LOWER ST. LOUIS RIVER ECOSYSTEM

Physical Setting of the Lower St. Louis River

Physical conditions such as water depth, water clarity, water temperature, substrate composition (e.g., gravel, sand, silt, mud), and nutrient abundance determine the variety of aquatic and palustrine (i.e., wet or marshy) habitats of the Lower St. Louis River. Similarly, climate, landforms, soil texture, and related physical characteristics determine the range of terrestrial habitats that surround the river's palustrine and aquatic habitats. The St. Louis River System Stage One Remedial Action Plan document contains an in-depth description of the physical setting of the river (MPCA and WDNR 1992). The following less-detailed summary is included to give the reader a basic understanding of the landforms and hydrologic regime that define the Lower St. Louis River area.

The Lower St. Louis River flows through thick layers of red clay that were deposited approximately 11,000 years ago as the Superior Lobe of the Laurentide Ice Sheet retreated (Farrand and Drexler 1985). After the level of ancestral Lake Superior dropped, the river and its tributaries cut deeply incised valleys through the easily eroded clay. When the lake level rose again, the river valley was flooded, creating a complex estuary with an irregular shoreline and bays at the mouth of each tributary. The ongoing, gradual rebound of the earth's crust faster to the east and north is causing the water level to continue rising slowly within the estuary.

The baymouth bar that protects the waters of the Duluth-Superior Harbor is typical of freshwater estuary systems. The lakeward side of the bar is composed primarily of sand, and the landward side consists of finer sediments. The baymouth bar as a whole shelters the harbor from the high-energy wind and waves of Lake Superior, allowing wetland habitats to develop.

Remnants of at least two older baymouth bars that formed during earlier periods of higher lake levels are found within the estuary. Grassy Point, located about 8 miles upstream from the mouth of the St. Louis River, represents a baymouth bar from an earlier glacial lake stage when the water level was at least 3 feet higher than the current level. Approximately 5 miles upstream from the mouth of the St. Louis River is Rice's Point (Minnesota)/Connors Point (Wisconsin), another remnant baymouth bar.

When first charted by William Hearding in 1861, the Lower St. Louis River was relatively shallow and was bordered by a variety of wetlands and riparian forest communities. Wetland vegetation such as emergent marshes and floating peat islands covered much of the estuary itself. The forests of the surrounding uplands were dominated by coniferous and mixed deciduous/coniferous stands that lengthened the spring snow-melt period and slowed runoff. A thick layer of organic duff on the forest floor also helped slow the movement of water from the land into the river. A variety of fish, waterfowl, mammals, and other wildlife used the area for breeding and migration.

It has been estimated that since Hearding's time, approximately 3,000 acres of shallow wetland habitat have been lost as a result of intentional filling, and approximately 4,000 acres of the estuary have been dredged or deepened for navigation (DeVore 1978). Despite these significant changes, the Lower St. Louis River still provides vital habitat for fish, nesting colonial water birds and waterfowl, migratory shorebirds and songbirds, and many other animals. The estuary supports a large, diverse warm-water fish community of approximately 45 native species (WDNR and MDNR unpublished data).

Changes in water depth within the river are influenced by the seiche, which occurs when wind or atmospheric pressure causes oscillations in the water of Lake Superior. The change in the water level as a result of the seiche is usually less than a foot. Areas of the river closest to the lake are most strongly influenced, but a strong seiche can reverse the direction of the river's flow as far upstream as Fond du Lac. As the seiche effect moves up the river it also causes opposing flow between the unidirectional river current (moving horizontally) and the oscillating lake current (moving vertically). The seiche causes an exchange of water between the lake and the river, and it can also contribute to stratification within the river as colder lake water flows beneath the warmer (and therefore less dense) river water. Seasonal changes in the water level of Lake Superior are caused by dry-season evaporation and spring snowmelt and rain. Long-term fluctuations in the lake level result from variations in precipitation and evaporation rates. Modeling predictions indicate that global climate changes might result in lower water levels in Lake Superior in the future (Zhuikov 1999). These short-term and long-term fluctuations in the level of Lake Superior affect the formation and distribution of wetlands within the estuary.

Water clarity is also very important to aquatic habitats and wetland plant communities. The water clarity is affected by the turbidity and tannin staining of the tributary rivers and streams, as well as resuspension of fine sediments within the estuary. Changes in water clarity are also related to climate and rainfall; sediment load is greatest following heavy rains. The upper reaches of the river drain many boggy areas, and in years of heavy rain the bogs are flushed, moving more tannin-stained water from bogs and wetlands into the river. These changes in water clarity influence the depth of light penetration and thus the amount and type of submerged vegetation.

Many human activities also influence the physical conditions of the Lower St. Louis River. Dams, constructed to generate electricity, also affect water flow, water level, and the amount of sediment transported by the river. Dams act as sediment traps, greatly decreasing the rate at which the upper part of the estuary is replenished by sediment. Dredging of the shipping channel, which has occurred for over 100 years, coupled with isostatic rebound of land to the north and east, has resulted in an overall deepening of the harbor. As more shallow water habitats are transformed to open water, fetch increases, wave strength increases, and erosion of shallow water areas and shorelines increases. Commercial shipping and recreational boating also increase shoreline erosion as a result of wave action caused by bow wake and propeller wash.

Many of the changes that humans have made to the surrounding uplands have resulted in accelerated movement of water from the land into the river. The extent of impervious surfaces in the watershed increased significantly as both residential and commercial development increased; traditional stormwater management practices increased the volume and speed of runoff to tributary streams, ditches, and the river itself. Attempts to farm and develop the clay soils within the watershed entailed extensive drainage of wetlands. In addition, today's early successional forests and deciduous forests do less to slow snowmelt and rain runoff than did the more diverse coniferous forests. This results in greater peak flows in streams and greater erosion of stream banks, thereby increasing the amount of sediment deposited in the Lower St. Louis River.

Historical and Current Habitats of the Lower St. Louis River

"Habitat" is a broad term meaning the environment where an organism lives. This environment may be described by physical characteristics, biological characteristics, or a combination of both. For example, the "estuarine river channel" discussed later in this document is a habitat that is defined by its physical characteristics—it is the part of the river channel near where the river empties into Lake Superior. The “spruce-fir forest” is a habitat defined primarily by its biological characteristics—the dominant tree species found in the habitat. An “emergent marsh” suggests something about both its physical and biological characteristics—it is dominated by plant species such as cattails, bulrushes, and other emergent vegetation, and it is located in a shallow water setting.

The intent of this section is to provide an overview of both the historical and current habitats of the Lower St. Louis River area. Later in this document, a more specific term—“plant community”—will be used for habitats that can be defined by a certain set of biological characteristics. Plant communities are defined by a predictable assemblage of dominant plant species, for example, “northern conifer-hardwood forest.” The term “habitat” will be used for habitats that are defined by physical characteristics, for example, “aquatic habitat.”

A broad picture of the forests that historically surrounded the Lower St. Louis River can be drawn from the notes of surveyors employed by the U.S. government’s General Land Office. In order to open up land for settlement, the federal government divided the land into 6-mile square areas called “townships.” Each township was further divided into 1-mile-square “sections.” Between 1832 and 1866 in Wisconsin and between 1847 and 1907 in Minnesota, surveyors systematically traveled across the land, establishing “corners” every half-mile and township corners every 6 miles. The surveyors recorded the species and size of trees at each corner, and they also made notes about the landscape they crossed. In 1930, Francis Marschner compiled these General Land Office survey records to create generalized maps of the presettlement vegetation of Minnesota. Robert Finley did a similar compilation of survey records in Wisconsin and published them as a map in 1976. Both the Minnesota and Wisconsin presettlement vegetation maps were later transferred to a digital format by their respective Department of Natural Resources. More recently, the Great Lakes Ecological Assessment project reviewed the presettlement maps for Minnesota, Wisconsin, and Michigan and reclassified the various cover types into a consistent set of land cover classes as part of a land cover change assessment project (Snetsinger 2000; Snetsinger and Ventura 2000).

The Lower St. Louis River lies within the transition zone between the boreal forests of Canada and the northern hardwood forests of the United States. Prior to European settlement, the area was also home to the white and red pine forests unique to the Great Lakes region (Map 2. Presettlement Vegetation of the Lower S. Louis River Project Area). According to these interpretations of presettlement vegetation, boreal spruce-fir forest dominated the area on the south side of the Lower St. Louis River in Douglas County, Wisconsin, and eastern Carlton County, Minnesota. Patches of red and white pine forests were embedded in the spruce-fir forest, as well as various conifer-dominated wetlands (Finley 1976; Marschner 1974). In addition, a significant band of northern hardwoods (sugar maple and basswood) mixed with pines (primarily white pine) extended approximately from present-day Duesler in Blackhoof Township (Minnesota) to the northeastern part of Duluth. Red and white pine-dominated areas were significant in northeastern Carlton County and around Duluth, in the periphery of the project area. Although smaller patches of conifer bogs and swamps were mapped within the surrounding matrix forests in Marschner’s interpretation, such wetlands were not shown in the more general interpretation of the lake states map. Numerous wetlands too small to appear in any of these interpretations were certainly present as well; such wetlands would have included bogs, fens, sedge meadows, and other wetland types.

Today the forest vegetation reflects the influence of human activities of the last 150 years (Map 3. Current Vegetation of the Lower St. Louis River Project Area). Harvested at least twice and intensively burned at least once, the forests surrounding the Lower St. Louis River are now largely maintained in an early successional stage of aspen-birch forest. Without widespread human impacts (particularly the unnaturally intense, post-logging slash fires), spruce, fir, pine, maple, and other species would have regrown after disturbances to form an irregular and varied patchwork of plant communities. Instead, those past influences in combination with ongoing forestry and other land management practices have created a forest lacking the natural variation of species composition, age, structure, and pattern that it once had.

There is no comparable historic map of the extent, composition, and pattern of the extensive wetlands of the Lower St. Louis River prior to the development of the harbor and areas immediately upstream. The General Land Office was concerned with land that could be homesteaded, so surveyors did not even attempt to survey riverine wetlands. However, other sources of information can paint a picture of the presettlement wetlands. According to Hearding's 1861 chart of the estuary, the area upstream of Rice's Point/Connors Point was less than 15 feet deep. The majority of the estuary between Rice's Point and Grassy Point was less than 10 feet deep. The shallowness of the estuary and anecdotal descriptions from early travelers suggest that much of the estuary consisted of emergent and submergent marshes. It was reported that the river channel was often difficult to find and follow because of the extensive emergent vegetation. Floating islands of peat, covered with wetland vegetation, were also described. It is estimated that approximately 7,000 acres of wetland and shallow water habitat were lost to dredging and creation of new land along the shoreline (DeVore 1978; MPCA and WDNR 1992). Air photo interpretations (based on photos from 1997 and 1999) indicate that approximately 2,000 acres of vegetated wetlands remain in the estuary; this includes wetlands either created or heavily influenced by human activities.

The baymouth bars of Minnesota and Wisconsin Points were home to a variety of plant community types, examples of which are still present today. Significant stands of old growth white and red pine forests exist on older stabilized dunes furthest from the Lake Superior shoreline. They transition to a shrubby juniper-lichen community, also found on the older dunes. Active dunes closer to the shore are dominated by beachgrass; the nearer to the lakeshore, the sparser the vegetation. The beach itself is not vegetated. Embedded within the forest and shrubland communities are a variety of wetland types, including sedge marshes and alder thickets. The harbor side of the Points supports some emergent and submergent vegetation in shoreline wetland communities. Although the vegetation has been heavily influenced by humans and some areas of the Points are developed, the remaining vegetation bears some resemblance to what was present prior to European settlement.

The estuarine wetlands of the St. Louis River are an excellent example of an ecological system that is endemic to the Great Lakes region. They form one of the largest complexes of estuarine wetlands in the Lake Superior Basin; only the Bad River-Kakagon Sloughs of Wisconsin are comparable. Similarly, the varied plant communities of Minnesota and Wisconsin Points are only found in the Great Lakes region, and they form one of only two examples of such plant communities in Lake Superior. Although the surrounding forests are not as extensive as they once were, the transition zone between boreal forest, northern hardwoods forest, and Great Lakes pine forest is also unique. The Great Lakes white and red pine forests are found nowhere else in the world, and this particular convergence of forest types, with its endemic Great Lakes element, is significant and worthy of conservation.

Although in need of some restoration, the ecosystems of the Lower St. Louis River are regionally and nationally significant.

Overview of Conservation Targets

Conservation targets are the elements of native biological diversity that are the focus of a conservation plan. Conservation targets may be ecological systems (boreal forest), plant communities (bluejoint wet meadow), aquatic habitats (sheltered bays), aggregations of species (native mussels), individual species (piping plover), or some combination of the elements of biological diversity.

This plan focuses on a relatively small number of conservation targets. This small set of targets will help focus actions on natural resources that encompass a much wider range of needs—the needs of nearly all the flora and fauna native to the Lower St. Louis River area. The conservation targets were selected using a “coarse filter-fine filter” approach, which is widely used by those involved in conservation planning, including The Nature Conservancy, state Gap Analysis programs, federal agencies (e.g., Kruger and Mishaga 1996), and numerous other entities, including corporations in some instances (e.g., Haufler et al. 1996). In this approach, plant communities and aquatic habitats are selected as surrogates for most individual native species of the area. The assumption is that if the plan addresses the needs of a “coarse filter” target such as beach dunes, most of the myriad plant and animal species dependent on the plant community (e.g., beachgrass, common juniper, beach heather, etc.) will also be sustained into the future. In some instances, the needs of individual species are not addressed solely by the “coarse filter” conservation targets. For example, the coarse filter assumption would suggest that sustaining or enhancing large areas of high quality aquatic habitats would be sufficient to meet the needs of native fish, mussels, and other aquatic species. However, in the case of the Lower St. Louis River ecosystem, focusing solely on habitat does nothing to address the problem of exotic species. In these cases, such species or groups of species are included as “fine filter” targets. The effectiveness of the coarse filter-fine filter approach has not been widely tested yet, but a handful of field studies offer preliminary support for this approach (Panzer and Schwartz 1998). Despite the lack of field testing, there is scientific support for the use of habitats and communities as surrogates for individual species in conservation planning efforts (Noss and Cooperrider 1994; Howarth and Ramsey 1991).

In late 1999, the Habitat Committee of the St. Louis River Citizens Action Committee (CAC) began the process of identifying conservation targets. Based on input from biologists in various divisions of the Wisconsin Department of Natural Resources (WDNR), Minnesota Department of Natural Resources (MDNR), U. S. Fish and Wildlife Service (U.S. FWS), University of Minnesota, Duluth-Natural Resources Research Institute (UMD-NRRI), University of Wisconsin-Superior (UWS), and The Nature Conservancy (TNC), a list of species and plant communities found in the Lower St. Louis River area was developed. WDNR and MDNR fisheries biologists delineated aquatic habitat types of the Lower St. Louis River. Two additional aquatic habitat types developed by TNC were included later.

The Habitat Committee agreed that all of the aquatic habitats and plant communities of the Lower St. Louis River and surrounding uplands would be conservation targets. A primary reason for this decision was that these plant communities and aquatic habitats serve as the “coarse filter” for ensuring that the needs of most native species are met. Additional species and species groups were identified as fine-filter targets. The process of selecting species targets is described in greater detail in the section on species targets. As the planning process continued, there were some revisions to the list of species conservation targets. Table 1 lists all conservation targets selected in the Lower St. Louis River area. More detailed discussions of the targets are included in following sections.

Table 1. Conservation Targets of the Lower St. Louis River

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
Baymouth Bar Community Targets
Beaches
Beachgrass dunes
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
(these targets form smaller patches within the various forest communities)
Eroding clay bluffs
Clay seeps
Conifer swamps
Hardwood swamps
Shrub swamps
Inland marshes
Wet meadows
Fens
Cliffs and rock outcrops
Species Targets
Native fish assemblage
Lake sturgeon
Native mussel assemblage
Migratory and breeding bird aggregations
Piping plover
Common tern
Wild rice

Conservation Targets - Plant Communities and Aquatic Habitats

Classification of Plant Community and Aquatic Habitat Conservation Targets

Two separate classification systems were used to describe the aquatic habitat targets and the plant community targets. Plant communities were classified according to biological characteristics, and aquatic habitats were classified based on physical characteristics. In wetlands, where the aquatic habitats meet the plant communities, the two classifications of conservation targets overlap, and there usually is not a one-to-one relationship between the aquatic habitat type and the plant community type. However, such classification criteria are consistent with those used by terrestrial community ecologists and aquatic ecologists throughout the U.S. and in other parts of the world.

Plant communities are easily described according to biological characteristics—usually the dominant plant species of the community plus the vegetation structure. Communities described in this fashion—such as white pine-red pine forests—are easily recognized and understood. Aquatic habitats are more easily described by their physical characteristics. Not all aquatic habitats are vegetated, and therefore plant species cannot be used consistently to describe them. Although certain animals (fish, mussels, insects) may typically be found in a particular assemblage in a particular habitat, information on such associations is not widely available. If such species assemblage information were available, a “sunfish-sculpin-green darter nymph” habitat would still not be as easily recognized as a “sheltered bay.”

The estuarine plant communities, as well as the baymouth bar, upland forest, and other plant communities were classified primarily by biological characteristics—the vegetation structure (e.g., forest, shrubland, etc.) and the dominant plant species of the community. The plant community targets in this plan are modified slightly from plant communities defined in the International Classification of Ecological Communities (ICEC), a classification that was developed by NatureServe and adopted as a standard by federal agencies and some conservation organizations (NatureServe 2001). For example, the pine-dominated forest communities listed by the ICEC include the following:

Red Pine-Aspen-Birch Forest
Red Pine / Blueberry Dry Forest
White Pine-Aspen-Birch Forest
White Pine / Mountain Maple Mesic Forest
White Pine / Blueberry Dry-Mesic Forest

Each of these forest communities is a specific variant of the white and red pine-dominated forests that occur throughout the Great Lakes region and share similar driving ecological processes. Rather than trying to address all five of these communities individually, they were grouped into a broader white pine-red pine forest type.

As part of a Great Lakes regional conservation planning initiative led by TNC, a group of scientists met in October 1998 to document the native plant communities and ecological diversity currently found in landscapes along the North Shore of Lake Superior, including the Lower St. Louis River. This group also provided a preliminary assessment of the viability of these communities. The resulting list of plant communities documented in the Lower St. Louis River formed the groundwork for a March 6, 2001, meeting with ecologists Carol Reschke of the Minnesota DNR County Biological

Survey and Eric Epstein of the Wisconsin DNR Natural Heritage Program. Starting with the October 1998 community list, Reschke and Epstein modified community descriptions as necessary to more accurately describe the communities found in the Lower St. Louis River area. They also described the ecological processes and other factors supporting those communities and the activities that threaten them. Locations of the plant communities were mapped using aerial photos from 1997 and 1999. See Appendix 2 for a more detailed list of the plant communities of the Lower St. Louis River and surrounding uplands.

On April 4, 2001, a meeting of aquatic biologists was held to review the major aquatic habitats within the Lower St. Louis River. Prior to the meeting, John Lindgren and Peter Ongstad of the MDNR worked with Dennis Pratt and Bill Blust of the WDNR to classify the Lower St. Louis River into major habitat types. They delineated these habitats based on a combination of factors: morphology, water depth, rate of flow, substrate, level of seiche effects, and presence of recent or historic industrial activities. The entire collections of fish sampling data from both the WDNR and MDNR were used to determine which fish species utilize various habitat types (Lindgren et al. 1997; WDNR and MDNR unpublished data). The earliest data sets date to 1974, and all are maintained in files in the respective DNR offices. Trawling data from the U.S. Geological Survey Great Lakes Science Center (Lake Superior Biological Station) were also incorporated. These data were compiled over varying time periods for a variety of purposes, such as tracking trends in species abundance, investigation of populations and impacts of non-native species, investigations for regulatory permits, and other purposes. Some sampling efforts, such as tracking species abundance, span more than twenty years. Sampling methods included electrofishing, gill netting, fyke (trap) netting, shore seining, and bottom trawling. The goal of incorporating all of these data was to provide the most complete picture of fish habitat use in a readily understood format. The major aquatic habitat types were refined during the April 2001 meeting. During this meeting, the biologists also provided information on the ecological values of the habitats, their current conditions, and the ecological processes and other factors influencing the health of the habitats.

Another factor in the classification of both aquatic habitats and plant communities is the continuum between "natural" communities or habitats and those that have been created by human activities. In some areas, "natural" communities—such as sugar maple-yellow birch hardwood forests—have regenerated since early logging events and now somewhat resemble the northern hardwood forests that were found prior to any significant logging activities. Although these communities have been affected by humans, they are still considered "natural." At the other end of the spectrum are areas such as the former US Steel plant site where the combination of historic and ongoing human activities have resulted in highly modified plant communities. Such human-created habitats contain assemblages of plant species that do not have a species composition resembling anything that would have developed without such human influence. These habitats are not considered "natural." Somewhere in the middle of the continuum are communities like the aspen-dominated forests around the estuary. Although aspen-birch forests do occur naturally, the extent and persistence of these aspen forests is the result of repeated clearcuts and the unnaturally intense fires that followed early logging. Dredge materials that have been colonized by a variety of plant species represent another area in the middle of this continuum—they are less natural than the aspen-birch forests, but more natural than communities that have developed on heavy industrial sites.

In developing a list of aquatic habitat and plant community targets for the Lower St. Louis River, those plant communities colonizing areas heavily influenced by human activities were generally not included as targets. To follow the above examples, the plant communities that colonized industrial sites or dredge materials would not be included as targets for their own inherent value. However, the plan does include a variety of species targets as well, and some of those species use such altered habitats. The endangered piping plover is an excellent example of a species that could use some of these altered habitats. **Therefore, altered habitats are still of conservation importance.** In addition, it may be possible to restore some of these communities or habitats to a somewhat more natural condition that is more beneficial to the native species that utilize them.

Some of the aquatic habitat types provide a notable exception to the rule of targeting plant communities or aquatic habitats that fall closer to the natural end of the continuum. Several aquatic habitats in the classification have been highly altered from their natural state and were classified separately from their natural counterparts. These highly altered habitats are included as targets. For example, the "lower estuarine (dredged) river channel" is classified and targeted separately from the "upper estuarine (undredged) river channel." In other aquatic habitat classifications, these two habitats would be considered a single type: "estuarine river channel." The dredged channel would be a very poor quality example of the type, and the undredged channel would be a better example of the same type.

These industrially-influenced habitats were classified separately for a few reasons:

1. To underscore the expectation that most of the industrially-influenced habitats will remain industrially-influenced; it is not the goal of this plan to return all of these industrial habitats to their presettlement condition.
2. To underscore the importance of these habitats to native fish, birds, and other species, even in their current condition.

In addition, it would have been impossible to determine the natural habitat of the industrially-influenced bays and slips and place them with their natural counterpart. They could have been part of the estuarine river channel, estuary flats, sheltered bays, or clay-influenced river mouths.

Mapping Plant Communities and Aquatic Habitats

Plant communities and aquatic habitats were mapped to obtain a complete coverage of their locations throughout the Lower St. Louis River area. In addition, the maps also provide a framework for identifying where good examples of conservation targets still remain, and where restoration or management could improve the health of poor examples of conservation targets.

Plant communities were mapped in the area lying within a half-mile of the Lower St. Louis River shoreline, below the Fond du Lac dam. This map was intended to assist in the development of plant community targets, to inform area-specific recommendations about restoration and management of conservation targets, and to serve as a repository for information on the location of high-quality examples of conservation targets. Extremely limited human and financial resources prevented this map from being completed until late in the planning process, and planners were unable to take full advantage of the map data during the planning process. Nonetheless, the resulting map is an excellent tool that depicts the location of plant community conservation targets. It will be used for recording high-quality examples of targets and for guiding decisions about where restoration and management may be appropriate.

The plant communities in and adjacent to the Lower St. Louis River were mapped by Carol Reschke (Ecologist, MDNR) and Eric Epstein (Ecologist, WDNR) through interpretation of aerial photos.

Before mapping could begin, they reviewed and revised the list of U.S. National Vegetation Classification (NatureServe 2001) vegetation types that had been documented around the Lower St. Louis River. Color-infrared aerial photos from 1997 were used for the Minnesota side of the river and the small portions of the Wisconsin side of the river covered by those photos; black and white aerial photos from 1999 were used for the remainder of the Wisconsin side of the river. Using field data and professional knowledge of the Lower St. Louis River area, they delineated boundaries of different plant community types. Most polygons were delineated through air photo interpretation; some polygons have also been visited and checked by Eric Epstein or Carol Reschke. A quantitative accuracy assessment has not been completed for this map. Occasionally, it was not possible to distinguish between two community types. For example, it was sometimes difficult to tell whether an area was "White pine-aspen-birch forest" or "White pine / mountain maple mesic forest." Some polygons contain both of these community types. In other polygons, two or more plant communities intermingled at such a fine scale that it was impossible to map them as separate polygons. As a result, close to 90 combinations of plant community types were mapped in this process. For display purposes, plant community types were grouped according to the dominant vegetation. For example, mixed emergent marsh is often intermingled with alder swamp, other shrub swamp, wet meadow, or lake bed. Instead of displaying all five combinations, those polygons were simply mapped as mixed emergent marsh. Map 4, a series of vegetation maps with grouped plant communities is found at the end of the Plan.

Since only a limited area around the Lower St. Louis River could be mapped in detail, Minnesota and Wisconsin land cover layers may serve as additional references. These maps are much coarser than the air photo interpretations, and users must be familiar with their overall accuracy and limitations before using them. The Wisconsin map was developed by the WDNR using Landsat Thematic Mapper (TM) satellite imagery primarily from 1992, and the Minnesota map was developed by the MDNR using Landsat (TM) imagery primarily from the early 1990s.

There is usually a direct correlation between the conservation targets of the Habitat Plan and the individual plant associations or cover types mapped from the aerial photos. In some cases, several similar plant associations are lumped into a single target. For example, the "Bluejoint Wet Meadow," "Lake Sedge Wet Meadow," and "Tussock Sedge Wet Meadow" plant associations are grouped under the more general target "Wet Meadows." It is important that examples of the variations of wet meadows are present and healthy in the Lower St. Louis River area, but the individual variants will not be treated as separate conservation targets. Appendix 2 also summarizes the relationship between plant community conservation targets and individual plant associations that were mapped.

An additional complication involves the upland forest community targets. All of them correlate clearly to more detailed plant community associations. However, there are several areas that are mapped as an aspen-birch-red maple plant association. This association could be a highly degraded example of any of the three upland forest community targets, depending on the location. For example, the south side of the estuary was once a true spruce-fir boreal forest (which included some aspen and birch). Today some of those polygons are almost entirely aspen and birch, but they could potentially be managed to reintroduce the spruce and fir components. In this particular case, these areas of aspen could be described as highly degraded or altered spruce-fir boreal forest. Reschke and Epstein's detailed vegetation map accordingly includes notations indicating which upland forest community is more likely. These notations are based on interpretations from the presettlement vegetation maps of Marschner and Finley (Marschner 1974; Finley 1976). Because those maps were not intended to be used at a very fine scale, individual notations carry a lower level of confidence. However, across a larger area, it is likely that most of the notations are correct.

The mapping of aquatic habitats was relatively straightforward. Based on their professional knowledge of the estuary and many years of accumulated fish monitoring, John Lindgren and Peter Ongstad of the MDNR and Dennis Pratt and Bill Blust of the WDNR delineated aquatic habitats defined by physical characteristics. The physical features selected to delineate the aquatic habitats are thought to be those features used by fish and other aquatic organisms to identify desirable habitat. The aquatic habitats were then reviewed and revised by several other biologists. The delineated habitats were compared to patterns of usage by mussels and birds, which informed some additional refinements and largely confirmed the original classification. Because of its relative simplicity, the aquatic habitat map was completed early in this planning process. It also included all of the aquatic habitats of the Lower St. Louis River, with the exception of the clay-influenced and bedrock tributary streams, which were included as separate conservation targets later in the process. Map 5, "Aquatic Habitat Types" is included at the end of the Plan.

Natural Range of Variation of Ecosystems and Their Processes

In describing the health of aquatic habitats and plant communities, it is necessary to introduce another emerging concept in the field of conservation biology: the "natural range of variation." Although this terminology is relatively new, the defining of the natural range of variation in many ecosystems has been underway for many years. The somewhat more recent development is that of conservation biologists applying the concept to assess ecosystem health and make recommendations for managing or restoring ecosystems to a more "natural" state.

The "natural range of variation" of an ecosystem is defined as the range of variability in ecological processes that would be seen under conditions that are considered "normal" from an ecosystem perspective. From that perspective, "normal" conditions are those in which human activities have had little or no impact on the structure, composition, and functioning of the ecosystem. Ecologists generally think of presettlement conditions as representing something close to normal, or natural, for most ecosystems. Presettlement conditions are derived from land surveys completed just prior to European settlement of the region. In this Plan, it is assumed that these conditions were not strongly influenced by human activites.

Although there is evidence to suggest that some Native American management practices had significant influence on certain ecosystems, this evidence is generally stronger for the prairie regions of North America. It is unclear whether Native American activities significantly altered the structure or composition of forests of the western Great Lakes region, although wild rice cultivation may have had some level of influence on wetland species composition in this region. It is possible that some of the sandspits and peatlands were burned to encourage blueberries, cranberries, and other desirable species.

Under these "natural," "normal," or "presettlement" conditions, an ecosystem might experience fires, storms, insect outbreaks, nutrient cycling, species succession, species competition, surface and groundwater flow, and numerous other large and small scale processes, depending on the ecosystem in question. Not every process plays an important role in every ecosystem. Within a given ecosystem, each of its processes would have had some level of variation and some level of influence. In some ecosystems, one or more of the processes could be highly variable, with extreme fluctuations. The fluctuations might be entirely random, or they might be tied to other variables having a certain periodicity (e.g., increased or decreased storms related to the El Nino/La Nina events). For others, certain processes might have had less variation. For example, stream or river systems whose flow derives mainly from groundwater will have less variability in the volume and rate of flow than systems whose flow derives mainly from precipitation and snow melt events.

To provide a more concrete understanding of the "natural range of variation" concept, the natural range of variation of a driving ecological process in northern conifer-hardwood forests is described below as an example. Northern conifer-hardwood forests occur in a band from eastern Minnesota to Maine. They are (or were) dominated by hardwoods such as sugar maple, basswood, and yellow birch, and conifers such as hemlock and sometimes white pine. Storms that cause "blowdowns" or "windthrows" are a critical ecological process in this forest system. Blowdown events shape the successional patterns, age structure, species composition, and related characteristics of the northern conifer-hardwood ecosystem. After a blowdown, conditions may sometimes permit fire to ignite in the downed trees, but Stearns (1949) observed that fire rarely appears to spread into the surrounding hardwoods forest. Evidence suggests that fires almost never ignited in a mature stand of this forest type (Frelich and Lorimer 1991).

Stearns (1949) was among the first to document the theory that storm-related blowdowns were a driving process shaping the northern conifer-hardwoods ecosystem. Using Government Land Office (GLO) surveyor notes, climate data, and other historic records, Canham and Loucks (1984) estimated the rotation period (or return time) and scale at which these events took place in northern Wisconsin prior to European settlement. They estimated that the return time for a catastrophic blowdown (causing complete canopy blowdown) is 1,210 years. This figure is based on an assumption that blowdowns more than fifteen years old would not be noticeable enough for surveyors to record them. If it is assumed that blowdowns up to twenty years old were recorded, the return time would be 1,612 years. Frelich and Lorimer's (1991) investigation of northern conifer-hardwoods forests yielded similar return frequency (1,183 years) for catastrophic disturbance events; fire events were included with blowdown events. They also analyzed rotation periods for a range of non-catastrophic disturbance events. These analyses also show the influence of light to medium disturbances in creating variable age structures that still include mature age classes in this forest type.

What all these figures tell us is that northern conifer-hardwood forests formed a mosaic of patches of varying stages of succession, with "old-growth" patches dominating the mosaic. Areas that had experienced blowdowns more recently would be in earlier stages of succession. Areas that had experienced them more than 200-300 years earlier would have mature, uneven-aged trees of varying species; such areas would be in a condition that is frequently referred to as "old-growth." Because of the higher frequency of light to medium disturbance events, many of the "old-growth" patches would actually have a complex structure that included very old trees (200-400 years), a range of age classes from seedling to mature tree, and dead and dying trees. Sugar maple, one of the defining species of this forest type, can live between 300 and 400 years. A recent analysis by Frelich (1999) indicates that 83-91% of the northern conifer-hardwood forest would be in this advanced stage of stand development at any given time. Coupled with the knowledge of species succession patterns in this forest type, ecologists can paint a broad picture of what a healthy northern conifer-hardwood forest ecosystem might look like.

The natural range of variation of fire regimes, blowdown events, hydrologic regimes, and other driving ecological processes is considered part of the benchmark against which the health of an ecosystem is assessed. The current state of knowledge of the natural range of variation for each ecosystem's driving processes is one of the characteristics used to assess the current and desired state of health of each conservation target in the Lower St. Louis River area. Many other characteristics are also used and are identified in later sections of the Plan.

Descriptions of Plant Community and Aquatic Habitat Conservation Targets

In order to maintain or enhance the health of these conservation targets, it is necessary to describe what constitutes a healthy example of each target and compare that to their current state of health in the Lower St. Louis River area. It is also critical to describe the level of health that is desired—in other words, a conservation goal for each target. Gathering this information constituted the next steps in this conservation planning process. The information summarized here was compiled from the March and April 2001 experts workshops (described in the section on classification of conservation targets), as well as individual communications with biologists and ecologists familiar with the St. Louis River ecosystem. The compiled descriptions and other information have also been extensively reviewed by appropriate experts.

The term "health" has numerous connotations. In this plan, the "health" of conservation targets is described from a purely biological or ecological perspective. For plant communities and aquatic habitats, a healthy state is one closely resembling the state that would be expected under presettlement conditions. In a healthy ecosystem, species composition, habitat structure, nutrient cycling, hydrology, successional dynamics, disturbance events, and other ecological processes are functioning within their natural range of variation. For a spruce-fir forest, a dynamic system that is naturally subject to events like fire and spruce budworm outbreaks, a "healthy" forest can include an area that has been impacted by fire or spruce budworm. Some areas in a spruce-fir forest may naturally escape fire more often than other areas by virtue of topographic position, lakes, or other features; in these areas, it is "healthy" for dead or dying trees to be present. It is also "healthy" or normal for such forests to experience blowdowns; dead trees either decay or burn in the next fire. Human intervention is not required to improve the ecological health of a spruce-fir forest under any of these circumstances; these are circumstances experienced within this ecosystem over the last 10,000 years, mostly unaided and unaffected by human activities.

In the following descriptions, the current state of health of the conservation targets is summarized with qualitative rankings of "Good," "Fair" or "Poor." A **Good** ranking indicates that a habitat or community closely resembles presettlement conditions, or that a species is secure and reproducing in the Lower St. Louis River. The supporting ecological processes are operating within or close to the natural range of variation. A **Fair** ranking indicates some alteration from presettlement conditions. The species composition, physical setting, age class distribution, or other characteristics of a habitat or community may be somewhat altered and supporting ecological processes are somewhat outside the natural range of variation. A Fair ranking for an individual species indicates it is either in decline or it has declined but stabilized. A **Poor** ranking indicates a habitat or community that shows significant alteration from presettlement conditions, or a species with a very low or non-existent local population. Ecological processes are significantly outside the natural range of variation.

The desired state of health for each conservation target is summarized in its conservation goal. Ideally, conservation goals are described in detail; where appropriate and available, quantitative measures are included. However, there is frequently insufficient information to provide a highly specific picture of desired future conditions. For example, although rough estimates of numbers of breeding pairs of certain bird species are available, it is not possible to make credible recommendations of the number of breeding pairs that "should" be present. Similarly, the natural range of variation in the flow of the St. Louis River is not known. As these information gaps are filled, conservation goals should be revised to reflect the new information.

It is important to recognize that the conservation goals described here represent an ideal from an ecological perspective, and that it may not be practical to achieve every goal to its full extent. Some goals were established in a circumscribed fashion, because it is not the intent of this plan to recommend the restoration of the entire estuary and its surroundings to a presettlement condition. Where a goal does recommend something closer to presettlement condition (for example, in the estuarine wetlands and forested lands that do remain), it is important to recognize that practical considerations are expected to play a role in where, how, and to what extent those goals are achieved. By setting conservation goals that will achieve a mix of ecological and social benefits, this Plan presents a new vision of the St. Louis River ecosystem toward which communities, organizations, and individuals can work in cooperation and partnership.

Estuarine Aquatic Habitats

The volume, rate, and depth of water flow—or the "hydrologic regime"—is a driving ecological process that determines or strongly influences the health of all of the estuarine aquatic habitats. As mentioned previously, fluctuations in Lake Superior's water level and the flow of the St. Louis River are the determinants of water level and flow in the estuary. Lake Superior's water level fluctuates on a daily, seasonal, and annual basis. Long-term lake level fluctuations lack a predictable pattern (U.S. ACOE 1987) and result from annual variability in precipitation and evaporation. In general, the lake level tends to rise in the spring as a result of snowmelt and heavy rainfall, and it peaks during the summer. Increased evaporation and lower levels of precipitation during dry fall and winter months allow the lake level to gradually fall during the remainder of the year. These annual fluctuations also vary with the timing and amount of snowfall, ice cover, and rain, as well as the timing and rate of spring thaw. Control structures permit some regulation of water level in Lake Superior, but this direct human influence is minor compared to the influence of natural climatic events. More frequent and noticeable water level fluctuations result from seiches on Lake Superior. Wind, storms, or differences in atmospheric pressure cause water to "set up" on part of Lake Superior. Water level is correspondingly lowered on the other side of the lake. When such weather events subside, the level of the "set up" water begins dropping and the water level begins rising on the other side of the lake. This causes the oscillations in water level known as a seiche. Such oscillations occur frequently in Lake Superior. In the Lower St. Louis River, the seiche causes changes in water level ranging from 1 to 10 inches, and it can reverse the direction of flow in the estuary.

The hydrology of the St. Louis River is determined by a combination of both surface water (runoff from snowmelt and rainfall) and groundwater (water that has percolated through the soil and is stored in bedrock or layers of glacial materials). Its headwaters are in the Seven Beavers/Sand Lake peatlands system, which is largely fed by groundwater. Calculations using Marschner's presettlement vegetation map show that roughly 40% of the watershed was once covered by conifer bogs and swamps. Despite some early attempts to drain such wetlands, these peatlands are still present. Such wetlands receive significant contributions from groundwater and contribute to the base flow of the St. Louis River. However, groundwater levels draw down somewhat as summer progresses, depending on precipitation, and the flow of the river is typically reduced in the late summer and fall. Snowmelt and spring rains create a pulse of higher flow in the spring; the spring pulse varies annually according to the amount of snow and rain and the timing of warmer temperatures. The seasonal and annual variation in the flow of the river prior to the conversion of forest to other uses and other forest types is what would be considered the natural range of variation in the hydrologic regime.

Reservoirs constructed on tributaries as well as the main stem of the St. Louis River have altered the natural variability of water flow into the estuary. Less than one-quarter of the watershed flow is regulated by the five headwater reservoirs located on the Whiteface, Cloquet, Otter, and Beaver rivers (Island Lake, Rice Lake, Whiteface Lake, Boulder Lake, and Fish Lake reservoirs). These reservoirs reduce natural variability by increasing winter flow, reducing the peak spring run-off flow and severity of flooding, and discharging year-round minimum flows to provide for recreation and fish habitat in the Cloquet, Whiteface, and St. Louis rivers. The five hydroelectric dams located on the main stem of the St. Louis River have a minimal long-term impact on flows, since they have little storage capability. Minimum year-round flows are also supplied to the St. Louis River channel below the Thomson and Fond du Lac dams to provide aesthetic views, whitewater recreation, fish habitat, and to help minimize fish stranding (L. Neudahl, MN Power, personal communication, 2002).

The altered variability in water flow does not affect tributaries that flow directly into the river below Fond du Lac dam, such as the Pokegama, Little Pokegama, and Red rivers on the Wisconsin side, and Miller, Kingsbury, Stewart, and Mission creeks on the Minnesota side. In contrast, stormwater management, impervious surfaces, forest management practices, and other land use changes and hydrologic modifications have created water flow that is more highly variable than normal. Runoff from storms and snowmelt consequently has much greater volume, speed, and erosional force, and therefore carries greater sediment loads in these tributary streams.

These two ecological processes—lake level fluctuations and river flow—in combination with the morphology of the estuary, are the main factors determining the nature and extent of the wetland and aquatic habitats in the estuary. These larger processes influence another critical ecological process: nutrient cycling. Nutrients are carried into the wetlands from the surrounding uplands via the river and its tributaries. Changes in land use throughout the watershed are thought to have increased the quantity of nutrients transported to the estuary. If nutrient loads reach a sufficiently high level in an aquatic system, eutrophication can result. Another potential contributor to nutrient cycling in the estuary is seiche events. Although not studied in the St. Louis River, the exchange of lake and river water that occurs during seiche events is known to contribute nitrogen in Lake Superior coastal wetlands that have been studied (Kelly et al. 1999).

Hydrology also affects the condition of substrates, another important factor determining the health of aquatic habitats. A hydrologic regime that falls within the natural range of variation maintains substrates in a good condition. It replenishes sediments at a natural rate in some habitats and flushes sediments from others. A natural hydrologic regime would allow most aquatic habitats in the Lower St. Louis River to experience relatively little disturbance of sediments for much of the time. Healthy substrates support healthy communities of benthic (bottom-dwelling) invertebrates, which are a critical link in the food web for fish, many bird species, and other wildlife. More than 80 genera of benthic invertebrates have been documented in the Lower St. Louis River. They include representatives of the following Orders: mayflies (Ephemeroptera), caddisflies (Trichoptera), midges (Chironimidae), isopods (Isopoda), amphipods (Amphipoda), worms (Oligochaeta), and other taxa (Crane et al. 1997; Breneman et al. 2000). Factors other than hydrologic regime may also influence the condition of substrates; disturbances to substrates, caused by dredging, stormwater discharge, and ship movement, are the most critical factors negatively impacting the health of the substrate and its benthic invertebrate community in the Lower St. Louis River (Breneman et al. 2000). Although contaminants are a significant problem for benthic invertebrates in a number of discrete areas of elevated contamination (Redman and Janisch 1995; Schubauer-Berigan and Crane 1997; Crane et al. 1997; IT Corp. 1997; AScI Corporation 1999; Crane et al. 2000, 2002), they do not appear to be a significant problem in the majority of the estuary (Breneman et al. 2000). The health of the wetlands and aquatic habitats is in large part dependent on these ecosystem processes operating within their natural range of variation.

Aquatic habitats and their conditions in the Lower St. Louis River differ widely from the Fond du Lac dam to Lake Superior. Some areas are vegetated, others are not. Some areas have fast-moving or deep water, others are shallow with slow-moving currents. Industrial and commercial activities have heavily impacted some areas, while others are far less altered. Appendix 3 contains more detailed descriptions and ecological values of each habitat. The information presented here was compiled from the April 2001 meeting of aquatic biologists and individual communications with biologists.

Large Riverine Reach
Located from the Fond du Lac dam to the downstream end of Nekuk Island, this habitat is characterized by relatively high water velocity, a riverine riffle-pool-run structure, and very little emergent or submergent vegetation. This segment of the river does not often experience the effects of the seiche and so may not be considered part of the estuary. It includes most of the prime spawning habitat for walleye, lake sturgeon, and other fish that need high velocity water over a coarse substrate. Although upstream dams alter the flow of the river and may starve this particular section of sediments that it would otherwise receive, this habitat is in fairly good condition. Purple loosestrife is present around Nekuk Island. It is unclear whether dam operations have brought the river's hydrologic regime far outside the natural range of variation. The geomorphology is not altered, surrounding land is forested, and native fish species are present. Historically, this habitat was impacted by extensive development on the Minnesota side; it is unclear whether such impacts affect this habitat today. Detailed water chemistry data were not compiled, but it does not appear that this upstream portion of the estuary suffers from poor water quality.
Current Condition: Fair/Good
Conservation Goal: Replicate the natural flow regime to the extent possible; this should benefit all of the estuarine aquatic habitats. Avoid any loss of area or degradation of this habitat type. Ensure that the native fish assemblage found in this habitat, including spawning walleye, lake sturgeon, longnose sucker, white sucker, and smallmouth bass, continues to utilize it. Darters and other riverine-obligate fish species should be present. Migratory raptors and waterfowl should use this habitat, particularly during spring migration.

Upper Estuarine (Undredged) River Channel
Found from below Nekuk Island to Stryker Bay, this habitat includes both natural river channel and formerly dredged channel. The upstream boundary coincides with the upstream extent of the seiche effect; the downstream boundary extends to the area where regular dredging takes place. Both lake level fluctuations and river hydrology influence this habitat. This part of the river channel was flooded

by rising lake level resulting from post-glacial isostatic rebound. It is rich in fish species, is home to high numbers of native mussels, and may be an important wintering habitat for fish. Gary-New Duluth and other neighborhoods abut this segment of the estuary on the Minnesota side, but the Wisconsin side is still forested. This habitat contains the US Steel Superfund site, a discrete area of highly contaminated sediment. Although it was formerly dredged and the hydrologic regime altered, this habitat is generally in fair to good condition.
Current Condition: Fair/Good
Conservation Goal: Replicate the natural flow of the river to the extent feasible and otherwise maintain current conditions. Channel morphology should reflect the natural hydrologic regime to the extent that it can be replicated. Avoid any loss of area or further degradation of this habitat type. Ensure continued high abundance of native mussels and other invertebrates. Ensure channel catfish, stonecat, burbot, juvenile lake sturgeon, and other native fish continue to utilize the habitat.

Lower Estuarine (Dredged) Channel
From Stryker Bay to the Duluth and Superior entries, the river channel is dredged regularly to maintain a depth of 27 feet. This creates frequently disturbed deep-water habitat. It is used by some fish as wintering habitat, and it is an important feeding area for fish-eating birds. Water quality is greatly improved compared to the period between the late 1800s and the 1970s, but further improvements are necessary. This habitat contains the St. Louis River/Interlake/Duluth Tar Superfund site, a discrete area of highly contaminated sediment. This portion of the channel is in poor ecological health, but the current economic importance of commercial shipping makes it impractical to consider any restoration at this time.
Current Condition: Poor
Conservation Goal: Implement continued improvements in water quality and replicate the natural hydrologic regime to the extent possible. Avoid any loss of this open water habitat. Avoid further degradation of this habitat. Ensure that native species continue to utilize this habitat at current or higher levels.

Upper Estuary Flats
The flats of the upper estuary, from the Oliver Bridge to Grassy Point, have relatively unmodified shorelines. They are depositional habitats with low water velocity where wind and wave action have the greatest influence on water movement. Lake level fluctuations have a stronger influence on this habitat than the river's hydrologic regime. Some areas support submergent or emergent marshes in various conditions; based on vegetation mapping, the marshes total roughly 100 acres. Purple loosestrife and other undesirable exotic plants are present in some areas. Considering that these flats cover close to 1,580 acres, it is surprising that there are not larger areas of wetland vegetation. Higher turbidity, rising water level due to isostatic rebound, and changes in benthic composition due to underwater log debris remaining from the late 1800s are three potential causes of the lack of vegetation. Newspaper and other accounts suggest that this habitat was once densely vegetated, making the actual river channel very difficult to find. The flats support a high abundance of forage fish, panfish, and waterfowl, and overall appear to be in fair condition.
Current Condition: Fair/Poor
Conservation Goal: Maintain and enhance the current condition. Determine where it is ecologically appropriate to increase the area of vegetated wetlands and implement re-establishment of appropriate vegetation where feasible. Patches of submergent and floating-leaved vegetation, including pondweeds, water lilies, wild celery, and wild rice, should be present in some areas; these areas should be intermingled with areas of open water, depending on water depth and clarity. Emergent vegetation,

including bulrushes, cattails, and arrowhead, should be present in very shallow areas, generally closer to the shoreline. The location and size of patches of open water and wetland vegetation will vary over time due to variations in the hydrologic regime. Non-native plant species should not be present. Native fish and bird species should continue to utilize this habitat; breeding bird and spawning fish diversity should increase as habitat is improved.

Sheltered Bays

Located along the Minnesota and Wisconsin shorelines between Nekuk Island and Stryker Bay, many of the sheltered bays include the highest quality remaining wetlands in the estuary. Sheltered bays are an example of a pulse-stable wetland community; the seiche causes pulses of water and sediment to move in and out of the bays, helping to prevent the wetlands from filling in with sediment or becoming dominated by dense woody vegetation. Wind-induced resuspension of sediments may also be an important mechanism of sediment transport in shallow areas. Most bays have extensive areas of emergent and submergent aquatic vegetation interspersed with areas of open water 3-5 feet deep, thereby supporting the highest diversity of plant and animal species of any habitat type in the estuary. Some sheltered bays are surrounded by shrub swamps dominated by willow, alder, or other species. Sheltered bays provide spawning areas for many species of fish. They support a high diversity and abundance of invertebrates. The extensive emergent wetlands are very important for waterfowl and wading birds. Wild rice, an aquatic plant of significant ecological and native cultural importance, grows in some sheltered bays. The health of these bays varies from one location to another; some have been impacted by excessive sediment inputs, and some exhibit lower than expected species diversity and/or invasion by exotic species. Purple loosestrife and other undesirable exotic plant species have become established in a number of sheltered bays. North Bay and Airplane Bay are representative of sheltered bays in good condition on the Minnesota side; the best examples on the Wisconsin side are upstream of the Village of Oliver. Although a few of the Wisconsin sheltered bays have relicts from historic logging operations, they are generally in very good condition. The area upstream of Oliver is owned and managed by the WDNR to protect the bays from the impacts of erosion and sedimentation; not all sheltered bays in Wisconsin have protected watersheds. The influence of the altered hydrologic regime resulting from dam operations is unclear. Since seiche events and other lake level fluctuations also play an important role, the altered river flow may have less impact.
Current Condition: Variable—Fair to Good
Conservation Goal: Maintain and protect sheltered bays that are in good condition. Improve all other sheltered bays to bring them into good condition. Non-native plant species should not be present. Patches of submergent and floating-leaved vegetation, including pondweeds, water lilies, wild celery, and wild rice, should be present in some areas; these areas should be intermingled with areas of open water, depending on water depth and clarity. Emergent vegetation, including bulrushes, cattails, and arrowhead, should be present in very shallow areas, generally closer to the shoreline. The location and size of patches of open water and wetland vegetation will vary over time due to variations in the hydrologic regime. Wet meadows and shrub swamps should be present in some areas around the perimeter of sheltered bays. The hydrologic regime of contributing watersheds, along with sediment deposition and transportation should be within the natural range of variation. The diversity of native fish, birds, and other species utilizing this habitat should continue to be high.

Clay-Influenced River Mouths

This habitat type is typified by the long, narrow drowned river mouths on the Wisconsin side of the estuary, most of which are located between the Oliver Bridge and the Bong Bridge. Pokegama Bay, Little Pokegama Bay, and Kimballs Bay are the only examples of this type. Lake level fluctuations as well as tributary stream hydrology influence this habitat. Shorelines are steep, highly erodible, and deeply incised; turbidity is usually high, especially after rain events. Altered stream hydrology causes the high turbidity. Emergent and submergent vegetation is very limited in this habitat type because of restricted light penetration associated with turbidity and water depth. The exotic ecotype of common reed (*Phragmites australis*) is present in the Pokegama Bay marshes. The diversity of fish populations is similar to sheltered bays, but the abundance is lower. Although these river mouths would have naturally experienced higher sediment levels than other estuarine habitats, past and present land uses have increased the sedimentation rates.

Current Condition: Fair

Conservation Goal: Bring the tributaries' hydrologic regime, erosion, and sediment inputs within a range closer to that of presettlement conditions. This should improve the extent and diversity of wetland vegetation, thereby increasing the abundance of fish and wildlife supported by this habitat. Emergent, floating-leaved, and submergent native plants should be present in areas where water depth can naturally support these types of wetland vegetation.

Industrially-Influenced Bays

Industrially-influenced bays are found on both sides of the river. The bays are generally 4-5 feet deep, with varying occurrences of emergent and submergent aquatic vegetation. Lake level fluctuations have the strongest influence on water level and flow in these bays. Many bays have high concentrations of industrial debris such as rebar, concrete, and wood, and some sediments are highly contaminated with PAHs, mercury, lead, PCBs, and other toxins. Exposure to the contaminants associated with the sediments adversely affects many organisms and degrades the habitat. Consequently, these bays are in very poor health.

Current Condition: Poor

Conservation Goal: At a minimum, avoid the loss of any open water of these bays. Restore industrially-influenced bays to habitat similar to the sheltered bays (in good condition) whenever possible. This includes ensuring a diversity of native emergent, floating-leaved, and submergent vegetation, as well as increased diversity of native fish and bird species utilizing this habitat type. Remediate contaminated sediments.

Industrial Slips

Industrial slips are located along the shoreline of both St. Louis Bay and Superior Bay; the level of commercial use varies between slips. Slips where ships regularly move in and out experience water displacement but very little unidirectional water flow. The water is frequently disturbed and turbid in the most active slips. Substrates may be sandy and scoured, or they may contain more silty sediments with varying levels of contaminants (e.g., PAHs, mercury) or industrial materials. There is little vegetation within the slips, primarily due to water depth, but wetland vegetation is present at the shallow heads of some slips. Despite the poor conditions, even active slips are used by fish and water birds.

Current Condition: Poor

Conservation Goal: Since shipping is an important industry in the Twin Ports area, the minimum goal is to avoid the loss of any open water or wetland components of these habitats (due to filling or other activities). In addition, some abandoned slips should be identified for restoring the aquatic habitat to a fair to good condition. Ensure that native species continue to utilize this habitat at current or higher levels. Remediate contaminated sediments.

Lower Estuary (Industrial Harbor) Flats
The industrial harbor flats, located between Grassy Point and the Duluth and Superior entries, are similar to the flats of the upper estuary, but they have been more heavily altered by industrial and commercial activity. They cover roughly 2,400 acres. The shoreline has been greatly modified, and the subsurface topography is complex with old river channels and borrow pits. Lake level fluctuations exert the greatest influence on water level in this habitat. This habitat may have once held the highest mussel abundance in the estuary; it is now one of the only areas where observers have documented that native mussels are being killed by the zebra mussel infestation. Extensive submergent and emergent wetland vegetation was likely present in this habitat prior to the estuary's industrial and commercial development, but very little vegetation remains today.
Current Condition: Poor
Conservation Goal: Avoid the loss or further degradation of any of this aquatic habitat. If practical, restore some portion of the flats to an appropriate vegetated condition. As with the dredged channel, slips, and industrially-influenced bays, restoring this entire area to a good ecological condition requires a significant financial investment, and the importance of commercial shipping may weigh against this. Ensure that native species continue to utilize this habitat at current or higher levels.

Clay-Influenced Bay
Allouez Bay, southeast of the Superior Entry, is unique within the estuary. It is a shallow, protected bay, with little water exchange between the bay and the lake. However, lake level fluctuations are the primary determinant of water level in the bay. Two small surface runoff-dominated tributaries—Bear Creek and Bluff Creek—empty into the bay. There is abundant emergent and submergent vegetation, which provides excellent habitat for fish and waterfowl. Mudflats, which are used by a variety of bird species, are also present. Many species of fish spawn in Allouez Bay, including northern pike, muskellunge, bluegill, black crappie, smallmouth bass, and yellow perch. The exotic ecotype of common reed (*Phragmites australis*) is present in Allouez Bay, but it is not yet common.
Current Condition: Fair/Good
Conservation Goal: The relatively good quality of this habitat should be maintained and enhanced. Reduce turbidity to its natural range of variation; restore the natural hydrologic regime of the tributaries feeding this bay. Ensure the continued diversity of native aquatic plants; non-native plant species should not be present. Enhance the diversity of native fish and bird species utilizing this habitat.

Clay-Influenced Tributaries
These aquatic habitats were identified as targets as part of the Great Lakes aquatic ecoregional planning process. They include tributaries such as the Red River and Little Pokegama River, as well as the larger Nemadji River. Bluff Creek and Bear Creek are also included in this habitat type. They are defined by a broader set of physical characteristics than the other estuarine aquatic habitats. Their health is determined in part by their own hydrologic regime, not by Lake Superior or the St. Louis River. They are first- or second-order, medium- to low-gradient, groundwater- and surface water-influenced streams, flowing through lacustrine red clay deposits. These tributaries provide habitat for a variety of the native fish found in the estuary. The surface water hydrology of these streams has been altered by ditches, wetland draining, and other hydrologic modifications in the watersheds. Changes in the composition of the surrounding forest have resulted in excessively high flows and extremely low flows, which in turn cause excessive streambank erosion, increased sedimentation, and habitat impairment. Ditching and developed areas create higher peak flows and increased sediment loads in these streams.
Current Condition: Variable—Fair to Poor

Conservation Goal: The hydrology and related sediment loads within the respective watersheds should be managed to more closely resemble presettlement conditions. Ensure that native species continue to utilize this habitat at current or higher levels. Restore in-stream habitat where degraded.

Bedrock-Influenced Tributaries

These aquatic habitats include small tributaries such as Keene Creek, Miller Creek, Kingsbury Creek, Knowlton Creek, Stewart Creek, Sargent Creek, and Mission Creek on the Minnesota side of the river. The health of these tributaries is determined primarily by their own hydrologic regimes, not by Lake Superior or the St. Louis River. They are first- or second-order, medium-gradient, surface water-influenced streams that flow primarily over bedrock. These tributaries provide habitat for a variety of the native fish found in the estuary. In most cases, the hydrologic regime has been altered by efforts to channel stormwater from the city of Duluth and other developed areas. Ditching and developed areas in the watershed create higher peak flows and increased sediment loads in these streams.

Current Condition: Variable—Fair to Poor

Conservation Goal: The hydrology and related sediment loads within the respective watersheds should be managed to more closely resemble presettlement conditions. Ensure that native species continue to utilize this habitat at current or higher levels. Restore in-stream habitat where degraded.

Although some of the habitats described above have been highly altered by human impacts, all areas of open water and wetland habitat in the Lower St. Louis River are important because of the variety of fish and bird species that utilize each type, depending on the individual species and its preferences. Fish are likely to spawn in one habitat and feed in other habitats, depending on the species, life stage, and season. Walleye, for example, typically spawn in fast-moving water over a rocky or gravelly substrate. They may take cover within submergent aquatic vegetation or shadows in deeper water during the day and forage in submergent aquatic vegetation, particularly at dusk. Birds similarly utilize a range of wetland habitats. Many species of water birds nest and feed among the emergent and submergent aquatic vegetation, while raptor species prefer to hunt over open waters. Although land immediately adjacent to some of the aquatic habitats is heavily developed, this is not an indication that such aquatic habitats are of no value. Even abandoned slips are important to some fish species, despite the developed nature of the surrounding landscape. In addition, altered habitats can recover naturally. For example, the upper riverine reach was once surrounded by human development, yet today it is considered to be in fairly good condition. Thus, a minimum goal for all of these aquatic habitats is to prevent any further losses of open water or wetlands. Restoration of poor or fair conditions and enhancement of good conditions are recommended for most habitats.

Estuarine Plant Communities

Great Lakes Coastal Wetland Complex

The Great Lakes coastal wetland complex is a component in several of the aquatic habitat targets because of the way they were classified, using physical descriptors. It is included as a target separate from the aquatic habitat targets to ensure that the factors determining the health of such wetlands are not overlooked. Although the estuarine wetlands are not on the Lake Superior shoreline proper, they are connected to and heavily influenced by the hydrology of the lake and are therefore described as Great Lakes wetlands.

The Great Lakes coastal wetland complex is a mosaic of varying combinations of submergent marsh, emergent marsh, wet meadows or fens, and wet shrublands. Anecdotal evidence suggests that when Europeans arrived in the area, floating mats of peat, vegetated with sedges and other species, extended out from the shoreline in shallow areas. (Such floating mats are present today at other estuarine sites on western Lake Superior, including Port Wing, Bark Bay, Sand Bay, and the Bad River-Kakagon Sloughs.) The size of Great Lakes coastal wetland complexes varies, depending on the extent of the area with suitable morphology and water depth. Pondweeds, wild celery, water lilies, wild rice, and other species dominate the submergent marshes. Bulrushes, cattails, arrowhead, and other species form the emergent vegetation in shallower waters. Sedge species, and sometimes willow or alder, are found in wet meadows or fens adjacent to the emergent marshes. Willow, alder, and bog birch may dominate shrublands next to the wet meadows or the emergent marshes. Mud flats with little or no vegetation may be part of these complexes as well. In the Lower St. Louis River area, these Great Lakes wetland complexes are found in the clay-influenced bay, the sheltered bays, some of the clay-influenced river mouths, and the upper estuary flats. Wetland vegetation is also present in some of the industrially-influenced habitats, but it generally does not form the same diverse complex of species and wetland types as the more natural wetland complexes. The map developed by Reschke and Epstein shows the current location of the plant communities making up the coastal wetland complex, as well as the plant communities discussed in the following sections (Map 3. Current Vegetation of the Lower St. Louis River Project Area).

The presence and pattern of wetlands found in and along the Lower St. Louis River is controlled primarily by morphology within the estuary and by fluctuations in water depth, which is primarily determined by the water level of Lake Superior. As described above, water depth within the estuary changes in response to the seiche as well as in response to longer-term natural and human-induced fluctuations in the lake level; the flow of the St. Louis River also has some influence. The distribution of the estuarine wetlands is also influenced by flow velocity, sediment deposition, substrate composition, and nutrient input. Higher flow velocity might prevent vegetation from becoming established. Higher levels of sediment deposition may result in loss of wetland habitat or decreased light levels that make it impossible for submergent vegetation to survive. Some substrates, such as densely compacted clay or industrial slag, may prevent the establishment of wetland vegetation as well.

The structure of these wetlands provides habitats for numerous fish, bird, and mammal species, as well as a wide diversity of invertebrate species. A small number of amphibian species also utilize these wetlands. The productivity of the wetlands is a source of food (either directly or indirectly) for all fish and aquatic invertebrates, as well as many of the birds that breed in or migrate through the Lower St. Louis River area. High quality examples of these wetland complexes are found in the Red River Breaks/St. Louis River Marshes, Oliver Marsh, Allouez Bay, North Bay, Airport Bay, and other locations.

Current Condition: Variable—Poor to Fair/Good
Conservation Goal: The conservation goals for the aquatic habitats in the previous section referenced protection, enhancement, or restoration of the wetland vegetation that makes up the Great Lakes coastal wetland complexes. Existing wetland complexes in the sheltered bays, the upper estuary flats, the clay-influenced bay (Allouez Bay), and clay-influenced river mouths should be maintained and enhanced. In some sheltered bays, and perhaps parts of the upper estuary flats, they may need some enhancement and/or restoration. Where feasible, restoration of some of the components of these wetland complexes (e.g., submergent marsh, emergent marsh) is recommended for the industrially-impacted habitats.

Non-native plant species should not be present in any of these wetland complexes. Patches of submergent and floating-leaved vegetation, including pondweed, water lily, wild celery, and wild rice, should be present in some areas; these areas should be intermingled with areas of open water, depending on water depth and clarity. Emergent vegetation, including bulrushes, cattails, and arrowhead, should be present in very shallow areas, generally closer to the shoreline. The location and size of patches of open water and wetland vegetation will vary over time due to variations in the hydrologic regime. Wet meadows and shrub swamps should be present in some areas and mud flats in others. The hydrologic regime of contributing watersheds along with sediment deposition and transportation should be within the natural range of variation. The diversity of native fish, birds, and other species utilizing this habitat should continue to be high.

Baymouth Bar Communities

The baymouth bar complex of communities is another important component of the estuarine ecosystem. The barrier spits of Minnesota and Wisconsin Points are formed and maintained by longshore currents transporting and depositing sand. These spits are home to sandy beaches, beachgrass dunes, dune shrublands, and dune pine forests, as well as interdunal wetlands embedded within some of the surrounding communities. (Harbor-side wetlands are included within the Great Lakes wetland complex.) The beaches are located on the lake side, scoured and shaped by the waves, wind, and ice of Lake Superior. If vegetation is present at all, it is very sparse and found only in the upper part of the beach that is usually beyond the reach of the waves. A complex of wind-formed dunes lies just beyond the beach. Further away from the shoreline, these active dunes support beachgrass. Behind this front line of dunes are more stable dunes with a greater variety of vegetation, including grasses, sedges, and various forbs. This vegetation transitions into a zone dominated by juniper and lichens, which grades into the dune pine forests dominated by white pine and red pine. The pine forests of Minnesota and Wisconsin Points are actually a unique variant of the pine forests that were present on the mainland. However, their relationship to the other plant communities of the baymouth bar make it more appropriate to treat the dune pine forests with the other baymouth bar communities. More detailed descriptions of these communities are found in the Minnesota Point Environmental Management Plan (Park Point Community Club 1999).

Each of these vegetation zones is influenced by different ecological processes. The entire baymouth bar system is maintained by longshore currents transporting and depositing sand. Prior to the development of permanent structures (homes, jetties) on and adjacent to the sandbars, the configuration of the baymouth bar slowly shifted over time in response to currents, storm events, and lake level fluctuations. Similarly, the active dunes were relatively mobile and shifted in response to wind direction and storms. In the more vegetated areas, particularly the forest, occasional surface fires would have cleared undergrowth and allowed young pines to become established, thus maintaining the dune pine forests. It is unclear how frequently these fires took place, or how frequently stand-killing fires occurred. The importance of such fires to the juniper shrubland and beachgrass vegetation is also unclear. The beachgrass dunes were more influenced by their landscape position (on the wind-exposed, semi-stabilized foredune) than by fire events. Interdunal wetlands formed in low areas (blowouts, wind-formed hollows) where poorly drained organic soils accumulated and helped capture surface water runoff or intersected the lake level. These processes have all been altered by the permanent structures now found on and around the Points.

A large proportion of the presettlement acreage of these plant communities has been converted to urban and commercial development, particularly on Minnesota Point. While the small size and linear nature of the Points naturally limits the extent of the plant communities, the greatly reduced current extent is of concern. In addition, the remnant dune pine forest contains a variety of non-native plant species. The juniper-lichen shrubland is sensitive to trampling, and the juniper may not be replacing itself. Beachgrass dunes are also sensitive to trampling. Weedy species, such as poison ivy and spotted knapweed, are common and locally dominant. Interdunal wetlands have been mostly eliminated. The natural dynamics of the entire system have been interrupted by permanent structures, allowing erosion in some areas and preventing deposition in other areas. The Army Corps of Engineers manages an on-going beach nourishment program to replace eroded sand. Again, the Minnesota Point Environmental Management Plan provides an excellent and more detailed discussion of these concerns.

Current Condition: Variable—Poor to Fair/Good
Conservation Goal: Improve the current health of the plant communities. Ensure that the diversity of native species expected in each plant community type is present. Non-native plant species should not be present. Ornamental species and species native to the U.S. that would not normally occur in these plant communities should be eliminated (e.g., Scot's pine (*Pinus sylvestris*), spotted knapweed). Increase the extent of the dune pine forest and juniper-lichen shrubland to the maximum acreage that is feasible, while limiting them to the portion of the dunes where they would naturally occur. Restore interdunal wetlands in appropriate low areas; species that are naturally found in this community may include bluejoint (*Calamagrostis canadensis*), various sedges (*Carex* spp.), twig-rush (*Cladium mariscoides*), spikerush (*Eleocharis* spp.), and others. Maintain the beachgrass dune plant community. If it becomes feasible, restore the natural movement of sand in this ecosystem, both on land and in water. If the natural fire regime can be estimated, and prescribed fires become feasible, implement a prescribed burn program.

Upland Forest Communities

The upland forest communities within the watershed of the Lower St. Louis River are an integral part of the estuarine ecosystems. While they are not directly connected to the estuary, their presence, composition, and condition greatly influences the transport of water, sediments, nutrients, and other materials into the estuarine ecosystems. They provide habitat for both breeding and migratory birds, as well as numerous other native species not targeted individually in this Habitat Plan.

The composition of upland forest communities is determined by climate, soil type, soil moisture, landforms, water table, sunlight, nutrient availability, and human activities. Natural disturbance regimes are an important ecological process shaping the structure and composition of the upland forests surrounding the estuary. Although wildfires are usually suppressed today, fires historically burned at varying intervals around western Lake Superior, depending on the type of forest. In the main part of its range, the boreal spruce-fir forest was prone to large and frequent fires that destroyed large portions of stands and "reset" the forest to an early successional stage. In the Lower St. Louis River area, however, the boreal forest is at the southern edge of its range; it is estimated that in presettlement times its primary extent covered roughly 325,000 acres and it was intermingled with other, less fire-prone forest types (Marschner 1974; Finley 1976). Because of the proximity of Lake Superior and the presence of less fire-prone forest types, fires may not have burned quite as frequently or on such grand scales as they do in the heart of the boreal forest region. Nonetheless, the boreal spruce-fir forests experienced more frequent fires than the other forest types in the Lower St. Louis River. White and red pine forests were subject to frequent surface fires that cleared some of the understory; stand-killing fires were less frequent. Northern hardwood and northern conifer-hardwood forests rarely experienced fire at all; they existed in moist protected areas, and the moisture levels under presettlement conditions very rarely allowed fire. Small-scale blowdown events were more typical for these forests.

Large blowdown events are historically and currently a major natural disturbance for some forest types, as evidenced by the July 4, 1999, windstorm in the Boundary Waters Canoe Area Wilderness of Minnesota. Insect infestations can also cause significant disturbance. For example, spruce budworm can defoliate millions of acres in a single infestation, and their impacts make affected forests highly prone to large and intense fires.

Knowledge of a forest community's natural disturbance regime gives an idea of how a healthy example of that forest should appear. In the absence of ongoing human-induced modifications, northern hardwood and northern conifer-hardwood forests would have been predominantly "old-growth"—which means numerous mature trees, a range of other age classes, and dead or dying trees—with only a few areas in a predominantly early successional stage (Canham and Loucks 1984; Frelich and Lorimer 1991). Approximately half of the stand in white pine-red pine conifer forests would have been in a multi-aged state, with the remainder in earlier stages of succession (Frelich 1999), a result of more frequent disturbance (Whitney 1986; Heinselman 1973). Although the boreal spruce-fir forest in the southwestern Lake Superior area may have experienced less frequent disturbance than its more northerly spruce-fir counterparts, it experienced more frequent disturbance than either the northern conifer-hardwoods or the pine forests; it would have had an even higher proportion in early successional stages than either of the other two forest communities.

On the south side of the estuary, between Cloquet (Minnesota) and Lake Superior, aspen now dominates the red clay bluffs and surrounding uplands, and deciduous shrublands are present in lowlands. Spruce and fir are present only in smaller areas. Significant areas of pasture, crops, and other grassland have replaced forest cover. On the north side of the estuary, the variety of forest cover types remains similar to the presettlement vegetation, but there is a much higher proportion of early successional aspen-birch cover. Deciduous shrublands are frequent in both lowland and upland areas. Small remnants of mature northern conifer-hardwood forests of sugar maple, basswood, and white pine remain. Some red oak cover appears to have replaced some of the northern conifer-hardwood cover. There is a high concentration of these forest remnants near the Duluth neighborhoods of Fond du Lac, Morgan Park, and Smithville. Urban development has entirely replaced much of the forest cover along both sides of the estuary, and features such as roads and smaller developments fragment the remaining vegetation surrounding the urban cores. Throughout all of these forests, intense post-logging slash fires early in the twentieth century may have burned away much of the soil layer and its seed bank in some areas, making it even more difficult for forests to recover and undergo natural successional processes (E. Epstein, WDNR, personal communication, 2002). A newly identified complicating factor in the northern conifer-hardwoods system is the recent establishment of non-native earthworms, which eliminate the organic duff required by many plant species for germination (Hale et al. 2002) The predominance of the early successional, aspen-dominated forest cover around the estuary indicates overall poor health of all the forest communities, although some higher quality remnants remain. High-quality remnants of particular significance include Clough Island and the Magney-Snively Forest (near Duluth). The ongoing Duluth Natural Resources Inventory may help add to this list.

Current Condition: Poor to Fair with Good quality remnants in some locations
Conservation Goal: Maintain or enhance all existing high quality remnants, and restore much of the remaining forested area to the composition and structure that would be expected if its ecological processes were operating within their natural range of variation. Detailed recommendations are provided below; they are copied from estimates of the expected natural range of variability developed

by Frelich (1999) for northeastern Minnesota forest ecosystems. Further assessments are needed to determine the range of spatial patterns of the patches of the different successional stages.

Restore boreal spruce-fir forests by managing a large portion of the aspen forest on the south side of the estuary so that much of it succeeds to a dynamic spruce-fir forest with its various successional stages represented in more natural proportions, with embedded patches of other mixed conifers. Ideally, the total area of spruce-fir forest managed within the range of natural variation will be in the range of 75,000 acres. This is based on a visual estimate of currently forested areas that are located within the area that was historically occupied by boreal spruce-fir forest. Total recommended area should be refined to reflect both ecological and social considerations. Table 2 shows the proportions of the various successional stages that would be present in the dominant spruce-fir system if fire, blowdowns, and other disturbance processes were functioning within their natural range of variation. It does not specify the pattern created by the patches of the different successional stages.

Table 2. Estimated range of variation of successional stages in boreal spruce-fir forest (per Frelich 1999).

Boreal spruce-fir Forest growth stage	Age	% landscape
Sapling birch	0-10	4.8-9.2
Pole-mature birch	11-50	15.9-26.1
Mature birch-conifer	51-80	10.3-14.9
Multi-aged conifer	>81	46.8-66.6
Sapling-pole conifer	0-50	1.6-2.1
Pole-mature conifer	51-80	0.1-0.8

Restore northern hardwoods and northern conifer-hardwoods in much of the area where they were formerly found, building on existing remnants. Ideally, the total area of northern conifer-hardwood forest managed within its natural range of variation will be in the range of 25,000 acres. Table 3 shows the proportions of the various successional stages that would be present if blowdowns and other disturbance processes were functioning within their natural range of variation.

Table 3. Estimated range of variation of successional stages in northern conifer-hardwood forest (per Frelich 1999).

Northern hardwoods Forest growth stage	Age	% landscape
Sapling birch	0-10	0.2-0.5
Pole-mature birch	11-50	1.0-1.9
Mature birch-maple	51-100	1.0-1.8
Mature maple	101-150	1.2-2.2
Multi-aged maple	>150	83.5-91.2
Sapling maple	0-10	0.5-0.9
Pole-mature maple	11-120	5.0-9.1

Much of the approximately 28,000 acres in the project area formerly covered by white pine-red pine forests has been converted to other land uses. Where white pine-red pine forest remains, it should be maintained. Ideally, the total area of white pine-red pine forest managed within its natural range of variation will be in the range of 10,000 acres. Table 4 shows the proportions of the various successional stages that would be present if fire, blowdowns, and other disturbance processes were functioning within their natural range of variation.

Table 4. Estimated range of variation of successional stages in white pine-red pine forest (per Frelich 1999).

White pine-red pine Forest growth stage	Age	% landscape
Sapling birch	0-10	3.2-6.3
Pole-mature birch	11-50	11.3-19.8
Mature birch-pine	51-80	9.7-12.2
Mature white pine	81-120	9.2-13.1
Multi-aged pine-spruce-fir	121-200	11.8-12.4
Multi-aged spruce-fir	>200	23.5-44.3
Sapling-pole pine	0-50	0.6-1.3
Sapling-pole spruce-fir	0-50	1.2-1.4
Multi-aged white pine	>120	9.9-10.7

Other Inland Plant Communities

Several other plant communities are found in smaller patches within the surrounding upland forest, or along the tributary streams that flow through it to the estuary:
Eroding clay bluffs
Clay seeps
Conifer swamps
Hardwood swamps
Shrub swamps
Inland marshes
Wet meadows
Fens
Cliffs and rock outcrops

These communities are embedded within a larger forest matrix, and their health depends in large part on that of the surrounding forest. Except for the cliffs and rock outcrops, all of these communities are shaped by the combination of their topographic position and the flow of groundwater and surface water. For example, a surrounding forest in good health would experience surface water flows that are within the natural range of variation. The aspen-dominated forests of the present allow for faster snowmelt than the former mix of conifers and hardwoods, and thus a larger pulse of surface water runoff is experienced in the spring. This contributes to increased erosion of the clay bluffs and seeps and increases the amount of sediment deposited in the inland wetland communities.

Species composition is another indicator of the health of all of these communities. They should contain the expected diversity of native species. Some of these communities may be naturally more diverse than others. Non-native plant species should not be present.

It is difficult to generalize about the health of these communities throughout the Lower St. Louis River area. Some examples are in fairly good condition, with a large diversity of species, including rare species. Others are more degraded, invaded by exotic species or impacted by a highly altered hydrologic regime. Some high quality examples of these smaller, specific plant communities are found within the Superior Municipal Forest, including inland marshes, wet meadows, and shrub swamps (Epstein et al. 1997). The Nemadji River Bottoms contain a unique example of hardwood swamp, as well as examples of eroding clay bluffs and seeps. The Pokegama-Carnegie wetlands also contain high-quality examples of several of the inland wetland groups. The Nemadji River Marshes contain good examples of the inland wetlands and would be a good candidate for some restoration efforts (Epstein et al. 1997).

Current Condition: Variable—Poor to Fair/Good
Conservation Goal: Although small and less visible than other conservation targets, these communities should be managed to maintain and/or improve their condition. The appropriate assemblage of native plant species should be present; refer to NatureServe's *International Classification of Ecological Communities: Terrestrial Vegetation* (2001) for descriptions of species composition. Ecosystem processes, including hydrology and fire, should be functioning within their natural range of variation.

Conservation Targets - Species Assemblages and Individual Species

The diversity of animal life in the Lower St. Louis River ecosystem is unique and worthy of protection. It includes numerous species that are rare within Minnesota or Wisconsin. Although most are not endangered, a number of species are experiencing population declines in all or parts of their range. Many face varying degrees of competition from introduced exotic species. Potential species targets were reviewed and revised by a subset of the Habitat Committee and other biologists in the region. To determine which species should be conservation targets in this planning effort, several considerations were taken into account. Based on the assumptions applied in the coarse filter-fine filter approach, the Habitat Committee agreed that not every single native species found in the Lower St. Louis River would require individual attention, and it would be impractical to consider so many species on an individual basis. The Habitat Committee agreed to target species that fit in one or more of the following categories:

- Imperiled and endangered native species, including globally rare species (ranked G1-G3 by Natural Heritage programs), federally listed or proposed for listing as Threatened or Endangered, or on the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (international significance).
- Species of special concern due to vulnerability, declining trends, disjunct distributions, or endemic status within the ecoregion.
- Focal species, including keystone species, wide-ranging (regional) species, and umbrella species.
- Major groupings of species that share common natural processes or have similar conservation requirements (e.g., freshwater mussels, forest-interior birds).
- Globally significant examples of species aggregations (e.g., a migratory shorebird aggregation).

Biologists on the Habitat Committee concluded that there are not any mammals, reptiles, or amphibians currently known to live in the estuary that fit the above criteria or are otherwise in need of individual treatment in this plan. Most terrestrial and aquatic invertebrates, including insects, are too numerous and poorly understood in the project area to treat on an individual basis, with the exception of native mussels. Although none of the native mussels found in the Lower St. Louis River are rare, they are highly vulnerable to known stresses that won't be addressed simply through maintaining or improving their habitat. Therefore, native mussels as a group are included as a conservation target in this plan.

Native fish are also included as a species group target by the Habitat Committee. With the exception of the lake sturgeon, all native fish species documented in the river have relatively stable populations. Similar to native mussels, fish are vulnerable to stresses that won't be addressed if the plan only focuses on habitats. For these reasons, lake sturgeon is considered an individual conservation target, and the remaining native fish assemblage is another.

Birds are a third species group that fit several of the criteria. Although a number of resident species are either globally imperiled, federally listed, or known to be declining or vulnerable, it is impractical to address each of them individually in this plan. However, those breeding birds experiencing significant population declines are addressed individually in this Habitat Plan. The enormous aggregations of birds occurring in the Lower St. Louis River during spring and fall migrations are globally significant and therefore fit the last species target criterion. Avian habitat requirements should generally be met through the "coarse-filter" part of this planning approach—the targeting of plant communities and aquatic habitats. However, to ensure that the diversity and numbers of migratory bird species using the area are maintained, the migratory bird aggregation is included as a species group target. In addition, some species that meet one or more of the criteria, such as the great blue heron, are addressed in the St. Louis River System Remedial Action Plan (RAP) Stage Two (MPCA and WDNR 1995). Instead of repeating those recommendations here, the Stage Two RAP recommendations related to the conservation targets are included in Appendix 4.

Plant species are not overlooked in this planning effort; however, wild rice is the only individual species known to meet any of the species criteria. Future revisions to this Plan should investigate the status of rare plant species recently documented on Minnesota Point; it may eventually be determined that they meet one or more of the above criteria.

Descriptions of Species Conservation Targets

Native Fish Assemblage
Approximately 45 native fish species have been documented in the Lower St. Louis River (WDNR and MDNR, unpublished data). Forage species such as emerald shiner, spottail shiner, blacknose dace, and fathead minnow inhabit the estuary, along with piscivorous species such as yellow perch, white bass, muskie, walleye, and northern pike. A range of habitats and an adequate food supply are necessary to maintain this diversity; Appendix 5 summarizes these requirements for individual species. It is worth noting that even frequently disturbed aquatic habitats, such as the industrial slips, are commonly used by numerous native species. Appendix 6 summarizes the use of various aquatic habitats in the Lower St. Louis River by both native and non-native fish. The productivity of the estuarine wetlands is the basis of the food supply for fish, birds, and other wildlife.

Native fish populations have rebounded since water quality in the estuary began to improve in the late 1970s. The RAP Stage One (MPCA and WDNR 1992) document gives a more detailed overview of the history behind this recovery. Some fish species that had disappeared from the estuary due to water quality problems were able to re-establish reproducing populations. Although water quality has improved dramatically, there are still concerns due to sewage overflows, contaminated sediments, and other factors. In addition, native populations face competition from numerous undesirable exotic species, including the Eurasian ruffe, rainbow smelt, and several other species.

Current Condition: Fair/Good
Conservation Goal: Maintain and enhance healthy, reproducing populations of native fish species. (Current information is insufficient to recommend specific population sizes or ranges of population sizes for native fish species.)

Lake Sturgeon
Although most fish species in the Lower St. Louis River are relatively secure across their range, lake sturgeon are of particular concern. Lake sturgeon are long-lived fish that do not reproduce until approximately twenty years of age. A rehabilitation project coordinated by the WDNR and MDNR has been active since 1983 (Schram et al. 1999). Although preliminary results suggest success, it is too early to determine whether stocked fish will reproduce or whether a viable population will be established. Overfishing and habitat loss throughout its range are among the primary causes of lake sturgeon decline. Although these threats are not limited to the Lower St. Louis River, it is important to maintain suitable habitat within the estuary to ensure the health of the local lake sturgeon population.

Current Condition: Fair
Conservation Goal: Reestablish a healthy, reproducing local lake sturgeon population. Current information is insufficient to recommend a specific number. As information becomes available, modify the conservation goal to appropriately reflect this.

Native Mussel Assemblage
Native mussels are an important and vulnerable part of the ecosystem of the Lower St. Louis River. They are also a food source for many native fish species, including lake sturgeon, some redhorse species, some suckers, and others (Baker 1918). The Lower St. Louis River has not yet been extensively sampled for its mussel fauna; surveys completed by MDNR biologists in 2000 and 2001 will facilitate the understanding of mussel distribution and habitat in the Lower St. Louis River. The MDNR surveys documented eight native species: giant floater (*Pyganodon grandis)*, mucket (*Actinonaias ligamentina*), eastern elliptio (*Elliptio complanata*), creeper (*Strophitus undulatus*), fat mucket (*Lampsilis siliquoidea*), white heelsplitter (*Lasmigona complanata*), creek heelsplitter (*Lasmigona compressa*), and black sandshell (*Ligumia recta*). Although plain pocketbook (*Lampsilis cardium*) shells were found, no live specimens were located. All species were found only in the large riverine reach, the upper estuarine (undredged) river channel, and the lower estuary industrial harbor flats (MDNR, unpublished data, 2000.)

Mussels filter water—which carries both oxygen and food particles—through their gills. This method of breathing and eating makes them particularly susceptible to poor water quality. Pollutants and high sediment loads caused by hydrologic alterations are among the causes of the widespread and continuing decline of most freshwater mussels in North America. Exotic species (e.g., zebra mussels) have further contributed to freshwater mussel decline and have eliminated native species in some areas. The health of native mussel populations can serve as an indicator of water quality and perhaps of overall ecosystem health.

Although mussels can use their "foot" to move around in response to water level fluctuations, adults cannot travel great distances. The mussel species native to the Lower St. Louis River rely on fish hosts for dispersal. The larvae, or glochidia, are parasites that attach to the gills of the fish; once they have developed into juvenile mussels, they drop from the fish host and settle in the substrate. Although some mussel species are highly specialized and only use one or a few host species, the mussels found in the Lower St. Louis River use a variety of fishes as hosts. This relationship between mussels and their fish hosts points to the importance of maintaining a healthy assemblage of native fish species in the estuary.

Current Condition: Unknown; although initial surveys have been completed, current population sizes are not known.
Conservation Goal: Ensure healthy populations of all native mussels. Additional research and survey work is needed to determine current and desired population levels for each species. As this information becomes available, modify the conservation goal to reflect this understanding.

Breeding Bird Assemblage
The Lower St. Louis River and its environs are home to a diverse array of native bird species. Over 230 species have been documented in the Lower St. Louis River (Niemi et al. 1979). This area is both an important breeding area and a critical migratory stopover location. Common terns and other colonial nesting birds use sandy beaches and other sparsely vegetated areas in the estuary. Piping plovers once nested on the beaches as well, but they are not known to have nested in the Lower St. Louis River area since 1985. A wide range of species nest in the emergent marshes, including sedge wren, marsh wren, Virginia rail, and sora, although several marsh-nesting species appear to have disappeared from the estuary over the last 30 or so years (Niemi et al. 2000). Black tern colonies were historically present in the marshes, but they are not known to have nested there in recent years (Niemi et al. 2000). Some of these bird species are easily disturbed by human recreational activities, which may be the reason they are no longer breeding in the area. The estuary supports a rich variety of plants, insects, molluscs, crustaceans, fish, and other food sources for birds that breed in or around the estuary. A list of bird species that typically use this area for breeding is included in Appendix 7A.

Current Condition: Fair
Conservation Goal: Ensure breeding birds continue to nest in the Lower St. Louis River area at current or higher numbers. As breeding bird habitat size and type requirements become better understood, modify this conservation goal to reflect more specific knowledge of the requirements.

Migratory Bird Assemblage
The diversity of habitat and extent of wetland and shoreline habitats make the Lower St. Louis River ideal for migrating birds as well. Niemi et al. (1979) describe the regional significance of the Lower St. Louis River as a migratory stopover site:

> "In general, the sheer diversity of passerine [songbird] species migrating through the estuary was rivaled by few areas in the Upper Midwest. During peak migration and when inclement weather "grounded" migrants, the brush and wooded areas along Minnesota and Wisconsin

> Points were literally "alive" with birds…During transect counts of passerines that we conducted in wooded areas of Minnesota and Wisconsin Points, we often were forced to simply estimate the number of passerines (in terms of 100s) because it was impossible to count all the individuals let alone identify them to species."

In addition to songbirds, high numbers of raptors, shorebirds, waterbirds, gulls, and terns migrate through the area each spring and fall. Several factors make the Lower St. Louis River an important stopover site. In addition to the abundance of food and shelter in the estuary, many migrants avoid flying over large bodies of water. In the spring, birds migrating north from across the central United States encounter the south shore of Lake Superior and travel westward until they reach the estuary. In the fall, birds migrating south are effectively channeled along the western edge of Lake Superior through the area of the estuary. During migration, waterfowl, raptors, gulls, terms, shorebirds, and waders are concentrated in a relatively small area. Some years, observers have reported seeing tens of thousands of birds. In 1998, 98 bird species were observed migrating through the Minnesota Point area during the spring, and 77 species passed through on the fall migration (Hawrot and Nicoletti 1999). A list of bird species that typically use this area during migration is included in Appendix 7B.

The estuary still contains relatively large expanses of wetlands, which provide an important source of food for both migrants and residents. The productivity of the wetlands forms the basis of the food supply; many species feed on tubers, seeds, and other plant parts, while other birds feed on fish or invertebrates that rely on wetland productivity. Because sandy beach habitats are far from common in the Upper Midwest, the Lower St. Louis River is one of the few desirable places for shorebirds to stop during their migrations. The estuary is especially important during the spring migration because it is often the only place with open water early in the season. This combination of diverse habitats—open water, beaches, and a wide variety of wetland and forest communities—in close proximity to each other makes the Lower St. Louis River a truly unique and important area for birds. Since much of the wetland and shoreline habitats of the Great Lakes has been eliminated or highly degraded, protection of such habitats in the Lower St. Louis River area is even more critical.

Current Condition: Fair/Good
Conservation Goal: Ensure the Lower St. Louis River continues to attract and support the enormous diversity and numbers of migrating birds.

Piping Plover
The piping plover (*Charadrius melodus*) is a rare shorebird that breeds only in North America. The Great Lakes population is federally endangered, and the Great Plains and Atlantic Coast populations are on the federal threatened species list. The Great Lakes population underwent an alarming decline from more than several hundred pairs in the early 1900s to only twelve pairs in the mid-1980s (Russell 1983). Although the Great Lakes population has increased since federal listing in 1985, no significant recovery has occurred. The piping plover is included as an individual species conservation target because of its highly imperiled status. Habitat loss, primarily to recreation and shoreline housing, and other related human disturbances are believed to be among the primary causes of plover decline. The piping plover nests on sandy or sand/cobble beaches with little or no vegetation. Pairs typically nest solitarily, but nests may be loosely clumped if habitat is suitable. Disturbance by people or their pets interferes with courtship and mating behavior or frightens birds from their nests.

Although intense surveys have been conducted, there are no records of plovers nesting in the Lower St. Louis River area since 1985 (Penning and Cuthbert 1993; Niemi et al. 2000). In the late 1970s, the local breeding population was already small; only five pairs were nesting at the Port Terminal area at that time (Niemi et al. 1979). Historical estimates indicate the maximum number of breeding pairs in the estuary was twelve (F. Cuthbert, personal communication, 2002). Since 1985, plovers have been observed in the area during the spring, suggesting that plover recolonization of the estuary is possible if conditions are favorable.

Within the estuary, the following locations have been used by nesting plovers or have potential as future nesting sites: Minnesota Point (lake side near airport), Wisconsin Point, Hearding Island, Barker's Island, Interstate Island, Erie Pier, and the Port Terminal. Two of these sites, Wisconsin Point and Interstate Island, were recently designated as "Critical Habitat" by the U.S. Fish and Wildlife Service (U.S. FWS 2001). Minnesota Point has some high-quality piping plover breeding habitat, but the high level of human use has been cited as a potential problem. However, careful planning and management could make plover nesting successful while still allowing human recreational use of the beach. The harbor side of Wisconsin Point has good potential for plover use, but extensive and intensive vegetation management will be required to make this site suitable. Hearding and Barker's islands were created from dredge materials and were used historically by plovers. However, development, succession of vegetation, and proximity to humans now render these sites unsuitable for plovers, and management to encourage plovers does not appear to be feasible. Interstate Island, also created from dredge material, has been suggested as potential piping plover nesting habitat. However, intensive use of this site by ring-billed gulls (*Larus delawarensis*) precludes nesting by piping plovers because early-nesting gulls occupy all of the habitat. Additionally, in the context of the entire estuary, Interstate Island is an acceptable location for large numbers of gulls, and efforts to deter gulls at this location would likely cause them to move to less satisfactory locations. Erie Pier has also been suggested as a possible nest site for piping plovers based on observations of non-breeding birds, but disturbance and general habitat characteristics indicate plover nesting should not be encouraged at this site. The Port Terminal is a historic nesting site, but like Erie Pier, heavy human disturbance and private ownership make management and protection difficult. Therefore, with appropriate management and protection, Minnesota and Wisconsin Points appear to have the greatest potential to attract piping plovers. An additional option for plover habitat in the Lower St. Louis River area is creation of one or more islands from new dredge material. The U.S. Fish and Wildlife Service (U.S. FWS) is currently coordinating a formal evaluation of habitat conditions in the estuary to recommend action for habitat restoration and plover recolonization; this Habitat Plan will incorporate the results and recommendations from the U.S. FWS evaluation once it is published.

Current Condition: Poor
Conservation Goal: Reestablish a breeding population of piping plover in the estuary in the short term, pending the results of the referenced U.S. FWS evaluation.

Common Tern

The common tern (*Sterna hirundo*) faces problems similar to those of the piping plover. It is a colonial nesting bird, and in the Great Lakes region it prefers sparsely vegetated sand or gravel beaches on isolated islands or shorelines of large lakes. It faces threats of habitat loss and disturbance by humans, as well as competition and predation from ring-billed gulls. The only common tern nesting colony in the Lower St. Louis River is on Interstate Island; there were 215 common tern nests on this island during a recent breeding season (Pearson 1999). Although the common tern has not experienced the dramatic population declines of the piping plover, smaller localized declines have occurred in the Great Lakes region. The common tern is included as an individual species conservation target because of the high level of threat to its habitat in combination with population decline. Given the similarity between habitat and other requirements of the common tern and piping plover, as well as their willingness to share nesting habitat, management strategies should address these species together.

Current Condition: Fair
Conservation Goal: Unknown. The breeding population in the Lower St. Louis River should, at a minimum, be maintained at its current level. It is currently unclear whether any increase in the number of breeding pairs should be recommended. The U.S. FWS has planned a species assessment for the Great Lakes population. Recommendations from that assessment should be used to update and refine this conservation goal as they become available.

Other Bird Species
Several additional bird species are of particular note because of rangewide population declines and/or disappearance from the Lower St. Louis River. However, the current level of knowledge of these species and their populations is not sufficient to develop meaningful numeric conservation goals for the Lower St. Louis River. In addition, it was agreed that these species would not receive the same level of attention as the piping plover and common tern for these reasons:

- Population decline does not appear to be as significant as that of the piping plover or common tern; and/or
- Cause(s) of local and/or range-wide population decline is not understood.

As for the breeding bird and migratory bird assemblages, suitable habitat should be available for these species, even if they are not currently breeding in the estuary. These species should also be monitored periodically to determine their status in the Lower St. Louis River project area. The factors contributing to their decline are probably cumulative and widespread, and it is generally beyond the scope of this plan to address such problems at a range-wide scale. However, as the causes of local and range-wide population declines are clarified, those causes should be addressed to the extent that is applicable and possible within the Lower St. Louis River. A large number of such localized efforts across the core of each species' range can contribute to the overall recovery of each. As additional information becomes available for these species, conservation strategies may be identified in subsequent revisions to this plan.

The black tern (*Chlidonias niger*), American bittern (*Botaúrus lentiginósus*), and yellow-headed blackbird (*Xanthocéphalus xanthocéphalus*) were historically known to breed in the estuary, but they either disappeared sometime during the last two or three decades or they were not documented during a 1999 breeding survey (Niemi et al. 2000). Species not observed during the 1999 survey may have been missed because of the timing and duration of the survey; however, given their former frequency of occurrence, the recent lack of documentation is of concern. It is important to have suitable breeding habitat available for these three species in case any are able to re-establish breeding populations. By targeting breeding bird and aquatic habitats in this Plan, the needs of these three species should be adequately addressed.

Although the black tern is widespread and still considered relatively common, the species is experiencing a serious decline across its range and is likely to be considered for federal listing under the Endangered Species Act. The North American population declined by over 70% between 1966 and 1989 (Sauer and Droege 1992), and its numbers have continued to drop. It constructs floating nests in wetlands, and the extensive conversion of wetlands to other uses has likely contributed to the population decline. The last time this species nested in the estuary is unknown, although there were several small colonies present in emergent marshes during the late 1970s (J. Green, personal communication, 2002). WDNR biologists surveying coastal wetlands in the late 1990s did not find breeding black terns anywhere along the western shore of Lake Superior. At least four active colonies were present in this area in the mid-1980s. There is presently a small active colony (five to ten pairs) at a mitigation wetland several miles south of the city of Superior. The area around the Lower St. Louis River is close to the edge of this species' range; as its population has declined, its range may have contracted. The range-wide decline and likely associated range contraction is one of several possible causes of the disappearance of this species from the Lower St. Louis River; the actual cause(s) has not been clearly identified.

The American bittern was once present in the Lower St. Louis River area, but it was not recorded during a 1999 survey (Niemi et al. 2000). It is possible this species was overlooked in the 1999 survey because of the timing of the survey and the secretive behavior of this particular species. In the late 1990s, Allouez Bay was the only Lower St. Louis River wetland where WDNR biologists observed the American bittern. The estuary still has suitable habitat for the bittern, so it is unclear why this species has not been documented recently. The overall population has been in decline for many years, almost certainly due to loss and degradation of wetland habitat. If this bittern is no longer breeding in the estuary, it could be due to a contraction of its geographic range associated with overall population decline, degradation of wetland habitats in the estuary, a combination of these factors, or other unknown reasons. The American bittern nests in emergent marsh vegetation or sedge meadows with scattered shrubs; it utilizes all wetland types found in the estuary, including submergent marshes.

The yellow-headed blackbird sustained several small breeding colonies in the estuary in the past (Davis et al. 1978; J. Green, personal communication, 2002), but it was not documented during the 1999 survey (Niemi et al. 2000). There is currently a colony south of Superior in the same mitigation wetland used by black terns, but WDNR biologists did not find any yellow-headed blackbirds in Lake Superior coastal wetlands during the late 1990s. Based on a limited number of survey routes, Breeding Bird Survey data suggest this species has experienced significant declines in Minnesota and Wisconsin between 1980 and 2000 (Sauer et al. 2001). Herkert (1992) notes that development, wetland drainage, and changes in marsh vegetation are causes of local population declines in other parts of the Midwest; it is unclear whether any of those factors have caused its disappearance from the estuary. Another possible explanation is that the marsh wren is a nest predator, and marsh wrens have become common in cattail wetlands in Spirit Lake and Mud Lake, as well as some other areas in the estuary (Niemi et al. 2000). Duluth is at the far northeastern edge of the yellow-headed blackbird's range; range contraction associated with population declines could be another factor in its disappearance from the estuary.

Three additional species are highlighted due to rangewide population declines: the golden-winged warbler (*Vermivora chrysoptera*), sedge wren *(Cistothorus platensis)*, and wood thrush *(Hylocichla mustelina)*. All three are known or are very likely to occur in the Lower St. Louis River area. Their continued presence and reproductive success can serve as a partial indicator of ecosystem health.

The breeding range of the golden-winged warbler lies predominantly within the transition zone of northern hardwood forests and boreal forests. This species is declining across most of its range. It nests in early successional forest habitat or a range of shrubby or forested wetlands. It is fairly common in the large Pokegama-Carnegie complex of shrub swamp, wet meadow, and forest in the upper Pokegama River watershed (E. Epstein, WDNR, personal communication, 2002). WDNR biologists also found it occupying wet shrub habitat with scattered trees in the Superior Municipal Forest. Although a 1999 breeding survey did not record any individuals within the estuary itself, wet shrublands around the Lower St. Louis River are likely to support scattered, small populations of this species (Niemi et al. 2000).

The sedge wren is a widespread species that nests in sedge meadows and other wetlands, as its name suggests. Approximately 20% of the population is found in the transition zone between northern hardwood forest and boreal forest during the breeding season. Although trends suggest this species may be increasing within this region, the population appears to be in an overall decline. During a 1999 survey, this species was found to be "relatively common" in the Lower St. Louis River (Niemi et al. 2000). Parts of the estuary, including Allouez Bay and Oliver Marsh, are estimated to support over 25 breeding pairs. Sedge wrens are locally common in the Pokegama-Carnegie red clay wetland complex. This species is highlighted because of the overall declining trend.

The wood thrush breeds in mixed and deciduous forests of the north central and northeastern United States, as well as the southern portions of Canada's eastern provinces. An estimate based on Breeding Bird Survey data indicates this species has declined by 29% since 1966 (Sauer et al. 2000). Forest fragmentation and conversion of forests to other uses have contributed to its decline. Although much of the breeding population is found in the Appalachians and the Southeastern Coastal Plain of the U.S., the remainder is distributed across a range of ecoregions, including the transition zone of northern hardwood forests and boreal forests. The population has experienced a significant decline in this ecoregion. It is relatively uncommon around the Lower St. Louis River; forested habitats in the project area likely support over 25 widely separated breeding pairs (Niemi et al. 2000; E. Epstein, WDNR, personal communication, 2002).

Wild Rice
Wild rice (*Zizania aquatica*) is an important species in wetland plant communities of the Upper Midwest and a vital food resource for migratory waterfowl. Although this species is not rare, it has experienced long-term declines in abundance in most wetlands where it occurs, and it has disappeared from some wetlands altogether. Wild rice was historically very abundant in the Lower St. Louis River (and throughout the Upper Midwest) in sheltered bays and along shallow river flats. Optimal habitat for wild rice is clear, shallow water (1.5 - 3 feet deep) with a low velocity current, over a silty or mucky substrate (Eggers and Reed 1997). It is vulnerable to wave action and other water disturbances at certain growth stages. Increased sedimentation and turbidity in wetlands have contributed to its range-wide decline. This species has also been severely impacted by contaminants, introduced species such as carp, Canada geese, and purple loosestrife, and hydrologic modifications resulting from dams and dredging.

Current Condition: Poor
Conservation Goal: Restore healthy populations of wild rice to appropriate wetland habitats in the estuary. More information is needed to develop a more specific conservation goal.

Regional and Global Significance of the Lower St. Louis River

The previous descriptions of the conservation targets of the Lower St. Louis River illustrate the unique and special qualities of the ecosystems of the area. The combination of ecosystems within the Lower St. Louis River—estuarine wetlands and aquatic habitats, baymouth bar complex, and surrounding upland forest—are very unusual in Lake Superior, the Upper Midwest, the Great Lakes region, and the world. Many of the ecosystems and native species are rare and/or declining across their range. This concentration of such diverse ecosystems, along with the location on the western end of Lake Superior, make the estuary a critical migratory stopover and an important breeding area for many species. Great Lakes wetland systems are unique from a global perspective, and the St. Louis River wetlands are the largest such complex on the Lake Superior shore, representing a significant source of productivity for the entire Lake Superior ecosystem. The estuary and its tributaries are unusual in having such a variety of habitat types supporting a large and diverse assemblage of native fish species. The baymouth bars are unusual in the Great Lakes—aside from Minnesota and Wisconsin Points, the only similar examples are Point Pelee and Long Point in Ontario and Long Island-Chequamegon Point in Wisconsin. Not surprisingly, the plant communities supported by these baymouth bars are endemic to the Great Lakes and are rare and declining across their range. The transitional area between the vast ecosystems of the boreal forest and northern conifer-hardwoods forest also supports the endemic Great Lakes pine forest. The freshwater estuary and baymouth bar systems are virtually absent elsewhere in the interior of North America. The Lower St. Louis River is one of the largest and most important of such systems. In spite of human impacts, the Lower St. Louis River ecosystem is both regionally and globally significant and therefore warrants the consideration presented in this Habitat Plan.