THREATS TO THE LOWER ST. LOUIS RIVER ECOSYSTEM

To identify effective means of managing and enhancing the health of the Lower St. Louis River ecosystem, it is necessary to understand the requirements of a healthy ecosystem and what factors may be causing negative impacts.

The previous section outlined the requirements for the health of the conservation targets of the Lower St. Louis River. The intent of this section is to outline the most critical factors that are negatively impacting the health of the conservation targets—the aquatic habitats, plant communities, and species—including factors that have a significant likelihood of impacting the conservation targets in the future. These factors are referred to as "threats." Understanding the threats to an ecosystem is critical to developing feasible, efficient strategies that can mitigate the threats and thereby improve or protect the health of the conservation targets.

Threats can be described in two parts: a stress and a source of stress. Stresses are the processes or events that have direct impacts on the conservation targets. The sources of stress are the entities, actions, or conditions causing the stresses. Stresses are what need to be eliminated or minimized to protect the conservation targets, but this can only be done by acting on the **sources** of the stress. For example, degraded water quality may be a stress to fish, mussels, or other conservation targets. However, that stress may be caused by any number of factors, for example, increased runoff and erosion from large development projects, pollution from industrial sources, or nutrients from agricultural runoff. To eliminate that stress, the cause of the degraded water quality must be clearly identified.

Threat analysis is the process of identifying, evaluating, and ranking the factors that either threaten the conservation targets directly or threaten the ecological systems and processes that support and maintain the conservation targets. During the two workshops held in March and April 2001, aquatic and terrestrial biologists began to identify and evaluate which human actions are having a negative impact on the conservation targets in the Lower St. Louis River. Follow-up discussions further clarified which activities pose threats to the conservation targets and which threats are most critical. The identified threats were briefly reviewed during a Threats and Strategies meeting in May 2001 and a Habitat Committee meeting in June 2001.

Often, a single activity causes multiple stresses, thereby impacting multiple conservation targets. For example, commercial and residential development contribute to four of the major identified stresses. Sometimes multiple activities contribute to a single stress, and some threats occur at scales far greater than that of the Lower St. Louis River project area (e.g., global climate change and airborne contaminants). Several large-scale threats are identified at the end of this section, but it is beyond the scope of this Plan to develop strategies to mitigate such threats.

This plan is intended to address the needs of ecosystems and native species, and it is therefore written from an ecosystem perspective. It is important to recognize that the intent of this Threats section is to catalog and explain the human activities that have or are expected to have a negative impact on the health of the conservation targets—the birds, fish, mussels, wetlands, forests, and other targets. However, it is not intended to suggest or imply that all human activities are "bad," or should be eliminated. Instead, this section highlights the need for careful and creative planning of future developments and other endeavors, as well as the need to mitigate the impacts of current human activities.

Overview of Stresses and Sources of Stress

The most critical stresses and sources of stress to all of the conservation targets are summarized below. They are the stresses and sources of stress for which various strategies have been developed in this Habitat Plan.

The subsection immediately following this overview is organized around the five most critical stresses. For each stress, there is a description of the conservation targets it affects, the source(s) of the stress, and the ways in which the stress impacts the targets. The next subsection is organized around the three primary sources of stress. For each source, there is a list of the stresses it causes and a description of the ways in which it causes the stress. Although this creates some redundancies, it is helpful to the planning process to separate stresses from their sources.

The information about stresses provides an understanding of how the ecosystems and species are negatively impacted by certain activities. Information about the sources of the stress provides a clear link to the strategies that have been developed to address the sources. Finally, two sources of stress that are beyond the scope of this plan—airborne deposition of chemical contaminants and global climate change—are discussed at the end of the section.

Critical Stresses to Conservation Targets

- **Loss of habitat** directly eliminates the conservation targets we are trying to preserve.
- **Increased sedimentation** threatens the survival of many habitats, especially the sheltered bays.
- **Competition from undesirable exotic species** threatens the survival of native species and plant communities.
- **Exposure to sediment-associated contaminants** threatens the health of native species.
- **Degraded water quality** impairs the health and diversity of the aquatic habitats, wetland plant communities, native fish and mussel assemblages, and other native species dependent on these resources.

Critical Sources of Stress to Conservation Targets

- **Residential, commercial, and industrial development** within the watershed and immediate harbor area result in the direct loss of upland and wetland habitat, increased erosion and sedimentation, degradation of water quality, and the introduction and spread of undesirable exotic species.
- **Commercial shipping** results in the need for dredging and filling, thereby contributing to direct loss of habitat; shipping also contributes to increased erosion as well as the introduction and spread of many undesirable exotic aquatic species.
- **Contaminated sediments** from a variety of historical industrial and commercial sources expose native species to toxins that may increase mortality and decrease reproduction.
- **Forest management practices** contribute to increased peak flows, which result in increased erosion and sedimentation and degraded water quality.

The five most critical stresses and the multiple sources contributing to each are summarized in Table 5. This table is not intended to be comprehensive; it highlights only the most critical stresses and sources of stress.

Table 5. Primary Stresses and Sources of Stress to Conservation Targets

Stress	Sources of Stress
Loss of habitat	Development Commercial shipping (dredging and filling) Other sources
Increased sedimentation	Development Forest management practices Other sources
Competition from undesirable exotic species	Commercial shipping Development (accidental release or dispersal of undesirable exotic species) Other sources
Exposure to sediment-associated contaminants	Contaminated sediments (from historical, municipal sewage, commercial, and industrial releases) Other sources
Degraded water quality	Development Commercial shipping Contaminated sediments (from historical, municipal sewage, commercial, and industrial releases) Forest management practices Other sources

There are numerous other stresses and sources of stress that are affecting conservation targets in the Lower St. Louis River, but they are not discussed in this Plan. The Habitat Plan has intentionally focused solely on those threats that are currently thought to be most critical to the conservation targets. Strategies were developed with the intent of mitigating the most critical threats discussed in this section. Appendix 8 contains a detailed list of the individual stresses and sources of stress facing each conservation target in the Lower St. Louis River area.

Stresses

Loss of Habitat

Loss of habitat directly eliminates the conservation targets we are trying to preserve. It is generally caused by the conversion of natural land cover to another use, such as providing homes for people, developing commerce and industry, and growing crops. Habitat loss (including habitat fragmentation and degradation) has, or is expected to, negatively impact the following conservation targets:

Estuarine Aquatic Habitat Targets
Upper estuarine (undredged) river channel
Upper estuary flats
Sheltered bays
Clay-influenced river mouths
Lower estuary (industrial harbor) flats

Estuarine Plant Community Targets
Great Lakes coastal wetland complex
Baymouth Bar Community Targets
Beaches
Dune shrublands
Interdunal wetlands
Dune pine forests
Upland Forest Community Targets
White pine-red pine forest
Northern conifer-hardwoods forest / Northern hardwoods forest
Spruce-fir boreal forest
Other Inland Plant Community Targets
Conifer swamps
Hardwood swamps
Shrub swamps
Inland marshes
Wet meadows
Fens
Species Targets
Native fish assemblage
Lake sturgeon
Native mussel assemblage
Migratory and breeding bird aggregations
Piping plover
Common tern

Historical habitat losses in the Lower St. Louis River include the elimination of much of the Great Lakes coastal wetland complexes and estuarine aquatic habitats, which were filled to create land for various developments in the estuary or dredged for shipping. The St. Louis River System Remedial Action Plan Stage One (MPCA and WDNR 1992) summarizes these losses:

> "The Wisconsin Department of Natural Resources has estimated that over 3,000 acres of marsh and open water have been filled in the lower estuary below the former Arrowhead Bridge. It is also estimated that roughly 4,000 acres of the estuary have been dredged. This leaves an estimated 5,000 acres which have not been drastically altered, mostly in the upper estuary (MIC 1985)."

These losses represent roughly 60% of the total area of the St. Louis River estuary (DeVore 1978). Although largely irreversible, it is important to recognize the extent of the historical losses because it highlights the importance of preventing further losses of habitat. In addition, some restoration of lost habitats and communities, particularly the Great Lakes coastal wetland complex, will prove to be feasible.

Since European settlement, over half the wetland area in the conterminous U.S. has been lost (Dahl 1990), and losses of Great Lakes coastal wetlands and estuarine aquatic habitats in the St. Louis River represent one small part of those cumulative losses. These widespread losses have contributed to the decline of many bird species that rely on wetland habitats for breeding, including black terns (Peterjohn and Sauer 1997) and least bitterns (Gibbs et al. 1992). Preventing further wetland losses across North America—in such places as the Lower St. Louis River—is necessary to help address the decline in these species.

Similarly, the historical widespread loss of wetlands has likely had some impact on native fish populations. Submergent and emergent marshes that partially comprise Great Lakes coastal wetland complexes are preferred spawning habitats for many fish native to the Lower St. Louis River. Although some similar habitats remain, the overall loss of habitat likely increases competition and limits the reproductive output of species that rely on these habitats for spawning. Little is known about historical numbers and distribution of mussels in the Lower St. Louis River, but it is highly probable that dredging eliminated a significant portion of the substrate that native mussels require.

Future or proposed commercial, industrial, and residential development projects have the potential to cause further losses of Great Lakes coastal wetlands and estuarine aquatic habitats, as well as inland wetlands. This is a critical threat to these conservation targets, particularly since they have already experienced such severe historical losses. Such losses would also pose a continued threat to bird and fish populations. Although these losses may appear insignificant in comparison to overall future wetland losses across North America, each loss contributes to the cumulative loss that results in ongoing, range-wide population declines in bird species. Furthermore, such losses have the potential to reduce both the diversity and overall numbers of birds breeding in the estuary.

Forested habitats have also been lost to development and other land use changes. The development of the Twin Ports metropolitan area resulted in the loss of spruce-fir forests, northern conifer-hardwood forests, and white pine-red pine forests. Much of northern Minnesota and Wisconsin are still forested, including the Lower St. Louis River project area, and have the potential to support healthy forest ecosystems. The greater problem for the extensive forest ecosystems that remain is their widespread conversion to early successional stages, which is typically well outside the natural range of variation for these ecosystems. The loss of the unique dune pine forests on Minnesota and Wisconsin Points is also significant; those forests and associated communities will likely not be replaced, nor are they represented elsewhere in the region. Future development projects have a high potential to cause further loss of forest habitats, as well as forest fragmentation and degradation.

The combination of forest habitat loss and forest degradation in and around the Twin Ports area is a factor in the cumulative decline of bird species that nest in forested habitats, such as the wood thrush. The widespread conversion to early successional forests has likely lowered the diversity of forest-dependent bird species that still breed around the estuary. Ongoing and potential future loss and fragmentation of habitat is a critical stress faced by most of the conservation targets of the Lower St. Louis River. Numerous planned or proposed development projects have the potential, if not carefully planned, sited, or implemented, to further contribute to the already enormous loss of habitat in the project area.

Increased Sedimentation

Sedimentation is a serious and ongoing threat, particularly to the sheltered bay habitats and their accompanying Great Lakes coastal wetland complexes. Sedimentation is also a problem for the clay-influenced bay, clay-influenced river mouths, and the industrially-influenced bays. The sheltered bays and clay-influenced bay provide critical habitat for fish spawning, bird nesting, and feeding for a wide range of species. Sediments slowly fill these bays, causing the decline and loss of wetland vegetation. In addition, suspended clay reduces light penetration in the already dark, tannic waters of the river.

Lower light penetration results in less habitat available for submergent plants. The decline and loss of wetland vegetation that results from sedimentation also means lower productivity (reduced food availability) and loss of spawning and nesting habitat, all of which negatively impact native bird and fish populations. Following is a list of conservation targets that are negatively impacted by increased sedimentation:

Estuarine Aquatic Habitat Targets
Upper estuarine (undredged) river channel
Lower estuarine (dredged) river channel
Upper estuary flats
Sheltered bays
Clay-influenced river mouths
Industrially-influenced bays
Lower estuary (industrial harbor) flats
Industrial slips
Clay-influenced bay
Estuarine Plant Community Targets
Great Lakes coastal wetland complex
Other Inland Plant Community Targets
Hardwood swamps
Shrub swamps
Inland marshes
Wet meadows
Fens
Species Targets
Native fish assemblage
Lake sturgeon
Native mussel assemblage
Migratory and breeding bird aggregations
Wild rice

Sediment is naturally carried along streams and rivers throughout the St. Louis River watershed and deposited in the sheltered bays, clay-influenced bay, clay-influenced river mouths, and the industrially-influenced bays. The Nemadji River in particular naturally carries a high sediment load because it flows through highly erodible red clay soils. The Nemadji River Basin Project of the late 1980s concluded that 98% of the sediment carried by the Nemadji River comes from mass wasting of bluffs along the streams (NRCS 1998). However, human activities have accelerated the natural erosion process. Modifications in the watershed, such as conversion of mature forest cover to forest in the early stage of succession (or row crop agriculture and pastures), cause an increase in peak flow rates, which greatly increases streambank erosion and increases sediment transport.

Many historical and current human activities cause increased sediment loads. Metropolitan areas create vast expanses of impervious surfaces (roads, parking lots, driveways, sidewalks, and buildings), which do not absorb rainfall. The combination of impervious surfaces and stormwater pipes has greatly increased the rate and volume of surface water runoff. High speed, high volume stormwater flows erode and carry elevated quantities of sediment that are deposited in the various bays and river mouths. The development of the Twin Ports metropolitan area has also eliminated wetlands that would otherwise absorb excess rainfall, further contributing to high volumes of stormwater flow. Proposed and future development projects in the Twin Ports area have a high potential for eliminating additional wetlands and further increasing the intensity of stormwater runoff. Carefully planned and implemented projects can reduce or eliminate these impacts.

Loss of vegetative cover during construction projects causes erosion that can also have a significant impact on sediment levels. Recreational activities, such as mountain biking and riding off-road vehicles, also contribute to erosion and sedimentation in critical wetland habitats. Again, this is not intended to imply that human activities, such as economic development, should be stopped. Rather, it points to the need for careful and creative planning, not only of development projects, but also of forestry, agriculture, recreation, and other land use activities.

Competition from Undesirable Exotic Species

Undesirable exotic species are one of the primary threats to the Lower St. Louis River ecosystem. By competing for habitat, food, and breeding areas, undesirable exotic species can cause localized eradication of native species, impact fisheries, spread disease, and reduce species biodiversity. The Lower St. Louis River is one of the most important habitats in western Lake Superior for approximately 45 native fish (WDNR and MDNR unpublished data), eight native mussel species, and unique Great Lakes coastal wetland complexes. Undesirable exotic species pose a serious threat to the health of the following conservation targets:

Estuarine Aquatic Habitat Targets
Large riverine reach
Upper estuary flats
Sheltered bays
Clay-influenced river mouths
Clay-influenced bay
Estuarine Plant Community Targets
Great Lakes coastal wetland complex
Baymouth Bar Community Targets
Beachgrass dunes
Dune shrublands
Interdunal wetlands
Dune pine forests
Other Inland Plant Community Targets
Hardwood swamps
Shrub swamps
Inland marshes
Wet meadows
Fens
Species Targets
Native fish assemblage
Lake sturgeon
Native mussel assemblage
Wild rice

Since the early 1800s, over 160 non-native species have been introduced into the Great Lakes (Ricciardi and MacIsaac 2000), many through ballast water discharge. At least 31 species currently found in Lake Superior are non-native, including sixteen fish, five invertebrates, four pathogens and parasites, and six wetland and aquatic plants (Mills et al. 1993). These non-native species have been introduced via several pathways, and over 60% have arrived since 1960, following the opening of the St. Lawrence Seaway.

Undesirable exotic species that have already arrived in the Lower St. Louis River are impacting or are likely to eventually impact native flora and fauna throughout the entire estuary. The Duluth-Superior Harbor is an international port with annual traffic of 1,100 ships, which discharge an enormous quantity of ballast water while in port. Therefore, the Harbor remains a likely site for additional introductions of undesirable exotic species, as well as a source for transferring undesirable exotic species to other ports or inland waters.

Following are descriptions of some individual undesirable exotic species that are currently found in or around the estuary and their known or likely impacts on the native biota of the Lower St. Louis River. Minnesota Sea Grant also has an excellent section on its web site that provides even more detailed information on most of the species included in this section (http://www.seagrant.umn.edu/exotics/). Other Sea Grant programs also have information on undesirable exotic species and can be accessed through the National Sea Grant program page (http://www.nsgo.seagrant.org/NationalSeaGrant.html).

Zebra mussels (*Dreissena polymorpha*) were brought to the Great Lakes from Europe via ballast water sometime during the late 1980s. The zebra mussel was first recorded in the Lower St. Louis River in 1989 (Kraft 1993). Following a decade during which little evidence of zebra mussels was found, the populations grew and expanded across the lower harbor in 1998 (D. Jensen, MN Sea Grant, personal communication, 2001). Subsequent sampling during the 2000 field season suggested that the population has increased dramatically (MDNR, unpublished data). Zebra mussels attach themselves in dense layers to surfaces, including aquatic plants, boats, motors, docks, pilings, breakwaters, surface water intake pipes, and native mussels—frequently by the tens of thousands. By virtue of their numbers and position on native mussels, they easily out-compete them in gathering plankton, the primary food item for both zebra mussels and native mussels. In addition, zebra mussels can cover native mussel shells so densely that they are unable to open and close their shells, causing suffocation or starvation. Zebra mussels also blanket other firm substrates, eliminating habitat for the native species. Zebra mussel larvae are carried downstream by currents; because they do not use fish hosts, it is more difficult for them to spread upstream. However, upstream water currents caused by seiches may allow the larvae to move to the upper estuary. Preventing human-assisted upstream movement should help to slow the spread throughout the estuary.

Observations by commercial divers in addition to staff of the Minnesota Department of Natural Resources (MDNR) and Wisconsin Department of Natural Resources (WDNR) suggest that impacts on native mussels are already occurring in the lower harbor. Currently, reports by recreational anglers suggest that the infestation has extended upstream as far as Spirit Island.

Although both native and exotic fish species in the estuary are known to feed on zebra mussels, there is currently no effective means of controlling this exotic invader, and the outlook for native mussels is grim if the zebra mussel flourishes.

Eurasian ruffe (*Gymnocephalus cernuus*) is a small perch-like fish that was first introduced to the Great Lakes in the St. Louis River from ballast discharge. Since its discovery in 1986, ruffe has become the most abundant fish in bottom trawl stock assessments (Bronte et al. 1998). Despite efforts to control ruffe through sport fishing regulations and stocking of predator fishes, the population grew to about 6 million by 1996 (Mayo et al. 1998). Concurrent decreases in native fish populations raised concern over the impacts of ruffe on fish communities; however, natural population dynamics may explain some of these changes (Bronte et al. 1998).

Concern over the increase of ruffe has been supported by several studies that indicate potential predation on eggs of lake herring (Selgeby 1998), demonstrated reduced growth of yellow perch in the presence of ruffe (Schuldt et al. In prep.), and the ability of ruffe to grow quickly at lower temperatures allowing ruffe to cause a greater ecological impact (Henson and Newman 2000).

Ruffe have spread at least 190 miles east of the Duluth-Superior Harbor along Lake Superior's South Shore and are found north as far as Thunder Bay, Ontario. In northern Wisconsin, ruffe are found off shore in Lake Superior and now dominate several South Shore streams as well (D. Jensen, MN Sea Grant, personal communication, 2001). Scientists from the U.S. Fish and Wildlife Service Fisheries Resource Office and U.S. Geological Survey Great Lakes Science Center (Lake Superior Biological Station) in Ashland, Wisconsin, conduct annual surveillance and monitoring for ruffe in the St. Louis River and other waters.

Round goby (*Neogobius melanostomus*) spread to the Great Lakes via contaminated freshwater ballast water discharged from transoceanic ships. Following their discovery in the St. Clair River (between Lake Erie and Lake Huron) in 1990, they quickly spread to many areas of the Great Lakes. They commonly reach population densities of 30-50 per square meter within one year. These small, bottom-dwelling fish feed chiefly on clams, mussels, amphipods, and crustaceans. Like ruffe, their lateral line system enables them to feed in complete darkness. Round gobies have detrimental impacts on native species through competition for food, habitat, shelter, and predation on eggs and young of native fish. For example, they are known to consume eggs of lake trout (Chotkowski and Marsden 1999) and lake sturgeon (Nichols et al. 2002). They aggressively drive out native species such as sculpin and darters.

Round gobies also feed extensively on zebra mussels, which can be relatively contaminated with PCBs, PAHs, and heavy metals. This round goby-zebra mussel interaction has been linked to an increase in PCBs further up the food web elsewhere in the Great Lakes (D. Jensen, MN Sea Grant, personal communication, 2001).

The only known location of round goby in Lake Superior is the Duluth-Superior Harbor. Although a few were first found in 1995, a major infestation was reported by two young anglers in 1998. Recent research suggests that the infestation remains in the Duluth-Superior harbor, but the population is growing. Unless interlake and intralake transport of ballast water is effectively addressed, round gobies are likely to spread to other ports around the Great Lakes.

Rainbow smelt (*Osmerus morax*) entered Lake Superior sometime in the 1940s or early 1950s. It takes advantage of the warm, shallow water wetlands of the estuary for spawning, conditions which allow for rapid increases in its population. Smelt may be negatively impacting native fish species, such as lake herring, by preying on larval stages.

Sea lamprey (*Petromyzon marinus*) is a primitive fish and an extremely destructive parasite that entered the Great Lakes system through the Welland Canal (between Lake Ontario and Lake Erie). Although present in the Lower St. Louis River, it does not yet appear to be utilizing potentially good spawning habitat in upper parts of the estuary. It is one of the few aquatic invaders for which a variety of control methods have been developed, but it is not clear whether any of these control methods will be effective in the St. Louis River estuary.

Threespine stickleback (*Gasterosteus aculeatus*) is a small fish that was documented in the Lower St. Louis River in 1994. It is unclear whether it migrated to the Great Lakes via the Hudson Bay watershed or was introduced in ship ballast water. This species is commonly used in acute toxicity tests so it might have been released from an environmental laboratory in the area. Although initially thought to be a more benign invader, anecdotal accounts reported to MDNR staff suggest that it is outcompeting many of the smaller, native fish, including yellow perch. There is currently insufficient research that clearly documents the impacts of this non-native species. However, given the preliminary accounts and observation of its aggressive behavior, it is likely that this species will have negative impacts on native fish as well.

Rusty crayfish (*Orconectes rusticus*) is one of the few undesirable exotic species not introduced by commercial shipping activities. Rusty crayfish were first identified in the Duluth-Superior area in a pond on the campus of the University of Minnesota-Duluth. They have since expanded their range to include the St. Louis River estuary. There is also a small possibility that anglers and the bait industry contributed to the introduction of this species to the estuary. The rusty crayfish reaches high population densities, displacing native crayfish and causing increased fish predation on native crayfish. It is thought to negatively impact fish populations by consuming fish eggs. Its impacts on submergent aquatic vegetation is probably the most critical; Lodge and Lorman (1987) and Olsen et al. (1991) both documented decreased diversity and abundance of aquatic plants due to the crayfish's habit of cutting stems as it feeds. The loss of rooted aquatic plants makes increased nutrients available to algae with subsequent reduction in available light for other plant growth.

Purple loosestrife (*Lythrum salicaria*), a highly invasive garden plant that has also been used by highway departments to vegetate roadsides, is present in various wetlands in the Lower St. Louis River area. It is especially prevalent along shoreline wetlands stretching from Duluth and Superior upstream past Fond du Lac. Left uncontrolled, purple loosestrife can take over and dominate entire wetlands, reducing the diversity of native wetland plant species and the bird, fish, and other animal species that depend on the native vegetation. It is important to control purple loosestrife before it becomes impossible to manage. Traditional control methods like cutting, burning, and herbicide treatment have been used with limited success. Currently, biocontrol agents (purple loosestrife-eating beetles) have been released in seven wetland areas within the Lower St. Louis River. This technique shows promise for controlling purple loosestrife infestations by significantly reducing their abundance and allowing native plants to re-colonize an area.

Common reed (*Phragmites australis*), **reed canarygrass** (*Phalarus arundinacea*), and **hybrid cattail** (*Typha* x *glauca*) are three invasive wetland plants (Galatowitsch et al. 1999) that are of great concern in the St. Louis River. Although the common reed is a widespread species native to some parts of North America and elsewhere around the globe, a highly invasive exotic ecotype has been introduced to North America (Saltonstall 2002). Research summarized by Saltonstall (2002) indicates that the natural range of the common reed in the U.S. did not include the western Great Lakes. The common reed now found in a few places in the Lower St. Louis River is mostly likely the exotic ecotype (C. Reschke MDNR and E. Epstein WDNR, personal communication, 2002.) Reed canarygrass is also native to parts of North America; a European ecotype was introduced as forage for livestock. It is unclear whether reed canarygrass or hybrid cattail are currently present anywhere in the estuary. However, it is highly likely that reed canarygrass is present, or will be introduced via stormwater runoff in the near future. Similar to purple loosestrife, all three species aggressively displace native plant species in wetlands and can form monocultures that are difficult to control or eradicate. Common reed and reed canarygrass are a poor food source for waterfowl and other species; they cause a significant overall decrease in food availability in wetlands. In addition to drastically altering the species composition of wetlands, these changes also have negative impacts on birds, fish, and numerous other species that utilize the wetlands.

Beachgrass (*Ammophila breviligulata*) is a native species that inhabits the dunes of Minnesota and Wisconsin Points. It is an integral part of the dune ecosystem, and efforts to restore this important native grass species are ongoing. The concern with this species is the use of ecotypes from areas east of the western Lake Superior region. Although it is the same species, eastern ecotypes may be adapted to slightly different environmental and climatic conditions. If eastern ecotypes are less hardy and breed with the local ecotype, they have the potential to eventually decrease the health of the beachgrass population throughout the Points.

Other undesirable exotic species documented in the estuary include common carp (*Cyprinus carpio*), alewife (*Alosa pseudoharengus*), white perch (*Morone americana*), American eel (*Anguilla rostrata*), Asiatic clam (*Corbicula fluminea*), spiny waterflea (*Bythotrephes cederstroemi*), and tubenose goby (*Proterorhinus marmoratus*).

Exposure to Sediment-associated Contaminants

Elevated levels of sediment-associated contaminants, including metals, PAHs, PCBs, pesticides, and dioxins/furans, are contributing to a number of confirmed and possible use impairments in the St. Louis River Area of Concern (AOC). These use impairments include food chain effects as well as degradation of benthic macroinvertebrate communities and fish and wildlife habitat. There are also impairments to human uses including fish consumption advisories, restrictions on dredged material management, and increased costs to industry (IJC 1989).

Sediments support the growth of bacteria, algae, sedges, and other plants—organisms that represent the foundation of aquatic food webs. Invertebrates living both in and on the sediments consume the bacteria, algae, plants, and other organisms that are associated with the sediments. These invertebrates, in turn, are an important food source for fish, birds, reptiles, and amphibians. Therefore, sediment quality is of critical importance to fish and wildlife due to the fundamental role that sediments play in the aquatic food web (Crane et al. 2000).

Sediments also provide habitats for many aquatic and wildlife species during portions of their life cycle. For example a variety of fish species utilize sediments for spawning and incubation of their eggs. In addition, juvenile fish often find refuge from predators in sediments and in the aquatic vegetation supported by sediments. Many amphibian species burrow into sediments in the fall and remain there throughout the winter months. In these instances, sediments serve as important overwintering habitats. Therefore, sediments play a variety of essential roles in terms of maintaining the structure and function of aquatic ecosystems (Crane et al. 2000).

Sediment quality is important in the St. Louis River AOC because many toxic contaminants, found in only trace amounts in water, are found at much greater concentrations in sediments. Consequently, the sediments can serve as both a sink and a source of contaminants to the water column and biota. Sediment-associated contaminants have the potential to adversely affect many organisms. Some contaminants, such as mercury and PCBs, are known to bioaccumulate in the food chain.

Exposure to sediment-associated contaminants has or is expected to negatively impact the following conservation targets:

Estuarine Aquatic Habitat Targets
Upper estuarine (undredged) river channel
Lower estuarine (dredged) river channel
Upper estuary flats
Sheltered bays
Clay-influenced river mouths
Industrially-influenced bays
Lower estuary (industrial harbor) flats
Industrial slips
Clay-influenced bay
Estuarine Plant Community Targets
Great Lakes coastal wetland complex
Species Targets
Native fish assemblage
Lake sturgeon
Native mussel assemblage
Migratory and breeding bird aggregations
Piping plover
Common tern
Wild rice

Sediments with elevated concentrations of contaminants from several sites in the St. Louis River AOC have been shown to be toxic to sediment-dwelling organisms and/or associated with alterations of benthic invertebrate community structure (Prater and Anderson 1977; Redman and Janisch 1995; Schubauer-Berigan and Crane 1996, 1997; Crane et al. 1997; IT Corp. 1997; Breneman et al. 2000; Crane et al. 2002). Other contaminant-related stresses to ecological systems within these sites may include uptake and accumulation of toxic substances in the food chain of fish and wildlife that in turn may result in cancer and deformities, physiological and reproductive effects, and degradation of aquatic habitat including vegetative and water quality impacts. In addition, public recreation and aesthetic values are diminished in many of these contaminated sediment areas. Navigation and shipping can also be adversely affected by increased costs for disposing of dredged material and/or significant decreases in dredging activity.

Fish consumption advisories are currently in effect for several species of fish in the Lower St. Louis River from the Fond du Lac dam to Lake Superior because of elevated concentrations of mercury and/or PCBs in the fish tissue (MDH 2002; WDNR 2002). Advisories range from “Unlimited” consumption to “One meal per month” to “Do not eat,” depending on species and size of fish, the contaminant of concern, and the sensitivity of the human population. Women who are or may become pregnant and children under the age of 15 are at greater risk.

Degraded Water Quality

Water quality in the Lower St. Louis River has improved tremendously since 1978, when the Western Lake Superior Sanitary District (WLSSD) began operating. However, improvements are still needed. Several point and nonpoint sources of nutrients, contaminants, pathogens, and suspended sediments currently contribute to degraded water quality in the lower estuary. Excess sediments and nutrients degrade wetlands; if nutrients (especially phosphorus) reach sufficiently high levels, native wetland vegetation can eventually be replaced by algae, in a process known as eutrophication. Various other pollutants can cause short-term die-off as well as longer-term health problems for populations of fish, mussels, and other species. Degraded wetland habitat and reduced fish and other food resources negatively impact many bird species that utilize the Lower St. Louis River for nesting and feeding. The following conservation targets are negatively impacted by degraded water quality:

Estuarine Aquatic Habitat Targets
Large riverine reach
Upper estuarine (undredged) river channel
Lower estuarine (dredged) river channel
Upper estuary flats
Sheltered bays
Clay-influenced river mouths
Industrially-influenced bays
Lower estuary (industrial harbor) flats
Industrial slips
Clay-influenced bay
Clay-influenced tributaries
Bedrock-influenced tributaries
Estuarine Plant Community Targets
Great Lakes coastal wetland complex
Species Targets
Native fish assemblage
Lake sturgeon
Native mussel assemblage
Migratory and breeding bird aggregations
Piping plover
Common tern
Wild rice

Current degradation of water quality in the Lower St. Louis River is thought to be caused by resuspension of in-place contaminants, nutrient loading, sediment loading, pesticide runoff, and other point and non-point sources. Stormwater runoff associated with developed areas may carry into the river greater loads of sediment (from stormwater drainage), nutrients (from turf fertilizers), pesticides (from turf grass and various other sources), and contaminants from road runoff (e.g., oil and grease;

PAHs and zinc from abraded tire particles). The City of Superior's extensive stormwater management program has resulted in improved water quality. Runoff from poorly managed timber harvest areas and agricultural areas can also contribute to increased sediment, nutrients, herbicides, and pesticides. Short-term water quality problems can result from periodic overflows or breaks in sewer lines that allow untreated sewage to flow into the river. Impacts to water quality may also occur as the result of oil or hazardous material spills. For example, in 1992, a train carrying petroleum byproducts including benzene derailed and fell into the Nemadji River on the outskirts of Superior, Wisconsin. Such episodic events can cause fish kills and related problems. The longer-term impacts of spills is unclear; it depends in part on the individual circumstances of a given spill. Other sources of pollutants include outflow from sewage treatment plants and industry, although the waste water treatment plants continue to work actively on source reduction as well as reducing pollutants in their effluent.

Sources of Stress

Residential, Commercial, and Industrial Development

Residential, commercial, and industrial development projects result in many changes to the land and water. The most obvious impact of development is the direct loss, degradation, and fragmentation of upland and wetland habitats and the resulting negative impacts on species that utilize those habitats. Development is the primary cause of habitat loss and sedimentation, a significant contributor to degraded water quality; it is also a factor contributing to the spread of undesirable exotic plant species.

Undeveloped forested land and other vegetative cover absorbs stormwater and slows the velocity of the runoff. Wetlands, duff layers, and soils within forests act as natural sponges to hold water and release it gradually. But when land is developed, the loss of forest, wetlands, and other vegetative cover, in combination with the associated increase of impervious surface area, causes a higher volume of water to drain off the land more quickly. This greater volume of faster moving water in the natural drainageways causes erosion of the stream banks and channels. Eroded sediments from the St. Louis River watershed are most often deposited in the bays, river mouths, and other aquatic habitats in the estuary. This chain of events increases rates of sedimentation in the Lower St. Louis River, thereby contributing to degraded water quality as well.

In addition to increased sediment loads, urban runoff may contain high concentrations of trace metals, hydrocarbons, chlorides, and bacteria (Schueler 1987; U.S. EPA 1983).

Lawn and turf maintenance associated with developed areas in the watershed frequently includes use of fertilizers, herbicides, fungicides, and insecticides, which may be carried into the streams and river; of particular concern for aquatic habitats is phosphorus. The extent to which these nonpoint sources contribute to degraded water quality in the estuary requires further evaluation.

Although it is now illegal for plant nurseries to sell known invasive plant species in both Minnesota and Wisconsin, purple loosestrife has already been introduced. Until recently, gardeners planted purple loosestrife as ornamental plants; seeds are often transported into wetlands via stormwater runoff. Occasionally, less reputable plant nurseries may ignore invasive species laws, and customers may further contribute to the spread of undesirable exotic species. In addition, new ornamentals are continually introduced to U.S. nurseries and garden supply stores and may represent a high potential for new plant species with invasive characteristics to invade either wetland or upland ecosystems.

Commercial Shipping

Dredging and deliberate filling have been the two greatest causes of habitat loss in the Lower St. Louis River, and they remain a continual threat. Development projects are often the cause of deliberate filling, but filling is also a result of maintenance dredging of the main shipping channel and some of the industrial slips and navigation channels. Whenever dredging takes place, the dredge materials must be deposited somewhere. Erie Pier is the facility that currently processes and stores dredge materials. Previous dredge management proposals have suggested using dredge material to fill the sheltered bays, industrial slips, and deep holes found on the flats and undredged portions of the river channel. Such filling would result in the direct loss of estuarine aquatic habitats and their associated Great Lakes coastal wetland complexes; it would also negatively impact the native fish, birds, and other species that are dependent on these habitats.

Commercial shipping is also the primary cause of the introduction of undesirable exotic aquatic species to the estuary ecosystem. In the St. Louis River, ballast water has been the main pathway of spread for many of the undesirable exotic species now found there, including alewife (*Alosa pseudoharengus*), white perch (*Morone americana*), round goby (*Neogobius melanostomus*), three-spine stickleback (*Gasterosteus aculeatus*), Eurasian ruffe (*Gymnocephalus cernuus*), zebra mussel (*Dreissena polymorpha*), Asiatic clam (*Corbicula fluminea*), and spiny waterflea (*Bythotrephes cederstroemi*). New introductions of undesirable exotic species continue; the most recent, the tubenose goby (*Proterorhinus marmoratus*), was discovered in September 2001 (J. Lindgren, MDNR, personal communication, 2002). Other pathways for spread include unintentional and intentional fish stocking, construction of canals and water diversions, overland transport in bait buckets and on recreational boats, intentional planting for roadside and construction site stabilization, dispersal from ornamental gardens, and release of live specimens from biological supply houses or aquaria.

The U.S. Congress initiated efforts to address the issues of undesirable exotic aquatic species and ballast water when it passed the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (re-authorized in 1996 as the National Invasive Species Act, NISA). Established through this Act in 1993, the Ballast Water Management Program mandates that ships operating beyond the Exclusive Economic Zone (EEZ) exchange ballast water in the open ocean before entering the Great Lakes. The purpose of ballast water exchange is to discharge undesirable exotic plants and animals contained in ballast water before entering the Great Lakes and to potentially kill with salt water any freshwater organisms that remain. While this program is widely recognized for reducing the frequency of new introductions to the Great Lakes, it has not completely “closed the door” for three reasons: 1) Current ship designs do not allow contents in ballast tanks to be completely exchanged. 2) Open-ocean exchange is not fully effective due to the survival of resistant forms of non-native species (e.g., euryhaline organisms, resting life stages, viruses, and other pathogens). 3) Nearly 80% of commercial vessels entering the Great Lakes, called NOBOBs (no ballast on board), are exempt under current regulations, despite the fact that they contain significant residual (unpumpable) ballast water and sediment. These vessels can eventually discharge these organisms into the Great Lakes when new water is pumped on-board and later released.

Transport via ballast water creates enormous potential for the rapid spread of species that might otherwise have remained more localized for a longer time period. Although ships from foreign ports are required to exchange ballast water in the open ocean before entering the Great Lakes, there is currently no law that prevents ships within the Great Lakes from taking on ballast water in one port and dumping it in another port (interlake or intralake). One program addressing this issue has been established on a limited scale. Recognizing the threats posed by Eurasian ruffe in the Duluth-Superior Harbor, the Great Lakes fleet implemented a voluntary ballast water management program in 1994 aimed at preventing the spread of ruffe beyond western Lake Superior. The program was expanded to the Port of Alpena, Michigan, when ruffe were found there in 1995. Compliance with this voluntary program is reported to be high, but ballast water discharge from foreign and domestic ships remains a threat to the health and well-being of the St. Louis River ecosystem. Efforts are underway by the Great Lakes Panel on Aquatic Nuisance Species (ANS) to strengthen federal legislation through re-authorization of NISA to address current legislation gaps and to support establishment of ballast water criteria and standards, treatment technologies, and new vessel design.

In addition to habitat loss and spread of undesirable exotic species, commercial shipping also causes problems such as resuspension of sediments from propeller wash, increased shoreline erosion as a result of wakes, difficulty in establishing submergent vegetation in otherwise suitable habitat because of the disturbance from wakes, and potential oil or chemical spills. These factors all contribute to degradation of water quality and wetland habitats.

Contaminated Sediments

Contaminated sediments are a significant environmental concern in portions of the St. Louis River AOC. Sediment-associated contaminants are attributed to historical as well as contemporary sources and are introduced into the ecosystem from the atmosphere as well as from water. Contaminants originate from many sources, including industrial operations, municipal wastewater, stormwater, commercial and residential discharges, and point and nonpoint discharges.

Sediment assessment projects have been conducted in the estuary to determine the extent of contamination and to assess the impacts to benthic biota, fish, and wildlife. Data collected to support these more recent assessments confirm that various contaminants are present in portions of the St. Louis River AOC.

Mercury and PAHs are found in many depositional areas of the St. Louis River AOC, whereas metals, PCBs, dioxins and furans, organochlorine pesticides, tributyltin, and petroleum products tend to be more localized (MPCA and WDNR 1992; Redman and Janisch 1995; Schubauer-Berigan and Crane 1997; Crane et al. 1997; IT Corp. 1997; Crane 1999; Breneman et al. 2000, Crane et al. 2002). Based on the available sediment quality data, the St. Louis River/Interlake/Duluth Tar and US Steel Superfund sites are apparently the most contaminated sediment sites in the St. Louis River AOC (Schubauer-Berigan and Crane 1997; IT Corp. 1997). Other areas with elevated contaminant concentrations in the St. Louis River AOC include Hog Island Inlet/Newton Creek in Superior, Wisconsin (Redman and Janisch 1995), Crawford Creek wetland in Wisconsin (Blasland Bouck and Lee, Inc. 2000) as well as several industrial slips, areas adjacent to wastewater treatment plants, and other areas with historical sources of contaminants (SEH 1994; Schubauer-Berigan and Crane 1997; Crane et al. 1997; Crane 1999; Crane et al. 2002). Action is currently being taken by the Minnesota Pollution Control Agency (MPCA) and WDNR to implement source control measures and to remediate contaminated sediments at several locations in the St. Louis River AOC.

Since the St. Louis River is the second largest tributary to Lake Superior, the contribution of sediment-associated contaminants to Lake Superior and its biota is a serious issue. Based on limited data from a toxics loading study, King (1999) determined that the Duluth-Superior Harbor is a source of dieldrin, DDT, total PCBs, and several PAH compounds to Lake Superior.

While this section of the Habitat Plan describes contaminated sediments as a source of stress, it should be noted that the St. Louis River AOC also contains areas of relatively clean sediments that support important habitat for fish and wildlife. These relatively clean sites provide reference areas for determining contemporary background levels of anthropogenic contaminants in the AOC. Relatively clean areas have been identified by comparing sediment chemistry data from sample sites to data from reference areas such as remote inland lakes in northeastern Minnesota. These data have also been compared to Ontario's Lowest Effect Level Sediment Quality Goals (SQGs) (Persaud et al. 1993). Numerical sediment quality targets (SQTs) were recently established by the MPCA to assess sediment chemistry data in the St. Louis River AOC (Crane et al. 2000). In addition, the current development of a GIS-based sediment quality database for the St. Louis River AOC will facilitate the comparison of historical data sets to the SQT values (Crane 2001).

The Duluth-Superior Harbor shipping channels also contain substantial quantities of relatively clean materials that frequently comply with land-based application and use guidelines. Hence, dredged materials from the shipping channels are sorted at the Erie Pier dredged material processing facility in Duluth, Minnesota, and much of the material is re-used for construction, fill, and landscaping projects. Potential uses include nourishment of eroded beaches, habitat development, and other beneficial uses (U.S. ACOE 1997).

Forest Management Practices

Some current and historical forest management practices have contributed to increased sedimentation, degraded water quality, and loss of habitat within the Lower St. Louis River project area. For example, many of the remaining forests within the area are maintained in an early successional state dominated by aspen and birch. Studies indicate that on open land, in recent clear-cuts, and in young aspen forests up to fifteen years of age snowmelt occurs two-three times faster than in forests that are over fifteen years of age (Verry et al. 1983; Verry 1986). When too much of a watershed is maintained in the "open or young forest" condition, the greatly increased rate of snowmelt causes stream flow rates up to three times the rate found in areas of more diverse forest cover. The increased water velocity increases the rate of in-channel erosion and sedimentation in streams. This has been identified as a major concern within the Nemadji River watershed (NRCS 1988).

In the early part of the twentieth century, the forests in the St. Louis River watershed were harvested several times. The first wave of logging removed white pine, and later waves took out other species. The remaining slash was intentionally burned. Attempts were made to manage slash fires by burning in the spring while snow was still on the ground. However, the combination of very dry weather and piles of slash covering a large portion of the landscape resulted in a number of high-intensity fires in the early 1900s. In northeastern Minnesota in 1918, a combination of strong winds, dry autumn conditions, multiple slash piles throughout the area, and trains setting fires along the tracks resulted in a fire that burned an area extending from Brookston through Cloquet and the western edge of Duluth (Carroll and Raiter 1990). The pattern of repeated tree harvesting followed by intense fires may have eliminated the soil and seed sources in some areas. In other areas, the water table is now higher and deciduous shrubland has replaced the historic forest cover; it is hypothesized that there is a connection between the conversion to shrubland and the higher water table (E. Epstein, WDNR, personal communication, 2002).

The primary problem with current logging practices in this region is the short rotation period for aspen. Forests are managed for early successional species such as aspen and birch and are unable to recover to a more diverse assemblage of species. In many areas, it may not be sufficient to simply allow longer rotation periods; historical forest management practices may have caused the loss of soil seed banks and seed sources, making it very difficult for many forest systems to recover simply by increasing rotation periods. Soil compaction resulting from more recent forestry efforts further complicates forest recovery.

In addition, the construction of logging roads adds to forest fragmentation, contributes to erosion and sedimentation problems in watersheds, and provides pathways for the spread of undesirable exotic species. If poorly managed or inadequately closed, the roads also provide an inviting opportunity for use of off-highway vehicles (OHVs), further contributing to erosion and sedimentation problems.

Much of the project area is still forested, and the potential exists to manage the forest for both ecological health and economic benefit. However, intensive restoration and management may be necessary in some areas to restore or replicate the composition, structure, and function of these forest systems under their natural range of variation.

Airborne Deposition of Chemical Contaminants

The deposition of toxins transported through the atmosphere is a global problem. Coal-fired power plants and incinerators release heavy metals and PAHs, agricultural practices may release inorganic and organic compounds, and numerous other industrial, commercial, and residential activities also contribute contaminants to the atmosphere. The transport and deposition of these chemicals through rainfall or "dry fall" can have negative impacts on aquatic systems, particularly the fauna inhabiting the aquatic system. Due to the large scope of this problem, it will not be addressed further in this Habitat Plan; however, this Plan recognizes that Lower St. Louis River resources may be affected by these sources as well as by the more local sources identified.

Global Climate Change

There is a large and growing body of evidence that human activities around the world are causing changes in climate that are reflected in increased average temperatures and alterations in rainfall and other weather patterns. This is expected to be a source of stress to the conservation targets of the Lower St. Louis River. It is expected to cause loss or degradation of habitat over the long term and could eventually make the region uninhabitable for some native species. It is also predicted that climate change could aid in the spread of undesirable exotic species. Although it is recognized here as a potential source of stress, it is beyond the scope of this Habitat Plan to address.