Actions:

- The Great Lakes Panel on Aquatic Nuisance Species should continue work to strengthen federal legislation through reauthorization of NISA.
- The International Joint Commission, Coast Guard, and shipping industry should develop a comprehensive ballast water control plan. The plan should be coordinated throughout the Great Lakes states to ensure a consistent policy.
- Develop new technologies to treat and/or manage ballast water.

Strategy 15: Develop Zebra Mussel Control Strategy

Problem Summary: Introduced via ballast water in the late 1980s, the population of the non-native zebra mussel is currently expanding in the Lower St. Louis River. Zebra mussels attach themselves in dense layers to any hard surface, including native mussels, aquatic plants, surface water intake pipes, docks, and pilings. In addition to competing with native mussels for food, the zebra mussels cover native mussels so densely that they are unable to open and close their shells. Left unchecked, zebra mussels are likely to eliminate populations of native mussels throughout the harbor, and possibly upstream to the Fond du Lac dam.

Strategy: Develop a zebra mussel control strategy that includes preventing upstream expansion of zebra mussel populations and controlling or eliminating existing populations of zebra mussels.

Actions:

- Complete survey field work to determine habitat needs of native mussels.
- Identify important native mussel beds, map them, and eliminate zebra mussels.
- Establish a long-term monitoring protocol for zebra and native mussels; monitor the presence, locations, and abundance of native and non-native mussel species; determine upstream limits to distribution of zebra mussels, and determine the influence of seiche in distribution of zebra mussels.
- Determine water flow in the estuary and make predictions/assessments about whether zebra mussels will colonize and infest the entire Lower St. Louis River.
- Consult with experts from other areas, such as Lake Erie, the Mississippi River, and the St. Croix River, to help assess the likelihood of zebra mussels spreading in the Lower St. Louis River.

Strategies to Address Multiple Stresses

Strategy 16: Infuse the Lower St. Louis River Habitat Plan into Public Planning Processes

Problem Summary: From an ecological perspective, most of the major stresses to the Lower St. Louis River—loss of habitat, increased sedimentation, degradation of water quality, and exposure to sediment-associated contaminants—are directly related to land use decisions, but land use decisions are often based on incomplete or inaccurate ecological information. Rarely does the public planning process include a comprehensive determination of the effects that proposed land uses will have on the overall health of the watershed.

Strategy: The Lower St. Louis River Habitat Plan should be infused into public planning processes throughout the region. The focus should be on those plans that are directly linked to the estuary and the immediate surrounding communities of Superior and Duluth, such as the Port Plan and city comprehensive land use plans. Science-based information needs to be an integral part of the public planning process throughout the entire St. Louis River watershed.

Actions:

- Identify local planning initiatives within the Lower St. Louis River watershed, including but not limited to, the Port Plan, Port Management Plan, city comprehensive plans, and management plans for recreation areas.
- Once identified, members of the Habitat Plan partnership should be matched with each local planning initiative.

Strategy 17: Encourage the Development and Implementation of a Comprehensive Port Plan

Problem Summary: Commercial shipping and associated industries are a vital part of the Twin Ports economy. However, development projects, dredging and filling, and other commercial activities can result in the loss and degradation of critical estuarine aquatic habitats that support fish, mussels, and breeding and migratory birds. Balancing effective utilization of the waters, near shore areas, and waterfront lands of the Duluth-Superior Harbor while also protecting, restoring, and enhancing the valuable habitat of the Lower St. Louis River is a difficult task.

Strategy: A comprehensive Port Plan should be developed and implemented. A carefully developed and broadly accepted comprehensive Port Plan can help to provide needed balance. An effective Port Plan will provide the basis for protection, restoration, and enhancement of the many assets of the Duluth-Superior Harbor and will help assure that commerce and recreation can develop fully without impairment of the habitats that are so vital to the health of the western Lake Superior region. An effective Port Plan will identify sensitive areas where extra care is needed to preserve, restore, and enhance the values of the Lower St. Louis River, including critical and important habitat. An effective Port Plan will result in preservation of waterfront areas for uses that are consistent with the existing infrastructure, including the navigation channels and associated structures. It is very important that maritime

commerce utilize existing harbor infrastructure rather than encroach on the remaining high quality habitat areas of the Lower St. Louis River. Deep-water maritime commerce should be consolidated along the existing 28-foot channels and should use existing structures as much as possible. Land fronting the existing 23-foot channels should be reserved for maritime commerce that can utilize these channels without the requirement for deepening. Expansion of constructed and maintained navigation facilities should be carefully evaluated in light of the habitat values inherent in the Lower St. Louis River. The remaining waterfront land should be reserved for water-dependent activities including habitat protection, recreation, and scenic beauty. Land uses that are not water dependent should be restricted to non-waterfront sites. Plans should be developed to protect sensitive areas from spills and other accidents or failures. These plans should be included in the Port Plan directly or by reference.

Actions:

- Support the development of an effective Port Land-use Plan for the Superior, Wisconsin, portion of the Harbor. Complete review and acceptance of the Superior Port Plan will be important so that it can be used as a template for updating the Duluth Port Plan.
- Support revision of the Duluth Port Plan so the two plans form a comprehensive guide to effective management and utilization of the values of the Lower St. Louis River and the Duluth-Superior Harbor.

Strategy 18: Encourage the Development and Implementation of a Comprehensive Dredge Material Management Plan

Problem Summary: A century of dredging and disposing of dredged materials has extensively modified habitat in the Lower St. Louis River. Ongoing dredging and dredged materials management practices have the potential to cause additional loss and degradation of estuarine aquatic habitats and place additional stress on fish, mussel, and bird populations.

Strategy: A comprehensive dredged materials management plan (DMMP) should be developed and implemented. A draft DMMP was developed in 1997. This draft should be updated and approved. A good comprehensive DMMP can result in reduced impacts to habitats from dredging practices. While restoration of the habitat in the Lower St. Louis River to pre-dredging conditions is not feasible and is not a goal of this Habitat Plan, future dredged materials management activities should be designed and managed to minimize detrimental impacts to important habitats. Opportunities to protect, restore, or enhance habitat through the control and redesign of dredged material management practices should be fully exploited.

An effective dredged materials management plan will

- enable habitat restoration and enhancement that may be economically difficult or impossible without the benefit of redirected dredged materials management activities;
- reduce the need for dredging by recommending land use changes that will result in reduced sedimentation within the harbor;
- provide the basis to obtain additional funding to demonstrate and practice innovative beneficial reuse of dredged materials and important habitat restoration and enhancement activities.

Beneficial reuse of dredged materials to restore and enhance habitat may facilitate regulatory approval of dredging projects that would be difficult or impossible to authorize if containment or disposal of the dredged materials was proposed. It is also possible that streamlined regulatory processes can be utilized for projects that are consistent with an agency-approved comprehensive dredged materials management plan. Therefore, a comprehensive dredged materials management plan will benefit commercial interests in the harbor in addition to natural resources interests in the Lower St. Louis River.

Actions:

- A comprehensive dredged materials management plan should be developed cooperatively by the Port Authority, Corps of Engineers, WDNR, MDNR, MPCA, the CAC, and others. The Harbor Technical Advisory Committee (HTAC) of the Metropolitan Interstate Committee (MIC) will provide the best forum to bring the necessary partners together for this purpose. Considerable work has already been produced that can provide the basis for an effective dredged materials management plan.

INDICATORS OF SUCCESS

Once the implementation of the Habitat Plan is underway, it is critical to periodically assess whether the strategies being implemented are successfully mitigating threats and improving the health of the conservation targets. If the strategies implemented are not meeting the conservation goals of each target—typically, improving or maintaining the health of species and ecosystems—it is necessary to revise strategies. Monitoring the responses to management strategies and adjusting the strategies accordingly is referred to as "adaptive management." In this Habitat Plan, "adaptive management" includes adjustments not only to traditional ecosystem management strategies (e.g., prescribed fires, wetland restoration), but to the entire suite of strategies developed through this planning effort.

There are three levels at which the success of implementation of the Habitat Plan should be measured:

- health of the conservation targets;
- mitigation of the threats to the conservation targets; and
- implementation of the strategies.

Change in the health of conservation targets (plant communities, aquatic habitats, species) is the most fundamental measure of the successful implementation of any conservation plan. However, measurable changes for many of the conservation targets in this Plan will occur over widely varying time periods. For many conservation targets of the Lower St. Louis River, changes will not be measurable within three to five years of implementing the strategies intended to improve their health. At one extreme, the initial changes to upland forests may not be noticeable for a decade or more, and significant, long-term changes may not be measurable for several decades. At the other extreme, initial changes to piping plover populations could be noticeable within the first three to five years of implementing strategies intended to improve their health.

Since it will take some time for the health of conservation targets to show improvement, a second important indicator to monitor is how well threats to the conservation targets are mitigated. The mitigation of threats will be measurable somewhat earlier than changes in the overall health of conservation targets.

Finally, it is necessary to track the strategies outlined in this Plan to ensure that the appropriate actions are taken to successfully implement them. Since more than one strategy may improve the health of a single conservation target, it may be not be immediately clear which strategy is responsible for improvements in the health of that conservation target. Monitoring at all three levels—health of conservation targets, mitigation of threats, and implementation of strategies—will help clarify which strategies are successful and which strategies need to be revised or eliminated. Although the ultimate effects of each strategy will take several years to be measurable, the implementation of strategies should be tracked immediately.

To effectively assess changes in the health of conservation targets, it is critical for each monitoring effort to be clearly linked to the factors that define the health of the conservation targets. Those factors are described in the earlier text on the conservation targets and are also summarized in Table 6. A preliminary list of broadly defined monitoring efforts is included. Though extensive, this is not a final or comprehensive list of all necessary monitoring efforts. It represents priority areas where work should be initiated. Beginning to monitor the factors identified will be necessary to both measure success and refine future monitoring efforts.

Table 6. Factors indicating the health of the conservation targets and preliminary considerations for monitoring those factors.

*This is not a comprehensive list.

Conservation Target	Indicator of Health to be Measured	Preliminary Monitoring Considerations*
Estuarine Aquatic Habitat Targets		
Large riverine reach	Hydrologic regime (volume, rate, timing of river flow) Water quality (sediments, nutrients, chemistry) Habitat morphology Diversity and relative abundance of fish species Diversity and relative abundance of bird species Lake sturgeon spawning, reproduction	Develop hydrologic model for estuary that includes regime under natural range of variation. Sample peak, low, and base flows on periodic basis; compile seasonal and annual measurements and compare to hydrologic model under natural range of variation. Develop model of sediment and nutrient loads to estuary; describe loads expected under natural range of variation. Measure sediment and nutrient loads under range of conditions ("normal," post-storm, during spring thaw). Sample water chemistry. Periodically assess seasonal fish use and abundance in habitat. Periodically assess seasonal bird use and abundance in habitat. See also lake sturgeon.
Upper estuarine (undredged) river channel	Hydrologic regime (volume, rate, timing of river flow) Water quality (sediments, nutrients, chemistry) Habitat morphology Diversity and relative abundance of fish species Diversity and relative abundance of bird species	See large riverine reach.
Lower estuarine (dredged) river channel Lower estuary (industrial harbor) flats	Hydrologic regime (volume, rate, timing of river flow) Water quality (sediments, nutrients, chemistry) Diversity and relative abundance of fish species Diversity and relative abundance of bird species	See large riverine reach.

Upper estuary flats Sheltered bays Clay-influenced river mouths Clay-influenced bay	Hydrologic regime (volume, rate, timing of river flow) Water quality (sediments, nutrients, chemistry) Habitat morphology Diversity and relative abundance of fish species Diversity and relative abundance of bird species Diversity and relative abundance of wetland plant species Extent (acreage) of wetland vegetation	See large riverine reach. Conduct field surveys every three years; record native species composition, presence and abundance of any non-native species, and overall health ranking. Photo-monitoring should be part of these field surveys. Air photo interpretation every five years should be used to assess patterns of various wetland types (e.g., emergent marsh, submergent marsh, wet meadow, etc.) and compare changes in extent of the various wetland plant communities within the estuarine aquatic habitats.
Industrially-influenced bays	Hydrologic regime (volume, rate, timing of river flow) Water quality (sediments, nutrients, chemistry) Habitat morphology Diversity and relative abundance of fish species Diversity and relative abundance of bird species Diversity and relative abundance of wetland plant species Extent (acreage) of wetland vegetation (restored bays or slips)	See upper estuary flats, sheltered bays, clay-influenced river mouths, and clay-influenced bay. May not apply to all industrially-influenced bays.
Industrial slips	Water quality (sediments, nutrients, chemistry) Habitat morphology Diversity and relative abundance of fish species Diversity and relative abundance of bird species	Sample water chemistry. Periodically assess seasonal fish use and abundance in habitat. Periodically assess seasonal bird use and abundance in habitat.
Clay-influenced tributaries Bedrock-influenced tributaries	Hydrologic regime (volume, rate, timing of river flow) Water quality (sediments, nutrients, chemistry) Habitat morphology Diversity and relative abundance of fish species	See large riverine reach.

Estuarine Plant Community Targets		
Great Lakes coastal wetland complex	Diversity and relative abundance of wetland plant species Rare plant species Lack of non-native species Extent (acreage) of wetland vegetation Spatial patterns of wetland plant community types (e.g., emergent marsh, submergent marsh, wet meadow, etc.)	See upper estuary flats, heltered bays, clay-influenced river mouths, and clay-influenced bay.
Baymouth Bar Community Targets		
Beaches	Erosion and deposition of sand	Air photo or satellite imagery interpretation every five years to assess erosion and deposition patterns on Points and around western Lake Superior coastline.
Beachgrass dunes Dune shrublands Interdunal wetlands	Diversity and relative abundance of plant species Rare plant species Extent (acreage) of each community type Lack of non-native species	Conduct field surveys every three years; record native species composition, presence and abundance of any non-native species, and overall health ranking. Photo-monitoring should be part of these field surveys. Air photo interpretation every ten years should be used to assess extent and spatial patterns of these community types.
Dune pine forests	Diversity and relative abundance of plant species Rare plant species Extent (acreage) of each community type (increased from current area) Lack of non-native species	Conduct field surveys every three years; record native species composition, presence and abundance of any non-native species, and overall health ranking. Photo-monitoring should be part of these field surveys. Air photo interpretation every ten years should be used to assess extent and spatial patterns of this community type.
Upland Forest Community Targets		
White pine-red pine forests Northern conifer-hardwoods forest / Northern hardwoods forest Spruce-fir boreal forest	Diversity and relative abundance of plant species Age class structure of dominant tree species Extent (acreage) of each community type (increased from current area)	Map land cover and complete a change detection analysis, using satellite imagery, to assess species composition. Conduct field surveys to evaluate age class structure; every ten years may be an appropriate frequency.

Other Inland Plant Community Targets		
Eroding clay bluffs Clay seeps Conifer swamps Hardwood swamps Shrub swamps Inland marshes Wet meadows Fens	Diversity and relative abundance of plant species Hydrologic regime (volume, rate, timing, source of flow)	Conduct field surveys to evaluate the species diversity and structure of these finer-scale communities. Photo monitoring may be a good technique for assessing the eroding clay bluffs and clay seeps.
Cliffs and rock outcrops	Diversity and relative abundance of plant species	Conduct field surveys to evaluate the species diversity and structure of these finer-scale communities.
Species Targets		
Native fish assemblage	Diversity and relative abundance of native fish species Non-native aquatic animal species declining or eradicated	Continue existing fisheries sampling efforts; determine whether additional, more comprehensive sampling is necessary.
Lake sturgeon	Population size, age class structure	Continue WDNR's and MDNR's monitoring of population size and reproductive success; expand to include radio-tag monitoring.
Native mussel assemblage	Diversity and relative abundance of native mussel species Zebra mussel controlled or eradicated	Continue MDNR's mussel sampling effort to develop estimates of current populations of native species; continue field sampling to monitor both native and zebra mussel populations.
Migratory bird aggregations Breeding bird aggregations	Diversity and numbers of migratory birds Diversity and numbers of breeding birds	Coordinate with existing survey and other sampling efforts. Conduct a comprehensive breeding survey to estimate current breeding status and populations of breeding birds. Conduct periodic monitoring to estimate long-term trends. Conduct a comprehensive migratory survey to estimate current diversity and numbers of birds utilizing estuary.
Piping plover	Population size, reproduction	Conduct detailed annual surveys; coordinate with U.S. FWS recovery and monitoring efforts.
Common tern	Population size, reproduction	Conduct detailed annual surveys; coordinate with U.S. FWS recovery and monitoring efforts.
Wild rice	Population size/areal extent, reproduction	Conduct field surveys.

*This is not a comprehensive list.

Effective evaluations of how well threats are being mitigated also requires a clear link between the threats and the factors that indicate mitigation. These factors are summarized in Table 7.

Table 7. Threats and factors to be evaluated that indicate how well threats are being mitigated.

Stress	Sources of Stress	Indicator of Mitigation to be Measured
Loss of habitat	Development Commercial shipping (dredging and filling) Other sources	# of acres developed in/on "natural" communities or habitats (vs. acres redeveloped within existing developed areas). Monitor whether dredged area expands or remains stable.
Increased sedimentation	Development Forest management practices Other sources	Change in sediment load.
Competition from non-native species	Commercial shipping Development (accidental release or dispersal of non-native species) Other sources	Rate of introduction of new non-native species declines, or new introductions are eliminated. Populations of non-native species decline, are eliminated, or are controlled.
Exposure to sediment-associated contaminants	Contaminated sediments (from historical, municipal sewage, commercial, and industrial releases) Other sources	Acreage of highly contaminated sediments (acreage should decrease as problem is addressed).
Degraded water quality	Development Commercial shipping Contaminated sediments (from historical, municipal sewage, commercial, and industrial releases) Forest management practices Other sources	Water quality measures improve from current levels.

Measuring the health of conservation targets and the level of threat mitigation requires integration of monitoring activities and data across agencies and jurisdictional borders. Implementation of an ecological monitoring program should include application of a strong, statistically robust design and should utilize Geographic Information Systems (GIS) for analysis and display of results. Ideally, all of the specific examples described above will be part of a single coordinated monitoring effort among many agencies. It will be necessary for this integrated program to go beyond the levels of monitoring and coordination currently being done in the Lower St. Louis River.

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APPENDICES

Appendix 1. List of Participants and Reviewers

Appendix 2. List of Plant Communities Mapped in the Lower St. Louis River

Appendix 3. List and Descriptions of Aquatic Habitat Types of the Lower St. Louis River and Their Ecological Values

Appendix 4. Conservation Target-Related Recommendations from St. Louis River Remedial Action Plan Stage Two

Appendix 5. List of Fish Species Native to the Lower St. Louis River and Their Requirements

Appendix 6. Fish Use of Aquatic Habitats in the Lower St. Louis River

Appendix 7. Birds of the Lower St. Louis River

Appendix 8. Summary of Threats Identified for Each Conservation Target in the Lower St. Louis River

MAPS