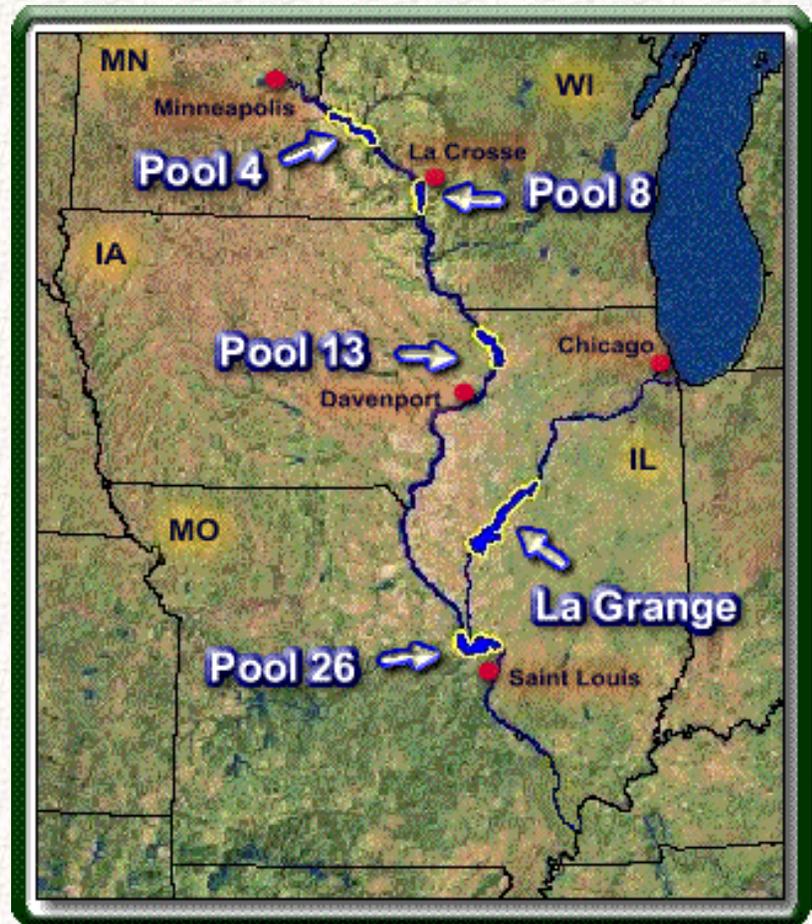




2001 Annual Status Report: Submersed and Rooted Floating–Leaf Vegetation in Pools 4, 8, 11, 13, and 26 of the Upper Mississippi River, and La Grange Pool of the Illinois River

Yao Yin, Heidi Langrehr, Theresa Blackburn, Megan Moore, Robert Cosgriff, and Thad Cook

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Preface

The [Long Term Resource Monitoring Program](#) (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U. S. Army Corps of Engineers [Environmental Management Program](#). The LTRMP is being implemented by the [Upper Midwest Environmental Sciences Center](#), a U.S. Geological Survey science center, in cooperation with the five [Upper Mississippi River System](#) (UMRS) states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem, given its multiuse character. The long-term goals of the program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

This report presents the results of aquatic vegetation stratified random sampling surveys conducted by field station personnel under the direction of the Upper Midwest Environmental Sciences Center. Pools 4, 8, 11 (2001 only), 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River were surveyed. This document satisfies Task 2.2.4.6, *Evaluate and Summarize Annual Present-day Results* under Goal 2, *Monitor Resource Change* of the Operating Plan (U.S. Fish and Wildlife Service 1993). The purpose of this report is to provide a summary of data regarding the distribution and abundance of submersed and floating-leaf vegetation collected from the field stations. This document was developed with funding provided by the Long Term Resource Monitoring Program.

Suggested citation is updated each year:

Yin Y., H. A. Langrehr, T. Blackburn, M. Moore, R. Cosgriff, and T. Cook. 2004. 2001 Annual Status Report: Submersed and rooted floating–leaf vegetation in Pools 4, 8, 11, 13, and 26 of the Upper Mississippi River, and La Grange Pool of the Illinois River. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. An LTRMP Web-based report available online at http://www.umesc.usgs.gov/reports_publications/ltrmp/veg/2001/vegetation-srs.html. (Accessed February 2004.)

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Abstract

Vegetation sampling was conducted between June 15 and August 17, 2001, in Pools 4, 8, 11, 13, and 26 of the Upper Mississippi River (UMR) and La Grange Pool of the Illinois River at 3,317 sites to quantify the status of rooted floating-leaf and submersed aquatic vegetation. Pool 11 was sampled as a pilot outpool sampling project. Three exotic species, Eurasian watermilfoil, curly pondweed, and brittle waternymph, were recorded along with 20 indigenous species. Overall, the species composition and indices of frequency and abundance of submersed aquatic vegetation within the study pools was similar to that reported since 1998. Submersed aquatic vegetation was abundant in the upper impounded pools (4, 8, and 13) of the UMR and scant or below the detection limit of the sampling protocol in Pool 26 of the UMR, and La Grange Pool of the Illinois River. Pool 11 had a moderate amount of vegetation. Based on the abundance index, the amount of submersed aquatic vegetation per site has displayed a steady decline in Pool 8 and a steady increase in Pool 13 since 1999. No obvious trends have been detected in Pool 4 while submersed aquatic vegetation remains scarce in Pool 26 and La Grange Pool.

Key words: Aquatic macrophyte, aquatic vegetation, Illinois River, Mississippi River, and monitoring, status and trend.

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Introduction

Aquatic vegetation in the [Upper Mississippi River System](#) (UMRS) provides food and habitat to fish and wildlife and is a vital component of this nationally significant ecosystem (Public Law 99-662, Upper Mississippi River Management Act of 1986). The UMRS is also a nationally significant navigation system. The building of locks and dams in the Upper Mississippi and Illinois Rivers for commercial navigation greatly expanded the rivers' backwater areas in which submersed aquatic vegetation flourished following the development. However, following a severe drought in the basin, aquatic vegetation in the Mississippi River experienced a drastic decline between 1989 and 1994 (Fischer and Claflin 1995; Rogers et al. 1995; Wiener et al. 1998; Tyser et al. 2001). As of 2001, the amount of submersed aquatic vegetation is still substantially lower than the historical high levels recorded in the 1970s.

Through the Upper Mississippi River Management Act of 1986, Congress established the [Environmental Management Program](#) of the UMRS in 1986 to ensure the coordinated development and enhancement of the Upper Mississippi River System. The Environmental Management Program consists of five elements, including Habitat Rehabilitation and Enhancement Projects (HREP), [Long Term Resources Monitoring Program](#) (LTRMP), Recreation Projects, Economic Impacts of Recreation Study, and Navigation Monitoring. Aquatic vegetation in the UMRS is monitored as a component of the LTRMP, along with the fish, water quality, and macroinvertebrate components. The LTRMP is administered by the U.S. Army Corps of Engineers and implemented by the Upper Midwest Environmental Sciences Center (UMESC) of the U.S. Geological Survey in partnerships with the Illinois Department of Natural Resources, Iowa Department of Natural Resources, Minnesota Department of Natural Resources, Missouri Department of Conservation, and Wisconsin Department of Natural Resources. Five key pools have been sampled for aquatic vegetation using stratified random sampling protocols since 1998 including Pools 4, 8, 13, and 26 of the Mississippi River and La Grange Pool of the Illinois River. In 2001, Pool 11 was sampled as a pilot outpool sampling project.

The objective of stratified random sampling was to accumulate data on aquatic vegetation over a long term (>50 years) using a standardized protocol across the system. The data provide information on the distribution and abundance of vegetation

within pools for the protection and enhancement of the Upper Mississippi River System. Although data on emergent macrophytes, filamentous alga, and duckweeds were included in the investigation, they are not reported here because our focus was on submersed and rooted floating–leaf vegetation. The full suite of data (inclusive of submersed, rooted floating–leaf, emergents, algae, and duckweeds) are archived in the UMESC database and are openly available online at http://www.umesc.usgs.gov/data_library/vegetation/vegetation_page.html.

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Study Areas

- [Pool 4](#)
- [Pool 8](#)
- [Pool 13](#)
- [Pool 26](#)
- [La Grange Pool](#)

Navigation [Pool 4](#) is 73.3 km (44 river miles) long and includes 14,700 ha (36,300 acres) of aquatic habitat. It is located between Lock and Dam 3 (above Red Wing, Minnesota) and Lock and Dam 4 (Alma, Wisconsin). Major tributaries include the Cannon and Vermillion Rivers on the Minnesota side and the much larger Chippewa River on the Wisconsin side. Lake Pepin, a riverine lake created by the Chippewa River delta, is located in the middle of Pool 4. The location of Lake Pepin divides the rest of the pool into upper Pool 4 and lower Pool 4. The smaller backwaters of upper Pool 4 have been degraded by sedimentation, whereas the larger backwaters of lower Pool 4 are much better habitat for vegetation.

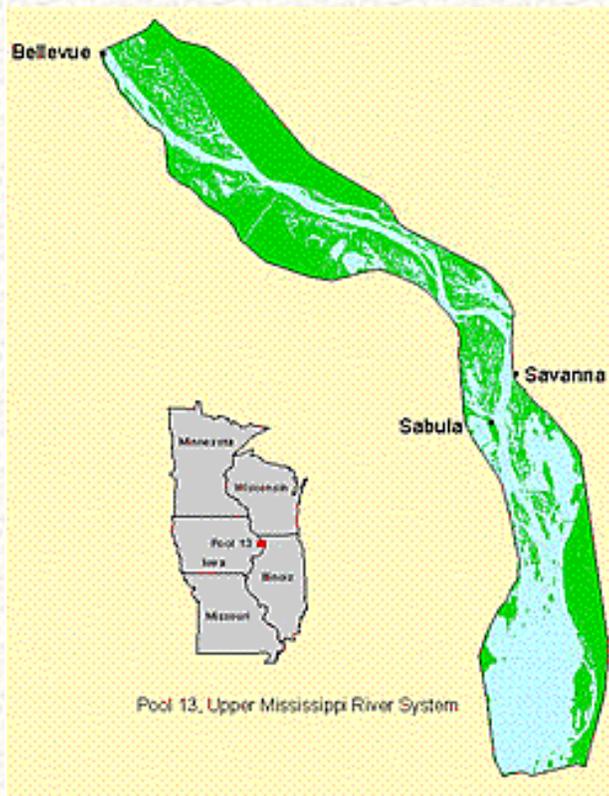


Click on the image for a larger view of Pool 4

Navigation [Pool 8](#) is 38.8 km (23.3 river miles) long and is bounded by Lock and Dam 7 (Dresbach, Minnesota) to the north and Lock and Dam 8 (Genoa, Wisconsin) to the south. It encompasses 9,000 ha (22,100 acres) of aquatic habitat. Major tributaries include the Black, Root, and La Crosse Rivers. The upper section of Pool 8 has high bank islands adjacent to the main channel, deep secondary channels, and backwater sloughs. The middle section contains low islands, braided channels, and small backwater sloughs. The lower section is a large open expanse of water.



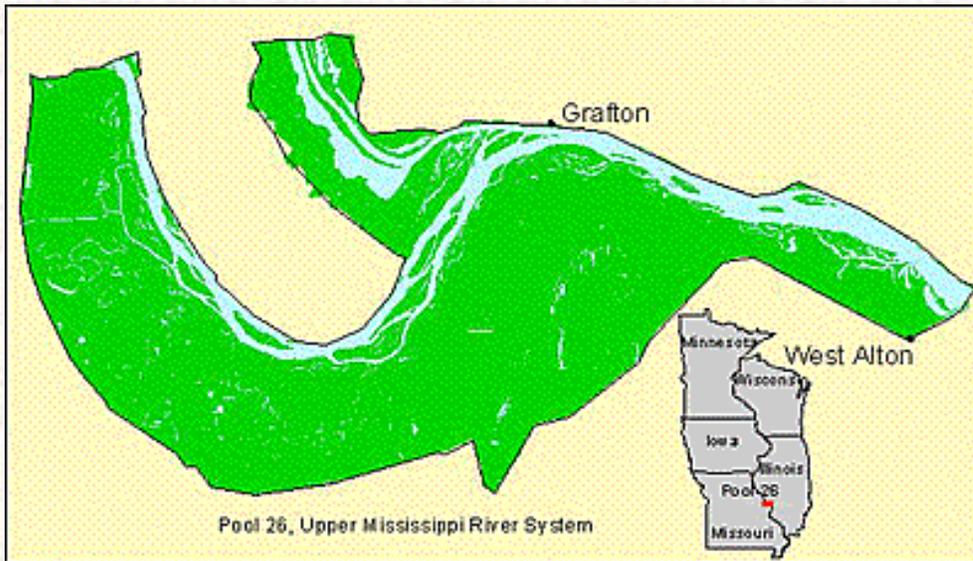
Click on the image for a larger view of Pool 8



Navigation [Pool 13](#) is 52.1 km (34.2 river miles) in length and is bounded by Lock and Dam 12 (Bellevue, Iowa) to the north and Lock and Dam 13 (Fulton, Illinois) to the south. It encompasses 11,400 ha (28,100 acres) of aquatic habitat. Similar to pools upstream, Pool 13 contains many high bank islands adjacent to the main channel in the upper section, braided backwater channels and sloughs in the middle section, and a large open lake-like area in the lower section of the pool. Major tributaries include the Apple and Plum Rivers on the Illinois side and Maquoketa and Elk Rivers on the Iowa side.

Click on the image for a larger view of Pool 13

The **Navigation [Pool 26](#)** study area includes water bodies along the Upper Mississippi River from Lock and Dam 25 (Winfield, Missouri) to Lock and Dam 26 (Alton, Illinois) and the lower Illinois River from its confluence with the Mississippi River north to Illinois River mile 12. This reach of the two rivers is bordered by high bluffs on the Illinois side and low elevation floodplain on the Missouri side. The reach encompasses 9,500 ha (23,700 acres) of aquatic habitat. Presently, most of the backwaters of the lower Illinois River are isolated from the river by low levees. Likewise, many of the secondary channels of the Mississippi River are isolated from the river on the upstream side.



Click on the image for a larger view of Pool 26

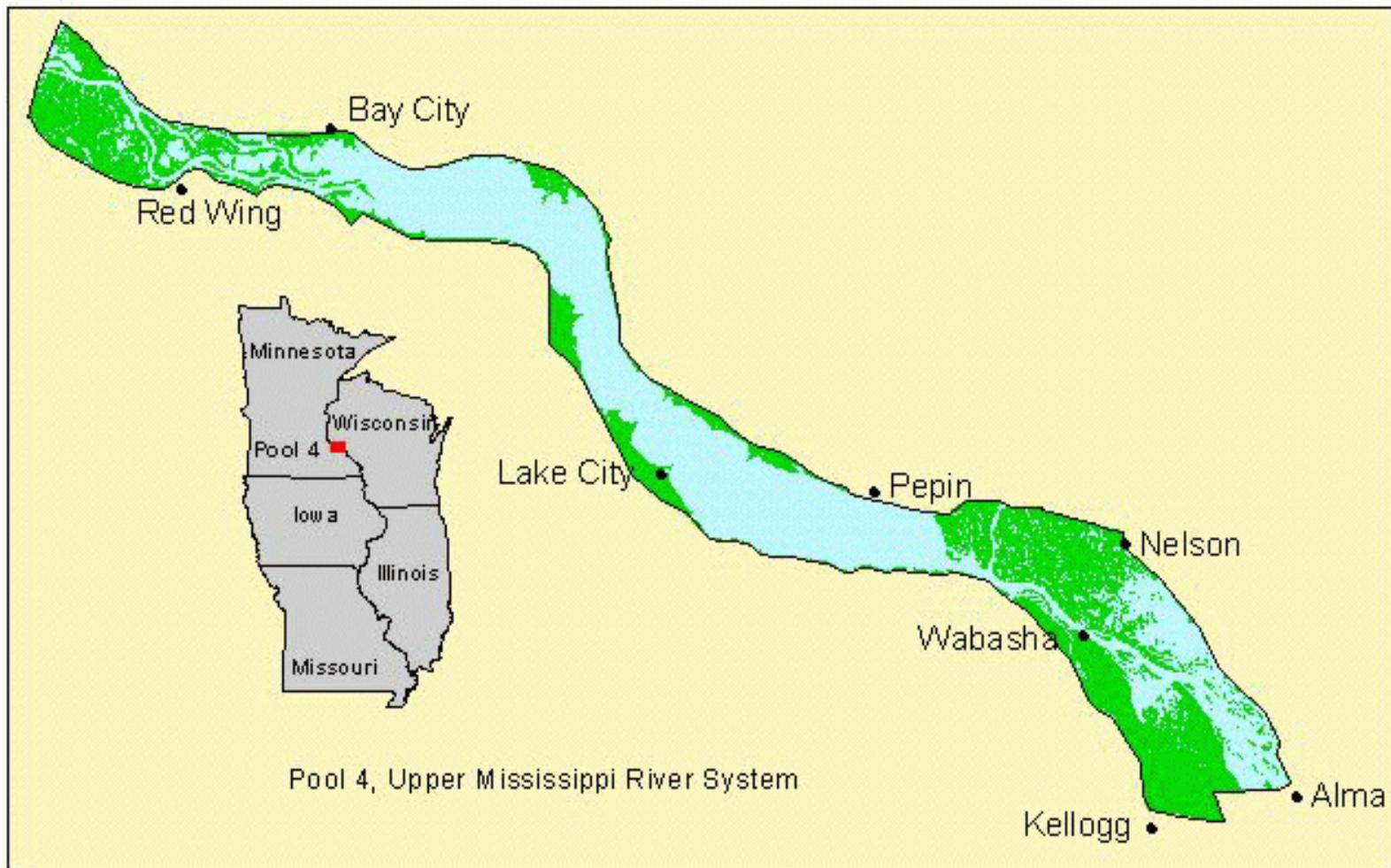
[La Grange Pool](#) on the Illinois

River is about 130 km (80 river miles) long and encompasses 10,750 ha (26,500 acres) of aquatic habitat. It is bounded by Peoria Lock and Dam to the north and La Grange Lock and Dam to the south. This reach has the highest proportion of backwaters, except for Pool 4, but these backwaters are highly degraded by excessive sedimentation over the last 150 years. Many backwaters are isolated by low levees. Major tributaries include the Sangmon, Mackinaw, and LaMoine Rivers.



Click on the image for a larger view of La Grange Pool

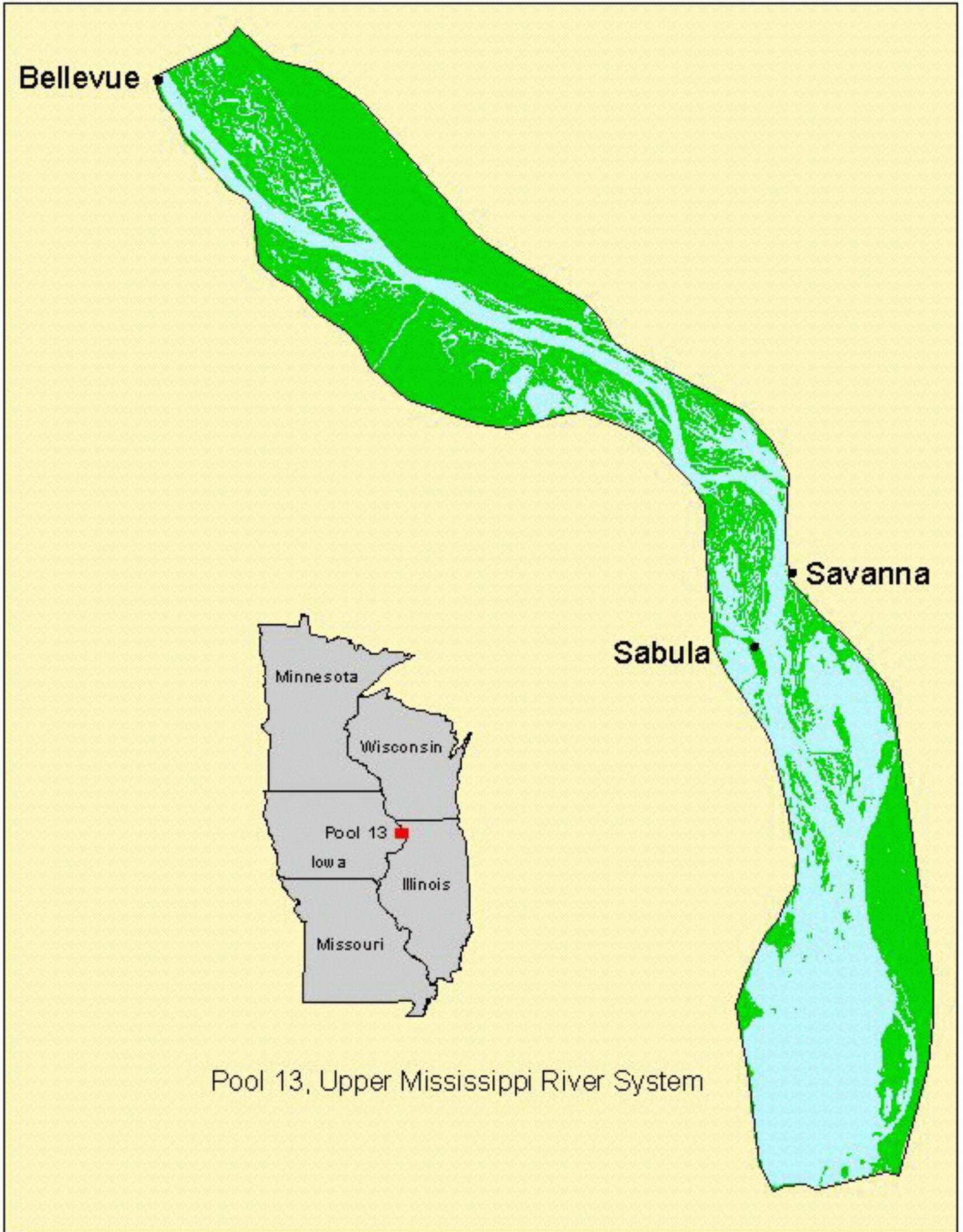
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http://www.umesc.usgs.gov/reports_publications/ltrmp/veg/2001/images/pool8.gif



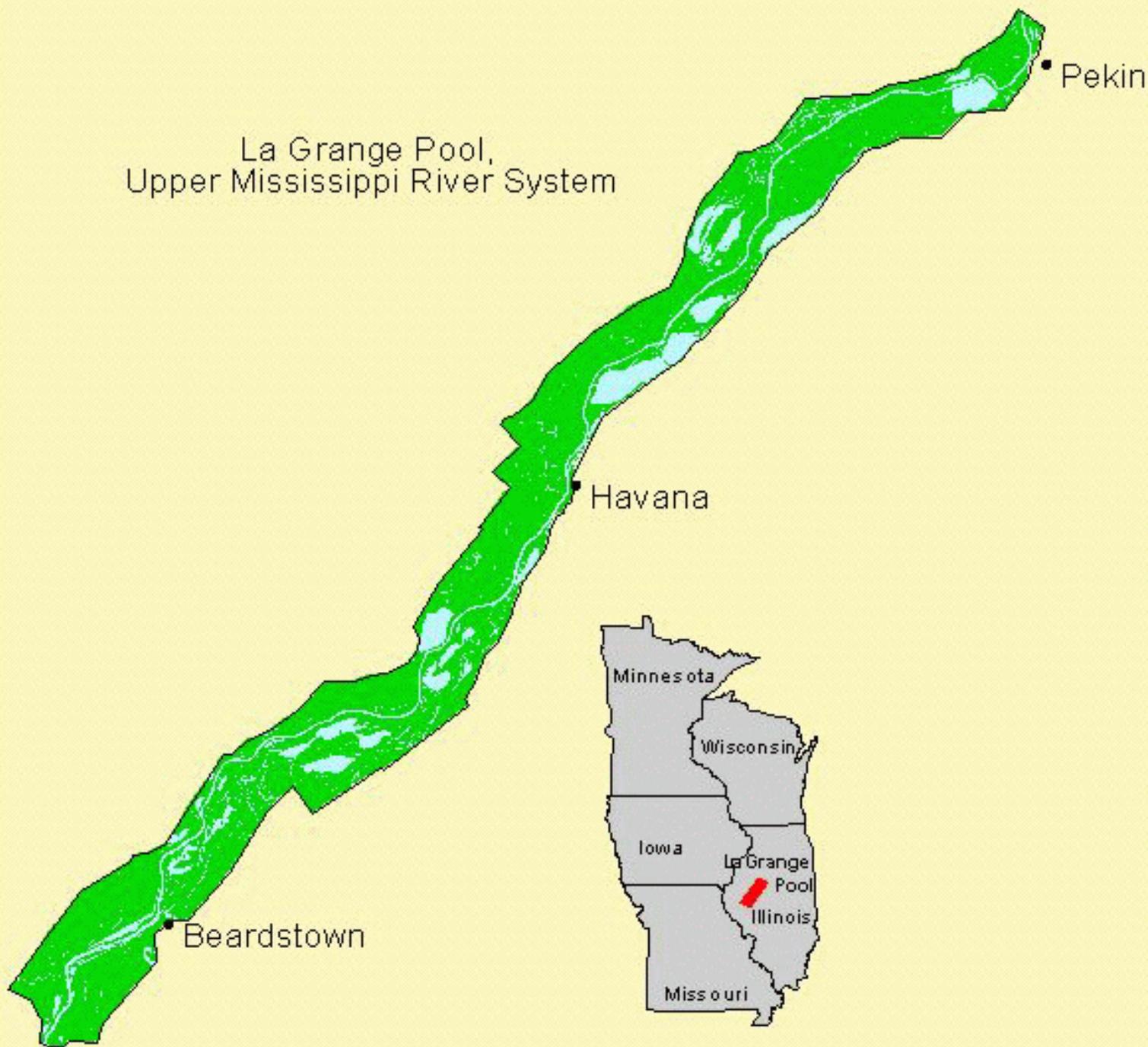


http://www.umesc.usgs.gov/reports_publications/ltrmp/veg/2001/images/pool13.gif





La Grange Pool,
Upper Mississippi River System





Methods

Sampling procedures were described in detail in [Yin et al. \(2000\)](#). The following is a brief description of the overall design.

Stratification

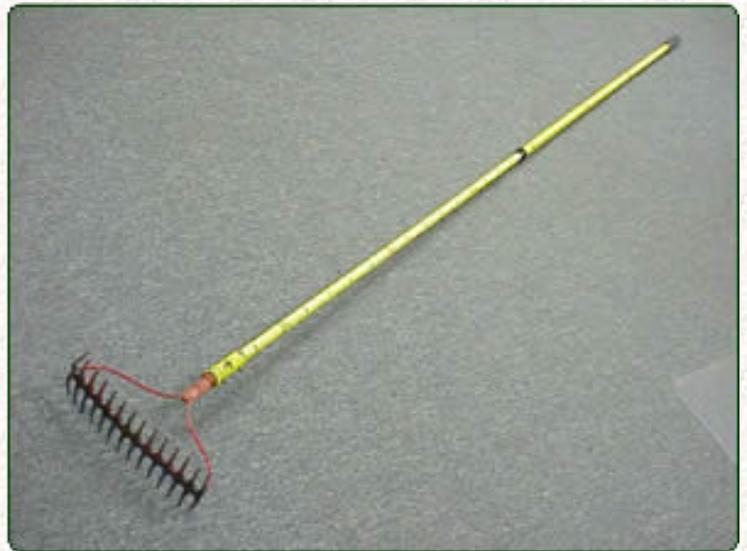
Stratified random sampling was initiated in 1998. Sampling sites were distributed in shallow water areas where water depth was less than or equal to 3 m deep at flat-pool condition. After 1998, sampling sites were distributed in less than or equal to 2.5 m depth. Deeper water areas most likely do not support aquatic vegetation. Shallow water areas were divided into general habitat types (strata), including main channel borders, secondary channels, contiguous backwaters, isolated backwaters, and impounded areas. Sampling efforts were generally proportional to acreage and perceived habitat heterogeneity of each stratum, except for the isolated backwater areas whose sampling sizes were kept small to ensure a timely completion of the investigation. Some areas were excluded from the sampling areas because of safety concerns and accessibility difficulties.

Site Selection

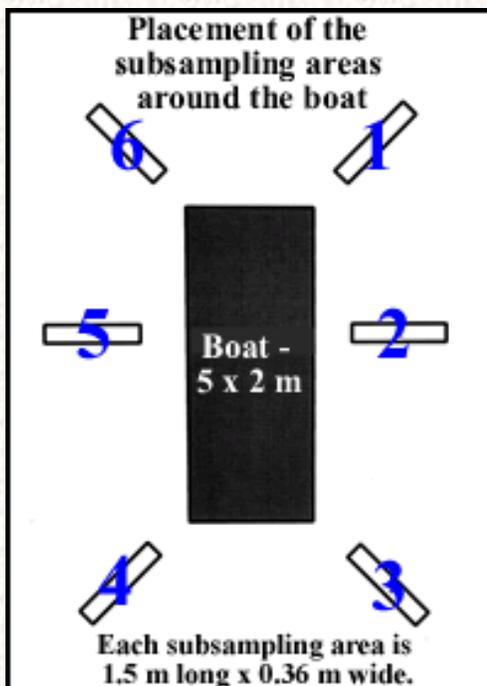
Sites were selected using a random number generator. A 50- X 50-m grid was generated and overlaid onto the stratified aquatic areas. Nodes of the grid were geospatially registered (Universal Transverse Mercator coordinates), and nodes that fell in the sampling strata were eligible for selection as sites. We navigated to the general area of a site using an enlarged hard-copy map and then switched to global positioning system (GPS) equipment with differentially corrected signals as the boat approached the targeted location. The boat was anchored at bow and stern when both the easting and northing coordinates displayed on the GPS unit were within 10 m (- or +) of their respective target readings. The actual GPS coordinates were read and recorded twice at each site, once immediately after the boat had been anchored and again before the boat was released for departure.

Equipment and Definitions

Submersed aquatic vegetation was collected using a long-handled, double-headed rake modified from Jessen and Lound (1962) and Deppe and Lathrop (1992). The rake is 36 cm (14 inches) wide, has 14, 5-cm (2 inches) long teeth on each side, and was made by welding two square-headed garden rakes together. The teeth are divided and marked into five equal parts (or 20% increments). The handle is about 3 m long, with a rope extension, and is scaled at 10-cm increments. Aquatic vegetation or aquatic species refer to the following plant types or life forms: submersed (S) and rooted floating-leaf (F).



The Site and Subsampling Areas



Each site had six subsampling areas, each of which was a rectangular area approximately 1.5 m long and 0.35 m wide (the width of the rake head). One subsampling area was located off each corner of the boat and the other two were located, one each, off the left and right sides.

Sampling and Data Recording

Individual species and different life forms of aquatic vegetation were recorded (e.g., submersed and rooted floating–leaf) as either present or absent at each subsampling area based on visual examination and a rake sample. When present, submersed species and the filamentous algae were given a **density rating** (see *table at lower left*) based on their thickness on the rake teeth. When present, rooted floating–leaf and emergent species were given a percent **cover rating** (see *table at lower right*). Species that had not been recorded in the six subsampling areas but were observed at the site were recorded and marked as "additional species." Fassett (1957), Voss (1972, 1985) and Gleason and Cronquist (1991) were the primary references used for plant identification. Scientific nomenclature and common names are based on those found in the U.S. Department of Agriculture's PLANTS Database (<http://plants.usda.gov/>).

Submersed vegetation density ratings	
Percent of rake teeth filled	Density rating
81-100	5
61-80	4
41-60	3
21-40	2
1-20	1
no plants retrieved	0

Rooted floating–leaf vegetation cover ratings	
Percent of area covered	Cover rating
81-100	5
61-80	4
41-60	3
21-40	2
1-20	1
none	0

Computation of Summary Indexes

Frequency

Frequency values in this report are computed by dividing the number of sites where a species was recorded by the number of sites investigated in the stratum, and then multiplied by 100 to convert it into a percentage.

$$F = \frac{\text{sites where species } A \text{ occurs in stratum } X}{\text{total number of sites in stratum } X} \times 100$$

The frequency value in a pool is computed by averaging the frequency values of the shallow water strata, weighted by acreage:

$$\left(\bar{F} = \frac{\sum_{j=1}^m F_j \cdot S_j}{\sum_{j=1}^m S_j} \right)$$

where F_j is the frequency in stratum j and S_j is the acreage of stratum j .

Abundance Index

An index is created to measure the quantity of a submersed species using both presence or absence and plant density rating data recorded in the six subsampling areas. We call it the abundance index to differentiate it from the frequency index. The abundance index is computed according to the following formula:

$$A = \frac{\log_2 \left(1 + \sum_{i=1}^6 V_i \right) + 3 \log_2 \left(1 + \frac{\sum_{i=1}^6 (R_i - V_i)}{6} \right) - 1}{14.6260} \times 100$$

where V_i is the presence or absence (1,0) and R_i is the plant density ranking (0,1,2,3,4,5) data for the i^{th} subsampling areas at the site ($i=1,2,3,4,5,6$). Data are treated before computation so that $V_i=1$ if $R_i \geq 1$ and, vice versa, $R_i \geq 1$ if $V_i=1$. The abundance index for a stratum is computed as the simple average of all its sites.

$$A = \frac{\sum_{j=1}^m A_j}{n}$$

The abundance index for a pool is computed as the average of all shallow water strata, weighted by acreage:

$$A = \frac{\sum_{j=1}^m A_j \cdot S_j}{\sum_{j=1}^m S_j}$$

where A_j is the abundance index of the species in stratum j and S_j is the acreage of stratum j .

Percent Cover (Rooted floating–leaf life form)

The percent cover of rooted floating–leaf life forms in a stratum is computed using the following formula:

$$C = \frac{\sum_{j=1}^m L_j \cdot A}{M}$$

where L_j is the cover rating at individual sites and A is the midpoint of the corresponding percent cover, and M is the total number of sites in the stratum. Percent cover in a pool is computed as the average of all shallow water strata, weighted by acreage:

$$C = \frac{\sum_{j=1}^m C_j \cdot S_j}{\sum_{j=1}^m S_j}$$

where C_j is percent cover in stratum j and S_j is the acreage of stratum j .

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2001 Results in Pool 4 of the Upper Mississippi River

Sampling Effort

Sampling was conducted from June 18 to August 1, 2001. Of the 650 sites targeted, 646 were sampled ([Figure 1](#)).

Submersed Aquatic Vegetation

The status of submersed aquatic vegetation (SAV) in Pool 4 varied among the strata sampled. Isolated backwaters had the highest abundance of SAV ([Table 2](#); [Figure 2](#)), followed by contiguous backwaters of the lower pool. In general, the lower pool contained significantly more SAV than the upper pool (57% and 7%, respectively). The SAV covered about 37% of the shallow water areas poolwide.

A total of 16 SAV species were recorded in the entire pool; however, most species were found either in the lower pool strata or isolated backwaters. Of the nine strata sampled, only three (isolated backwaters, lower pool contiguous backwaters, and lower pool secondary channels) supported a rich diversity of species (10 or more species per strata). Two strata (lower pool main channel border and lower Lake Pepin) supported moderate species diversity (eight and seven species, respectively). All four strata located in the upper portion of Pool 4 had few or no species (zero to three species). Coontail was the most abundant species found poolwide, followed closely by water stargrass. Wildcelery was most abundant in both lower pool contiguous backwaters and secondary channels.

Rooted Floating–Leaf Vegetation

Of the three rooted floating–leaf species present in Pool 4, only two were recorded in 2001: white waterlily and American lotus. Yellow pond-lily has been recorded in other years during stratified random sampling. Poolwide, the percent frequency of all rooted floating–leaf species was fairly sparse (8%) and was dominated by white waterlily (7%). Isolated backwaters had the highest percent cover of rooted floating–leaf vegetation that consisted entirely of white waterlily. The only stratum with American

lotus was the lower pool contiguous backwater. No rooted floating–leaf species was present in any main channel border strata or any upper pool strata with the exception of upper pool contiguous backwaters.

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Table 2. Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 4, Upper Mississippi River System, 2001.

Common name (Scientific name)	Contiguous backwater, upper <i>n</i> = 100		Contiguous backwater, lower <i>n</i> = 176		Isolated backwater <i>n</i> = 50	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common (<i>Utricularia macrorhiza</i>)	-	-	-	-	2.0 ± 2.0	0.1 ± 0.1
buttercup, longbeak (<i>Ranunculus longirostris</i>)	-	-	-	-	2.0 ± 2.0	0.1 ± 0.1
chara (<i>Chara</i> spp.)	-	-	1.1 ± 0.8	0.1 ± 0.1	4.0 ± 2.8	0.3 ± 0.2
coontail (<i>Ceratophyllum demersum</i>)	3.0 ± 1.7	0.2 ± 0.1	43.2 ± 3.7	6.3 ± 0.7	64.0 ± 6.9	12.7 ± 1.8
pondweed, curly (<i>Potamogeton crispus</i>)	-	-	11.4 ± 2.4	1.0 ± 0.2	6.0 ± 3.4	0.4 ± 0.2
pondweed, flatstem (<i>P. zosteriformis</i>)	-	-	6.8 ± 1.9	0.7 ± 0.2	8.0 ± 3.9	0.8 ± 0.4
pondweed, horned (<i>Zannichellia palustris</i>)	-	-	1.7 ± 1.0	0.2 ± 0.1	-	-
pondweed, leafy/small (<i>Potamogeton foliosus/</i> <i>pusillus</i>)	-	-	16.5 ± 2.8	1.9 ± 0.4	24.0 ± 6.1	3.1 ± 0.8
pondweed, longleaf (<i>P. nodosus</i>)	-	-	4.5 ± 1.6	0.6 ± 0.2	18.0 ± 5.5	1.8 ± 0.6
pondweed, Richardson's (<i>P. richardsonii</i>)	-	-	-	-	-	-
pondweed, sago (<i>P. pectinatus</i>)	11.0 ± 3.1	1.1 ± 0.3	15.3 ± 2.7	1.8 ± 0.4	52.0 ± 7.1	7.6 ± 1.1
stargrass, water (<i>Heteranthera dubia</i>)	-	-	37.5 ± 3.7	4.6 ± 0.5	10.0 ± 4.3	1.4 ± 0.6
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	-	-	23.9 ± 3.2	2.7 ± 0.4	2.0 ± 2.0	0.1 ± 0.1
waternymph, nodding (<i>Najas flexilis</i>)	-	-	9.1 ± 2.2	0.9 ± 0.2	-	-

Table 2. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

waterweed, Canadian (<i>Elodea canadensis</i>)	-	-	27.3 ± 3.4	3.2 ± 0.4	28.0 ± 6.4	3.6 ± 0.9
wildcelery (<i>Vallisneria americana</i>)	-	-	30.1 ± 3.5	4.6 ± 0.6	4.0 ± 2.8	0.4 ± 0.3
all submersed species	14.0 ± 3.5	1.3 ± 0.4	71.0 ± 3.4	12.0 ± 0.7	76.0 ± 6.1	15.1 ± 1.7
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	-	-	3.4 ± 1.4	0.8 ± 0.4	-	-
waterlily, white (<i>Nymphaea odorata</i>)	3.0 ± 1.7	0.3 ± 0.2	13.1 ± 2.5	2.6 ± 0.7	50.0 ± 7.1	5.0 ± 0.7
all rooted floating-leaf species	3.0 ± 1.7	0.3 ± 0.2	15.9 ± 2.8	3.3 ± 0.8	50.0 ± 7.1	5.0 ± 0.7

Table 2. Continued.

Common name (Scientific name)	Lake Pepin, upper <i>n</i> = 75		Lake Pepin, lower <i>n</i> = 75		Main channel border, upper <i>n</i> = 30	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common (<i>Utricularia macrorhiza</i>)	-	-	-	-	-	-
buttercup, longbeak (<i>Ranunculus longirostris</i>)	-	-	-	-	-	-
chara (<i>Chara</i> spp.)	-	-	-	-	-	-
coontail (<i>Ceratophyllum demersum</i>)	1.3 ± 1.3	0.1 ± 0.1	-	-	3.3 ± 3.3	0.4 ± 0.4
pondweed, curly (<i>Potamogeton crispus</i>)	-	-	-	-	-	-
pondweed, flatstem (<i>P. zosteriformis</i>)	-	-	-	-	-	-
pondweed, horned (<i>Zannichellia palustris</i>)	-	-	-	-	-	-
pondweed, leafy/small (<i>Potamogeton foliosus/pusillus</i>)	-	-	2.7 ± 1.9	0.3 ± 0.3	-	-
pondweed, longleaf (<i>P. nodosus</i>)	-	-	-	-	-	-
pondweed, Richardson's (<i>P. richardsonii</i>)	-	-	1.3 ± 1.3	0.1 ± 0.1	-	-
pondweed, sago (<i>P. pectinatus</i>)	2.7 ± 1.9	0.2 ± 0.2	10.7 ± 3.6	1.2 ± 0.4	-	-
stargrass, water (<i>Heteranthera dubia</i>)	1.3 ± 1.3	0.1 ± 0.1	17.3 ± 4.4	2.3 ± 0.6	-	-

Table 2. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	-	-	-	-	-	-
waternymph, nodding (<i>Najas flexilis</i>)	-	-	25.3 ± 5.1	4.0 ± 0.8	-	-
waterweed, Canadian (<i>Elodea canadensis</i>)	-	-	6.7 ± 2.9	0.7 ± 0.3	-	-
wildcelery (<i>Vallisneria americana</i>)	-	-	12.0 ± 3.8	1.3 ± 0.5	-	-
all submersed species	5.3 ± 2.6	0.4 ± 0.2	41.3 ± 5.7	5.9 ± 0.9	3.3 ± 3.3	0.4 ± 0.4
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	-	-	-	-	-	-
waterlily, white (<i>Nymphaea odorata</i>)	-	-	-	-	-	-
all rooted floating-leaf species	-	-	-	-	-	-

Table 2. Continued.

Common name (Scientific name)	Main channel border, lower <i>n</i> = 40		Secondary channel, upper <i>n</i> = 40		Secondary channel, lower <i>n</i> = 60	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common (<i>Utricularia macrorhiza</i>)	-	-	-	-	-	-
buttercup, longbeak (<i>Ranunculus longirostris</i>)	-	-	-	-	-	-
chara (<i>Chara</i> spp.)	-	-	-	-	-	-
coontail (<i>Ceratophyllum demersum</i>)	5.0 ± 3.5	0.5 ± 0.4	-	-	20.0 ± 5.2	1.8 ± 0.5
pondweed, curly (<i>Potamogeton crispus</i>)	7.5 ± 4.2	0.7 ± 0.4	-	-	11.7 ± 4.2	1.6 ± 0.6
pondweed, flatstem (<i>P. zosteriformis</i>)	-	-	-	-	3.3 ± 2.3	0.2 ± 0.2
pondweed, horned (<i>Zannichellia palustris</i>)	-	-	-	-	-	-
pondweed, leafy/small (<i>Potamogeton foliosus</i> / <i>pusillus</i>)	5.0 ± 3.5	0.7 ± 0.5	-	-	1.7 ± 1.7	0.1 ± 0.1
pondweed, longleaf (<i>P. nodosus</i>)	-	-	-	-	-	-

Table 2. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

pondweed, Richardson's (<i>P. richardsonii</i>)	2.5 ± 2.5	0.3 ± 0.3	-	-	-	-
pondweed, sago (<i>P. pectinatus</i>)	10.0 ± 4.8	1.7 ± 1.0	-	-	11.7 ± 4.2	1.2 ± 0.5
stargrass, water (<i>Heteranthera dubia</i>)	17.5 ± 6.1	2.1 ± 0.8	-	-	26.7 ± 5.8	3.6 ± 0.9
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	-	-	-	-	5.0 ± 2.8	0.5 ± 0.3
waternymph, nodding (<i>Najas flexilis</i>)	-	-	-	-	1.7 ± 1.7	0.1 ± 0.1
waterweed, Canadian (<i>Elodea canadensis</i>)	15.0 ± 5.7	1.5 ± 0.6	-	-	16.7 ± 4.9	2.2 ± 0.7
wildcelery (<i>Vallisneria americana</i>)	20.0 ± 6.4	4.0 ± 1.4	-	-	25.0 ± 5.6	3.9 ± 0.9
all submersed species	22.5 ± 6.7	4.9 ± 1.5	-	-	31.7 ± 6.1	5.2 ± 1.1
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	-	-	-	-	-	-
waterlily, white (<i>Nymphaea odorata</i>)	-	-	-	-	1.7 ± 1.7	0.2 ± 0.2
all rooted floating-leaf species	-	-	-	-	1.7 ± 1.7	0.2 ± 0.2

Table 2. Continued.

Common name (Scientific name)	Pool 4, upper <i>n</i> = 245		Pool 4, lower <i>n</i> = 351		Pool 4 <i>n</i> = 646	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common (<i>Utricularia macrorhiza</i>)	-	-	-	-	0.1 ± 0.1	<0.1 ± <0.1
buttercup, longbeak (<i>Ranunculus longirostris</i>)	-	-	-	-	0.1 ± 0.1	<0.1 ± <0.1
chara (<i>Chara</i> spp.)	-	-	0.7 ± 0.5	0.1 ± 0.1	0.6 ± 0.3	0.1 ± <0.1
coontail (<i>Ceratophyllum demersum</i>)	1.7 ± 0.9	0.1 ± 0.1	29.6 ± 2.4	4.1 ± 0.4	19.4 ± 1.4	2.8 ± 0.1
pondweed, curly (<i>Potamogeton crispus</i>)	-	-	9.1 ± 1.6	0.9 ± 0.2	5.1 ± 0.9	0.5 ± 0.1
pondweed, flatstem (<i>P. zosteriformis</i>)	-	-	4.6 ± 1.2	0.5 ± 0.1	2.8 ± 0.7	0.3 ± 0.1
pondweed, horned (<i>Zannichellia palustris</i>)	-	-	1.1 ± 0.6	0.1 ± 0.1	0.6 ± 0.3	0.1 ± <0.1

Table 2. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

pondweed, leafy/small (<i>Potamogeton foliosus/pusillus</i>)	-	-	11.3 ± 1.8	1.3 ± 0.2	7.1 ± 1.0	0.9 ± 0.1
pondweed, longleaf (<i>P. nodosus</i>)	-	-	2.8 ± 1.0	0.4 ± 0.1	2.3 ± 0.6	0.3 ± 0.1
pondweed, Richardson's (<i>P. richardsonii</i>)	-	-	0.4 ± 0.3	<0.1 ± <0.1	0.2 ± 0.2	<0.1 ± <0.1
pondweed, sago (<i>P. pectinatus</i>)	4.5 ± 1.4	0.4 ± 0.1	13.6 ± 1.9	1.6 ± 0.3	11.5 ± 1.2	1.4 ± 0.2
stargrass, water (<i>Heteranthera dubia</i>)	0.8 ± 0.8	0.1 ± 0.1	31.0 ± 2.5	3.9 ± 0.4	17.4 ± 1.4	2.2 ± 0.2
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	-	-	15.4 ± 2.0	1.8 ± 0.3	8.4 ± 1.2	1.0 ± 0.1
waternymph, nodding (<i>Najas flexilis</i>)	-	-	10.3 ± 1.6	1.2 ± 0.2	5.5 ± 0.9	0.7 ± 0.1
waterweed, Canadian (<i>Elodea canadensis</i>)	-	-	21.4 ± 2.3	2.5 ± 0.3	12.7 ± 1.3	1.5 ± 0.2
wildcelery (<i>Vallisneria americana</i>)	-	-	25.5 ± 2.4	3.9 ± 0.4	13.9 ± 1.3	2.1 ± 0.2
all submersed species	7.0 ± 1.8	0.6 ± 0.2	57.1 ± 2.5	9.6 ± 0.5	36.9 ± 1.6	6.0 ± 0.3
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	-	-	2.1 ± 0.9	0.5 ± 0.3	1.1 ± 0.1	0.3 ± 0.1
waterlily, white (<i>Nymphaea odorata</i>)	0.8 ± 0.6	0.1 ± <0.1	8.3 ± 1.6	1.6 ± 0.4	7.0 ± 0.9	1.1 ± 0.2
all rooted floating-leaf species	0.8 ± 0.6	0.1 ± <0.1	10.1 ± 1.7	2.1 ± 0.5	7.9 ± 1.0	1.3 ± 0.3

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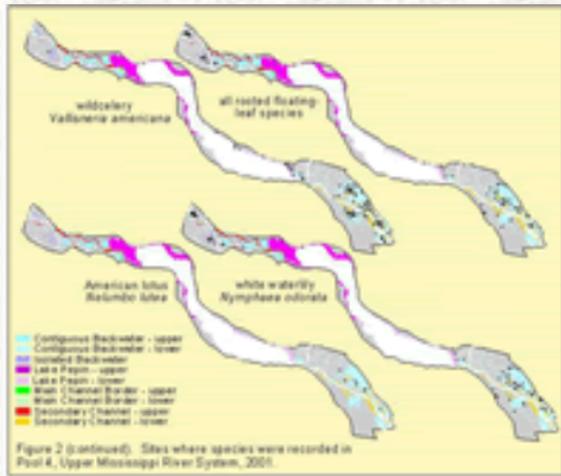
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Figure 2. Sites where species were recorded in Pool 4, Upper Mississippi River System, 2001.

Image Preview	Figure - Description
<p>Figure 2. Sites where species were recorded in Pool 4, Upper Mississippi River System, 2001.</p>	<p>Figure 2. Sites where species were recorded in Pool 4, Upper Mississippi River System, 2001. Species: all submersed species, common bladderwort (<i>Utricularia macrorhiza</i>), longbeak buttercup (<i>Ranunculus longirostris</i>), <i>Chara</i> spp., coontail (<i>Ceratophyllum demersum</i>), and horned pondweed (<i>Zannichellia palustris</i>).</p>
<p>Figure 2 (continued). Sites where species were recorded in Pool 4, Upper Mississippi River System, 2001.</p>	<p>Figure 2. Continued. Species: curly pondweed (<i>Potamogeton crispus</i>), flatstem pondweed (<i>P. zosteriformis</i>), leafy/small pondweed (<i>P. foliosus/pusillus</i>), longleaf pondweed (<i>P. nodosus</i>), Richardson's pondweed (<i>P. richardsonii</i>), and sago pondweed (<i>P. pectinatus</i>).</p>
<p>Figure 2 (continued). Sites where species were recorded in Pool 4, Upper Mississippi River System, 2001.</p>	<p>Figure 2. Continued. Species: water stargrass (<i>Heteranthera dubia</i>), Eurasian watermilfoil (<i>Myriophyllum spicatum</i>), nodding water nymph (<i>Najas flexilis</i>), and Canadian waterweed (<i>Elodea canadensis</i>).</p>



[Figure 2](#). Continued. Species: wildcelery (*Vallisneria americana*), all rooted floating–leaf species, American lotus (*Nelumbo lutea*), and white waterlily (*Nymphaea odorata*).

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2001 Results in Pool 8 of the Upper Mississippi River

Sampling Efforts

Sampling was conducted from June 15 to July 25, 2001. Of the 670 sites targeted, all were sampled ([Figure 3](#)). A drawdown was conducted in Pool 8 in 2001. It began on July 8 and was terminated on September 17, 2001.

Submersed Aquatic Vegetation

The status of SAV in Pool 8 varied among the strata sampled. Isolated backwaters had the highest abundance of SAV ([Table 3](#); [Figure 4](#)). Contiguous backwaters, impounded areas, main channel border areas, and secondary channels followed in decreasing order. Beds of aquatic vegetation were found throughout most of the shallow water areas, except in the lower fifth of the pool where beds were generally absent. The SAV covered approximately 48% of the shallow water areas poolwide.

A total of 15 species were recorded in Pool 8. Except the main channel border areas, each of the other four strata sampled harbored a rich assemblage of submersed plant species (ten or more species). Main channel border areas had a moderate assemblage of species (8). Coontail, Canadian waterweed, water stargrass, and sago pondweed were the most abundant species recorded.

Rooted Floating–Leaf Vegetation

White waterlily, American lotus, and yellow pond-lily were the three rooted floating-leaf species recorded. The percent cover of rooted floating–leaf species was the highest in the isolated backwaters. White waterlily and American lotus was scattered over much of the pool, while yellow pond-lily had a much more limited distribution. The three species together covered approximately 4% of the shallow water areas.

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Table 3. Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 8, Upper Mississippi River System, 2001.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 175		Isolated backwater <i>n</i> = 50		Impounded <i>n</i> = 225	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common (<i>Utricularia macrorhiza</i>)	5.1 ± 1.7	0.5 ± 0.2	14.0 ± 5.0	1.4 ± 0.5	-	-
chara (<i>Chara</i> spp.)	-	-	8.0 ± 3.9	0.8 ± 0.4	-	-
coontail (<i>Ceratophyllum demersum</i>)	63.4 ± 3.7	9.2 ± 0.7	92.0 ± 3.9	21.0 ± 1.8	11.1 ± 2.1	1.2 ± 0.3
pondweed, curly (<i>Potamogeton crispus</i>)	20.6 ± 3.1	2.0 ± 0.3	14.0 ± 5.0	1.9 ± 0.8	4.9 ± 1.4	0.6 ± 0.2
pondweed, flatstem (<i>P. zosteriformis</i>)	21.7 ± 3.1	2.5 ± 0.4	16.0 ± 5.2	1.5 ± 0.5	0.4 ± 0.4	<0.1 ± <0.1
pondweed, horned (<i>Zannichellia palustris</i>)	-	-	-	-	-	-
pondweed, leafy/small (<i>Potamogeton foliosus/pusillus</i>)	32.0 ± 3.5	3.9 ± 0.5	46.0 ± 7.1	6.9 ± 1.2	3.6 ± 1.2	0.4 ± 0.1
pondweed, longleaf (<i>P. nodosus</i>)	3.4 ± 1.4	0.4 ± 0.2	-	-	1.8 ± 0.9	0.2 ± 0.1
pondweed, Richardson's (<i>P. richardsonii</i>)	-	-	-	-	-	-
pondweed, sago (<i>P. pectinatus</i>)	28.6 ± 3.4	3.5 ± 0.5	20.0 ± 5.7	2.6 ± 0.8	13.3 ± 2.3	1.7 ± 0.3
stargrass, water (<i>Heteranthera dubia</i>)	16.6 ± 2.8	1.6 ± 0.3	4.0 ± 2.8	0.6 ± 0.4	25.3 ± 2.9	3.2 ± 0.4
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	9.1 ± 2.2	0.8 ± 0.2	-	-	5.3 ± 1.5	0.6 ± 0.2
waternymph, nodding (<i>Najas flexilis</i>)	1.7 ± 1.0	0.2 ± 0.1	12.0 ± 4.6	1.4 ± 0.6	0.4 ± 0.4	0.1 ± 0.1
waterweed, Canadian (<i>Elodea canadensis</i>)	38.9 ± 3.7	4.4 ± 0.5	42.0 ± 7.1	7.5 ± 1.4	12.4 ± 2.2	1.8 ± 0.4

Table 3. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

wildcelery (<i>Vallisneria americana</i>)	6.9 ± 1.9	0.7 ± 0.2	-	-	20.9 ± 2.7	3.1 ± 0.4
all submersed species	76.0 ± 3.2	12.6 ± 0.7	92.0 ± 3.9	21.8 ± 1.9	36.9 ± 3.2	5.8 ± 0.6
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	9.1 ± 2.2	1.3 ± 0.4	2.0 ± 2.0	0.2 ± 0.2	4.0 ± 1.3	0.7 ± 0.3
pond-lily, yellow (<i>Nuphar variegata</i>)	2.9 ± 1.3	0.3 ± 0.1	6.0 ± 3.4	1.8 ± 1.4	-	-
waterlily, white (<i>Nymphaea odorata</i>)	24.0 ± 3.2	6.7 ± 1.2	70.0 ± 6.5	41.8 ± 5.4	2.7 ± 1.1	0.3 ± 0.1
all rooted floating-leaf species	39.7 ± 3.5	8.2 ± 1.3	72.0 ± 6.4	43.6 ± 5.3	6.2 ± 1.6	0.9 ± 0.3

Table 3. Continued.

Common name (Scientific name)	Main channel border <i>n</i> = 100		Secondary channel <i>n</i> = 120		Pool 8 <i>n</i> = 670	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common (<i>Utricularia macrorhiza</i>)	-	-	-	-	2.0 ± 0.5	0.2 ± 0.1
chara (<i>Chara</i> spp.)	-	-	-	-	0.3 ± 0.1	<0.1 ± <0.1
coontail (<i>Ceratophyllum demersum</i>)	10.0 ± 3.0	0.9 ± 0.3	13.3 ± 3.1	1.7 ± 0.4	29.2 ± 1.5	4.3 ± 0.2
pondweed, curly (<i>Potamogeton crispus</i>)	2.0 ± 1.4	0.2 ± 0.1	4.2 ± 1.8	0.5 ± 0.2	9.4 ± 1.2	1.0 ± 0.1
pondweed, flatstem (<i>P. zosteriformis</i>)	1.0 ± 1.0	0.1 ± 0.1	4.2 ± 1.8	0.4 ± 0.2	7.6 ± 1.0	0.8 ± 0.1
pondweed, horned (<i>Zannichellia palustris</i>)	-	-	0.8 ± 0.8	0.1 ± 0.1	0.1 ± 0.1	<0.1 ± <0.1
pondweed, leafy/small (<i>Potamogeton foliosus/</i> <i>pusillus</i>)	-	-	8.3 ± 2.5	1.1 ± 0.4	13.7 ± 1.3	1.7 ± 0.2
pondweed, longleaf (<i>P. nodosus</i>)	-	-	2.5 ± 1.4	0.3 ± 0.2	2.2 ± 0.6	0.2 ± 0.1
pondweed, Richardson's (<i>P. richardsonii</i>)	1.0 ± 1.0	0.1 ± 0.1	-	-	<0.1 ± <0.1	<0.1 ± <0.1
pondweed, sago (<i>P. pectinatus</i>)	12.0 ± 3.3	2.0 ± 0.7	10.0 ± 2.8	1.2 ± 0.4	17.3 ± 1.6	2.2 ± 0.2
stargrass, water (<i>Heteranthera dubia</i>)	7.0 ± 2.6	0.8 ± 0.3	7.5 ± 2.4	0.6 ± 0.2	18.8 ± 1.7	2.2 ± 0.2
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	-	-	2.5 ± 1.4	0.2 ± 0.1	5.6 ± 1.0	0.6 ± 0.1

Table 3. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

waternymph, nodding (<i>Najas flexilis</i>)	-	-	0.8 ± 0.8	0.2 ± 0.2	1.3 ± 0.4	0.2 ± 0.1
waterweed, Canadian (<i>Elodea canadensis</i>)	2.0 ± 1.4	0.1 ± 0.1	8.3 ± 2.5	0.9 ± 0.3	20.0 ± 1.6	2.6 ± 0.2
wildcelery (<i>Vallisneria americana</i>)	7.0 ± 2.6	1.0 ± 0.4	7.5 ± 2.4	0.9 ± 0.3	13.7 ± 1.5	1.9 ± 0.2
all submersed species	24.0 ± 4.3	3.5 ± 0.8	22.5 ± 3.8	3.1 ± 0.6	47.5 ± 1.9	7.8 ± 0.4
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	3.0 ± 1.7	1.9 ± 1.2	4.2 ± 1.8	0.4 ± 0.2	5.4 ± 0.9	0.8 ± 0.2
pond-lily, yellow (<i>Nuphar variegata</i>)	-	-	-	-	1.0 ± 0.4	0.1 ± 0.1
waterlily, white (<i>Nymphaea odorata</i>)	-	-	3.3 ± 1.6	0.3 ± 0.2	11.2 ± 1.1	3.7 ± 0.4
all rooted floating-leaf species	3.0 ± 1.7	1.9 ± 1.2	5.8 ± 2.1	0.6 ± 0.2	15.2 ± 1.3	4.6 ± 0.5

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Figure 4. Sites where species were recorded in Pool 8, Upper Mississippi River System, 2001.

Image Preview	Figure - Description
<p>Figure 4 (continued). Sites where species were recorded in Pool 8, Upper Mississippi River System, 2001.</p>	<p>Figure 4. Species: all submersed species, common bladderwort (<i>Utricularia macrorhiza</i>), <i>Chara</i> spp., coontail (<i>Ceratophyllum demersum</i>), horned pondweed (<i>Zannichellia palustris</i>), and curly pondweed (<i>Potamogeton crispus</i>).</p>
<p>Figure 4 (continued). Sites where species were recorded in Pool 8, Upper Mississippi River System, 2001.</p>	<p>Figure 4. Continued. Species: flatstem pondweed (<i>Potamogeton zosteriformis</i>), leafy/small pondweed (<i>P. foliosus/pusillus</i>), longleaf pondweed (<i>P. nodosus</i>), Richardson's pondweed (<i>P. richardsonii</i>), sago pondweed (<i>P. pectinatus</i>), water stargrass (<i>Heteranthera dubia</i>), and Eurasian watermilfoil (<i>Myriophyllum spicatum</i>).</p>
<p>Figure 4 (continued). Sites where species were recorded in Pool 8, Upper Mississippi River System, 2001.</p>	<p>Figure 4. Continued. Species: nodding waterlily (<i>Najas flexilis</i>), Canadian waterweed (<i>Elodea canadensis</i>), wildcelery (<i>Vallisneria spiralis</i>), all rooted floating-leaf species, American lotus (<i>Nelumbo lutea</i>), yellow pond-lily (<i>Nuphar variegata</i>), and white waterlily (<i>Nymphaea odorata</i>).</p>



2001 Results in Pool 11 of the Upper Mississippi River

Sampling Efforts

Sampling was conducted from June 25 to July 25, 2001. Of the 568 sites targeted, 564 were sampled ([Figure 5](#)).

Submersed Aquatic Vegetation

Submersed aquatic vegetation (SAV) was found at low frequencies poolwide compared to Pools 4, 8, and 13. The only exception was isolated backwaters where SAV was present in 73.3% of sampled sites ([Table 4](#); [Figure 6](#)). The SAV was present in 26.2% of contiguous backwater sites and present between 9% and 12% in impounded, main channel border, and secondary channel areas.

A total of 13 submersed aquatic species were found in Pool 11, with the highest species richness occurring in contiguous backwater and isolated areas. Sago pondweed was the most abundant species poolwide (9.2%), followed by coontail (9.1%), and Eurasian watermilfoil (2.3%). The SAV was notably sparse in the lower pool (downstream from river mile 593), as 14% of sites were too deep to sample.

Rooted Floating–Leaf Vegetation

White waterlily, American lotus, and yellow pond-lily were the rooted floating–leaf species recorded in Pool 11. Rooted floating–leaf species were sparse poolwide, covering only 1.7% of sampled aquatic areas. Percent cover and frequency were highest in isolated backwaters (8% and 46.7%, respectively). Of the three species recorded, the American lotus and white waterlily were most abundant. Yellow pond-lily was found at only 0.2% of sites poolwide.

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Table 4. Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 11, Upper Mississippi River System, 2001.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 129		Isolated backwater <i>n</i> = 15		Impounded <i>n</i> = 204	
	Freq	AI	Freq	AI	Freq	AI
chara (<i>Chara</i> spp.)	-	-	13.3± 9.1	1.2 ± 0.8	-	-
coontail (<i>Ceratophyllum demersum</i>)	20.2 ± 3.5	2.4 ± 0.5	73.3 ± 11.8	19.7 ± 6.2	3.9 ± 1.4	0.5 ± 0.2
pondweed, curly (<i>Potamogeton crispus</i>)	0.8 ± 0.8	0.1 ± 0.1	-	-	1.5± 0.8	0.1 ± 0.1
pondweed, flatstem (<i>P. zosteriformis</i>)	0.8 ± 0.8	0.1 ± 0.1	6.7± 6.7	1.1 ± 1.1	1.0± 0.7	0.1 ± 0.1
pondweed, leafy/small (<i>P. foliosus/pusillus</i>)	2.3 ± 1.3	0.2 ± 0.1	20.0 ± 10.7	2.2 ± 1.3	-	-
pondweed, longleaf (<i>P. nodosus</i>)	1.6 ± 1.1	0.2 ± 0.2	6.7 ± 6.7	1.1 ± 1.1	0.5 ± 0.5	0.1 ± 0.1
pondweed, sago (<i>P. pectinatus</i>)	10.1 ± 2.7	1.1 ± 0.3	46.7 ± 13.3	6.0 ± 2.1	9.8 ± 2.1	1.4 ± 0.3
stargrass, water (<i>Heteranthera dubia</i>)	-	-	-	-	-	-
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	1.6 ± 1.1	0.2 ± 0.1	6.7± 6.7	1.1 ± 1.1	1.5 ± 0.8	0.1 ± 0.1
waternymph, nodding (<i>Najas flexilis</i>)	-	-	13.3 ± 9.1	2.4 ± 1.8	-	-
waternymph, southern (<i>N. guadalupensis</i>)	3.9 ± 1.7	0.5 ± 0.2	20.0 ± 10.7	2.8 ± 1.5	-	-
waterweed, Canadian (<i>Elodea canadensis</i>)	-	-	20.0 ± 10.7	2.3 ± 1.5	0.5 ± 0.5	<0.1 ± <0.1
wildcelery (<i>Vallisneria americana</i>)	0.8 ± 0.8	0.1 ± 0.1	-	-	2.0 ± 1.0	0.2 ± 0.1
all submersed species	26.4 ± 3.9	3.5 ± 0.6	73.3 ± 11.8	21.8 ± 6.1	11.8 ± 2.3	1.9 ± 0.4
	Freq	Cover	Freq	Cover	Freq	Cover

Table 4. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

lotus, American (<i>Nelumbo lutea</i>)	16.3 ± 3.3	3.0 ± 0.9	26.7 ± 11.8	6.7 ± 4.6	3.4 ± 1.3	0.5 ± 0.2
pond-lily, yellow (<i>Nuphar variegata</i>)	0.8 ± 0.8	0.1 ± 0.1	-	-	-	-
waterlily, white (<i>Nymphaea odorata</i>)	13.2 ± 3.0	4.0 ± 1.1	33.3 ± 12.6	7.3 ± 3.7	0.5 ± 0.5	0.1 ± 0.1
all rooted floating-leaf species	20.9 ± 3.6	8.4 ± 1.7	46.7 ± 13.3	14.0 ± 5.9	3.4 ± 1.3	0.7 ± 0.3

Table 4. Continued.

Common name (Scientific name)	Main channel border <i>n</i> = 139		Secondary channel <i>n</i> = 77		Pool 11 <i>n</i> = 564	
	Freq	AI	Freq	AI	Freq	AI
chara (<i>Chara</i> spp.)	-	-	-	-	0.3 ± 0.2	<0.1 ± <0.1
coontail (<i>Ceratophyllum demersum</i>)	1.4 ± 1.0	0.2 ± 0.1	7.8 ± 3.1	1.0 ± 0.4	9.1 ± 1.1	1.4 ± 0.2
pondweed, curly (<i>Potamogeton crispus</i>)	-	-	1.3 ± 1.3	0.1 ± 0.1	0.8 ± 0.3	0.1 ± <0.1
pondweed, flatstem (<i>P. zosteriformis</i>)	-	-	-	-	0.7 ± 0.3	0.1 ± <0.1
pondweed, leafy/small (<i>P. foliosus</i> / <i>pusillus</i>)	-	-	-	-	1.1 ± 0.4	0.1 ± <0.1
pondweed, longleaf (<i>P. nodosus</i>)	-	-	1.3 ± 1.3	0.1 ± 0.1	0.8 ± 0.4	0.1 ± 0.1
pondweed, sago (<i>P. pectinatus</i>)	7.9 ± 2.3	1.0 ± 0.3	-	-	9.3 ± 1.2	1.2 ± 0.2
stargrass, water (<i>Heteranthera dubia</i>)	2.2 ± 1.2	0.1 ± 0.1	-	-	0.7 ± 0.4	<0.1 ± <0.1
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	2.9 ± 1.4	0.3 ± 0.1	3.9 ± 2.2	0.3 ± 0.2	2.3 ± 0.7	0.2 ± 0.1
waternymph, nodding (<i>Najas flexilis</i>)	-	-	-	-	0.3 ± 0.2	0.1 ± <0.1
waternymph, southern (<i>N. guadalupensis</i>)	-	-	-	-	1.4 ± 0.5	0.2 ± 0.1
waterweed, Canadian (<i>Elodea canadensis</i>)	0.7 ± 0.7	0.1 ± 0.1	-	-	0.9 ± 0.4	0.1 ± 0.1
wildcelery (<i>Vallisneria americana</i>)	3.6 ± 1.6	0.5 ± 0.2	1.3 ± 1.3	0.1 ± 0.1	2.1 ± 0.6	0.2 ± 0.1
all submersed species	10.8 ± 2.6	1.3 ± 0.4	9.1 ± 3.3	1.2 ± 0.5	16.3 ± 1.5	2.5 ± 0.3
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	-	-	1.3 ± 1.3	0.1 ± 0.1	5.8 ± 0.9	1.1 ± 0.3

Table 4. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

pond-lily, yellow (<i>Nuphar variegata</i>)	-	-	-	-	0.2 ± 0.2	<0.1 ± <0.1
waterlily, white (<i>Nymphaea odorata</i>)	-	-	2.6 ± 1.8	1.3 ± 1.0	4.4 ± 0.8	1.3 ± 0.3
all rooted floating-leaf species	-	-	2.6 ± 1.8	1.3 ± 1.0	7.5 ± 1.0	2.7 ± 0.5

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Figure 6. Aquatic area strata and sampling points in Pool 11, Upper Mississippi River System, 2001.

Image Preview	Figure - Description
	<p>Figure 6. Species: all submerged species, <i>Chara</i> spp., coontail (<i>Ceratophyllum demersum</i>), curly pondweed (<i>Potamogeton crispus</i>), flatstem pondweed (<i>P. zosteriformis</i>), and leafy/small pondweed (<i>P. foliosus/pusillus</i>).</p>
	<p>Figure 6. Continued. Species: longleaf pondweed (<i>Potamogeton nodosus</i>), sago pondweed (<i>P. pectinatus</i>), water stargrass (<i>Heteranthera dubia</i>), Eurasian watermilfoil (<i>Myriophyllum spicatum</i>), nodding waterlily (<i>Najas flexilis</i>), and southern waterlily (<i>N. guadalupensis</i>).</p>
	<p>Figure 6. Continued. Species: Canadian waterweed (<i>Elodea canadensis</i>), wild celery (<i>Vallisneria spiralis</i>), all rooted floating-leaf species, American lotus (<i>Nelumbo lutea</i>), yellow pond-lily (<i>Nuphar variegata</i>), and white waterlily (<i>Nymphaea odorata</i>).</p>



2001 Results in Pool 13 of the Upper Mississippi River

Sampling Efforts

Sampling was conducted in a total of 31 working days from June 15, to August 6, 2001. Of the 610 sites targeted, 606 sites were sampled ([Figure 7](#)). A 1-ft drawdown was begun July 9 and ended July 12, 2001, because of inability to maintain the minimum water level needed to keep the 9-ft channel agreement.

Submersed Aquatic Vegetation

The abundance and frequency of submersed aquatic vegetation (SAV) in Pool 13 varied among strata sampled. The SAV was encountered most often in the isolated backwater areas (58%), followed by contiguous backwaters and the impounded area. ([Table 5](#); [Figure 8](#)). The SAV was sampled rarely in the secondary channels (14%) and main channel border areas (10%). The SAV covered about 42% of the shallow water areas poolwide.

A total of 12 species of SAV were collected in the pool. Contiguous backwaters and impounded areas had rich assemblages of plant species (10 or more species). The main channel border, secondary channel, and isolated backwater sites contained the least number of species (four, five, and six, respectively). Coontail was the dominant species in Pool 13, followed by sago pondweed. Wildcelery was dominant in the impounded area. Eurasian watermilfoil was not present in either isolated backwater or secondary channel sites.

Rooted Floating–Leaf Vegetation

American lotus and white waterlily were the only two rooted floating–leaf species encountered in Pool 13. American lotus was sampled at all but the main channel border sites and was much more abundant than white waterlily. White waterlily was sampled only in contiguous and isolated backwater and impounded sites. The two species together covered about 9% of the shallow water areas or areas where water depth

measured 3 m or less at flat pool.

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Table 5. Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 13, Upper Mississippi River System, 2001.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 198		Isolated backwater <i>n</i> = 59		Impounded <i>n</i> = 209	
	Freq	AI	Freq	AI	Freq	AI
coontail (<i>Ceratophyllum demersum</i>)	47.0 ± 3.6	9.4 ± 1.0	55.9 ± 6.5	9.5 ± 1.7	16.3 ± 2.6	3.2 ± 0.6
pondweed, curly (<i>Potamogeton crispus</i>)	11.1 ± 2.2	1.5 ± 0.3	-	-	2.4 ± 1.1	0.3 ± 0.1
pondweed, flatstem (<i>P. zosteriformis</i>)	0.5 ± 0.5	<0.1 ± <0.1	3.4 ± 2.4	0.3 ± 0.2	-	-
pondweed, leafy/small (<i>P. foliosus/pusillus</i>)	14.1 ± 2.5	1.4 ± 0.3	6.8 ± 3.3	0.6 ± 0.3	3.3 ± 1.2	0.5 ± 0.2
pondweed, longleaf (<i>P. nodosus</i>)	6.6 ± 1.8	0.6 ± 0.2	1.7 ± 1.7	0.4 ± 0.4	6.7 ± 1.7	0.9 ± 0.3
pondweed, sago (<i>P. pectinatus</i>)	35.9 ± 3.4	5.9 ± 0.7	32.2 ± 6.1	4.6 ± 0.9	13.4 ± 2.4	2.0 ± 0.4
stargrass, water (<i>Heteranthera dubia</i>)	9.6 ± 2.1	1.0 ± 0.2	-	-	13.4 ± 2.4	1.7 ± 0.4
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	11.1 ± 2.2	1.2 ± 0.3	-	-	11.0 ± 2.2	1.3 ± 0.3
waternymph, nodding (<i>Najas flexilis</i>)	18.2 ± 2.7	2.4 ± 0.4	-	-	1.0 ± 0.7	0.2 ± 0.1
waternymph, southern (<i>N. guadalupensis</i>)	0.5 ± 0.5	<0.1 ± <0.1	-	-	3.8 ± 1.3	0.4 ± 0.1
waterweed, Canadian (<i>Elodea canadensis</i>)	11.1 ± 2.2	1.2 ± 0.3	5.1 ± 2.9	0.7 ± 0.4	4.8 ± 1.5	0.5 ± 0.2
wildcelery (<i>Vallisneria americana</i>)	5.1 ± 1.6	0.5 ± 0.2	-	-	27.8 ± 3.1	6.0 ± 0.8
all submersed species	55.6 ± 3.5	12.2 ± 1.1	57.6 ± 6.5	11.1 ± 1.7	38.3 ± 3.4	9.4 ± 1.0
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	37.9 ± 3.5	16.1 ± 2.1	11.9 ± 4.2	1.2 ± 0.4	15.8 ± 2.5	7.5 ± 1.5
waterlily, white (<i>Nymphaea odorata</i>)	9.6 ± 2.1	3.2 ± 0.9	5.1 ± 2.9	0.5 ± 0.3	7.7 ± 1.8	1.7 ± 0.6

all rooted floating–leaf species	39.9 ± 3.5	18.8 ± 2.3	15.3 ± 4.7	1.5 ± 0.5	17.2 ± 2.6	9.5 ± 1.8
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Table 5. Continued.

Common name (Scientific name)	Main channel border <i>n</i> = 70		Secondary channel <i>n</i> = 70		Pool 13 <i>n</i> = 606	
	Freq	AI	Freq	AI	Freq	AI
coontail (<i>Ceratophyllum demersum</i>)	-	-	5.7 ± 2.8	0.5 ± 0.3	27.5 ± 1.7	5.3 ± 0.5
pondweed, curly (<i>Potamogeton crispus</i>)	-	-	-	-	5.0 ± 0.9	0.6 ± 0.1
pondweed, flatstem (<i>P. zosteriformis</i>)	-	-	-	-	0.4 ± 0.2	<0.1 ± <0.1
pondweed, leafy/small (<i>P. foliosus/pusillus</i>)	-	-	-	-	6.9 ± 1.1	0.7 ± 0.1
pondweed, longleaf (<i>P. nodosus</i>)	-	-	1.4 ± 1.4	0.2 ± 0.2	5.5 ± 1.0	0.7 ± 0.1
pondweed, sago (<i>P. pectinatus</i>)	7.1 ± 3.1	1.0 ± 0.5	8.6 ± 3.4	0.8 ± 0.3	21.7 ± 1.7	3.4 ± 0.3
stargrass, water (<i>Heteranthera dubia</i>)	1.4 ± 1.4	0.1 ± 0.1	1.4 ± 1.4	0.1 ± 0.1	9.5 ± 1.3	1.1 ± 0.2
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	2.9 ± 2.0	0.3 ± 0.2	-	-	9.0 ± 1.2	1.0 ± 0.2
waternymph, nodding (<i>Najas flexilis</i>)	-	-	-	-	6.9 ± 1.0	0.9 ± 0.2
waternymph, southern (<i>N. guadalupensis</i>)	-	-	-	-	1.9 ± 0.6	0.2 ± 0.1
waterweed, Canadian (<i>Elodea canadensis</i>)	-	-	-	-	6.3 ± 1.0	0.7 ± 0.1
wildcelery (<i>Vallisneria americana</i>)	7.1 ± 3.1	1.4 ± 0.7	1.4 ± 1.4	0.1 ± 0.1	14.6 ± 1.5	2.9 ± 0.3
all submersed species	10.0 ± 3.6	1.9 ± 0.8	14.3 ± 4.2	1.5 ± 0.5	41.7 ± 2.0	9.4 ± 0.6
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	-	-	1.4 ± 1.4	0.4 ± 0.4	21.2 ± 1.7	9.1 ± 1.0
waterlily, white (<i>Nymphaea odorata</i>)	-	-	-	-	7.1 ± 1.1	1.9 ± 0.4
all rooted floating–leaf species	-	-	1.4 ± 1.4	0.4 ± 0.4	22.7 ± 1.7	11.0 ± 1.1

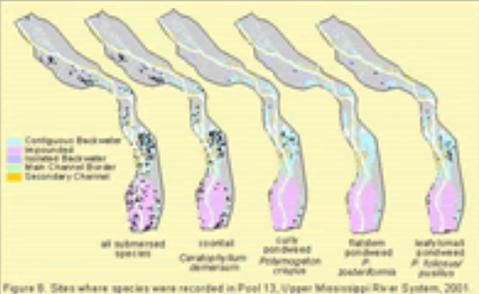
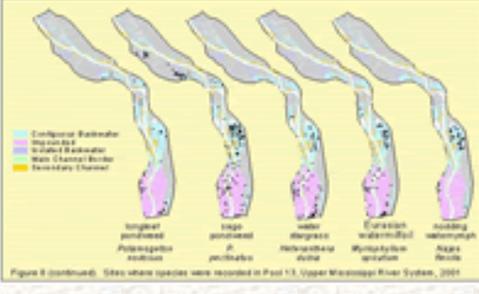
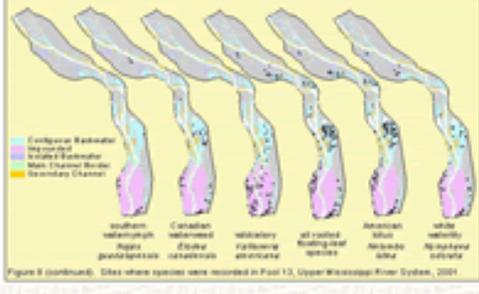


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Figure 8. Sites where species were recorded in Pool 13, Upper Mississippi River System, 2001.

Image Preview	Figure - Description
 <p>Figure 8. Sites where species were recorded in Pool 13, Upper Mississippi River System, 2001.</p>	<p>Figure 8. Species: all submersed species, coontail (<i>Ceratophyllum demersum</i>), curly pondweed (<i>Potamogeton crispus</i>), flatstem pondweed (<i>P. zosteriformis</i>), and leafy/small pondweed (<i>P. foliosus/pusillus</i>).</p>
 <p>Figure 8 (Continued). Sites where species were recorded in Pool 13, Upper Mississippi River System, 2001.</p>	<p>Figure 8. Continued. Species: longleaf pondweed (<i>Potamogeton nodosus</i>), sago pondweed (<i>P. pectinatus</i>), water stargrass (<i>Heteranthera dubia</i>), Eurasian watermilfoil (<i>Myriophyllum spicatum</i>), and nodding water nymph (<i>Najas flexilis</i>).</p>
 <p>Figure 8 (Continued). Sites where species were recorded in Pool 13, Upper Mississippi River System, 2001.</p>	<p>Figure 8. Continued. Species: southern water nymph (<i>Najas guadalupensis</i>), Canadian waterweed (<i>Elodea canadensis</i>), wildcelery (<i>Vallisneria americana</i>), all rooted floating-leaf species, American lotus (<i>Nelumbo lutea</i>), and white waterlily (<i>Nymphaea odorata</i>).</p>

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2001 Results in Pool 26 of the Upper Mississippi River

Sampling Efforts

Sampling in Pool 26 of the Upper Mississippi River System (UMRS) and lower Illinois River was conducted from June 15 to August 15, 2001. Of the 415 targeted sites, 413 were sampled ([Figure 9](#)).

Submersed Aquatic Vegetation

Six species of submersed aquatic vegetation (SAV) were sampled during the 2001 stratified random sampling episode from isolated backwaters of the lower Illinois River ([Table 6](#); [Figure 10](#)). Of the six species, coontail was the most common plant encountered followed by sago and longleaf pondweeds. The SAV was found in 11% of the isolated backwater sites.

Rooted Floating–Leaf Vegetation

Rooted floating–leaf vegetation was sampled from contiguous backwaters (3% frequency) and isolated backwaters of Pool 26 (UMRS; 2% frequency) and the lower Illinois River (11% frequency). Two species were recorded, American lotus and floating primrose-willow.

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Table 6. Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 26, Upper Mississippi River System, 2001.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 80		Isolated backwater, Illinois River <i>n</i> = 94		Isolated backwater, Mississippi River <i>n</i> = 60	
	Freq	AI	Freq	AI	Freq	AI
coontail (<i>Ceratophyllum demersum</i>)	-	-	3.2 ± 1.8	0.2 ± 0.1	-	-
pondweed, curly (<i>Potamogeton crispus</i>)	-	-	1.1 ± 1.1	0.1 ± 0.1	-	-
pondweed, longleaf (<i>P. nodosus</i>)	-	-	2.1 ± 1.5	0.3 ± 0.2	-	-
pondweed, sago (<i>P. pectinatus</i>)	-	-	2.1 ± 1.5	0.3 ± 0.2	-	-
waternymph, southern (<i>Najas guadalupensis</i>)	-	-	1.1 ± 1.1	0.2 ± 0.2	-	-
waterweed, Canadian (<i>Elodea canadensis</i>)	-	-	1.1 ± 1.1	0.1 ± 0.1	-	-
all submersed species	-	-	6.4 ± 2.5	0.8 ± 0.3	-	-
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	2.5 ± 1.8	0.5 ± 0.4	8.5 ± 2.9	3.8 ± 1.5	-	-
primrose-willow, floating (<i>Ludwigia peploides</i>)	-	-	5.3 ± 2.3	0.7 ± 0.4	1.7 ± 1.7	0.2 ± 0.2
all rooted floating-leaf species	2.5 ± 1.8	0.5 ± 0.4	10.6 ± 3.2	4.3 ± 1.6	1.7 ± 1.7	0.2 ± 0.2

Table 6. Continued.

Common name (Scientific name)	Impounded <i>n</i> = 40		Main channel border, Illinois River <i>n</i> = 40		Main channel border, Mississippi River <i>n</i> = 49	
	Freq	AI	Freq	AI	Freq	AI
coontail (<i>Ceratophyllum demersum</i>)	-	-	-	-	-	-

Table 6. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

pondweed, curly (<i>Potamogeton crispus</i>)	-	-	-	-	-	-
pondweed, longleaf (<i>P. nodosus</i>)	-	-	-	-	-	-
pondweed, sago (<i>P. pectinatus</i>)	-	-	-	-	-	-
waternymph, southern (<i>Najas guadalupensis</i>)	-	-	-	-	-	-
waterweed, Canadian (<i>Elodea canadensis</i>)	-	-	-	-	-	-
all submersed species	-	-	-	-	-	-
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	-	-	-	-	-	-
primrose-willow, floating (<i>Ludwigia peploides</i>)	-	-	-	-	-	-
all rooted floating-leaf species	-	-	-	-	-	-

Table 6. Continued.

Common name (Scientific name)	Secondary channel <i>n</i> = 50		Pool 26 <i>n</i> = 413	
	Freq	AI	Freq	AI
coontail (<i>Ceratophyllum demersum</i>)	-	-	1.2 ± 0.7	0.1 ± <0.1
pondweed, curly (<i>Potamogeton crispus</i>)	-	-	0.4 ± 0.4	<0.1 ± <0.1
pondweed, longleaf (<i>P. nodosus</i>)	-	-	0.8 ± 0.6	0.1 ± 0.1
pondweed, sago (<i>P. pectinatus</i>)	-	-	0.8 ± 0.6	0.1 ± 0.1
waternymph, southern (<i>Najas guadalupensis</i>)	-	-	0.4 ± 0.4	0.1 ± 0.1
waterweed, Canadian (<i>Elodea canadensis</i>)	-	-	0.4 ± 0.4	<0.1 ± <0.1
all submersed species	-	-	2.4 ± 1.0	0.3 ± 0.1
	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	-	-	3.3 ± 1.1	1.5 ± 0.5
primrose-willow, floating (<i>Ludwigia peploides</i>)	-	-	2.1 ± 0.9	0.3 ± 0.1

Table 6. Percent frequency, abundance index (AI), cover, and standard error...ed floating–leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

all rooted floating–leaf species	-	-	4.2 ± 1.2	1.6 ± 0.6
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Figure 10. Sites where species were recorded in Pool 26, Upper Mississippi River System, 2001.

Image Preview	Figure - Description
<p>Figure 10. Sites where species recorded in Pool 26, Upper Mississippi River System, 2001.</p>	<p>Figure 10. Species: all submersed species, coontail (<i>Ceratophyllum demersum</i>), curly pondweed (<i>Potamogeton crispus</i>), longleaf pondweed (<i>P. nodosus</i>), and sago pondweed (<i>P. pectinatus</i>).</p>
<p>Figure 10 (continued). Sites where species recorded in Pool 26, Upper Mississippi River System, 2001.</p>	<p>Figure 10. Continued. Species: southern waterlily (<i>Najas guadalupensis</i>), Canadian waterweed (<i>Elodea canadensis</i>), all rooted floating-leaf species, American lotus (<i>Nelumbo lutea</i>), and floating primrose-willow (<i>Ludwigia peploides</i>).</p>

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2001 Results in La Grange Pool of the Illinois River

Sampling Efforts

Stratified random sampling (SRS) for La Grange Pool was conducted from June 9 to August 17, 2001. Of the 430 sites targeted, 414 sites were sampled ([Figure 11](#)).

Submersed Aquatic Vegetation

The status of submersed aquatic vegetation (SAV) in La Grange Pool again varied highly between contiguous strata of the river proper and nonconnected, isolated floodplain lakes^[1] as it did in 2000. River stage near Havana was at or above flood stage through most of June. Contiguous and isolated backwaters, main channel borders, and side channels had 0% coverage of SAV recorded during SRS ([Table 7](#); [Figure 12](#)). Several medium-sized beds of coontail were observed while conducting an informal survey, but no sites fell within an SRS area. While at present, the river proper supports little SAV, isolated floodplain lake SAV was present in 77 % of the samples.

Isolated floodplain lakes harbored the only SAV recorded in the entire reach. A total of 12 species were recorded in this stratum. Eurasian watermilfoil had the highest frequency found in a total of 61% of the sites with northern watermilfoil having the second highest frequency of occurrence (44%), and coontail being third (35%). All other species of SAV recorded were not significantly more abundant than another, ranging from 2% to 5% frequency of occurrence.

Rooted Floating–Leaf Vegetation

American lotus and white waterlily were the two rooted floating–leaf species recorded in La Grange Pool. American lotus was recorded in both contiguous backwaters and isolated floodplain lakes while white waterlily was found only in isolated floodplain lakes. Isolated floodplain lakes had the highest percent cover of rooted floating–leaf vegetation (12%). American lotus only covered 1% of the contiguous backwaters.

[\[1\]](#) Lakes that are not influenced by the Illinois River.

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Table 7. Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in La Grange Pool, Illinois River, 2001.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 100		Isolated backwater <i>n</i> = 129		Lake <i>n</i> = 57	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common (<i>Utricularia macrorhiza</i>)	-	-	-	-	3.5 ± 2.5	0.5 ± 0.4
chara (<i>Chara</i> spp.)	-	-	-	-	5.3 ± 3.0	1.4 ± 0.9
coontail (<i>Ceratophyllum demersum</i>)	-	-	-	-	35.1 ± 6.4	6.1 ± 2.0
pondweed, curly (<i>Potamogeton crispus</i>)	-	-	-	-	1.8 ± 1.8	0.2 ± 0.2
pondweed, horned (<i>Zannichellia palustris</i>)	-	-	-	-	5.3 ± 3.0	0.6 ± 0.4
pondweed, leafy (<i>Potamogeton foliosus</i>)	-	-	-	-	1.8 ± 1.8	0.3 ± 0.3
pondweed, longleaf (<i>P. nodosus</i>)	-	-	-	-	1.8 ± 1.8	0.1 ± 0.1
pondweed, sago (<i>P. pectinatus</i>)	-	-	-	-	5.3 ± 3.0	0.6 ± 0.4
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	-	-	-	-	61.4 ± 6.5	11.6 ± 1.5
watermilfoil, northern (<i>M. sibiricum</i>)	-	-	-	-	43.9 ± 6.6	11.7 ± 2.4
waternymph, brittle (<i>Najas minor</i>)	-	-	-	-	3.5 ± 2.5	0.5 ± 0.4
waternymph, nodding (<i>N. flexilis</i>)	-	-	-	-	5.3 ± 3.0	1.4 ± 0.9
all submersed species	-	-	-	-	77.2 ± 5.6	21.9 ± 2.8
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	1.0 ± 1.0	0.5 ± 0.5	-	-	19.3 ± 5.3	6.8 ± 2.2

waterlily, white (<i>Nymphaea odorata</i>)	-	-	-	-	12.3 ± 4.4	5.4 ± 2.7
all rooted floating-leaf species	1.0 ± 1.0	0.5 ± 0.5	-	-	28.1 ± 6.0	11.9 ± 3.3

Table 7. Continued.

Common name (Scientific name)	Main channel border <i>n</i> = 78		Secondary channel <i>n</i> = 50		La Grange Pool* <i>n</i> = 357	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common (<i>Utricularia macrorhiza</i>)	-	-	-	-	-	-
chara (<i>Chara</i> spp.)	-	-	-	-	-	-
coontail (<i>Ceratophyllum demersum</i>)	-	-	-	-	-	-
pondweed, curly (<i>Potamogeton crispus</i>)	-	-	-	-	-	-
pondweed, horned (<i>Zannichellia palustris</i>)	-	-	-	-	-	-
pondweed, leafy (<i>Potamogeton foliosus</i>)	-	-	-	-	-	-
pondweed, longleaf (<i>P. nodosus</i>)	-	-	-	-	-	-
pondweed, sago (<i>P. pectinatus</i>)	-	-	-	-	-	-
watermilfoil, Eurasian (<i>Myriophyllum spicatum</i>)	-	-	-	-	-	-
watermilfoil, northern (<i>M. sibiricum</i>)	-	-	-	-	-	-
waternymph, brittle (<i>Najas minor</i>)	-	-	-	-	-	-
waternymph, nodding (<i>N. flexilis</i>)	-	-	-	-	-	-
all submersed species	-	-	-	-	-	-
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (<i>Nelumbo lutea</i>)	-	-	-	-	0.3 ± 0.3	0.1 ± 0.1
waterlily, white (<i>Nymphaea odorata</i>)	-	-	-	-	-	-
all rooted floating-leaf species	-	-	-	-	0.3 ± 0.3	0.1 ± 0.1



Figure 12. Sites where species were recorded in La Grange Pool, Upper Mississippi River System, 2001.

Image Preview

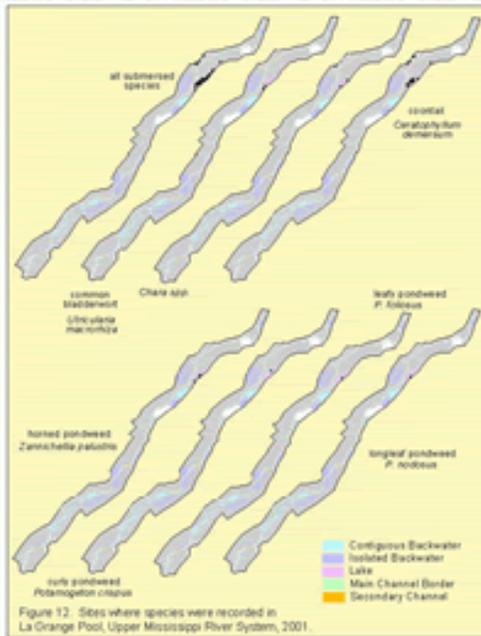
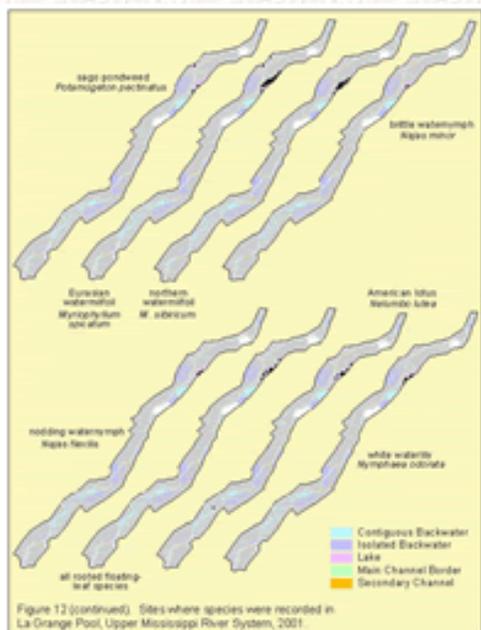


Figure - Description

[Figure 12.](#) Species: all submersed species, common bladderwort (*Utricularia macrorrhiza*), *Chara* spp., coontail (*Ceratophyllum demersum*), horned pondweed (*Zannichellia palustris*), curly pondweed (*Potamogeton crispus*), leafy pondweed (*P. foliosus*), and longleaf pondweed (*P. nodosus*).



[Figure 12.](#) Continued. Species: sago pondweed (*Potamogeton pectinatus*), Eurasian watermilfoil (*Myriophyllum spicatum*), northern watermilfoil (*M. sibiricum*), brittle waternymph (*Najas minor*), nodding waternymph (*N. flexilis*), all rooted-floating leaf species, American lotus (*Nelumbo lutea*), and white waterlily (*Nymphaea odorata*).



Summary

Longitudinal distribution

- Vegetation stratified random sampling was conducted in Pools 4, 8, 11, 13, and 26 and La Grange Pool in 2001. Pool 11 was sampled as a pilot outpool sampling project.
- The estimated percent frequencies of submersed aquatic vegetation in the shallow water areas in Pools 4, 8, 13, 26, and La Grange Pool were 36.9%, 47.5%, 41.7%, 0.3%, and 0%, respectively (Tables [2](#), [3](#), [5](#), [6](#), and [7](#)). The longitudinal pattern of [submersed aquatic vegetation](#) is the same as revealed in the previous three years from 1998 to 2000. Pool 11 (16.1%) had less submersed vegetation than the upper three pools ([Table 4](#)).
- This pattern is also consistent with the longitudinal pattern displayed in the aerial photographs of 1989 that submersed aquatic vegetation was abundant in the Upper Mississippi River reaches upstream of Lock and Dam 13, but rare or negligible elsewhere in the UMRS (Rogers and Theiling 1999). A deviation from this longitudinal pattern was observed after the 1987–89 drought and in 1993 after an unusually high flood disturbance, when little submersed aquatic vegetation occurred in the entire UMRS. We did not sample the entire UMRS in 2001, but we have no reason to suspect a deviation from the normal pattern occurred in 2001.
- The estimated percent frequencies of rooted floating-leaf vegetation in Pools 4, 8, 11, 13, and 26, and La Grange Pool were 7.9%, 15.2%, 7.5%, 22.7%, 4.2%, and 0.3%, respectively ([Tables](#)).
- Rooted floating-leaf species shifted in dominance from white water lily (Pools 4 and 8) to American lotus (Pools 13 and 26). This same longitudinal pattern has occurred since 1998. Neither American lotus (5.8%) nor white water lily (4.4%) was dominant in Pool 11.

Within-pool Distribution

- The within-pool distribution patterns of submersed aquatic vegetation were highly heterogeneous between pools but remained little changed since 1998.
- Submersed aquatic vegetation was sparse and species-poor in upper Pool 4 above Lake Pepin compared with the lower Pool 4 below Lake Pepin ([Figure 2](#)). Rooted floating-leaf vegetation followed the same general pattern. The most common submersed species included coontail and water stargrass.
- Submersed aquatic and rooted floating-leaf vegetation was distributed widely throughout Pool 8 except in the lower end where water depth generally exceeded 1 m ([Figure 4](#)). The most common submersed species included coontail, Canadian waterweed, and water stargrass.
- Submersed aquatic vegetation was found throughout Pool 11 ([Figure 6](#)). Rooted floating-leaf was found mostly in the middle portion of the pool. The most common submersed species included sago pondweed and coontail.
- A considerable amount of submersed aquatic vegetation was recorded in Pool 13, most of which occurred in the contiguous backwaters and impounded areas at the lower half of the pool ([Figure 8](#)). Most of the rooted floating-leaf vegetation was found in contiguous backwaters and along the shoreline in impounded areas in the lower half of the pool. The most common submersed species included coontail and sago pondweed.
- An insignificant amount of submersed aquatic and rooted floating-leaf vegetation was found in Pool 26, in the isolated backwater areas of the Illinois River ([Figure 10](#)).
- In La Grange Pool, submersed aquatic vegetation was found to exist in the lakes on the Illinois River floodplain and was absent in the river's backwater areas ([Figure 12](#)). Most rooted floating-leaf vegetation was found within lakes. Eurasian watermilfoil was the most common submersed species recorded.
- The distribution of submersed aquatic vegetation appears to be correlated with the physical parameters of water depth, current velocity, and fetch.

Status and Trend

- Based on 4 years of SRS percent frequency data, the spatial extents of [submersed](#)

[aquatic vegetation](#) in the five key pools have remained stable since 1998.

- However, the amount of vegetation per site, based on the abundance index, has displayed a trend of steady decline in Pool 8 and a steady increase in Pool 13 since 1999. Factors responsible for the two opposite trends are yet to be determined.
- Pool 13 has shown a slight increase in the frequency of [rooted floating-leaf vegetation](#) from 1998 to 2001 while the other pools have remained stable.
- Two exotic submersed species have been recorded, Eurasian watermilfoil and curly pondweed. Both were found in Pools 4, 8, 11, 13, and isolated lakes of the La Grange Pool. Curly pondweed has also been recorded in Alton Pool. Other than Eurasian watermilfoil in the isolated lakes of the La Grange Pool, neither species has been dominant, occurring in 15% or less of the sites in all pools and years.

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Tables

1.	Aquatic area strata and the number of sites sampled by pool, 2001.
2.	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 4, Upper Mississippi River System, 2001
3.	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 8, Upper Mississippi River System, 2001
4.	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 11, Upper Mississippi River System, 2001
5.	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 13, Upper Mississippi River System, 2001
6.	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 26, Upper Mississippi River System, 2001
7.	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in La Grange Pool, Illinois River, 2001

Note: Tables are updated as errors are found and corrected. Please refer to the last updated date when using the information.

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Appendix

Submersed and rooted floating–leaf species found during stratified random sampling in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River.^a

Common name	Scientific name	Species code	Family
<i>Submersed</i>			
bladderwort, common	<i>Utricularia macrorhiza</i> Le Conte synonymy <i>U. vulgaris</i> L.	UTMA	Lentibulariaceae
buttercup, longbeak	<i>Ranunculus longirostris</i> Godr. ^b	RALO2	Ranunculaceae
chara	<i>Chara</i> spp.	CH?AR	Characeae
coontail, coon's tail	<i>Ceratophyllum demersum</i> L.	CEDE4	Ceratophyllaceae
pondweed, alpine	<i>Potamogeton alpinus</i> Balbis	POAL8	Potamogetonaceae
pondweed, curly (curlyleaf)	<i>P. crispus</i> L.	POCR3	Potamogetonaceae
pondweed, horned	<i>Zannichellia palustris</i> L.	ZAPA	Zannichelliaceae
pondweed, leafy	<i>Potamogeton foliosus</i> Raf.	POFO3	Potamogetonaceae
pondweed, leafy/small	<i>P. foliosus</i> Raf./ <i>P. pusillus</i> L.	NLPW	Potamogetonaceae
pondweed, longleaf (American)	<i>P. nodosus</i> Poir	PONO2	Potamogetonaceae
pondweed, ribbonleaf	<i>P. epihydrus</i> Raf.	POEP2	Potamogetonaceae
pondweed, Richardson's	<i>P. richardsonii</i> (Benn.) Rydb.	PORI2	Potamogetonaceae
pondweed, sago	<i>P. pectinatus</i> L. synonymy <i>Stuckenia pectinatus</i> (L.) Boerner	POPE6	Potamogetonaceae
pondweed, small	<i>P. pusillus</i> L.	POPU7	Potamogetonaceae
pondweed, flatstem	<i>P. zosteriformis</i> Fern.	POZO	Potamogetonaceae
stargrass, water (grassleaf mudplantain)	<i>Heteranthera dubia</i> (Jacq.) MacM. synonymy <i>Zosterella dubia</i> Jacq.	ZODU	Pontederiaceae
watermilfoil, Eurasian (spike)	<i>Myriophyllum spicatum</i> L.	MYSP2	Haloragaceae

watermilfoil, northern (shortspike)	<i>M. sibiricum</i> Komarov	MYSI	Haloragaceae
waternymph, brittle	<i>Najas minor</i> All.	NAMI	Najadaceae
waternymph, nodding (slender naiad)	<i>N. flexilis</i> (Willd.) Rostk. and Schmidt	NAFL	Najadaceae
waternymph, southern	<i>N. guadalupensis</i> (Spreng.) Magnus	NAGU	Najadaceae
waterweed, Canadian	<i>Elodea canadensis</i> Michx.	ELCA7	Hydrocharitaceae
wildcelery (American eelgrass)	<i>Vallisneria americana</i> Michx.	VAAM3	Hydrocharitaceae
<i>Rooted floating-leaf</i>			
lotus, American	<i>Nelumbo lutea</i> Willd.	NELU	Nelumbonaceae
pond-lily, yellow	<i>Nuphar variegata</i> Durand ^c	NULU	Nymphaeaceae
primrose-willow, floating	<i>Ludwigia peploides</i> (Kunth) Raven	LUPE5	Onagraceae
waterlily, white	<i>Nymphaea odorata</i> Ait. synonymy <i>N. tuberosa</i> Paine	NYTU	Nymphaeaceae

^aScientific nomenclature and common names follow the USDA's PLANTS database (<http://plants.usda.gov/>). Common names used by Upper Mississippi River managers are also included.

^b*Ranunculus longirostris* and *R. trichophyllus* were combined (Voss 1985).

^cScientific nomenclature follows Gleason and Cronquist (1991). *Nuphar lutea* (L.) ssp. *variegata* (Dur.) E. O. Beal in PLANTS database.

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Table 1. Aquatic area strata and the number of sites sampled by pool, 2001.

Stratum description	Stratum numeric code	Stratum letter code	Pool 4	Pool 8	Pool 13	Pool 26	La Grange Pool
2001 sampling season							
Main channel border, Illinois River	1502	MCB-I	-	-	-	40	-
Main channel border	1503	MCB	-	100	70	49	78
Secondary channel	1504	SC	-	120	70	50	50
Main channel border, upper	1505	MCB-U	30	-	-	-	-
Main channel border, lower	1506	MCB-L	40	-	-	-	-
Secondary channel, upper	1507	SC-U	40	-	-	-	-
Secondary channel, lower	1508	SC-L	60	-	-	-	-
Contiguous backwater	1510	BWC	-	175	198	80	100
Contiguous backwater, upper	1511	BWC-U	100	-	-	-	-
Contiguous backwater, lower	1512	BWC-L	176	-	-	-	-
Lake Pepin, upper	1513	TDL-U	75	-	-	-	-
Lake Pepin, lower	1514	TDL-L	75	-	-	-	-
Impounded	1520	IMP	-	225	209	40	-
Isolated backwater	1530	BWI	50	50	59	60	129
Isolated backwater, Illinois	1531	BWI-I	-	-	-	94	-
Lake	1532	LK	-	-	-	-	57
Total for 2001 sampling season			646	670	606	413	414

Table 1b. Aquatic area strata and the number of sites sampled by nontarget pool, 2001.

Stratum description	Stratum numeric code	Stratum letter code	Pool 11
2001 sampling season			
Main channel border	1503	MCB	142

Table 1. All pools

Secondary channel	1504	SC	77
Contiguous backwater	1510	BWC	130
Impounded	1520	IMP	204
Isolated backwater	1530	BWI	15
Total for 2001 sampling season			568

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Figures

1.	Aquatic area strata and sampling points in Pool 4, Upper Mississippi River System, 2001.
2.	Sites where species were recorded in Pool 4, Upper Mississippi River System, 2001.
3.	Aquatic area strata and sampling points in Pool 8, Upper Mississippi River System, 2001.
4.	Sites where species were recorded in Pool 8, Upper Mississippi River System, 2001.
5.	Aquatic area strata and sampling points in Pool 11, Upper Mississippi River System, 2001.
6.	Sites where species were recorded in Pool 11, Upper Mississippi River System, 2001.
7.	Aquatic area strata and sampling points in Pool 13, Upper Mississippi River System, 2001.
8.	Sites where species were recorded in Pool 13, Upper Mississippi River System, 2001.
9.	Aquatic area strata and sampling points in Pool 26, Upper Mississippi River System, 2001.
10.	Sites where species were recorded in Pool 26, Upper Mississippi River System, 2001.
11.	Aquatic area strata and sampling points in La Grange Pool, Upper Mississippi River System, 2001.
12.	Sites where species were recorded in La Grange Pool, Upper Mississippi River System, 2001.

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Figure 1. Aquatic area strata and sampling points in Pool 4, Upper Mississippi River System, 2001.

Image Preview

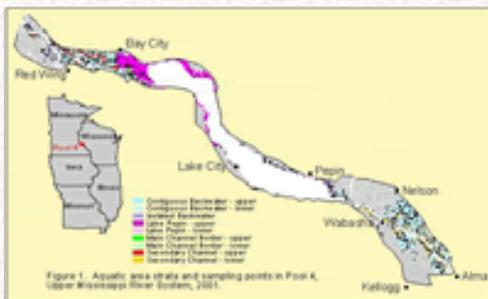


Figure - Description

[Figure 1.](#)

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Figure 3. Aquatic area strata and sampling points in Pool 8, Upper Mississippi River System, 2001.

Image Preview

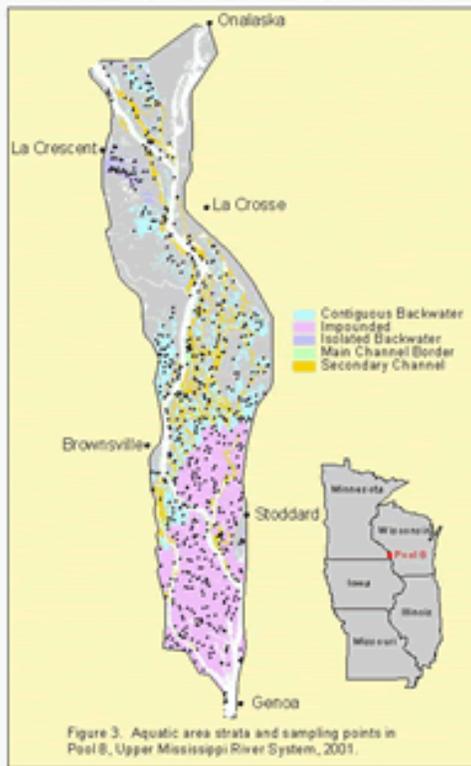


Figure - Description

[Figure 3.](#)

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Figure 5. Aquatic area strata and sampling points in Pool 11, Upper Mississippi River System, 2001.

Image Preview



Figure - Description

[Figure 5.](#)

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Figure 7. Aquatic area strata and sampling points in Pool 13, Upper Mississippi River System, 2001.

Image Preview	Figure - Description
<p>Figure 7. Aquatic area strata and sampling points in Pool 13, Upper Mississippi River, 2001.</p>	<p>Figure 7.</p>

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Figure 9. Aquatic area strata and sampling points in Pool 26, Upper Mississippi River System, 2001.

Image Preview

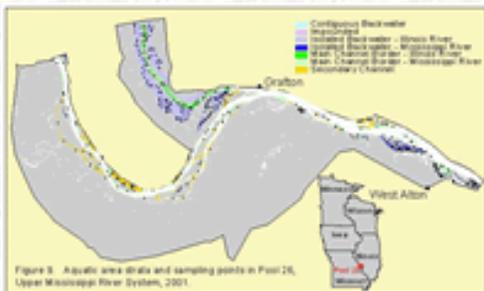


Figure - Description

[Figure 9.](#)

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Figure 11. Aquatic area strata and sampling points in La Grange Pool, Upper Mississippi River System, 2001.

Image Preview



Figure - Description

[Figure 11.](#)

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