling CPUE for Ruffe and competitors was calculated as the number of fish caught per hectare. For gill net surveys, CPUE was calculated as the number of fish caught per net using only those individual predatory fish determined to be large enough to consume Ruffe. Average CPUE for Ruffe, competitors, and predators were calculated across sample dates for each year.

Modeling Population Dynamics

Researchers applied an exponential growth model to look for a "boom" pattern in Ruffe CPUE. The model incorporated comparable data sets from 1985-1992 to document the beginning of the Ruffe invasion in the SLR. Researchers developed additional statistical models to determine whether competitor and predatory fish species' populations were correlated with each other and/or with Ruffe and how strong those correlations were. Using this method, the species with the strongest effect on Ruffe could be identified.

Findings

Ruffe populations in the SLR increased in the ten years following its first detection (1985-1995), followed by a decline from 1996-2015. In SLR, the Ruffe population conforms to the typical invasion theory "boom-bust" model and is currently in the "bust" phase. The rate of increase (1985-1995) contrasted with the more moderate rate of decline (1996-2015).

During the study period, researchers found the following correlations between Ruffe CPUE and other species' CPUE:

- Ruffe and Trout Perch (competitor) = strong, negative correlation
- Ruffe and Yellow Perch (competitor) = strong, positive correlation
- Ruffe and Emerald Shiner (competitor) = moderate, negative correlation
- Ruffe and Northern Pike (predator) = moderate, positive correlation

Negative correlations between Ruffe and competitor CPUE in SLR suggests that competition for food, space, or other resources may be contributing to the Ruffe decline. As Ruffe populations decrease, Trout Perch and Emerald Shiner may be outcompeting Ruffe and Yellow Perch. Researchers hypothesized that competition for spawning habitat and food were likely factors contributing to these correlations.

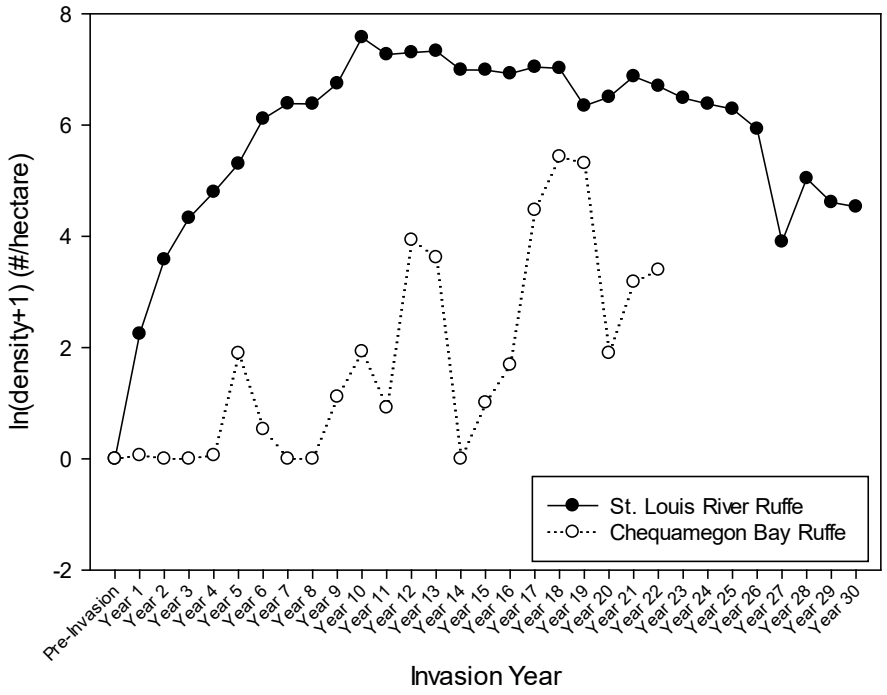


FIGURE 12. RUFFE POPULATIONS IN THE ST. LOUIS RIVER BY INVASION YEAR. ADAPTED FROM GUTSCH (2017); REFER TO APPENDIX E FOR A DISCUSSION OF THE CHEQUAMEGON BAY STUDY.

Conclusions

Research conducted by Gutsch (2017) supports earlier conclusions made by Bronte et al. (1998) that Ruffe was not causing a decline in native SLR fishes. Gutsch (2017) also concluded that the SLR Ruffe population has been declining for two decades and was in the "bust" phase of the invasion at the time of the study. In 1995, the Ruffe CPUE reached a maximum, possibly indicating the population had reached or exceeded its carrying capacity, and then slowly declined.

The Fish Technical Team reviewed the Ruffe assessment results and confirmed that the BUI 2 specific removal objective for the invasive species has been met. Armed with a better understanding of the boom-bust cycle of Ruffe invasion in the SLR, resource managers can better formulate management decisions related to its control. Though the action item is complete, SLR Ruffe populations continue to be measured and monitored through ongoing fisheries data collection by resource management partners.

Management Action 2.04: Semi-Aquatic Mammal Survey

"*Removal of this BUI is not dependent on specific small aquatic mammal population numbers. However, to support development of concurrence among state resource management agencies, a small mammal survey will be conducted in the estuary to verify that populations are not limited by physical habitat, food sources, water quality, or contaminated sediments*" (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2013).

The primary objective of the semi-aquatic mammal study undertaken in 2015 is to determine if the SLRAOC supports similar populations of mammal species versus a non-AOC area with comparable habitat. The justification for BUI removal must rely on this contemporary comparison of wildlife populations because historic (pre-

degradation) wildlife data are not available for the SLRAOC. Only limited anecdotal accounts are available; for example, WDNR staff report comments from long-time trappers that muskrat numbers today are a fraction of historic levels (personal communication with Greg Kessler, WDNR)

Methods

The assessment for this action item was completed by the University of Wisconsin – Madison under contract administered by Wisconsin Department of Natural Resources. Project partners included the MPCA, and Fond du Lac Band of Lake Superior Chippewa. The GLRI funded the study. The data were also the focus of a master's thesis by University of Wisconsin – Madison Department of Forest and Wildlife Ecology master's candidate Bryn Evans. A complete report on the study is included as **Appendix F**.

Target Species

Ms. Evans completed an estuary-wide survey of select semi-aquatic mammal species with the objective to determine if the SLRAOC currently supports populations of native mammal species in similar abundances as areas with less extensive impairment (Evans 2016). Four native species dependent on aquatic resources were selected to study: river otter, mink, beaver, and muskrat. These species span several trophic levels and have distinct roles within aquatic ecosystems, which presents both unique risks for species decline linked to industrialization as well benefits linked to species recovery. All four species are regulated as furbearers, and experienced extensive reductions in population size following European settlement of the area.

Study Areas

The research focused on the following areas within the SLRAOC: the St. Louis River from the Fond du Lac dam to the Bong Bridge, and the Nemadji River from six miles above Crawford Creek to its outlet in Allouez Bay. This area encompasses the diversity of flow regimes and habitat types in the SLRAOC. Due to a lack of data on semi-aquatic mammals in the SLRE prior to degradation, the study used reference areas to determine if target species' populations meet AOC recovery requirements based on statistical equivalency test demonstrating the equality of a degraded system and a control system. Although the estuary's size and characteristics are unmatched in the region, The Boulder Lake Reservoir and St. Croix River were selected as examples of relatively unimpaired lake and riverine reference systems, respectively.

Field Methods

To collect data on bever, otter, muskrat, and mink, motion-triggered trail cameras were deployed within the AOC and two reference sites. Three deployments using 28, 29, and 65 cameras occurred during multiple seasons spanning 2014-2016. In addition to camera traps, aerial surveys by fixed wing aircraft were used to collect fall and winter data on beaver, otter, and muskrat in 2015-2016. Data collected on the flights included a GPS track log of the flight path; starting and stopping locations and times for each segment of the surveys; and waypoints for any sign recorded. Observable sign for beaver consisted of lodges, food caches, and wood chips and downed trees because of chewing activity. Muskrat sign consisted of "push-ups" in the fall, which were generally not observable after snow had fallen. Otter sign consisted of tracks in snow, which were only observable during periods of ice cover and were discernable from other animal tracks by the distinctive sliding pattern in the snow. Detections of target species by aerial surveys and trail cameras were modeled to determine occupancy rates.

Findings

Detections of beaver, mink, muskrat and otter within the SLRAOC were found to be statistically similar to those in reference sites during all three seasons of the study. The study concluded that the removal objective for small semi-aquatic mammals is being met as there is no evidence that a current lack of suitable habitat, resources or pollution was impeding their ability to naturally repopulate the area. The data cannot ascertain if aspects of

habitat, food availability, or water quality are sub-optimal, but there is support that the ecosystem is healthy to the degree required for these species to meet their life requirements at levels similar to areas without the same history of degradation. Tech Team members have reviewed the study and affirmed that the metric for removal of the beneficial use impairment related to small aquatic mammals has been met.

Conclusions

A Small Mammal Technical Team was established and reviewed the results of this study. In 2017, the subcommittee accepted the report and concluded that the status of small mammal species in the St Louis River Area of Concern is sufficient to remove the beneficial use impairment.

Management Action 2.05: Piping Plover Habitat / Beach Nourishment

Piping Plovers are on the endangered species lists for Minnesota and Wisconsin, as well as being federally listed. Of the three Piping Plover breeding populations, the Great Lakes population is the only one listed as endangered. In the Great Lakes region, Piping Plovers use sparsely vegetated beaches, cobble pans, and sand spits to breed and raise their young for a period of approximately three to four months, annually. Wintering grounds range from North Carolina to Florida and along the Florida Gulf Coast to Texas, Mexico, and the Caribbean Islands. Threats to Piping Plovers include the following: habitat destruction and degradation, human disturbance, and contaminants. Plovers are also impacted by the genetic and geographic consequences of their small population size (U.S. Fish and Wildlife Service 2003).

Management action 2.05 was officially included in the SLRAOC "Roadmap to Delisting" in 2013 (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2013) and was determined necessary to restore historically lost nesting habitat for the endangered Piping Plover in the SLRE and support the 2003 USFWS Great Lakes Recovery Plan for the Great Lakes Piping Plover (U.S. Fish and Wildlife Service 2003). The 2003 Recovery Plan's ultimate objective is to remove the Great Lakes population from the list of Threatened and Endangered Species, requiring that specific recovery criteria for population size, reproduction, habitat, and long-term protection are met.

Methods

Management action 2.05 was led by the WDNR with the following partners: City of Superior, Fond du Lac Band of Lake Superior Chippewa, St. Louis River Alliance (SLRA), USACE, USEPA, USFWS, and the University of Wisconsin Sea Grant. This project was funded with approximately $4 million from the Great Lakes Restoration Initiative.

WDNR coordinated the project with support from a Restoration Site Team (RST) of local and regional species experts. The RST evaluated SLRE sites for their potential to attract and retain a Piping Plover colony, ultimately choosing the Wisconsin Point Bird Sanctuary (Bird Sanctuary). The Bird Sanctuary site is a fenced-in area owned by the WDNR. WDNR, USWFS, Douglas County, and the St. Louis River Alliance (SLRA) have all supported efforts to actively manage the Bird Sanctuary site since the 1980s for both Piping Plovers and Common Terns. Past management activities included grading, vegetation control, signage, fencing, removal of large woody debris, monitoring, and public outreach. The area is closed seasonally from April 1 through August 1 to reduce human impacts during breeding season.

In 2017, WDNR entered into an agreement with the USACE to design the project. Primary objectives of the design included the following:

- Provide adequate nesting acreage at locations that have shown plover activity in the past
- Create nesting areas that can be maintained over time using anticipated funding
- Sustain available habitat for 25-30 years

The design process recognized that constructing the habitat may provide ancillary benefits to the estuary such as creating a more sheltered place in Allouez Bay for manoomin (wild rice), fish spawning habitat, and dual use habitat for other shorebirds (USACE - Detroit District 2017).

The USACE evaluated historic water levels, resulting in a design incorporating target elevations that minimize impacts of water variability and shoreline erosion in the establishment of plover habitat. Beach widths, slopes, and open areas for breeding, nesting, and foraging were designed based on recommendations from RST species experts.

The project has created approximately 14 acres of open sand and cobble beach suitable for Piping Plover nesting and foraging habitat. The sand required to construct the beach was obtained through annual Operations and Maintenance dredging of the federal navigational channel by USACE. WDNR developed physical and chemical criteria for these construction materials to ensure their suitability for Piping Plover. In 2019, approximately 87,485 CY of approved dredged materials were placed to create the habitat. The existing spit feature was widened to encourage long-term connectivity, and a new beach was created. Following sand placement, the habitat was enhanced with cobbles, native dune grass restoration and a fence upgrade to deter predators.

See Figure 13 for photos showing the completed restoration.

FIGURE 13. BEFORE AND AFTER IMAGES SHOWING THE COMPLETED HABITAT RESTORATION AT WISCONSIN POINT. IMAGE SOURCE: GOOGLE EARTH

Partners will continue teaming up for Piping Plover, focusing efforts on long-term habitat establishment and management, outreach and education, and monitoring. WDNR, USFWS and the St. Louis River Alliance, with GLRI funding, are planning to:

- Assess habitat twice yearly to identify management actions necessary to maintain suitable habitat
- Conduct management actions to maintain suitable habitat (i.e., remove unwanted vegetation/wood, maintain slopes)
- Develop education and outreach materials to protect Piping Plover habitat from human activity and predators
- Monitor site for Piping Plovers, document nesting pairs, fledgling survival and success at the site

Outlined below are components of the AOC project's Establishment Phase. This work is supported with AOC program resources and will ensure the high-quality habitat is established and plans are in place for long term management.

1. Native dune grass will be planted on approximately 1 acre of the site outside of the nesting area.
2. Habitat assessments will be conducted twice per year by species experts to identify any actions needed to ensure the habitat is meeting the species criteria.
3. Habitat management actions identified will be conducted by the St. Louis River Alliance and WDNR. Actions to maintain the habitat criteria may include: woody debris and vegetation management, shoreline grading to maintain slope and manage cliffing, and cobble pan maintenance.
4. Property management actions including gate installation, fencing, and signage will be conducted by WDNR staff.
5. Monitoring of Plover Tiger Beetle (food source) re-colonization of the site.

Findings

The habitat has attracted Piping Plover in the few seasons that it has been available. During site monitoring in 2020 and 2021, 1 plover was observed using the habitat in each year. Annual monitoring begins in late April and continues daily until chicks are fledged or no nesting occurs (June-July).

Please see **Appendix G** for a complete summary (including photos) on the WI Point project

Conclusions

The project was successfully constructed as designed. Early monitoring results are encouraging and plans for long-term maintenance, management, and nest protection are in place to ensure the high-quality habitat is sustained into the future. A complete project summary report, including photos, is included as **Appendix G.**

The 2019 project is not the only work in the estuary to benefit the Piping Plover and long-term plans are in place to continue assisting this species recovery. AOC partners and agencies have been involved in managing the species and habitats for many years. Partners have conducted significant work related to piping plover habitat and outreach including plover monitoring, creating a educational curriculum, engaging the media and developing nesting attractants and improvements at Shafer beach.

Management Action 2.06: Interstate Island Avian Habitat Restoration

Interstate Island is a small island within the Duluth-Superior Harbor, constructed by the United States Army Corps of Engineers (USACE) in the late 1930s using dredge materials. In the 1980s, the site became of interest as habitat for Common Terns as human disturbance and site development in other nesting locations in the estuary made those places no longer viable for the species (Matteson 1988). A 1989 restoration project cleared all vegetation completely to expose sand substrate to attract Common Terns, which are listed as threatened in Minnesota and endangered in Wisconsin. The entire breeding population of the SLRE was subsequently attracted to the site in 1989 and 1990 (Penning 1993). The island has since been managed by MNDNR and WDNR as a Wildlife Management Area and Wildlife Refuge, respectively (Minchak and Staffon 2007).

A legacy of habitat loss in the SLRAOC has confined Common Terns to one, increasingly unstable site. A colony of Ring-billed Gulls also nests on the island. Competition for tern nesting habitat by Ring-billed Gulls has increased in recent years as gull nesting habitat has decreased due to flooding and erosion of the island, increasing the vulnerability of the tern colony. This vulnerability has been expressed in terms of decreased colony sizes and even complete colony failure in some years due to flooding, predation, or other unknown issues.

Interstate Island is the only federally designated critical habitat for Piping Plovers in the state of Minnesota. While Piping Plover have not nested at Interstate Island and are not likely to nest there while the Ring-billed Gull colony

is present, the island may be used as stopover habitat for Piping Plover, as well as other migrating shorebirds (United States Fish and Wildlife Service 2001). NRRI researchers monitoring shorebirds at Interstate Island observed 15 different species in 2019-20, including multiple plover and sandpiper species (Kolbe 2021)

In 2014, rising lake levels and increased storm surges resulted in significant and sustained flooding at Interstate Island. In 2015, the colony was only 101 nesting pairs, the lowest number since 1989 (Figure 4). This prompted local resource managers to increase the elevation of the tern nesting area and build a protective berm around it in 2015 to protect it from destruction by flooding. Though the 2015 construction successfully protected the nesting area for the time being, NRRI researchers and resource managers at MNDNR and WDNR watched water levels continually rise, while nesting and reproduction rates remained well below recovery goals (Figure 3).

The BUI 2 Avian Tech Team (Table 2) recommended that SLRAOC Coordinators review and revise the necessary management actions related to Common Tern habitat as the population is in decline due to legacy habitat loss. This recommendation resulted in the Interstate Island avian habitat restoration project being included as a BUI 2 management action in 2019 (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2019).

Methods

The Minnesota Land Trust (MLT) managed the Interstate Island avian habitat restoration project for the MNDNR and its partner the WDNR. Federal partners included the USEPA, USFWS, and the USACE. The project cost approximately $2,800,000 to manage, design, construct, and monitor. Funding support came to MNDNR and MLT from the GLRI via USEPA, Minnesota Outdoor Heritage Fund, NOAA Coastal Program, USFWS Great Lakes Fish and Wildlife Restoration Act, and USFWS Midwest Region Coastal Program. Through a USACE partnership, Harbor Maintenance Trust Funds were used to contract the excavation and placement of sand acquired through annual navigational channel operations and maintenance dredging.

A project Restoration Site Team (RST) comprised of project coordinators and local avian species experts began meeting in 2019 to develop the following restoration purpose and objectives and generate a concept design. The Project's primary purpose is to maintain viability of the largest Common Tern nesting colony in the Lake Superior watershed. Objectives supporting this purpose include the following:

1. Restore at least 5.5 acres of stable upland (above 605.5 feet IGLD85) habitat for nesting and rearing use by Common Terns and nesting and stopover use by other migratory shorebirds, including Piping Plover;
2. Increase island elevation to protect against flooding;
3. Stabilize the island perimeter to prevent scour and further habitat loss;
4. Enhance substrate composition and control woody vegetation;
5. Quantify target populations' status, nest success, and habitat usage; and
6. Develop and implement a proactive program to sustain habitat quality.

In 2019, the MLT awarded a design contract to SEH, Inc. (SEH). In consultation with the RST, SEH developed project plans and specifications that reflect habitat requirements listed in scientific literature and promote long-term habitat resiliency. The design incorporated specific habitat requirements of Common Terns and Piping Plover while providing sandy beach habitat for use by a variety of shorebirds. Specific requirements included shoreline slopes of approximately 8% and a minimum of 5.5 acres of habitat above an elevation of 605.5' IGLD85. This is equal to the historic Lake Superior high elevation of 604.5' IGLD85, with an additional foot incorporated to ensure island protection and resiliency to increasingly unpredictable Lake Superior water levels and storm surges

The design accommodated the use of both commercially-sourced sand and sandy material obtained through annual USACE operations and maintenance dredging in the Duluth-Superior Harbor. The project team worked

with the USACE to identify suitable materials, resulting in the project's construction being divided into two separate contracts managed by the MLT and USACE.

The MLT awarded a contract to JF Brennan Company (JF Brennan) in March 2020 to begin restoring habitat in the island's existing footprint. In April 2020, JF Brennan removed all woody vegetation to eliminate predatory bird perches. JF Brennan then placed commercially-sourced sand to elevate flooded areas of the island. The work was completed prior to May 1 to vacate the island prior to the Common Tern nesting season.

Following the nesting season and beginning in late August 2020, JF Brennan rebuilt the Common Tern nesting area. The new 30,000 sqft nesting area featured an embankment at a higher elevation to eliminate future flood risk. They also installed a permanent fencing system to assist in managing the nesting area and constructed rock vanes to protect the island against wind erosion.

Beginning in late September 2020 through early November, the USACE led the expansion of the island on the Wisconsin side to approximately double its previous size. The USACE awarded a contract to Roen Salvage Company (Roen Salvage) for the work, which beneficially used dredge materials from yearly navigation channel operation and maintenance dredging. Roen Salvage hydraulically placed and graded dredged sand in two separate lifts to expand the island footprint and tie in to the existing island. Two lifts were required to keep the highest quality sand at the surface. JF Brennan revisited the newly expanded island in April 2021 to install additional rock vanes in the island expansion area and perform any needed touch-up grading or fill placement. Though not directly related to Common Tern habitat restoration or required for BUI 2 removal, native dune vegetation will be planted on Interstate Island beginning in summer 2021 to provide additional stability (contractor and planting list to be determined).

See Figure 13 for aerial photos depicting the progression of construction at Interstate Island.

During the 2020 nesting season (mid-May through mid-August), NRRI researchers visited the island at least twice weekly to count Common Tern nests, monitor and band chicks, and monitor and band adults. Starting in mid-May, NRRI also researchers documented other migratory shorebirds through weekly surveys (through September) and perimeter camera traps, which take one photo every 10 minutes during daylight hours (through October). Annual tern and shorebird monitoring is contracted using project grant funds through 2023; tern monitoring will likely continue using state natural resource funding.

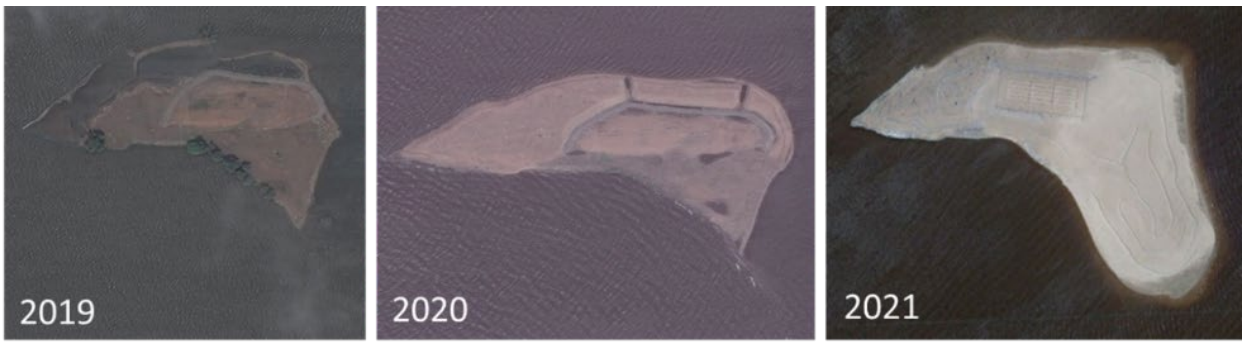


FIGURE 14. PROGRESSION OF RESTORATION CONSTRUCTION AT INTERSTATE ISLAND. IMAGE SOURCE: GOOGLE EARTH

Long-term Monitoring & Maintenance

In 2020, SEH developed a comprehensive Long-term Monitoring and Maintenance Plan (Plan) that identifies the goals, methods, schedule, and triggers for ongoing monitoring and maintenance of the restored Interstate Island

habitat (Short Elliott Hendrickson Inc. 2020). MN and WI wildlife managers have a history of jointly managing Interstate Island and will continue to do so, using the Plan as guidance.

The Plan incorporates measurable objectives related to the amount of stable upland habitat, nesting area and other island substrates, woody and invasive vegetation, and target avian populations' nesting and reproductive success. The Plan establishes performance standards, monitoring protocols, and reporting requirements. Any maintenance triggered by the plan would occur outside of the Common Tern nesting season (March 1 to August 30). The Plan is adaptive, with the MN and WI resource managers performing an annual review, updating the plan with any required changes or updates.

Findings

See **Appendix H** for a complete summary (including photos) on the Interstate Island project. Successful implementation of the project plans and specifications by JF Brennan and Roen Salvage were documented through field observation by project engineers, review of periodic field reports, and post-construction surveys. JF Brennan and Roen Salvage submitted final "as built" surveys which demonstrated the project produced 6.7 acres, slightly exceeding the project objectives for long-term, stable, upland habitat.

The 2020 nesting season was successful, with 108 nesting pairs and 1.32 young fledged per nest (Figure 4 and Figure 5). The fledgling rate was the highest observed since 2008. NRRI researchers continue to observe a diverse assemblage of migratory shorebirds using Interstate Island (Kolbe 2021). A total of four years of Common Tern and migratory shorebird monitoring will be completed under the project's funding, and it is assumed that long-term Common Tern monitoring by MN and WI wildlife managers will continue into the foreseeable future. These data will continue to demonstrate the impacts of this restoration work on target species.

The 2020 long-term monitoring and maintenance plan for Interstate Island in 2020 was developed by the project's design engineers with a high level of input and review from MN and WI resource managers and researchers. The plan is explicitly linked to measurable project objectives, allows for adaptive management, and has support from the state wildlife managers who jointly manage the island resource.

Conclusions

Due to the high level of input and involvement from local species experts, the design and specifications for the Interstate Island restoration project were highly tailored to the target species, appropriately protective/conservative, and are therefore have a high probability for long-term success. The project's construction contractors effectively implemented the project plans and specifications to meet objectives, as reflected in the review and acceptance of final as-built surveys. While several on-the-ground adjustments to the design were required to accommodate actual conditions, these adjustments did not compromise the achievement of the project's purpose and objectives.

The Common Tern removal objective has been met based on the implementation of the Interstate Island restoration project. The state agencies will continue to support habitat management and population monitoring at Interstate Island.

Future Actions

Extensive investments into the recovery of SLRE fish and wildlife populations are being made through the AOC Program. While the scope and duration of the SLRAOC is limited, the need for continued focus on SLRE fish and wildlife populations into the future is necessary to protect AOC investments, research and/or address continued limitations, and generally support the estuary resource. Therefore, Technical Team members provided the following recommendations regarding future planning, management, and study of fish and wildlife in the estuary. These recommendations go beyond the scope of the AOC program and may be pursued under other existing or future programs and are not required for BUI removal. Recommendations listed are in different stages of development, funding and implementation and inclusion in this document does not guarantee a recommendation will be implemented.

Recommendations for Fish

- Provide annual monitoring updates so the data sets for indicator species can be maintained as current.
- Continue the acoustic tagging study to investigate Lake Sturgeon movement patterns.
- Conduct molecular sexing to evaluate sex ratios of spawning and non-spawning Lake Sturgeon (MNDNR Fisheries Genetics Lab).
- As recommended by Minnesota Department of Natural Resources (2019)
    - Utilize stationary PIT tag receiver downstream of the spawning habitat below the Fond du Lac Dam to passively monitor PIT tagged Lake Sturgeon to collect additional data on the timing, duration and frequency of spawning movements in the SLR.
    - Investigating low female capture rate.
    - Expanding current drift netting efforts to better determine larval drift rates and compare to regional data.
    - Developing outreach and education.

Recommendations for Birds

- Restore, enhance, and protect marsh bird habitat. Example given: hemi marsh habitat creation and upland bird habitat restoration at Grassy Point (and beyond) and city of Duluth forested areas.
- Shallow marsh habitat is still limited; conduct future survey/research to determine if wetland bird populations are similar to local reference sites
- The Lake Superior Common Tern population should continue to be managed and monitored annually.
- By 2025, reevaluate, assess, and restate (if necessary) Wisconsin's Common Tern Recovery Plan (Matteson 1988) target objectives of 200 breeding pairs for the Duluth Superior Harbor.
- Additional research on mercury exposure in the food web for breeding birds on Interstate Island.
- Continue Common tern population modeling to refine recovery targets
- Additional research is needed to determine limiting factors for population growth for the Interstate Island Common Tern population and to anticipate long-term impacts of climate change.
- Research and implement plans on Interstate Island to prevent gulls from establishing nests and taking over the tern nesting area this winter or spring

- As recommended by Bracey et al. (2016)
    - The overall low use of the SLRE by shorebirds deserves further study
    - Attracting and reestablishing breeding Great Blue Herons in the SLR will most likely require keeping multiple large undisturbed areas of the appropriate habitat available or, if that is not feasible, possibly installing nest platforms. Many individual Great Blue Herons were observed in the SLR during the avian study period, but no colonies have been located for many years. Several local bird watchers in the area have suggested that a colony site exists in the Superior Municipal Forest. The authors suggest that an effort be made to search for the colony or colonies and provide adequate protection of these sites if possible.
- Continue to maintain piping plover habitat and monitor and protect the species in the SLR AOC.
- Investigate the impacts of contaminants (e.g., mercury) on the survival and productivity of breeding avian species.
- Perform Piping Plover habitat restoration on Minnesota Point
- Conduct toxicology monitoring for waterfowl species to explore impacts to consumption and breeding success

Recommendations for Mammals

- Conduct mink and muskrat toxicology monitoring to explore potential site-specific impacts to breeding success and fitness.

Assessment of the BUI Removal Target

Prior to the development of a BUI 2 removal target (2008), objectives (2013), and management actions (2013-19), the 1995 RAP Progress Report provided a list of recommended actions. As discussed in Section 4.2, these recommendations have since been implemented prior to 2013, or translated into six management actions via the 2013 Roadmap to Delisting and subsequent Remedial Action Plan updates. Completion of the six management actions has led the AOC Managing Agencies to consult with the BUI Technical Team to review and evaluate the BUI Removal Target and form a removal recommendation.

The BUI 2 Removal Target requires concurrence from resource managers. This is accomplished by reviewing the final recommendation with the AOC Leadership Team, comprised of lead supervisors from the Fond du Lac Band of Lake Superior Chippewa and three state agencies (Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, and Wisconsin Department of Natural Resources.) Upon gaining concurrence from the AOC Leadership Team, the final recommendation is shared with the Interagency Manager's Team. Managers from the three state agencies comprise this team and provide final concurrence and authorization to submit the final BUI removal package to EPA.

The Removal Target Has Been Met

The removal target will have been met when:

> *In consultation with their federal, tribal, local, and nonprofit partners, state resource management agencies concur that diverse native fish and wildlife populations are not limited by physical habitat, food sources, water quality, or contaminated sediments.*

The final delisting target for BUI 2 considers the following four key limitations to diverse, native fish and wildlife populations in the SLRAOC:

1. Water Quality
2. Physical Habitat
3. Contaminated Sediment
4. Food Sources

States establish and implement their own water quality standards, which provide benchmarks for assessing the Estuary's water quality limitations. To address the remaining three limitations, resource managers have selected common measures to demonstrate whether conditions support fish and wildlife populations, though formal measurable targets have not been established by the states. Each of these limitations are described further below.

Water Quality

Historically, degradation of water quality by industrial and urban discharges limited the ability of the aquatic habitat to support macrophytes and other healthy ecological functions. Contaminated sediments, suspended sediments and organic sediments historically discharged into the SLRE resulted in the impairment of fish and wildlife habitat and populations with an overall reduction of biological productivity of the system. Prior to the improvements in wastewater treatment in the late 1970s, water quality and biological investigations characterized the estuary as low in dissolved oxygen and high in total phosphorus and total suspended solids (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 1992). By the time the Stage I RAP was developed in 1992, many of these point source discharges were being treated as required by the Clean Water Act, and the primary concerns for the AOC

were legacy contamination and historical habitat degradation, as well as excess sediment and nutrient inputs prior to 1972.

Water quality protection is an important responsibility of federal and state government and the 1972 US Clean Water Act established water quality standards to monitor the condition of public waters and assure that waters support their designated uses. SLRAOC partner states adopt their own water quality standards into statute and use them to assess Clean Water Act impairments. The AOC program is tasked with addressing Beneficial Use Impairments and poor water quality resulting from pre-Clean Water Act discharges.

AOC Management of Water Quality

Water quality in the SLRAOC is addressed by multiple BUIs, as listed below. BUI statuses are current as of the 2020 SLRAOC RAP Update (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2020).

BUI 1: Fish Consumption Advisories. The removal target for BUI 1 requires that tissue concentrations of contaminants of concern are not significantly elevated from background. The strategy for BUI removal is closely linked to water quality, as sources of bioaccumulative contaminants of concern are closely linked to legacy pollution in sediments, which influences water quality. All four management actions developed to remove BUI 1 are in progress and are scheduled to be completed between 2022 and 2024.

BUI 5: Restrictions on Dredging. The removal target for BUI 5 requires remediation of contaminated sediment project sites in the SLRAOC. Contaminated sediments may contain a variety of toxic and/or bioaccumulative contaminants that are detrimental to water quality. The remediation sites are identified in the management action list for BUI 5; they are scheduled for completion in 2025.

BUI 6: Excessive Loading of Sediment and Nutrients. The removal target for BUI 6 requires that nutrient and sediment levels are not impairing water quality and habitat, based on specific criteria for: discharge permit compliance, total phosphorus concentrations in Lake Superior and the SLR, and wastewater overflows to the SLR contributing to organic matter and algal growth. The five management actions developed to remove BUI 6 were completed and the BUI was removed in 2020.

Continued Water Quality Limitations

As described above, completion of management actions associated with BUIs 1, 5, and 6 will improve SLRE water quality by addressing legacy-based fish consumption advisories, remediating legacy contaminant hot spots, and demonstrating acceptable sediment and nutrient loading. However, the strategy for removing BUI 2 does not require completion of management actions associated with other BUIs. BUI 2 is recommended for removal upon the successful completion of six required management actions with the understanding that water quality limitations may persist within the SLRE and ongoing water quality management is required.

Extensive sampling completed during RAP development and through ongoing research indicate the presence of contaminated sediments outside of targeted remediation projects, originating from a combination of legacy, precipitation, and watershed sources (Janssen, et al. 2021) (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2013). While the SLRAOC strategy involves identifying and remediating key legacy hot spots to acceptable levels, it is likely that: 1) there will be a lag between completing remediation projects and observing improvements to water quality and the food web, and 2) it is not feasible for AOC work to address the totality of pollution in the estuary including

pollution below action levels, natural sources, and modern sources that are the ongoing responsibility of natural resource management agencies.

Regardless of AOC status, resource management agencies continue to monitor, assess, and regulate SLRE water quality through the Clean Water Act and associated programs to ensure that conditions support the most sensitive species, as intended by applicable water quality standards. For example, a forthcoming Total Maximum Daily Load (TMDL) will determine the mercury reductions needed for lakes and rivers in the St. Louis River watershed to meet state water quality standards and support healthy consumption of fish. The Future Actions section provides recommendations to better understand and address continued limitations.

Physical Habitat

Physical habitat is the ecological setting that supports aquatic life in the estuary. Legacy impairments to physical habitat identified in the SLRAOC include loss through dredging and filling activities and decline in the quality of wetlands from invasion of non-native vegetation. Since 1861, approximately 3,400 acres of wetlands have been lost in the estuary through a combination of dredging and filling; this includes approximately 1,700 acres of shallow, open-water aquatic habitat in St. Louis Bay and Superior Bay that was converted to deep shipping channels (Hollenhorst, et al. 2013).

The 2002 Lower St. Louis River Habitat Plan (Habitat Plan) was developed to establish conservation targets for aquatic and terrestrial habitat in the Estuary using a source/stressor model (St. Louis River Citizens Action Committee 2002). Specific habitat restoration projects were then prioritized to achieve approximately 1,700 acres of restored aquatic habitat (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2013).

The Habitat Plan documents the ecological values of shallow sheltered bays, which are the objective of many SLRAOC fish and wildlife habitat improvements. Sheltered bays are critical spawning habitat for many species, including forage and non-game species. The shallow sheltered bay has the highest diversity of fish species and the highest abundance of fish; the bays also provide critical habitat for obligate wetland species.

Physical habitat for birds covers the important life behaviors of nesting, feeding, and migratory stopovers. Terns, Gulls and Plover nest on gravelly substrate and forage in shallow areas. Sandy beaches are stopovers for migrating Plovers. Waterfowl and marsh birds use vegetated wetlands for nesting and feeding.

AOC Management of Physical Habitat

Physical Habitat in the SLRAOC is addressed by multiple BUIs, as listed below. BUI statuses are current as of the 2020 SLRAOC RAP Update (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2020).

BUI 5: Restrictions on Dredging. The removal target for BUI 5 requires remediation of contaminated sediment project sites in the SLRAOC, which may also facilitate improvements to physical habitat where practicable. A “remediation to restoration” approach has been developed and adopted by SLRAOC partners to simultaneously address contaminated sediments and degraded habitat in remediation sites other than the shipping slips. Remediation sites are identified in the management action list for BUI 5; they are scheduled for completion by 2025.

BUI 9: Loss of Fish and Wildlife Habitat. The removal target for BUI 9 requires completion of identified aquatic habitat restoration projects, in addition to protection and rehabilitation of habitat in AOC

watersheds. Management actions for BUI 9 were heavily influenced by the 2002 Habitat Plan and include 17 restoration sites, plus 275 acres of wild rice restoration at multiple sites. A variety of habitat types will be restored including coastal wetlands, shallow sheltered bays, fish passages, stream banks, cold-water streams, sand dunes, and wild rice beds. As of the 2020 RAP, nine of 21 management actions are complete. The anticipated timeline for BUI 9 removal is 2025.

The BUI 9 removal target also requires an assessment of AOC habitat restoration and protection projects completed in Wisconsin prior to the 2013 Roadmap. As summarized in a 2015 WNDR report, these efforts included over 17,600 acres of habitat protection, over 345 acres of restoration (including 50 acres aquatic), 60,000 tons of contaminated sediment removed from Newton Creek and Hog Island, and invasives control throughout the estuary (Wick 2015).

Though not a BUI 9 removal requirement, MNDNR prepared a 2020 companion report documenting AOC habitat restoration and protection efforts completed in Minnesota prior to the 2013 Roadmap. The accomplishments summarized in this report include ten protection projects and 22 restoration projects totaling approximately 27,170 acres (Collins 2020).

Continued Physical Habitat Limitations

As described above, completion of management actions associated with BUI 5 and BUI 9 will improve physical habitat at key locations in the SLRE by remediating contamination and restoring habitat. Where needed to improve physical habitat for key species (i.e. Piping Plover and Common Tern), additional habitat restoration projects were identified as BUI 2 management actions. While these projects were strategically chosen to maximize SLRAOC outcomes, it is understood that: 1) there will likely be a lag between completing habitat restoration projects and documenting associated benefits to fish and wildlife populations, and 2) it is not feasible for the AOC program to address the totality of impacts to physical habitat in the SLRE and continued management and improvement is the ongoing responsibility of natural resource agencies and partners outside the AOC program.

Recognizing that management actions associated with BUIs 5 and 9 will complete the AOC-wide objective for addressing physical habitat, the strategy for removing BUI 2 does not require completion of management actions associated with other BUIs. BUI 2 is recommended for removal upon the successful completion of six required management actions with the understanding that some physical habitat limitations may persist within the SLRE and ongoing management and improvement of fish and wildlife habitat will continue. The Future Actions section provides recommendations to better understand and address continued limitations outside the AOC program.

Contaminated Sediments and Food Sources

These two conditions are assessed together since the legacy challenge for food sources, as identified in the 1992 RAP, is the potential contamination of the food chain in locations with elevated contaminants (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 1992). There is no clear documentation on how the various constituent units of the Duluth-Superior area handled their solid and liquid wastes prior to the 1970s, but it has also been established that a number of industries discharged directly and indirectly into the river or bay. Consequently, a number of sites within the AOC contain legacy pollutants from historical contamination with chemicals or toxic waste products.

At the time of AOC listing, restrictions on dredging was a beneficial use that was clearly identified as impaired in the SLRAOC. Sediments in many parts of the AOC exceeded guidelines developed by regulatory agencies to characterize in-place sediments and contained a variety of toxic or bioaccumulative contaminants, which have been shown to cause adverse effects to aquatic and terrestrial organisms. In

addition, serious economic and social consequences were thought to be imposed upon resource users through special dredging requirements and obligations for long-term sediment containment.

AOC Management of Contaminated Sediments and Food Sources

Sediment contamination in the AOC contributes directly or indirectly to eight of the nine BUIs (BUI 6: Excess Loading of Sediment and Nutrients is the exception); remediation of contaminated sediments is an obvious focus of AOC restoration efforts, not only from an ecological standpoint but also from the standpoint of stakeholder concern.

Legacy-contaminated sediments and food sources in the SLRAOC are addressed by multiple BUIs, with the two primary BUIs listed below. BUI statuses are current as of the 2020 SLRAOC RAP Update (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2020).

BUI 1: Fish Consumption Advisories. The removal target for BUI 1 requires that tissue concentrations of contaminants of concern are not significantly elevated from background. The strategy for BUI removal is closely linked to sediment, as sources of bioaccumulative contaminants of concern are closely linked to legacy pollution in sediments. All four management actions developed to remove BUI 1 are in progress and are scheduled to be completed between 2022 and 2024.

BUI 5: Restrictions on Dredging. The removal target for BUI 5 involves assessment and remediation when state action levels are exceeded of twenty-three contaminated sediment project sites in the SLRAOC. Sediment contaminant levels were investigated and quantified through several research efforts. The SLRAOC was divided into Sediment Assessment Areas (SAAs) to establish a common framework for assessing and displaying sediment contaminant data. Staff from MPCA and WDNR determined the need for remedial action at specific locations across the AOC. Remediation of contaminated sediments above action levels, as well as other necessary restorative actions, must be evaluated, designed, and implemented in support of any identified ecological endpoint objectives.

Continued Contaminated Sediment & Food Source Limitations

As described above, completion of management actions associated with BUIs 1, and 5 will improve the SLRE food web by addressing legacy-based fish consumption advisories and remediating legacy contaminant hot spots. However, the strategy for removing BUI 2 does not require completion of management actions associated with other BUIs. BUI 2 is recommended for removal upon the successful completion of six required management actions with the understanding that some limitations to the food web may persist within the SLRE and ongoing management is required beyond the AOC program.

Extensive sampling completed during RAP development and through ongoing research indicate the presence of contaminated sediments below action levels outside of targeted remediation projects, originating from a combination of legacy, precipitation, and watershed sources (Janssen, et al. 2021) (Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources 2013). While the SLRAOC strategy involves identifying and remediating key legacy hot spots to reduce exposure risk, it is likely that: 1) there will be a lag between completing remediation projects and observing improvements to the food web, and 2) it is not feasible for AOC work to address the totality of pollution in the estuary including legacy pollution below action levels, natural sources, and modern sources that are the ongoing responsibility of natural resource management agencies.

Regardless of AOC status, resource management agencies continue to monitor, assess, and regulate potential food web contaminant sources. The Future Actions section provides recommendations to better understand and address continued limitations.

The Removal Objectives Have Been Addressed

Removal of BUI 2 will be justified when it is shown that key native species populations of fish and wildlife are present and not limited by the legacy impairments referenced by the removal target. This is demonstrated by addressing the specific removal objectives for the fish and wildlife species listed below. Removal objectives were established to help identify key species, establish specific management actions, and guide AOC mangers toward achieving the removal target. All removal objectives have been met except the Lake Sturgeon objective. Species monitoring has shown the Lake Sturgeon specific removal objective metric has not yet been met, however resource managers have completed additional studies that justify BUI removal.

Fish

The following BUI 2 objectives were developed for target native and invasive fish species:

- Walleye gillnet catch per unit effort is maintained at or above 5.0 per lift with a proportional stock density between 30 and 60 in at least 50% of years surveyed since 2000.
- Muskellunge trap net CPUE is maintained at or above 1.0 per lift in at least 50% of years surveyed since 1997.
- Document an increasing trend of two to five year old Lake Sturgeon captured in summer index nets, with at least two index values greater than 2.0 per gillnet lift.
- An analysis of historical data that shows the Ruffe, and invasive species, is not inhibiting the native fish population.

CONCLUSION: Populations of Walleye and Muskellunge in the St. Louis River are meeting or exceeding the established objectives and invasive Ruffe are no longer inhibiting native fish populations. Lake Sturgeon populations are not currently meeting the BUI 2 objective, however justification to remove the BUI has been shown through additional study of legacy contaminants. Lake Sturgeon are not accumulating legacy contaminants at levels that impact reproduction and are likely limited by factors outside of the AOC program's focus. Lake Sturgeon recovery is part of agency program goals that extend beyond the AOC program's scope and timeline.

Based on evaluation of completed management actions, resource managers have reached consensus that SLRAOC fish populations are not limited by legacy impacts to water quality, physical habitat, contaminated sediment, or food sources at levels that require additional management actions under BUI 2. Continued efforts to remediate contaminated sediments and restore habitat under other BUIs will further benefit native fish populations in the estuary.

Wildlife

The following BUI 2 removal objectives were established for target wildlife species:

- Piping Plover nesting habitat is created with the SLRAOC.
- Common Tern nesting habitat at Interstate Island is restored and state agencies continue to support habitat management and population monitoring there.
- Great Blue Heron and Bald Eagle presence is recorded during one or more nesting seasons since 1997.
- Wetland bird species are surveyed and compared with 1979 survey results.
- A survey of semi-aquatic mammals in the estuary verifies that the status of small mammal species in the St Louis River Area of Concern is sufficient to remove the beneficial use impairment.

CONCLUSION: Removal objectives for wildlife were achieved. Species including Great Blue Heron and Bald Eagle met targets, while wetland bird species at Remediation to Restoration sites were surveyed and found to have greater abundance and similar species richness when compared to reference sites and similar species richness

when compared to historical surveys. Four species of semi aquatic mammals were surveyed and found to be similar to reference populations. Habitat restoration projects targeting Piping Plover and Common Tern were implemented to address legacy habitat loss, which includes long-term monitoring and maintenance.

Based on evaluation of completed management actions, resource managers have reached consensus that SLRAOC wildlife populations are not limited by legacy impacts to water quality, physical habitat, contaminated sediment, or food sources at levels that require additional management actions under BUI 2. Continued efforts to manage critical nesting habitat, remediate contaminated sediments and restore habitat under other BUIs will further benefit native wildlife populations in the estuary.

Public Involvement Process (this section will be completed after the comment period is complete)

Many types of public involvement activities are conducted as part of the SLRAOC program. Some are specific to projects and BUIs and others are related to the SLRAOC program more broadly and they are too numerous to be mentioned here. Three specific activities fall in the public involvement realm for this BUI:

1. The activities associated with the BUI 2 technical teams (see Table 2 for the current members and their affiliations). The technical teams' members assisted the SLRAOC Coordinators with activities associated with reaching the BUI 2 removal target, including: making recommendations on restoration project details, data collection and analyses, reviewing the findings, and providing input on the removal package.
2. The process to obtain public input on the BUI removal package. A thirty-day public comment period about the BUI 2 removal recommendation was held from March 28, 2022, through April 26, 2022. The draft removal document was placed on MNDNR's St. Louis River web site. A public meeting was held on April 14, 2022. A summary of public input will be added following the end of the comment period.
3. Additional outreach. A presentation about the BUI 2 removal recommendation was made at the St. Louis River Summit on March 1, 2021. About 285 people attended the Summit.
4. SLRA Letter of Support. The St. Louis River Alliance is the designated citizens' action committee for the SLRAOC. Information about the BUI 2 removal recommendation was presented to the members of the Alliance's Board on March 16, 2022. This included the presentation also shared at the public meeting. As a result of their review, a letter of support for the removal of BUI 2 was submitted on behalf of the St. Louis River Alliance (see **Appendix I**).

Removal Recommendation

Throughout the process of implementing management actions for this BUI, the SLRAOC staff consulted with the BUI technical teams, stakeholders, and federal staff assigned to this BUI. They analyzed the collected data in the context of the SLRAOC RAP BUI targets, actions, and removal objectives for the Degraded Fish and Wildlife Populations BUI.

The results of the scientific assessments, the input from the BUI Technical Teams, and the support of the St. Louis River Alliance and other stakeholders form the basis for this removal recommendation. Accordingly, the MPCA and the WDNR, with the concurrence of the MNDNR and the Fond du Lac Band of Lake Superior Chippewa, recommend that the USEPA concur with this recommendation to remove the Degraded Fish and Wildlife Populations BUI from the SLRAOC.

While BUI 2 removal is based on the successful completion of its listed management actions, continued benefits to fish and wildlife populations will also be realized through activities associated with other SLRAOC BUIs. These management actions for other BUIs, which include investigations, remediation, and restoration throughout the estuary, will positively impact the following legacy impairments to fish and wildlife populations: physical habitat, food sources, water quality, and contaminated sediments.

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