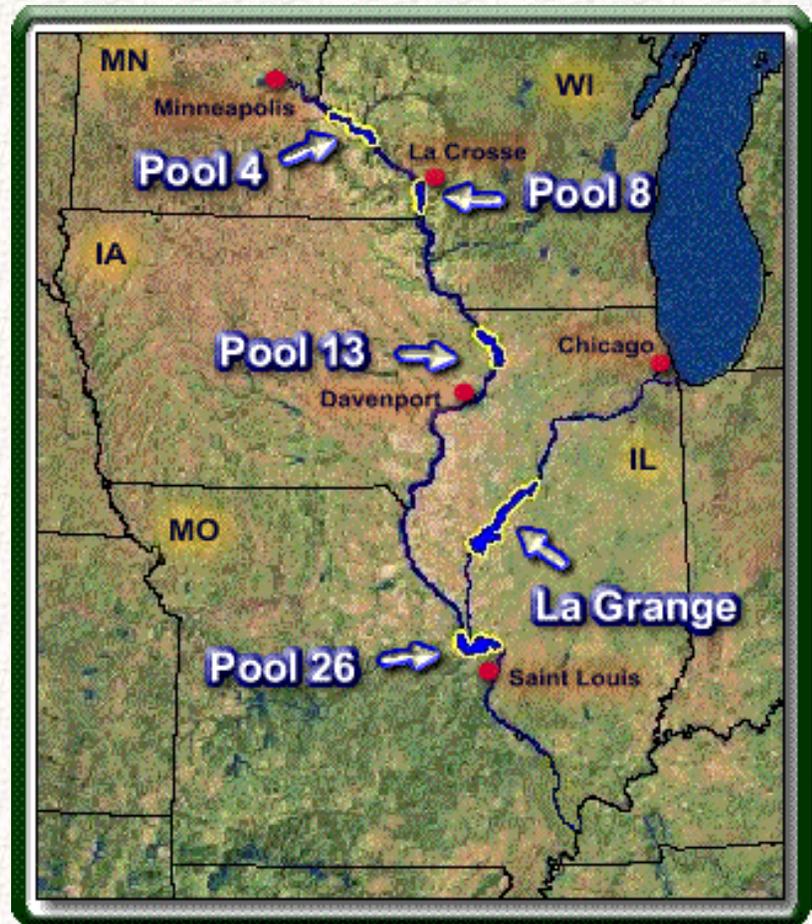




## 2002 Annual Status Report: Submersed and Rooted Floating–Leaf Vegetation in Pools 4, 5, 7, 8, 12, 13, and 26 of the Upper Mississippi River, and Alton and La Grange Pools of the Illinois River

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, 5, 7, 8, 12, 13, and 26 of the Upper Mississippi River and Alton and La Grange Pools 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:

Yin Y., H. A. Langrehr, T. Blackburn, M. Moore, R. Cosgriff, and T. Cook. 2004. 2002 Annual Status Report: Submersed and rooted floating–leaf vegetation in Pools 4, 5, 7, 8, 12, 13, and 26 of the Upper Mississippi River, and Alton and La Grange Pools 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/2002/vegetation-srs.html](http://www.umesc.usgs.gov/reports_publications/ltrmp/veg/2002/vegetation-srs.html). (Accessed February 2004.)

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## Abstract

Vegetation sampling was conducted between June 17 and August 28, 2002, in Pools 4, 5, 7, 8, 12, 13, and 26 of the Upper Mississippi River (UMR) and Alton and La Grange Pools of the Illinois River at 4,407 sites to quantify the status of rooted floating-leaf and submersed aquatic vegetation. Pools 5, 7, and 12, and Alton Pool were sampled to help determine how representative the key pools were of the Upper Mississippi River System. Three exotic species, Eurasian watermilfoil, curly pondweed, and brittle water nymph, were recorded along with 21 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, 5, 7, 8, and 13) of the UMR and scant or below the detection limit of the sampling protocol in Pool 26 of the UMR, and Alton and La Grange Pools of the Illinois River. Pool 12 had a moderate amount of submersed aquatic vegetation. The outpools were similar to the adjacent key pools in species richness and composition. In Pool 8, the amount of submersed vegetation per site, based on the abundance index, displayed a steady decrease from 1999 to 2001, but rebounded in 2002, while Pool 13 has increased steadily from 1999 to 2002. 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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Content manager: [Dr. Yao Yin](#)



## 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 2002, 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 2002, four additional pools were sampled to help determine how representative the key pools were of the UMRS. These included Pools 5, 7, and 12 of the Mississippi River and Alton Pool of the Illinois River.

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](http://www.umesc.usgs.gov/data_library/vegetation/vegetation_page.html).

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## Study Areas

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**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



Click on the image for a larger view of Pool 5

**Navigation [Pool 5](#)** is 23.5 km (14.6 river miles) long and includes 4,500 ha (11,120 acres) of aquatic habitat. It is located between Lock and Dam 4 (Alma, Wisconsin) to the north and Lock and Dam 5 (south of Minneiska, Minnesota) to the south. Major tributaries include the Zumbro and Whitewater Rivers, both of which enter on the Minnesota side. The upper section of Pool 5 has small backwater sloughs connected to the main channel. The middle section contains high bank islands adjacent to the

main channel, along with deep secondary channels, numerous braided tertiary channels and small backwater sloughs. The lower section primarily contains two large open expanses of water divided by a narrow band of islands that separate Weaver Bottoms from Spring Lake and the rest of the impounded area.

**Navigation [Pool 7](#)** is 19.6 km (12 river miles) in length and is bounded by Lock and Dam 6 (Trempealeau, Wisconsin) to the north and Lock and Dam 7 (Dresbach, Minnesota) to the south. It encompasses 5,400 ha (13,300 acres) of aquatic habitat. Pool 7 contains braided channels and sloughs in the upper section and a large open lake-like area (Lake Onalaska) in the lower section of the pool. The Black River on the Wisconsin side is a major tributary.



Click on the image for a larger view of Pool 7



Click on the image for a larger view of Pool 8

**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.

**Navigation [Pool 12](#)** is 42.1 km (26.3 river miles) in length and is bounded by Lock and Dam 11 (Dubuque, Iowa) to the north and Lock and Dam 12 (Bellevue, Iowa) to the south. It encompasses 4,879 ha (12,057 acres) of aquatic habitat. Levees are limited to the urban and industrial complex near Dubuque. There are no major tributaries entering the pool. Smaller streams include Catfish Creek (Iowa) and the Menominee,

Sinsinawa, and Galena Rivers (Illinois). A distinguishing character of Pool 12 is that islands are interspersed throughout the pool. There is no large expanse of open water typical of many pools.



Click on the image for a larger view of Pool 12



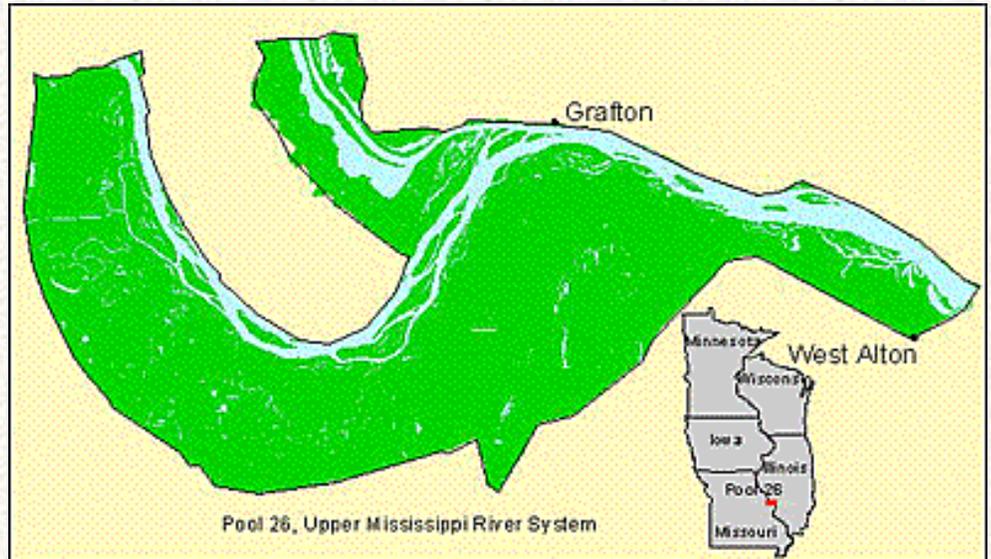
**Navigation Pool 13** is 52.1 km (34.2 river miles) in length and is bounded by Lock and Dam 12 (Bellevue, Iowa) to the north and Lock and Dam 13 (Fulton, Illinois) to the south. It encompasses 11,400 ha (28,100 acres) of aquatic habitat. Similar to pools upstream, Pool 13 contains many high bank islands 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

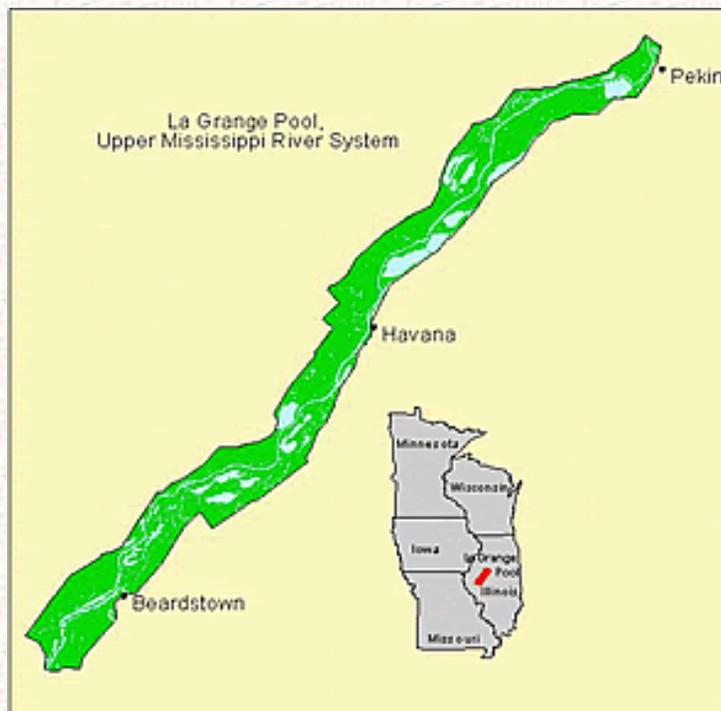
**Alton Pool** on the Illinois River includes water bodies along the lower Illinois from the La Grange Lock and Dam at river mile 81 near Beardstown to its confluence with the Mississippi River at river mile 0 (Grafton, Illinois). The reach encompasses 6,500 ha (16,100 acres) of aquatic habitat. Major tributaries include Mc Gee, Maucoupin, and Otter Creeks. Presently, most backwaters of the lower Illinois River are isolated from the river by low levees. Alton Pool houses several large contiguous backwater lakes



including Meredosia and Swan Lakes, but these backwaters are degraded by excessive sedimentation.

Click on the image for a larger view of Alton Pool

**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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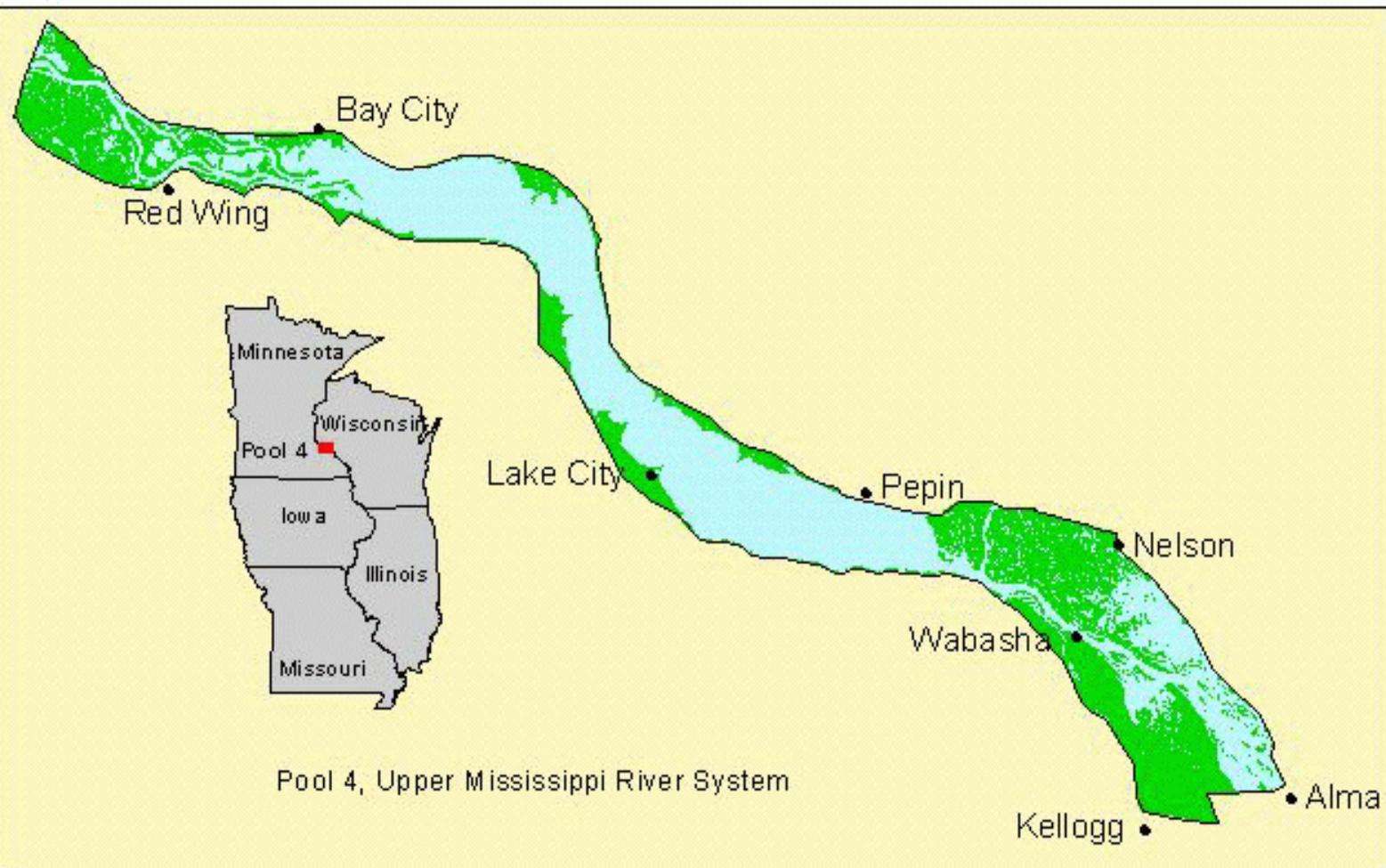
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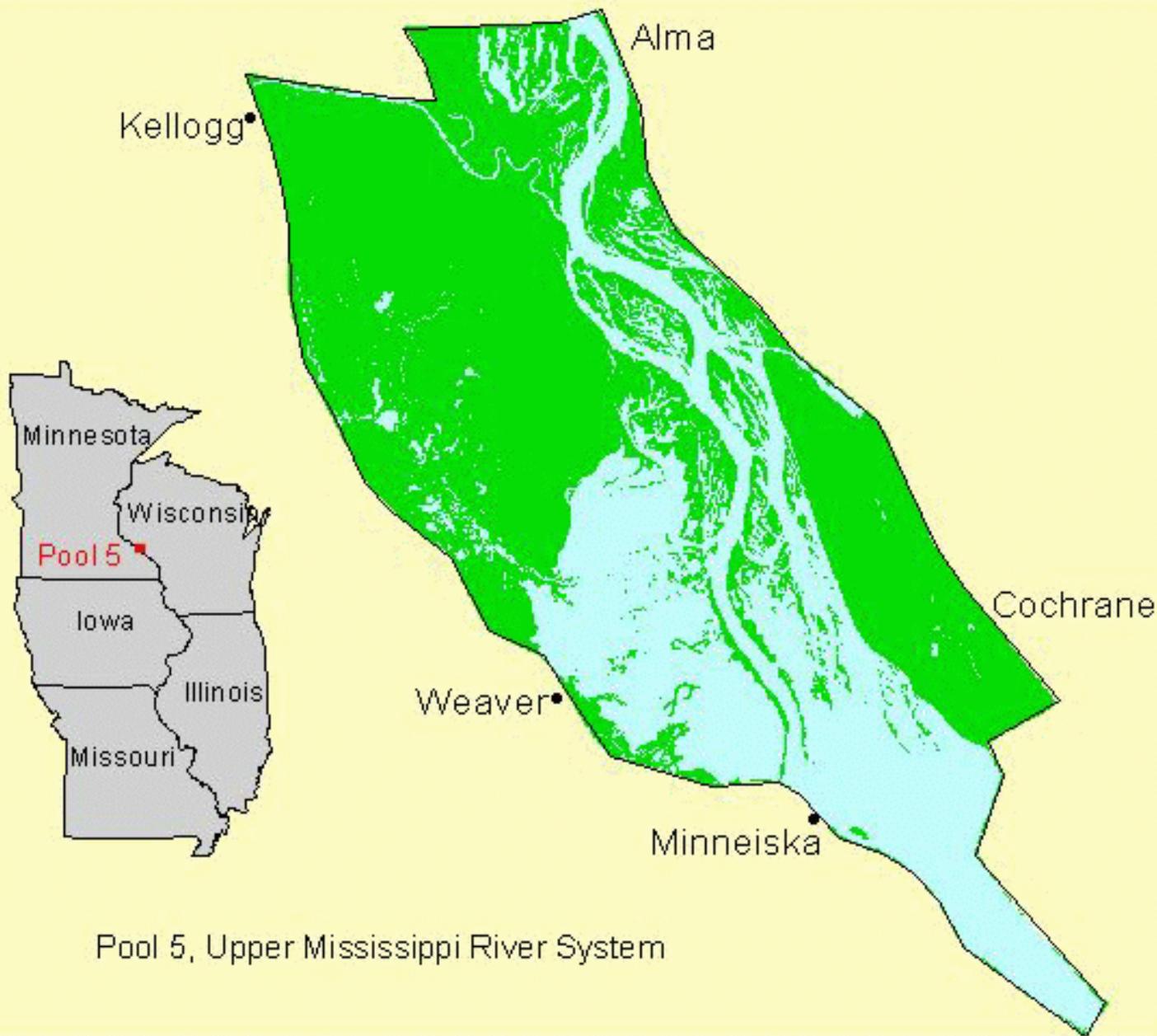
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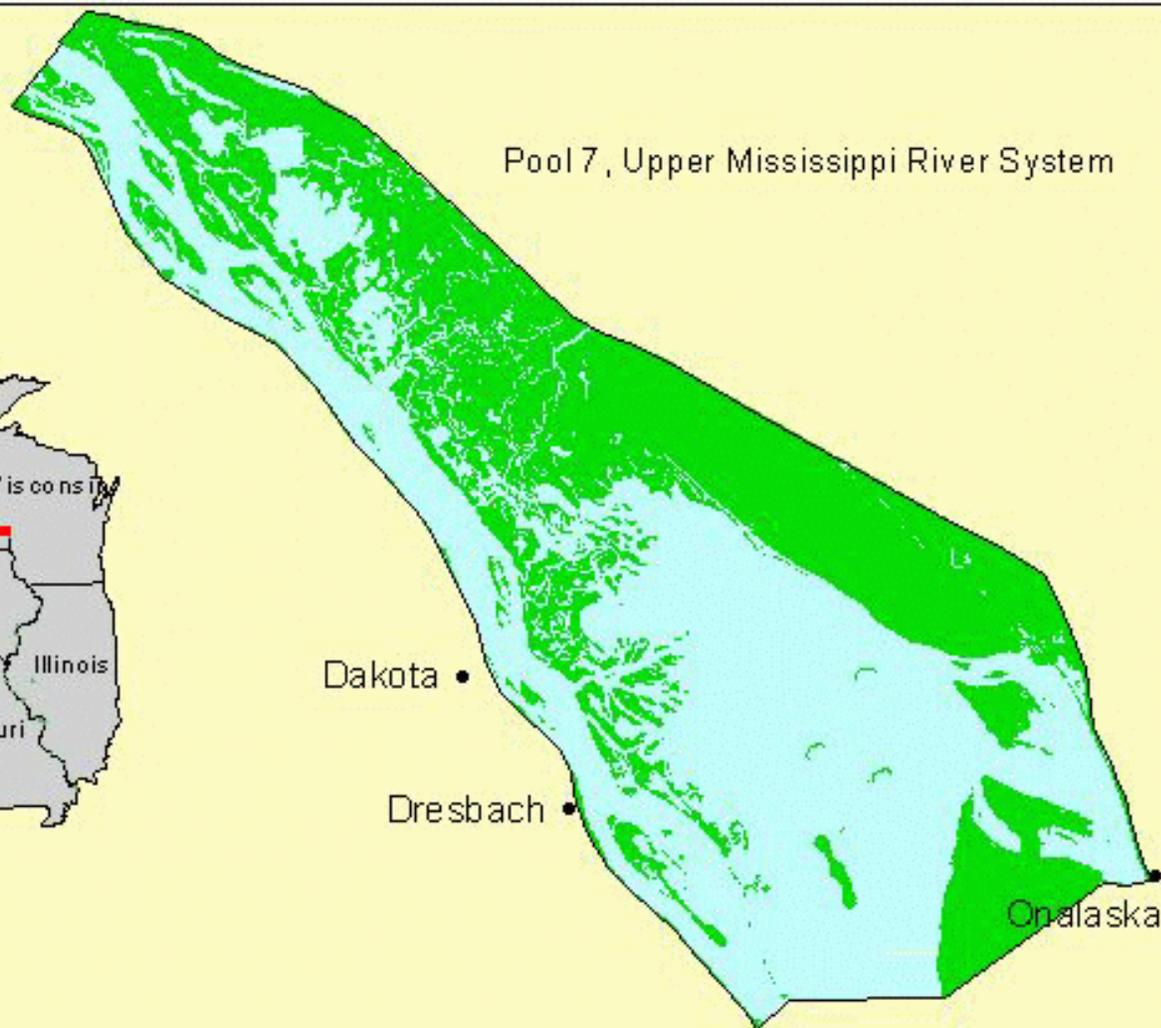
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Pool 5, Upper Mississippi River System

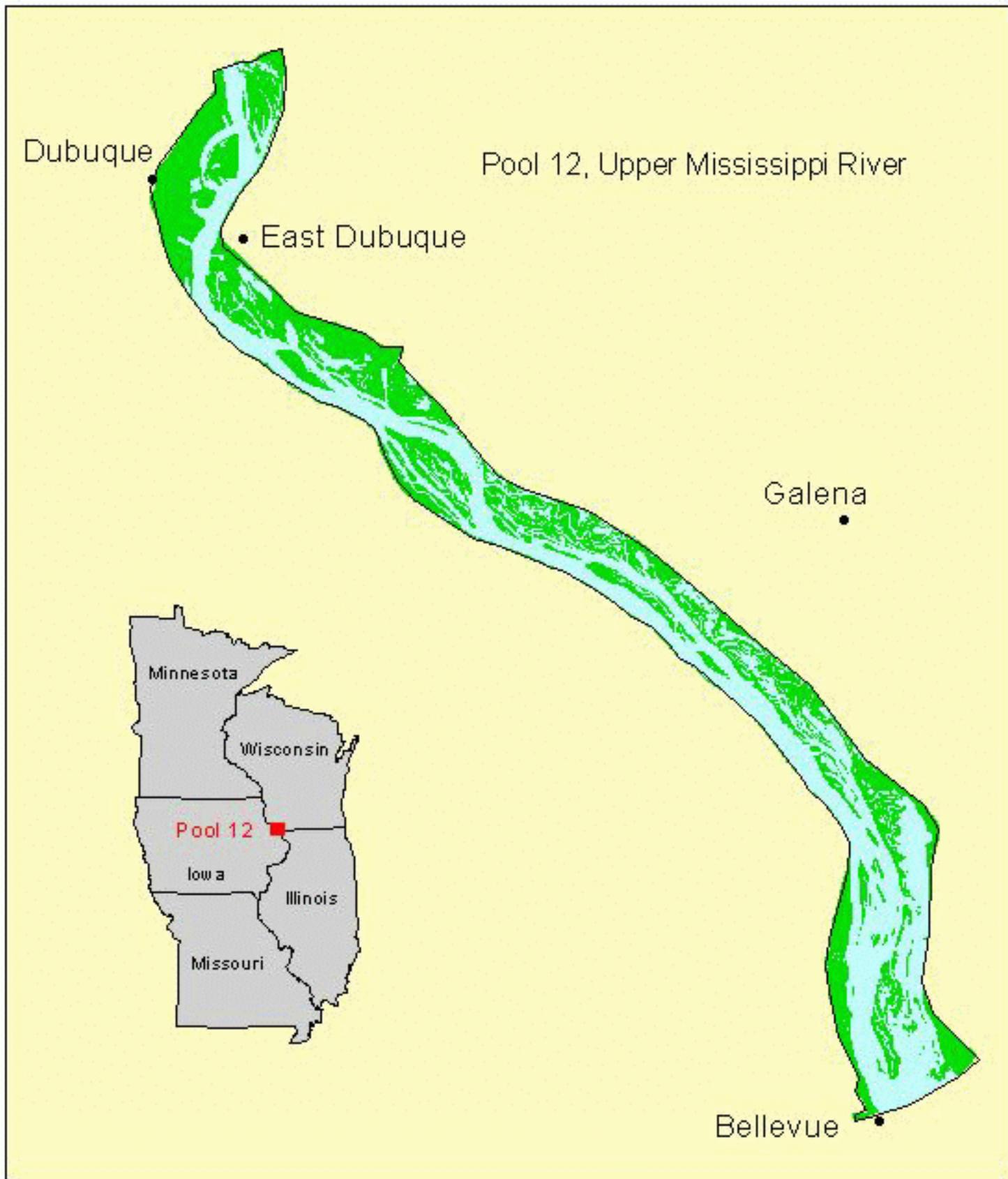
### Pool 7, Upper Mississippi River System

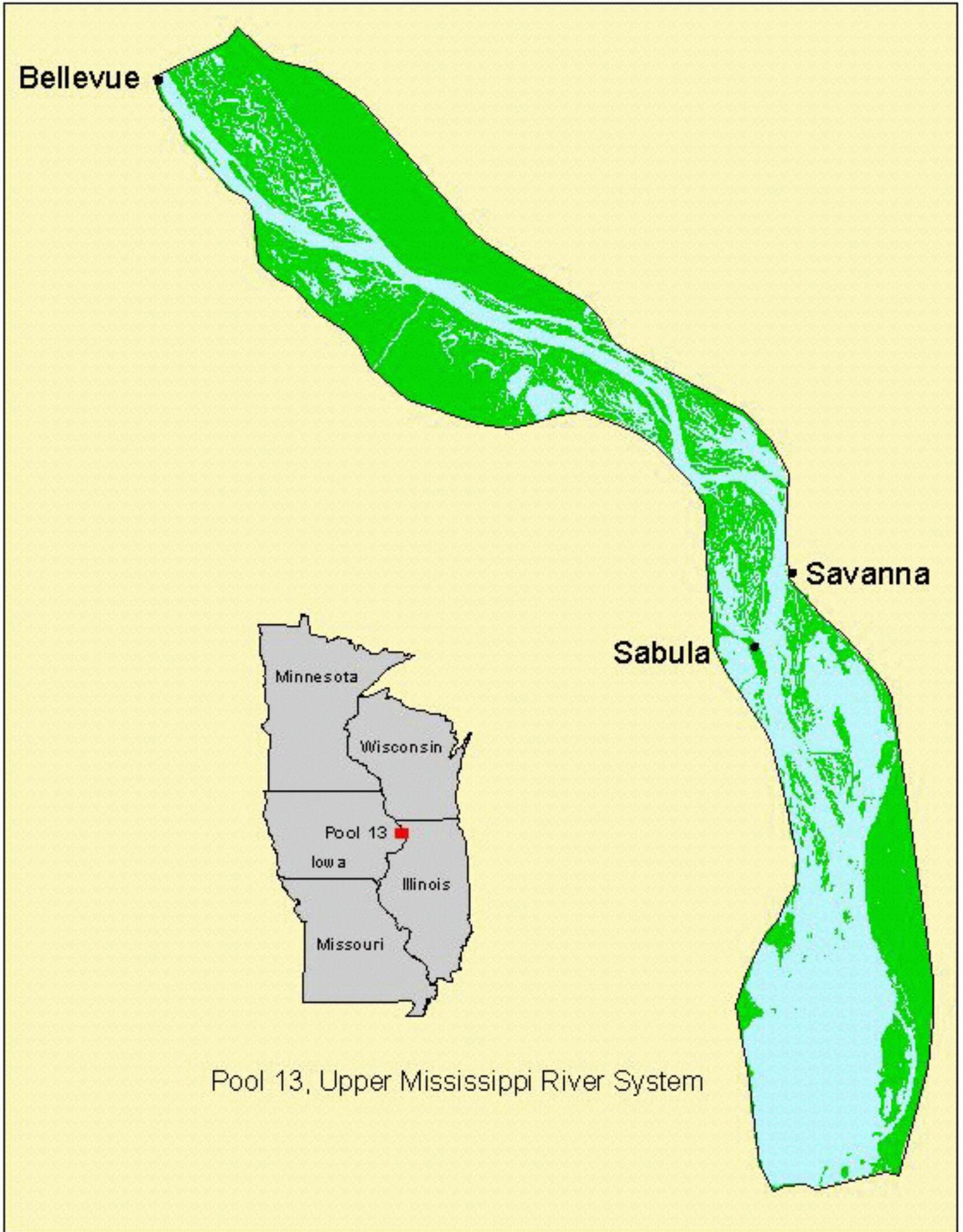




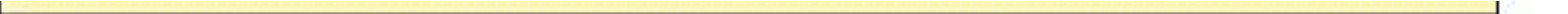
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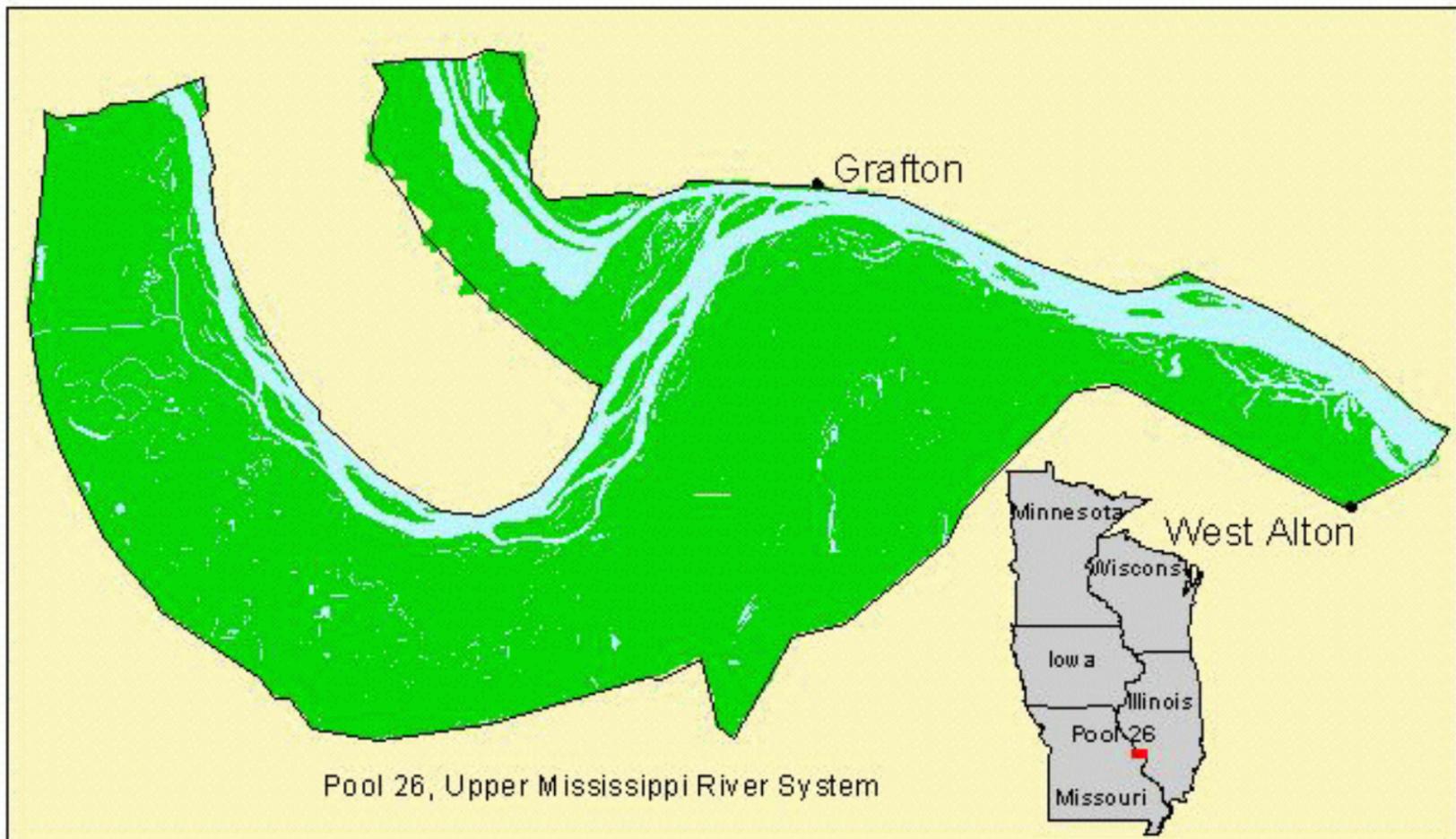


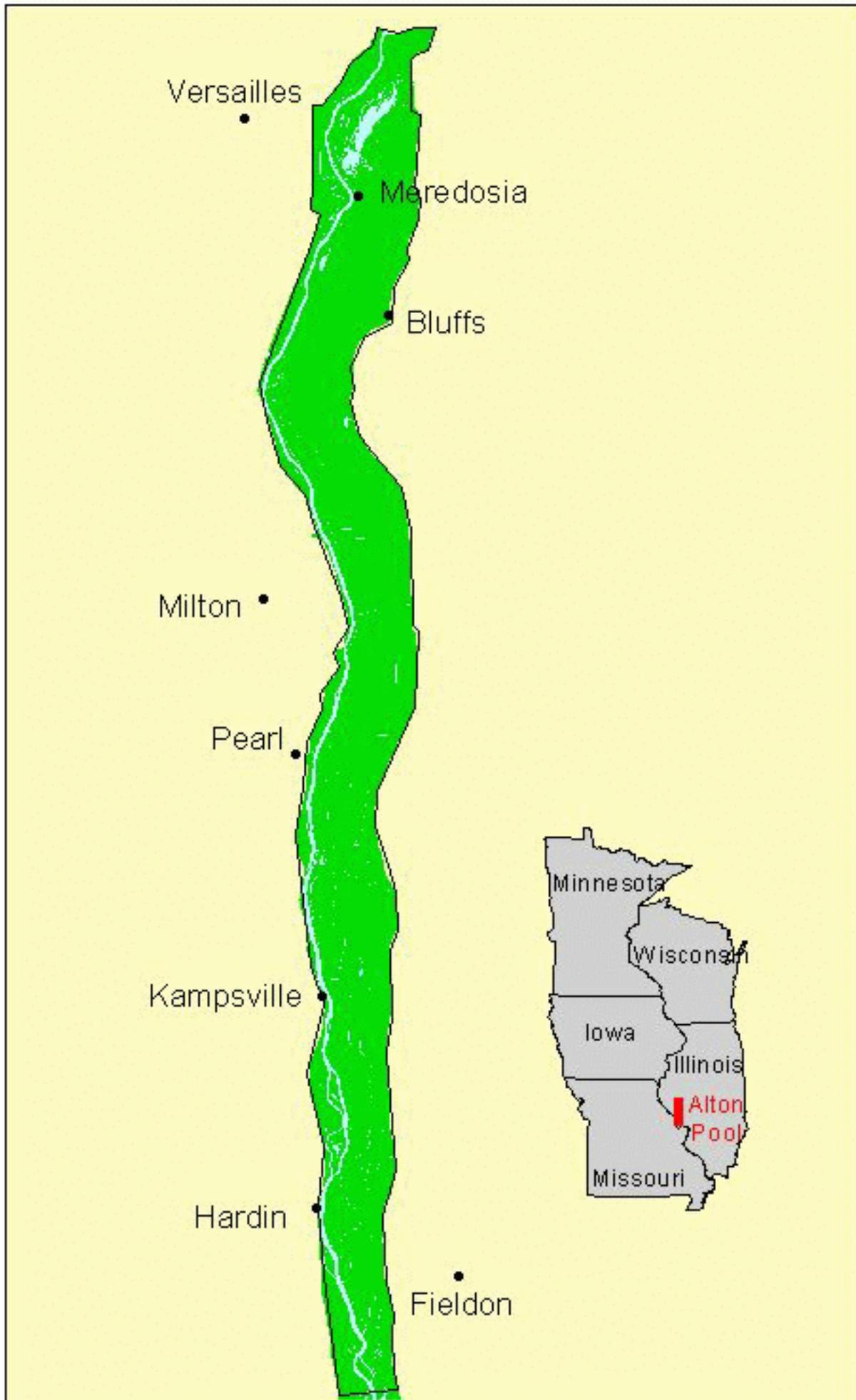




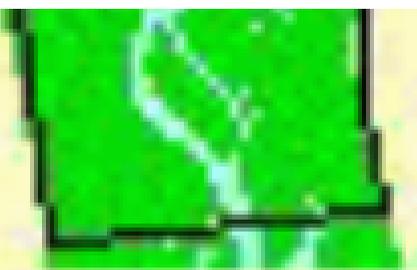
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[http://www.umesc.usgs.gov/reports\\_publications/ltrmp/veg/2002/images/poolalton.gif](http://www.umesc.usgs.gov/reports_publications/ltrmp/veg/2002/images/poolalton.gif)



Alton Pool, Upper Mississippi River System

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

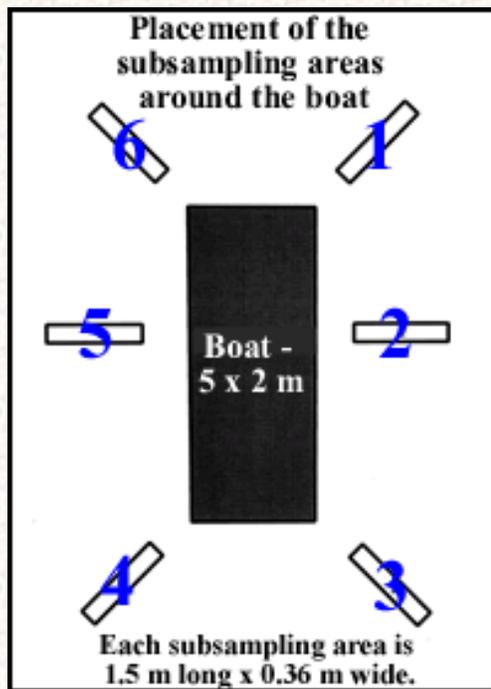
Sites were selected using a random number generator. A 50- X 50-m grid was generated and overlaid onto the stratified aquatic areas. Nodes of the grid were geospatially registered (Universal Transverse Mercator coordinates), and nodes that fell in the sampling strata were eligible for selection as sites. 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 (e.g., submersed and rooted floating–leaf) were recorded 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  $i^{\text{th}}$  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.

$$\left( A = \frac{\sum_{j=1}^n A_j}{n} \right)$$

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  $j$ .

Content manager: [Dr. Yao Yin](#)

*Last updated on November 5, 2003*

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## 2002 Results in Pool 4 of the Upper Mississippi River

### Sampling Effort

Sampling was conducted from June 17 to August 9, 2002. Of the 630 sites targeted, all were sampled ([Figure 1](#)).

### Submersed Aquatic Vegetation

Submersed aquatic vegetation (SAV) covered about 35.0% of the shallow water areas poolwide ([Table 2](#); [Figure 2](#)). Isolated backwaters had the highest percent frequency of SAV (83.3%) followed by contiguous backwaters of lower Pool 4 (67.2%). Generally, the frequency of SAV found in the combined lower pool strata (50.9%) was more than five times greater than in the combined upper pool strata (9.7%). Overall, Pool 4 had a 35.0% frequency of SAV for all strata combined.

A total of 16 species were recorded in the entire pool. Lower pool contiguous backwaters (14) had the most species recorded followed by isolated backwaters (12). Upper pool main channel border, upper pool secondary channels, and upper Lake Pepin strata each had only one species recorded. Coontail (17.1%) was the most frequently recorded species followed by wildcelery (15.4%), water stargrass (13.8%), and Canadian waterweed (13.3%). Wildcelery (37.8%) and coontail (33.9%) were the most frequently encountered species in lower pool contiguous backwaters.

### Rooted Floating–Leaf Vegetation

White waterlily, American lotus, and yellow pond-lily were the three rooted floating-leaf species recorded in Pool 4. Together, all rooted floating-leaf species had a cover of about 1% and a frequency of 10%. The percent frequency of rooted floating-leaf species was the highest in the isolated backwaters (46.7%) and lower pool contiguous backwaters (21.7%); nearly absent in upper pool contiguous backwaters (5%) and lower pool secondary channels (3.3%), and nonexistent in all other strata.



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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, 2002.

Common name (Scientific name)	Contiguous backwater, upper <i>n</i> = 100		Contiguous backwater, lower <i>n</i> = 180		Isolated backwater <i>n</i> = 30	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	-	-	-	6.7 ± 4.6	1.1 ± 0.8
buttercup, longbeak ( <i>Ranunculus longirostris</i> )	-	-	-	-	3.3 ± 3.3	0.4 ± 0.4
chara ( <i>Chara</i> spp.)	-	-	0.6 ± 0.6	0.1 ± 0.1	-	-
coontail ( <i>Ceratophyllum demersum</i> )	7.0 ± 2.6	0.9 ± 0.3	33.9 ± 3.5	4.4 ± 0.5	73.3 ± 8.2	14.0 ± 2.3
pondweed, curly ( <i>Potamogeton crispus</i> )	-	-	13.9 ± 2.6	1.3 ± 0.3	26.7 ± 8.2	3.0 ± 1.0
pondweed, flatstem ( <i>P. zosteriformis</i> )	-	-	11.1 ± 2.3	1.3 ± 0.3	10.0 ± 5.6	1.0 ± 0.7
pondweed, horned ( <i>Zannichellia palustris</i> )	-	-	0.6 ± 0.6	0.1 ± 0.1	-	-
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	2.0 ± 1.4	0.2 ± 0.2	16.7 ± 2.8	1.9 ± 0.3	40.0 ± 9.1	5.9 ± 1.4
pondweed, longleaf ( <i>P. nodosus</i> )	1.0 ± 1.0	0.2 ± 0.2	5.6 ± 1.7	0.6 ± 0.2	23.3 ± 7.9	2.4 ± 0.9
pondweed, sago ( <i>P. pectinatus</i> )	14.0 ± 3.5	1.6 ± 0.4	8.9 ± 2.1	0.9 ± 0.2	63.3 ± 8.9	9.2 ± 1.4
stargrass, water ( <i>Heteranthera dubia</i> )	-	-	30.6 ± 3.4	3.6 ± 0.5	20.0 ± 7.4	1.5 ± 0.6
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	-	-	28.9 ± 3.4	3.6 ± 0.5	-	-
watermilfoil, northern ( <i>Myriophyllum sibiricum</i> )	-	-	0.6 ± 0.6	0.1 ± 0.1	3.3 ± 3.3	0.9 ± 0.9
waternymph, nodding ( <i>Najas flexilis</i> )	1.0 ± 1.0	0.1 ± 0.1	2.2 ± 1.1	0.2 ± 0.1	16.7 ± 6.9	1.9 ± 0.9

Table 2. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 2002.

waterweed, Canadian ( <i>Elodea canadensis</i> )	2.0 ± 1.4	0.3 ± 0.2	30.0 ± 3.4	3.8 ± 0.5	33.3 ± 8.8	4.0 ± 1.2
wildcelery ( <i>Vallisneria americana</i> )	-	-	37.8 ± 3.6	5.3 ± 0.6	-	-
all submersed species	16.0 ± 3.7	2.1 ± 0.5	67.2 ± 3.5	10.2 ± 0.6	83.3 ± 6.9	17.5 ± 2.1
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	-	-	5.0 ± 1.6	0.5 ± 0.2	-	-
pond-lily, yellow ( <i>Nuphar variegata</i> )	-	-	0.6 ± 0.6	0.1 ± 0.1	-	-
waterlily, white ( <i>Nymphaea odorata</i> )	5.0 ± 2.2	0.7 ± 0.4	19.4 ± 3.0	2.6 ± 0.6	46.7 ± 9.3	5.3 ± 1.2
all rooted floating-leaf species	5.0 ± 2.2	0.7 ± 0.4	21.7 ± 3.1	2.8 ± 0.6	46.7 ± 9.3	5.3 ± 1.2

Table 2. Continued.

Common name (Scientific name)	Lake Pepin, upper n = 75		Lake Pepin, lower n = 75		Main channel border, upper n = 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> )	-	-	4.0 ± 2.3	0.3 ± 0.2	3.3 ± 3.3	0.6 ± 0.6
pondweed, curly ( <i>Potamogeton crispus</i> )	-	-	1.3 ± 1.3	0.1 ± 0.1	-	-
pondweed, flatstem ( <i>P. zosteriformis</i> )	-	-	-	-	-	-
pondweed, horned ( <i>Zannichellia palustris</i> )	-	-	-	-	-	-
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	-	-	9.3 ± 3.4	0.8 ± 0.3	-	-
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	-	-	-	-
pondweed, sago ( <i>P. pectinatus</i> )	8.0 ± 3.2	0.7 ± 0.3	6.7 ± 2.9	0.7 ± 0.3	-	-
stargrass, water ( <i>Heteranthera dubia</i> )	-	-	14.7 ± 4.1	1.4 ± 0.4	-	-

Table 2. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 2002.

watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	-	-	-	-	-	-
watermilfoil, northern ( <i>Myriophyllum sibiricum</i> )	-	-	-	-	-	-
waternymph, nodding ( <i>Najas flexilis</i> )	-	-	16.0 ± 4.3	2.2 ± 0.6	-	-
waterweed, Canadian ( <i>Elodea canadensis</i> )	-	-	6.7 ± 2.9	0.5 ± 0.2	-	-
wildcelery ( <i>Vallisneria americana</i> )	-	-	10.7 ± 3.6	1.6 ± 0.6	-	-
all submersed species	8.0 ± 3.2	0.7 ± 0.3	25.3 ± 5.1	4.0 ± 0.8	3.3 ± 3.3	0.6 ± 0.6
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	-	-	-	-	-	-
pond-lily, yellow ( <i>Nuphar variegata</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	0.3 ± 0.2	-	-	18.3 ± 5.0	1.7 ± 0.5
pondweed, curly ( <i>Potamogeton crispus</i> )	7.5 ± 4.2	0.7 ± 0.5	-	-	8.3 ± 3.6	1.3 ± 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/pusillus</i> )	-	-	-	-	8.3 ± 3.6	0.8 ± 0.4

Table 2. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 2002.

pondweed, longleaf ( <i>P. nodosus</i> )	-	-	-	-	1.7 ± 1.7	0.2 ± 0.2
pondweed, sago ( <i>P. pectinatus</i> )	15.0 ± 5.7	1.7 ± 0.7	5.0 ± 3.5	0.5 ± 0.4	5.0 ± 2.8	0.6 ± 0.4
stargrass, water ( <i>Heteranthera dubia</i> )	10.0 ± 4.8	0.9 ± 0.4	-	-	13.3 ± 4.4	1.7 ± 0.6
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	2.5 ± 2.5	0.3 ± 0.3	-	-	8.3 ± 3.6	1.1 ± 0.5
watermilfoil, northern ( <i>Myriophyllum sibiricum</i> )	-	-	-	-	-	-
waternymph, nodding ( <i>Najas flexilis</i> )	-	-	-	-	-	-
waterweed, Canadian ( <i>Elodea canadensis</i> )	7.5 ± 4.2	0.5 ± 0.3	-	-	10.0 ± 3.9	1.5 ± 0.6
wildcelery ( <i>Vallisneria americana</i> )	15.0 ± 5.7	2.1 ± 0.8	-	-	16.7 ± 4.9	2.3 ± 0.7
all submersed species	20.0 ± 6.4	2.8 ± 1.0	5.0 ± 3.5	0.5 ± 0.4	25.0 ± 5.6	3.7 ± 0.9
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	-	-	-	-	-	-
pond-lily, yellow ( <i>Nuphar variegata</i> )	-	-	-	-	-	-
waterlily, white ( <i>Nymphaea odorata</i> )	-	-	-	-	3.3 ± 2.3	0.3 ± 0.2
all rooted floating-leaf species	-	-	-	-	3.3 ± 2.3	0.3 ± 0.2

Table 2. Continued.

Common name (Scientific name)	Pool 4, upper <i>n</i> = 245		Pool 4, lower <i>n</i> = 355		Pool 4 <i>n</i> = 630	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	-	-	-	0.3 ± 0.2	<0.1 ± <0.1
buttercup, longbeak ( <i>Ranunculus longirostris</i> )	-	-	-	-	0.1 ± 0.1	<0.1 ± <0.1
chara ( <i>Chara</i> spp.)	-	-	0.3 ± 0.3	<0.1 ± <0.1	0.2 ± 0.2	<0.1 ± <0.1
coontail ( <i>Ceratophyllum demersum</i> )	1.9 ± 0.7	0.2 ± 0.1	24.4 ± 2.3	3.0 ± 0.3	17.1 ± 1.3	2.3 ± 0.2
pondweed, curly ( <i>Potamogeton crispus</i> )	-	-	10.5 ± 1.7	1.1 ± 0.2	6.8 ± 1.0	0.7 ± 0.1
pondweed, flatstem ( <i>P. zosteriformis</i> )	-	-	7.3 ± 1.5	0.8 ± 0.2	4.4 ± 0.8	0.5 ± 0.1

Table 2. Percent frequency, abundance index (AI), cover, and standard error...ed floating–leaf vegetation in Pool 4, Upper Mississippi River System, 2002.

pondweed, horned ( <i>Zannichellia palustris</i> )	-	-	0.3 ± 0.3	<0.1 ± <0.1	0.2 ± 0.2	<0.1 ± <0.1
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	0.5 ± 0.4	0.1 ± 0.1	13.0 ± 1.9	1.4 ± 0.2	8.9 ± 1.1	1.1 ± 0.1
pondweed, longleaf ( <i>P. nodosus</i> )	0.3 ± 0.3	<0.1 ± <0.1	3.7 ± 1.1	0.4 ± 0.1	3.1 ± 0.7	0.4 ± 0.1
pondweed, sago ( <i>P. pectinatus</i> )	9.1 ± 2.2	0.9 ± 0.2	8.6 ± 1.5	0.9 ± 0.2	11.2 ± 1.3	1.3 ± 0.1
stargrass, water ( <i>Heteranthera dubia</i> )	-	-	24.0 ± 2.4	2.7 ± 0.3	13.8 ± 1.3	1.5 ± 0.2
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	-	-	19.2 ± 2.2	2.4 ± 0.3	10.3 ± 1.2	1.3 ± 0.2
watermilfoil, northern ( <i>Myriophyllum sibiricum</i> )	-	-	0.3 ± 0.3	0.1 ± 0.1	0.3 ± 0.2	0.1 ± <0.1
waternymph, nodding ( <i>Najas flexilis</i> )	0.3 ± 0.3	<0.1 ± <0.1	4.2 ± 1.0	0.5 ± 0.1	3.1 ± 0.6	0.3 ± 0.1
waterweed, Canadian ( <i>Elodea canadensis</i> )	0.5 ± 0.4	0.1 ± 0.1	21.6 ± 2.3	2.7 ± 0.3	13.3 ± 1.3	1.6 ± 0.2
wildcelery ( <i>Vallisneria americana</i> )	-	-	28.6 ± 2.5	4.1 ± 0.4	15.4 ± 1.3	2.2 ± 0.2
all submersed species	9.7 ± 2.2	1.1 ± 0.2	50.9 ± 2.5	7.7 ± 0.4	35.0 ± 1.7	5.4 ± 0.3
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	-	-	3.1 ± 1.0	0.3 ± 0.1	1.7 ± 0.5	0.2 ± 0.1
pond-lily, yellow ( <i>Nuphar variegata</i> )	-	-	0.3 ± 0.3	<0.1 ± <0.1	0.2 ± 0.2	<0.1 ± <0.1
waterlily, white ( <i>Nymphaea odorata</i> )	1.3 ± 0.6	0.2 ± 0.1	12.5 ± 1.9	1.6 ± 0.4	9.3 ± 1.1	1.2 ± 0.2
all rooted floating–leaf species	1.3 ± 0.6	0.2 ± 0.1	13.9 ± 1.9	1.8 ± 0.4	10.0 ± 1.1	1.3 ± 0.2

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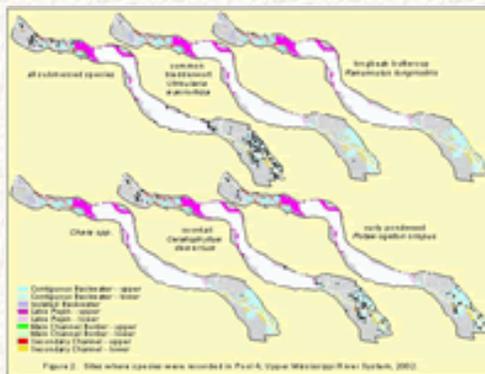
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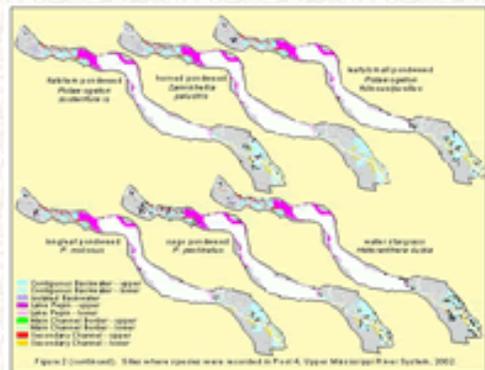
**Figure 2.** Sites where species were recorded in Pool 4, Upper Mississippi River System, 2002.

## Image Preview

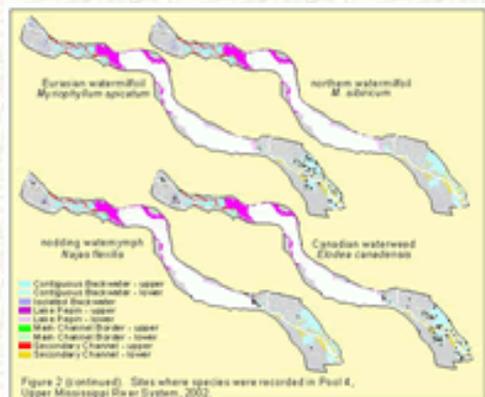
## Figure - Description



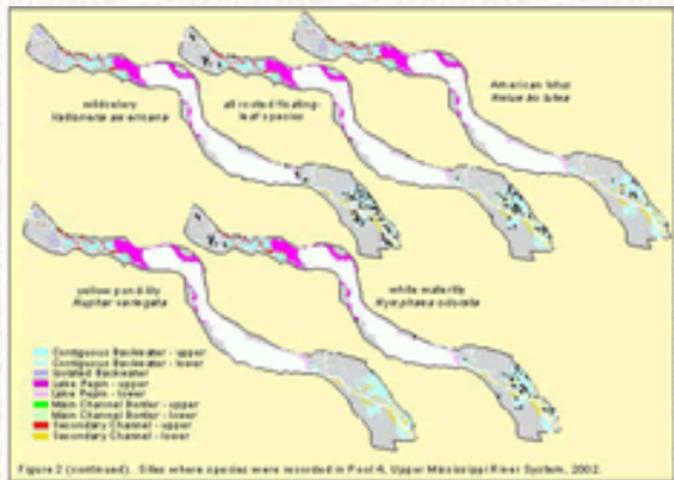
[Figure 2.](#) Sites where species were recorded in Pool 4, Upper Mississippi River System, 2002. Species: all submersed species, common bladderwort (*Utricularia macrorhiza*), longbeak buttercup (*Ranunculus longirostris*), *Chara* spp., coontail (*Ceratophyllum demersum*), and curly pondweed (*Potamogeton crispus*).



[Figure 2.](#) Continued. Species: flatstem pondweed (*P. zosteriformis*), horned pondweed (*Zannichellia palustris*), leafy/small pondweed (*Potamogeton foliosus/pusillus*), longleaf pondweed (*P. nodosus*), sago pondweed (*P. pectinatus*), and water stargrass (*Heteranthera dubia*).



[Figure 2.](#) Continued. Species: Eurasian watermilfoil (*Myriophyllum spicatum*), northern watermilfoil (*M. sibiricum*), nodding waterlily (*Najas flexilis*), and Canadian waterweed (*Elodea canadensis*).



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

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## 2002 Results in Pool 5 of the Upper Mississippi River

### Sampling Effort

Sampling was conducted from July 18 to August 5, 2002. Of the 404 sites targeted, all were sampled ([Figure 3](#)).

### Submersed Aquatic Vegetation

Submersed aquatic vegetation (SAV) covered about 28.5% of the shallow water areas poolwide ([Table 3](#); [Figure 4](#)). Contiguous backwaters had the highest percent frequency of SAV (51.8%). Impounded areas (27.2%), main channel border (15.5%), and secondary channels (14.0%) followed in decreasing order. Beds of SAV were found throughout most of the shallow water areas, except in the lower portion of the impounded stratum where SAV was nearly absent.

A total of 14 species were recorded in the entire pool. Contiguous backwaters (13) had the most species recorded followed by impounded areas (10), secondary channels (8), and main channel borders (7). Sago pondweed (10.5%) was the most frequently recorded species followed by water stargrass (9.5%), coontail (9.2%), and Canadian waterweed (9.2%).

### Rooted Floating–Leaf Vegetation

White waterlily, American lotus, and yellow pond-lily were the three rooted floating-leaf species recorded. Together, the three species had a cover of 2.7% and a frequency of 9.8% of the shallow water areas of Pool 5.

The percent frequency of rooted floating-leaf species was the highest in the contiguous backwaters (40.0%). Rooted floating-leaf species were not found in main channel border sites. The contiguous backwater stratum was the only area to contain all three rooted floating-leaf species. American lotus (3.5%) and white waterlily (2.9%) were found minimally in the impounded area, while white waterlily (4.0%) was the only recorded species in secondary channels.



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**Table 3.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 5, Upper Mississippi River System, 2002.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 110		Impounded <i>n</i> = 173	
	Freq	AI	Freq	AI
chara ( <i>Chara</i> spp.)	0.9 ± 0.9	0.1 ± 0.1	-	-
coontail ( <i>Ceratophyllum demersum</i> )	36.4 ± 4.6	5.6 ± 0.8	3.5 ± 1.4	0.2 ± 0.1
pondweed, curly ( <i>Potamogeton crispus</i> )	8.2 ± 2.6	0.6 ± 0.2	2.3 ± 1.1	0.2 ± 0.1
pondweed, flatstem ( <i>P. zosteriformis</i> )	10.9 ± 3.0	1.1 ± 0.3	-	-
pondweed, horned ( <i>Zannichellia palustris</i> )	-	-	0.6 ± 0.6	0.1 ± 0.1
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	18.2 ± 3.7	2.2 ± 0.5	1.7 ± 1.0	0.2 ± 0.1
pondweed, longleaf ( <i>P. nodosus</i> )	10.0 ± 2.9	1.1 ± 0.3	0.6 ± 0.6	0.1 ± 0.1
pondweed, Richardson's ( <i>P. richardsonii</i> )	0.9 ± 0.9	0.1 ± 0.1	-	-
pondweed, sago ( <i>P. pectinatus</i> )	6.4 ± 2.3	0.8 ± 0.3	13.3 ± 2.6	1.4 ± 0.3
stargrass, water ( <i>Heteranthera dubia</i> )	10.9 ± 3.0	1.2 ± 0.4	10.4 ± 2.3	1.0 ± 0.3
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	28.2 ± 4.3	3.2 ± 0.5	5.2 ± 1.7	0.5 ± 0.2
waternymph, nodding ( <i>Najas flexilis</i> )	1.8 ± 1.3	0.2 ± 0.2	-	-
waterweed, Canadian ( <i>Elodea canadensis</i> )	26.4 ± 4.2	3.1 ± 0.5	6.9 ± 1.9	0.7 ± 0.2
wildcelery ( <i>Vallisneria americana</i> )	10.0 ± 2.9	1.1 ± 0.3	9.8 ± 2.3	1.7 ± 0.4

Table 3. Percent frequency, abundance index (AI), cover, and standard error...ted floating-leaf vegetation in Pool 5, Upper Mississippi River System, 2002

all submersed species	51.8 ± 4.8	8.6 ± 0.9	27.2 ± 3.4	3.6 ± 0.5
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	10.0 ± 2.9	2.8 ± 1.2	3.5 ± 1.4	0.9 ± 0.6
pond-lily, yellow ( <i>Nuphar variegata</i> )	1.8 ± 1.3	0.4 ± 0.3	-	-
waterlily, white ( <i>Nymphaea odorata</i> )	32.7 ± 4.5	7.6 ± 1.7	2.9 ± 1.3	0.9 ± 0.5
all rooted floating-leaf species	40.0 ± 4.7	10.7 ± 2.0	5.2 ± 1.7	1.7 ± 0.7

Table 3. Continued.

Common name (Scientific name)	Main channel border <i>n</i> = 71		Secondary channel <i>n</i> = 50		Pool 5 <i>n</i> = 404	
	Freq	AI	Freq	AI	Freq	AI
chara ( <i>Chara</i> spp.)	-	-	-	-	0.2 ± 0.2	<0.1 ± <0.1
coontail ( <i>Ceratophyllum demersum</i> )	2.8 ± 2.0	0.2 ± 0.1	12.0 ± 4.6	1.0 ± 0.4	12.0 ± 1.5	1.6 ± 0.2
pondweed, curly ( <i>Potamogeton crispus</i> )	1.4 ± 1.4	0.1 ± 0.1	2.0 ± 2.0	0.1 ± 0.1	3.7 ± 1.0	0.3 ± 0.1
pondweed, flatstem ( <i>P. zosteriformis</i> )	-	-	-	-	2.7 ± 0.7	0.3 ± 0.1
pondweed, horned ( <i>Zannichellia palustris</i> )	-	-	-	-	0.4 ± 0.4	0.1 ± 0.1
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	1.4 ± 1.4	0.1 ± 0.1	2.0 ± 2.0	0.2 ± 0.2	5.7 ± 1.1	0.7 ± 0.1
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	-	-	2.8 ± 0.8	0.3 ± 0.1
pondweed, Richardson's ( <i>P. richardsonii</i> )	-	-	-	-	0.2 ± 0.2	<0.1 ± <0.1
pondweed, sago ( <i>P. pectinatus</i> )	4.2 ± 2.4	0.5 ± 0.3	2.0 ± 2.0	0.1 ± 0.1	10.3 ± 1.7	1.1 ± 0.2
stargrass, water ( <i>Heteranthera dubia</i> )	5.6 ± 2.8	0.4 ± 0.2	4.0 ± 2.8	0.4 ± 0.3	9.8 ± 1.6	1.0 ± 0.2
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	-	-	6.0 ± 3.4	0.7 ± 0.4	10.5 ± 1.5	1.1 ± 0.2
waternymph, nodding ( <i>Najas flexilis</i> )	-	-	-	-	0.4 ± 0.3	0.1 ± <0.1
waterweed, Canadian ( <i>Elodea canadensis</i> )	7.0 ± 3.1	0.5 ± 0.2	2.0 ± 2.0	0.1 ± 0.1	11.4 ± 1.6	1.2 ± 0.2

Table 3. Percent frequency, abundance index (AI), cover, and standard error...ted floating–leaf vegetation in Pool 5, Upper Mississippi River System, 2002

wildcelery ( <i>Vallisneria americana</i> )	5.6 ± 2.8	0.7 ± 0.4	2.0 ± 2.0	0.2 ± 0.2	9.1 ± 1.6	1.4 ± 0.3
all submersed species	15.5 ± 4.3	1.7 ± 0.5	14.0 ± 5.0	1.7 ± 0.6	31.6 ± 2.5	4.6 ± 0.4
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	-	-	-	-	4.6 ± 1.1	1.3 ± 0.5
pond-lily, yellow ( <i>Nuphar variegata</i> )	-	-	-	-	0.4 ± 0.3	0.1 ± 0.1
waterlily, white ( <i>Nymphaea odorata</i> )	-	-	4.0 ± 2.8	0.4 ± 0.3	10.0 ± 1.4	2.4 ± 0.5
all rooted floating–leaf species	-	-	4.0 ± 2.8	0.4 ± 0.3	13.2 ± 1.6	3.7 ± 0.7

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**Figure 4.** Sites where species were recorded in Pool 5, Upper Mississippi River System, 2002.

## Image Preview

## Figure - Description

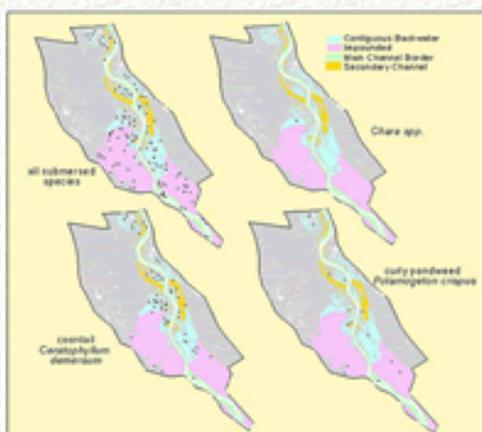


Figure 4. Sites where species were recorded in Pool 5, Upper Mississippi River System, 2002.

[Figure 4.](#) Sites where species were recorded in Pool 5, Upper Mississippi River System, 2002. Species: all submersed species, *Chara* spp., coontail (*Ceratophyllum demersum*), and curly pondweed (*Potamogeton crispus*).

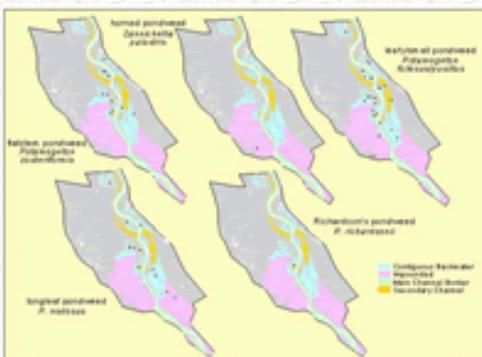


Figure 4 (continued). Sites where species were recorded in Pool 5, Upper Mississippi River System, 2002.

[Figure 4.](#) Continued. Species: flatstem pondweed (*P. zosteriformis*), horned pondweed (*Zannichellia palustris*), leafy/small pondweed (*Potamogeton foliosus/pusillus*), longleaf pondweed (*P. nodosus*), and Richardson's pondweed (*P. richardsonii*).

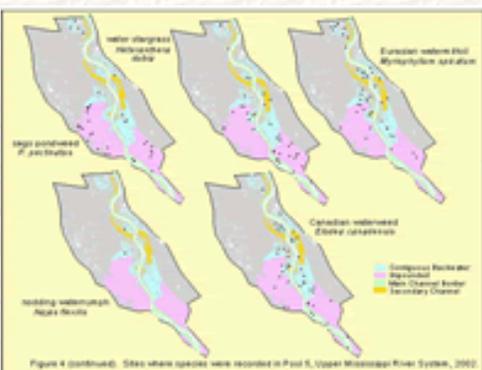
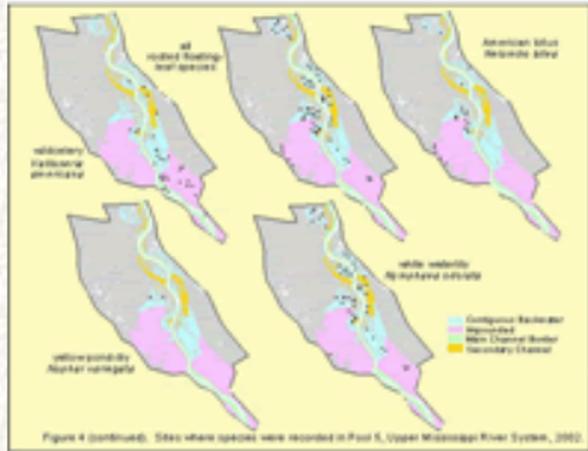


Figure 4 (continued). Sites where species were recorded in Pool 5, Upper Mississippi River System, 2002.

[Figure 4.](#) Continued. Species: sago pondweed (*P. pectinatus*), water stargrass (*Heteranthera dubia*), Eurasian watermilfoil (*Myriophyllum spicatum*), nodding waterlily (*Najas flexilis*), and Canadian waterweed (*Elodea canadensis*).



[Figure 4](#). Continued. Species: wildcelery (*Vallisneria americana*), all rooted floating–leaf species, American lotus (*Nelumbo lutea*), yellow pond-lily (*Nuphar variegata*), and white waterlily (*Nymphaea odorata*).

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## 2002 Results in Pool 7 of the Upper Mississippi River

### Sampling Effort

Sampling was conducted from August 5 to August 28, 2002. Of the 406 sites targeted, 392 were sampled ([Figure 5](#)).

### Submersed Aquatic Vegetation

Submersed aquatic vegetation (SAV) covered about 39% of the shallow water areas poolwide and was found throughout most of the pool ([Table 4](#); [Figure 6](#)). Contiguous backwaters had the highest percent frequency of SAV (90%). Impounded areas (60%), secondary channels (25%), and main channel border (7%) followed in decreasing order.

A total of 15 species were recorded in the entire pool. Contiguous backwaters and impounded areas had the most species recorded (14) followed by secondary channels (8), and main channel border areas (4). Coontail (29%) was the most frequently recorded species in Pool 7 followed by Canadian waterweed (27%) and wildcelery (22%).

### Rooted Floating–Leaf Vegetation

White waterlily, American lotus, and yellow pond-lily were the three rooted floating-leaf species recorded. The three species together covered about 4% of the shallow water areas and appeared to be limited to more sheltered areas of Pool 7.

The percent cover of rooted floating-leaf species was the highest in contiguous backwaters (9%) followed by secondary channels (6%) and impounded areas (3%). No rooted floating-leaf vegetation was found in main channel border areas.

White waterlily and American lotus were scattered throughout much of Pool 7, while yellow pond-lily was found at one site in the north end of Lake Onalaska.



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**Table 4.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 7, Upper Mississippi River System, 2002.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 102		Impounded <i>n</i> = 171	
	Freq	AI	Freq	AI
bladderwort, common ( <i>Utricularia macrorhiza</i> )	3.9 ± 1.9	0.3 ± 0.2	-	-
buttercup ( <i>Ranunculus</i> spp.)	-	-	0.6 ± 0.6	<0.1 ± <0.1
chara ( <i>Chara</i> spp.)	10.8 ± 3.1	1.2 ± 0.4	2.3 ± 1.2	0.3 ± 0.2
coontail ( <i>Ceratophyllum demersum</i> )	86.3 ± 3.4	15.8 ± 0.9	26.3 ± 3.4	4.0 ± 0.6
pondweed, curly ( <i>Potamogeton crispus</i> )	10.8 ± 3.1	0.9 ± 0.3	2.3 ± 1.2	0.2 ± 0.1
pondweed, flatstem ( <i>P. zosteriformis</i> )	54.9 ± 5.0	7.6 ± 0.8	14.0 ± 2.7	1.3 ± 0.3
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	30.4 ± 4.6	3.1 ± 0.5	10.5 ± 2.4	1.1 ± 0.3
pondweed, longleaf ( <i>P. nodosus</i> )	9.8 ± 3.0	1.0 ± 0.3	1.2 ± 0.8	0.1 ± 0.1
pondweed, Richardson's ( <i>P. richardsonii</i> )	3.9 ± 1.9	0.3 ± 0.2	11.7 ± 2.5	1.0 ± 0.2
pondweed, sago ( <i>P. pectinatus</i> )	3.9 ± 1.9	0.5 ± 0.2	8.2 ± 2.1	0.7 ± 0.2
stargrass, water ( <i>Heteranthera dubia</i> )	28.4 ± 4.5	3.0 ± 0.5	28.1 ± 3.4	3.5 ± 0.5
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	43.1 ± 4.9	5.6 ± 0.7	20.5 ± 3.1	2.4 ± 0.4
waternymph, nodding ( <i>Najas flexilis</i> )	12.7 ± 3.3	1.2 ± 0.3	5.3 ± 1.7	0.5 ± 0.2
waterweed, Canadian ( <i>Elodea canadensis</i> )	76.5 ± 4.2	12.0 ± 0.8	26.9 ± 3.4	3.5 ± 0.5

Table 4. Percent frequency, abundance index (AI), cover, and standard error...ted floating-leaf vegetation in Pool 7, Upper Mississippi River System, 2002

wildcelery ( <i>Vallisneria americana</i> )	33.3 ± 4.7	3.8 ± 0.6	53.8 ± 3.8	11.3 ± 0.9
all submersed species	90.2 ± 3.0	18.9 ± 0.9	60.2 ± 3.8	13.3 ± 0.9
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	18.6 ± 3.9	4.6 ± 1.4	7.0 ± 2.0	1.9 ± 0.7
pond-lily, yellow ( <i>Nuphar variegata</i> )	1.0 ± 1.0	0.1 ± 0.1	-	-
waterlily, white ( <i>Nymphaea odorata</i> )	23.5 ± 4.2	5.1 ± 1.3	8.2 ± 2.1	1.4 ± 0.5
all rooted floating-leaf species	37.3 ± 4.8	9.2 ± 1.8	12.3 ± 2.5	3.0 ± 0.9

Table 4. Continued.

Common name (Scientific name)	Main channel border <i>n</i> = 71		Secondary channel <i>n</i> = 48		Pool 7 <i>n</i> = 392	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	-	-	-	0.6 ± 0.3	0.1 ± <0.1
buttercup ( <i>Ranunculus</i> spp.)	-	-	-	-	0.4 ± 0.4	<0.1 ± <0.1
chara ( <i>Chara</i> spp.)	-	-	-	-	3.2 ± 0.9	0.4 ± 0.1
coontail ( <i>Ceratophyllum demersum</i> )	1.4 ± 1.4	0.1 ± 0.1	16.7 ± 5.4	2.5 ± 0.9	32.4 ± 2.4	5.3 ± 0.4
pondweed, curly ( <i>Potamogeton crispus</i> )	-	-	-	-	3.2 ± 0.9	0.3 ± 0.1
pondweed, flatstem ( <i>P. zosteriformis</i> )	-	-	12.5 ± 4.8	1.8 ± 0.7	19.0 ± 2.0	2.2 ± 0.2
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	-	-	-	-	11.6 ± 1.7	1.2 ± 0.2
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	2.1 ± 2.1	0.2 ± 0.2	2.5 ± 0.7	0.2 ± 0.1
pondweed, Richardson's ( <i>P. richardsonii</i> )	-	-	-	-	8.5 ± 1.7	0.8 ± 0.2
pondweed, sago ( <i>P. pectinatus</i> )	-	-	2.1 ± 2.1	0.1 ± 0.1	6.4 ± 1.5	0.6 ± 0.1
stargrass, water ( <i>Heteranthera dubia</i> )	4.2 ± 2.4	0.4 ± 0.3	12.5 ± 4.8	2.2 ± 0.9	24.9 ± 2.5	3.1 ± 0.4
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	1.4 ± 1.4	0.1 ± 0.1	6.3 ± 3.5	0.7 ± 0.4	21.0 ± 2.3	2.5 ± 0.3

Table 4. Percent frequency, abundance index (AI), cover, and standard error...ted floating-leaf vegetation in Pool 7, Upper Mississippi River System, 2002

waternymph, nodding ( <i>Najas flexilis</i> )	-	-	-	-	5.4 ± 1.3	0.5 ± 0.1
waterweed, Canadian ( <i>Elodea canadensis</i> )	-	-	18.8 ± 5.7	2.6 ± 0.9	31.6 ± 2.5	4.4 ± 0.4
wildcelery ( <i>Vallisneria americana</i> )	5.6 ± 2.8	0.8 ± 0.4	14.6 ± 5.1	2.0 ± 0.8	43.5 ± 2.8	8.5 ± 0.6
all submersed species	7.0 ± 3.1	0.9 ± 0.4	25.0 ± 6.3	4.7 ± 1.3	57.4 ± 2.7	12.4 ± 0.7
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	-	-	4.2 ± 2.9	3.8 ± 2.6	8.0 ± 1.5	2.4 ± 0.6
pond-lily, yellow ( <i>Nuphar variegata</i> )	-	-	-	-	0.1 ± 0.1	<0.1 ± <0.1
waterlily, white ( <i>Nymphaea odorata</i> )	-	-	2.1 ± 2.1	1.9 ± 1.9	9.2 ± 1.6	1.9 ± 0.4
all rooted floating-leaf species	-	-	6.3 ± 3.5	5.6 ± 3.2	14.4 ± 1.9	4.0 ± 0.7

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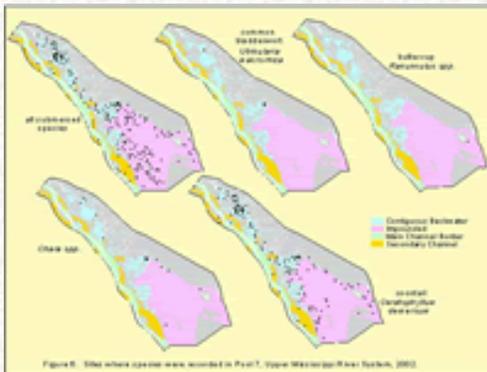
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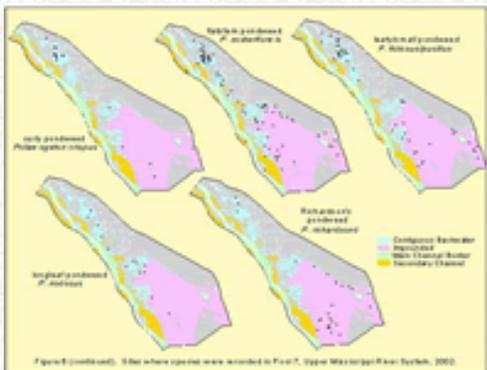
**Figure 6.** Sites where species were recorded in Pool 7, Upper Mississippi River System, 2002.

## Image Preview

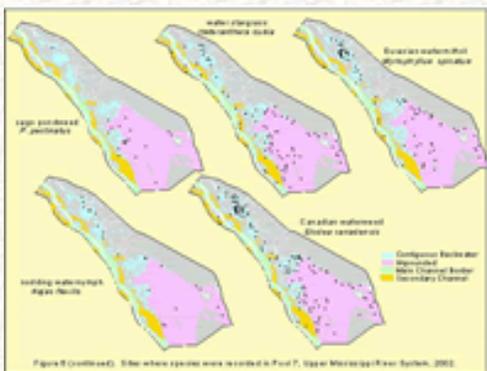
## Figure - Description



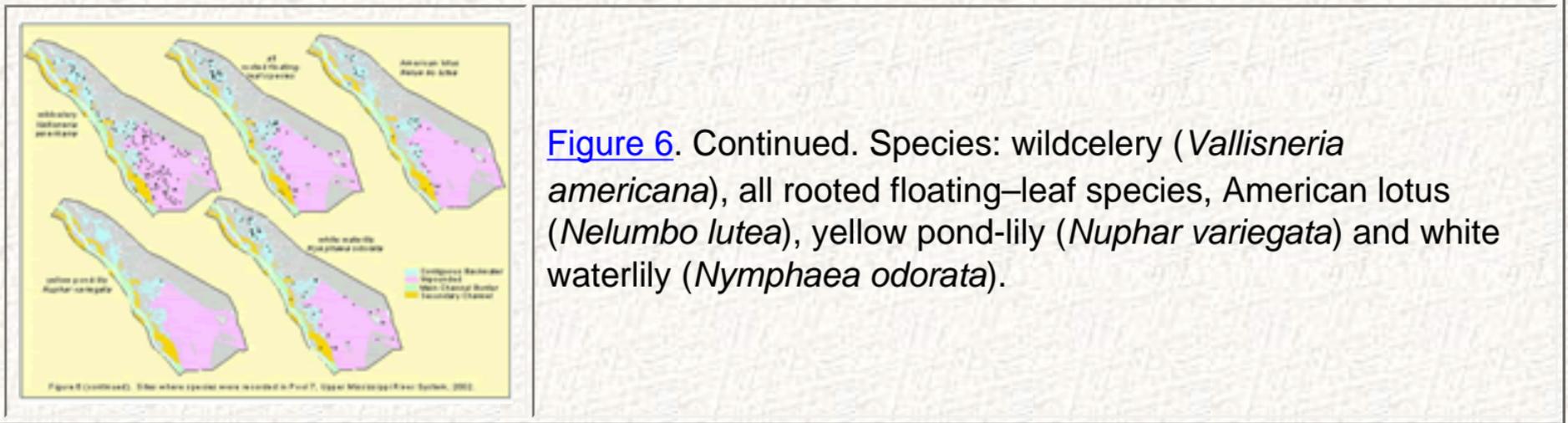
[Figure 6.](#) Sites where species were recorded in Pool 7, Upper Mississippi River System, 2002. Species: all submersed species, common bladderwort (*Utricularia macrorhiza*), buttercup (*Ranunculus* spp.), *Chara* spp., and coontail (*Ceratophyllum demersum*).



[Figure 6.](#) Continued. Species: curly pondweed (*Potamogeton crispus*), flatstem pondweed (*P. zosteriformis*), leafy/small pondweed (*Potamogeton foliosus/pusillus*), longleaf pondweed (*P. nodosus*), and Richardson's pondweed (*P. richardsonii*).



[Figure 6.](#) Continued. Species: sago pondweed (*P. pectinatus*), water stargrass (*Heteranthera dubia*), Eurasian watermilfoil (*Myriophyllum spicatum*), nodding waternymph (*Najas flexilis*), and Canadian waterweed (*Elodea canadensis*).



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## 2002 Results in Pool 8 of the Upper Mississippi River

### Sampling Efforts

Sampling was conducted from June 17 to August 1, 2002. Of the 650 sites targeted, 644 were sampled ([Figure 7](#)). A drawdown was conducted in Pool 8 in 2002. It began on June 17 and was terminated on September 15, 2002. This was the second year a drawdown was conducted in Pool 8. We revisited the 2001 sites in Pool 8 to allow change estimates for not only the pool and strata but also for individual sites, thereby increasing the statistical power to identify drawdown related vegetation responses.

### Submersed Aquatic Vegetation

Submersed aquatic vegetation (SAV) covered about 53.4% of the shallow water areas poolwide and was found throughout most of the pool ([Table 5](#); [Figure 8](#)). Isolated backwaters had the highest percent frequency of SAV (89%). Contiguous backwaters (76%), impounded areas (47%), secondary channels (29%), and main channel border (17%) followed in decreasing order.

A total of 15 species were recorded in Pool 8. Contiguous backwaters (13) had the most species recorded. All other strata had 8 or more species. Canadian waterweed (31%) was the most frequently recorded species followed by water stargrass (28%) and coontail (28%).

### Rooted Floating–Leaf Vegetation

White waterlily, American lotus, and yellow pond-lily were the three rooted floating-leaf species recorded. The three species together covered about 6% of the shallow water areas.

The percent cover of rooted floating-leaf species was the highest in isolated backwaters (40%) followed by contiguous backwaters (12%). White waterlily and American lotus were scattered throughout much of the upper two-thirds of Pool 8, while yellow pond-lily had a much more limited distribution.



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**Table 5.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 8, Upper Mississippi River System, 2002.

Common name (Scientific name)	Contiguous backwater n = 174		Isolated backwater n = 26		Impounded n = 224	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common ( <i>Utricularia macrorhiza</i> )	2.9 ± 1.3	0.4 ± 0.2	3.8 ± 3.8	0.3 ± 0.3	-	-
chara ( <i>Chara</i> spp.)	1.7 ± 1.0	0.2 ± 0.1	-	-	-	-
coontail ( <i>Ceratophyllum demersum</i> )	54.0 ± 3.8	8.5 ± 0.7	88.5 ± 6.4	21.5 ± 3.1	14.7 ± 2.4	2.4 ± 0.4
pondweed, curly ( <i>Potamogeton crispus</i> )	25.9 ± 3.3	3.3 ± 0.5	26.9 ± 8.9	3.0 ± 1.1	3.6 ± 1.2	0.3 ± 0.1
pondweed, flatstem ( <i>P. zosteriformis</i> )	23.6 ± 3.2	2.8 ± 0.4	7.7 ± 5.3	0.7 ± 0.5	0.4 ± 0.4	<0.1 ± <0.1
pondweed, horned ( <i>Zannichellia palustris</i> )	-	-	-	-	-	-
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	25.9 ± 3.3	3.1 ± 0.4	57.7 ± 9.9	7.3 ± 1.6	3.6 ± 1.2	0.4 ± 0.1
pondweed, longleaf ( <i>P. nodosus</i> )	9.2 ± 2.2	1.2 ± 0.3	-	-	1.8 ± 0.9	0.2 ± 0.1
pondweed, Richardson's ( <i>P. richardsonii</i> )	-	-	-	-	0.9 ± 0.6	0.1 ± <0.1
pondweed, sago ( <i>P. pectinatus</i> )	25.9 ± 3.3	2.8 ± 0.4	19.2 ± 7.9	2.0 ± 0.9	10.3 ± 2.0	1.3 ± 0.3
stargrass, water ( <i>Heteranthera dubia</i> )	25.9 ± 3.3	3.4 ± 0.5	-	-	37.5 ± 3.2	5.4 ± 0.5
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	27.6 ± 3.4	3.5 ± 0.5	-	-	17.0 ± 2.5	1.9 ± 0.3
waternymph, nodding ( <i>Najas flexilis</i> )	4.0 ± 1.5	0.4 ± 0.2	7.7 ± 5.3	0.8 ± 0.5	0.4 ± 0.4	<0.1 ± <0.1
waterweed, Canadian ( <i>Elodea canadensis</i> )	54.6 ± 3.8	8.9 ± 0.7	46.2 ± 10.0	8.4 ± 2.3	22.8 ± 2.8	3.8 ± 0.6

Table 5. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 8, Upper Mississippi River System, 2002.

wildcelery ( <i>Vallisneria americana</i> )	8.6 ± 2.1	0.9 ± 0.2	-	-	30.8 ± 3.1	5.0 ± 0.6
all submersed species	76.4 ± 3.2	14.8 ± 0.8	88.5 ± 6.4	23.6 ± 3.4	47.3 ± 3.3	9.3 ± 0.8
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	8.0 ± 2.1	1.3 ± 0.4	-	-	7.6 ± 1.8	1.6 ± 0.5
pond-lily, yellow ( <i>Nuphar variegata</i> )	3.4 ± 1.4	0.6 ± 0.3	3.8 ± 3.8	1.9 ± 1.9	-	-
waterlily, white ( <i>Nymphaea odorata</i> )	29.3 ± 3.5	10.1 ± 1.7	65.4 ± 9.5	38.1 ± 8.3	2.2 ± 1.0	0.5 ± 0.3
all rooted floating-leaf species	36.2 ± 3.7	11.8 ± 1.8	65.4 ± 9.5	40.4 ± 8.3	8.5 ± 1.9	1.9 ± 0.6

Table 5. Continued.

Common name (Scientific name)	Main channel border <i>n</i> = 100		Secondary channel <i>n</i> = 120		Pool 8 <i>n</i> = 644	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	-	-	-	1.0 ± 0.4	0.1 ± <0.1
chara ( <i>Chara</i> spp.)	-	-	-	-	0.5 ± 0.3	<0.1 ± <0.1
coontail ( <i>Ceratophyllum demersum</i> )	3.0 ± 1.7	0.3 ± 0.2	13.3 ± 3.1	1.6 ± 0.4	28.0 ± 1.7	4.6 ± 0.3
pondweed, curly ( <i>Potamogeton crispus</i> )	2.0 ± 1.4	0.1 ± 0.1	3.3 ± 1.6	0.3 ± 0.2	10.6 ± 1.2	1.3 ± 0.2
pondweed, flatstem ( <i>P. zosteriformis</i> )	-	-	4.2 ± 1.8	0.4 ± 0.2	7.7 ± 1.0	0.9 ± 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/pusillus</i> )	1.0 ± 1.0	0.1 ± 0.1	5.8 ± 2.1	0.7 ± 0.3	12.1 ± 1.2	1.4 ± 0.2
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	2.5 ± 1.4	0.5 ± 0.3	3.8 ± 0.8	0.5 ± 0.1
pondweed, Richardson's ( <i>P. richardsonii</i> )	-	-	-	-	0.4 ± 0.3	<0.1 ± <0.1
pondweed, sago ( <i>P. pectinatus</i> )	11.0 ± 3.1	1.7 ± 0.5	6.7 ± 2.3	0.7 ± 0.2	14.5 ± 1.5	1.6 ± 0.2
stargrass, water ( <i>Heteranthera dubia</i> )	9.0 ± 2.9	1.3 ± 0.4	13.3 ± 3.1	1.4 ± 0.4	28.3 ± 1.9	3.9 ± 0.3
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	1.0 ± 1.0	0.1 ± 0.1	4.2 ± 1.8	0.5 ± 0.2	16.9 ± 1.6	2.0 ± 0.2

Table 5. Percent frequency, abundance index (AI), cover, and standard error...ed floating–leaf vegetation in Pool 8, Upper Mississippi River System, 2002.

waternymph, nodding ( <i>Najas flexilis</i> )	-	-	-	-	1.6 ± 0.5	0.2 ± 0.1
waterweed, Canadian ( <i>Elodea canadensis</i> )	4.0 ± 2.0	0.6 ± 0.3	16.7 ± 3.4	2.3 ± 0.5	31.0 ± 1.9	5.1 ± 0.4
wildcelery ( <i>Vallisneria americana</i> )	6.0 ± 2.4	0.9 ± 0.4	8.3 ± 2.5	1.0 ± 0.4	19.3 ± 1.7	2.9 ± 0.3
all submersed species	17.0 ± 3.8	2.9 ± 0.7	29.2 ± 4.2	4.5 ± 0.7	53.4 ± 2.0	10.5 ± 0.5
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	4.0 ± 2.0	2.4 ± 1.4	5.0 ± 2.0	1.3 ± 0.8	6.9 ± 1.1	1.4 ± 0.3
pond-lily, yellow ( <i>Nuphar variegata</i> )	-	-	-	-	1.1 ± 0.4	0.2 ± 0.1
waterlily, white ( <i>Nymphaea odorata</i> )	-	-	5.8 ± 2.1	0.8 ± 0.3	12.7 ± 1.2	4.6 ± 0.6
all rooted floating–leaf species	4.0 ± 2.0	2.4 ± 1.4	7.5 ± 2.4	1.8 ± 0.8	18.1 ± 1.5	6.2 ± 0.7

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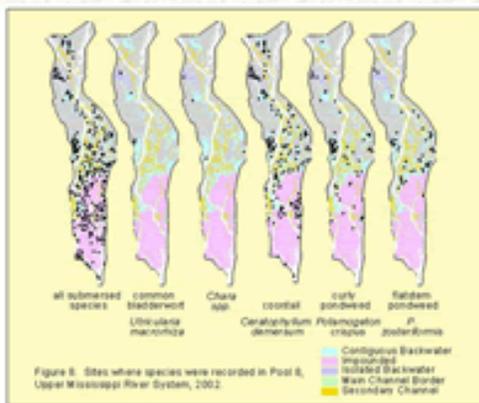
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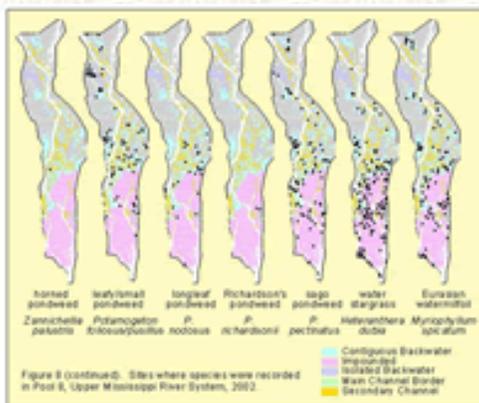
**Figure 8.** Sites where species were recorded in Pool 8, Upper Mississippi River System, 2002.

## Image Preview

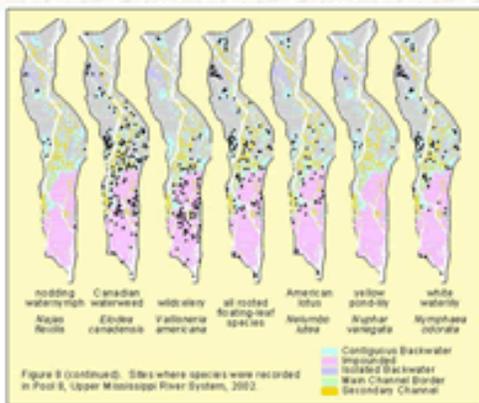


## Figure - Description

[Figure 8](#). Species: all submersed species, common bladderwort (*Utricularia macrorhiza*), *Chara* spp., coontail (*Ceratophyllum demersum*), curly pondweed (*Potamogeton crispus*), and flatstem pondweed (*P. zosteriformis*).



[Figure 8](#). Continued. Species: horned pondweed (*Zannichellia palustris*), leafy/small pondweed (*Potamogeton foliosus/pusillus*), longleaf pondweed (*P. nodosus*), Richardson's pondweed (*P. richardsonii*), sago pondweed (*P. pectinatus*), water stargrass (*Heteranthera dubia*), and Eurasian watermilfoil (*Myriophyllum spicatum*).



[Figure 8](#). Continued. Species: nodding waterlily (*Najas flexilis*), Canadian waterweed (*Elodea canadensis*), wild celery (*Vallisneria spiralis*), all rooted floating-leaf species, American lotus (*Nelumbo lutea*), yellow pond-lily (*Nuphar variegata*), and white waterlily (*Nymphaea odorata*).



## 2002 Results in Pool 12 of the Upper Mississippi River

### Sampling Efforts

Sampling was conducted in a total of 14 working days from July 23 to August 14, 2002. Of the 405 sites targeted, 404 were sampled ([Figure 9](#)).

### Submersed Aquatic Vegetation

Submersed aquatic vegetation (SAV) was encountered at 12.8% of the shallow water areas poolwide ([Table 6](#); [Figure 10](#)). The frequencies of SAV varied among strata sampled. Contiguous backwater areas exhibited the highest percent frequency of occurrence of SAV with 33.3%. Impounded areas (27.2%), secondary channel (8.0%), and main channel border sites (3.3%) followed in decreasing order.

A total of 10 SAV species were collected in Pool 12. Both contiguous backwaters and impounded area contained nine SAV species. Main channel border and secondary channel sites contained the least number of SAV species with five and three, respectively.

Coontail (8.3%) was the most frequently encountered species poolwide followed by sago pondweed (5.5%) and water stargrass (2.6%). Eurasian watermilfoil was found in all but the secondary channel stratum.

### Rooted Floating–Leaf Vegetation

American lotus and white water lily were the only two rooted floating-leaf species encountered in Pool 12 and together covered about 6.1% of the shallow water areas or areas where water depth measured 3 m or less at flat-pool condition.

The percent frequency of rooted floating-leaf vegetation was highest in contiguous backwaters (35.0%) followed by the impounded area (30.9%). American lotus and white water lily were sampled only in contiguous backwater and impounded strata. American lotus was encountered more often than white water lily in both strata.



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**Table 6.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 12, Upper Mississippi River System, 2002.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 120		Impounded <i>n</i> = 81	
	Freq	AI	Freq	AI
coontail ( <i>Ceratophyllum demersum</i> )	25.8 ± 4.0	3.2 ± 0.6	14.8 ± 4.0	1.4 ± 0.4
pondweed, curly ( <i>Potamogeton crispus</i> )	0.8 ± 0.8	0.1 ± 0.1	2.5 ± 1.7	0.3 ± 0.2
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	0.8 ± 0.8	0.1 ± 0.1	3.7 ± 2.1	0.3 ± 0.1
pondweed, longleaf ( <i>P. nodosus</i> )	6.7 ± 2.3	0.7 ± 0.3	14.8 ± 4.0	2.1 ± 0.7
pondweed, sago ( <i>P. pectinatus</i> )	10.8 ± 2.8	1.1 ± 0.3	11.1 ± 3.5	1.4 ± 0.5
stargrass, water ( <i>Heteranthera dubia</i> )	5.0 ± 2.0	0.4 ± 0.2	16.0 ± 4.1	2.3 ± 0.7
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	5.0 ± 2.0	0.5 ± 0.2	8.6 ± 3.1	1.1 ± 0.4
waternymph, nodding ( <i>Najas flexilis</i> )	0.8 ± 0.8	0.2 ± 0.2	-	-
waterweed, Canadian ( <i>Elodea canadensis</i> )	0.8 ± 0.8	0.1 ± 0.1	2.5 ± 1.7	0.2 ± 0.1
wildcelery ( <i>Vallisneria americana</i> )	-	-	7.4 ± 2.9	1.5 ± 0.6
all submersed species	33.3 ± 4.3	4.6 ± 0.7	27.2 ± 5.0	5.2 ± 1.2
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	30.0 ± 4.2	17.2 ± 2.9	29.6 ± 5.1	22.2 ± 4.1
waterlily, white ( <i>Nymphaea odorata</i> )	10.8 ± 2.8	3.3 ± 1.2	2.5 ± 1.7	0.5 ± 0.4
all rooted floating-leaf species	35.0 ± 4.4	20.5 ± 3.2	30.9 ± 5.2	22.8 ± 4.1

**Table 6.** Continued.

Common name (Scientific name)	Main channel border <i>n</i> = 153		Secondary channel <i>n</i> = 50		Pool 12 <i>n</i> = 404	
	Freq	AI	Freq	AI	Freq	AI
coontail ( <i>Ceratophyllum demersum</i> )	0.7 ± 0.7	<0.1 ± <0.1	2.0 ± 2.0	0.1 ± 0.1	9.2 ± 1.3	1.0 ± 0.2
pondweed, curly ( <i>Potamogeton crispus</i> )	-	-	-	-	0.6 ± 0.3	0.1 ± <0.1
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	-	-	-	-	0.8 ± 0.4	0.1 ± <0.1
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	-	-	3.9 ± 0.8	0.4 ± 0.1
pondweed, sago ( <i>P. pectinatus</i> )	2.6 ± 1.3	0.2 ± 0.1	6.0 ± 3.4	0.5 ± 0.3	6.7 ± 1.3	0.7 ± 0.1
stargrass, water ( <i>Heteranthera dubia</i> )	2.0 ± 1.1	0.2 ± 0.1	-	-	4.4 ± 0.9	0.5 ± 0.1
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	0.7 ± 0.7	0.1 ± 0.1	-	-	2.8 ± 0.7	0.3 ± 0.1
waternymph, nodding ( <i>Najas flexilis</i> )	-	-	-	-	0.2 ± 0.2	<0.1 ± <0.1
waterweed, Canadian ( <i>Elodea canadensis</i> )	-	-	2.0 ± 2.0	0.1 ± 0.1	1.1 ± 0.6	0.1 ± <0.1
wildcelery ( <i>Vallisneria americana</i> )	1.3 ± 0.9	0.2 ± 0.1	-	-	1.7 ± 0.6	0.3 ± 0.1
all submersed species	3.3 ± 1.4	0.5 ± 0.2	8.0 ± 3.9	0.6 ± 0.3	15.2 ± 1.7	2.2 ± 0.3
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	-	-	-	-	11.8 ± 1.3	7.6 ± 0.9
waterlily, white ( <i>Nymphaea odorata</i> )	-	-	-	-	3.0 ± 0.7	0.8 ± 0.3
all rooted floating-leaf species	-	-	-	-	13.1 ± 1.3	8.4 ± 1.0

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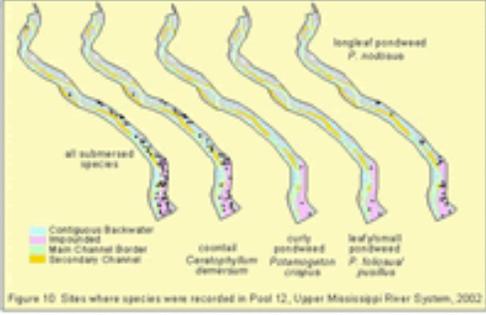
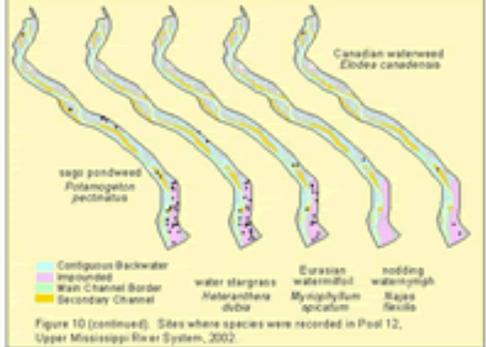
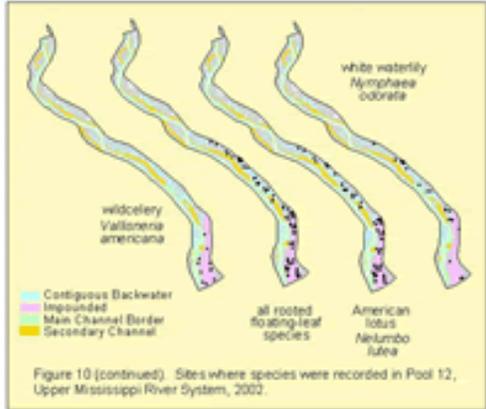
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**Figure 10.** Sites where species were recorded in Pool 12, Upper Mississippi River System, 2002.

Image Preview	Figure - Description
 <p>Figure 10 (continued) Sites where species were recorded in Pool 12, Upper Mississippi River System, 2002.</p>	<p><a href="#">Figure 10.</a> Species: all submersed species, coontail (<i>Ceratophyllum demersum</i>), curly pondweed (<i>Potamogeton crispus</i>), leafy/small pondweed (<i>P. foliosus/pusillus</i>), and longleaf pondweed (<i>P. nodosus</i>).</p>
 <p>Figure 10 (continued) Sites where species were recorded in Pool 12, Upper Mississippi River System, 2002.</p>	<p><a href="#">Figure 10.</a> Continued. Species: sago pondweed (<i>Potamogeton pectinatus</i>), water stargrass (<i>Heteranthera dubia</i>), Eurasian watermilfoil (<i>Myriophyllum spicatum</i>), nodding waterlily (<i>Najas flexilis</i>), and Canadian waterweed (<i>Elodea canadensis</i>).</p>
 <p>Figure 10 (continued) Sites where species were recorded in Pool 12, Upper Mississippi River System, 2002.</p>	<p><a href="#">Figure 10.</a> Continued. Species: wildcelery (<i>Vallisneria americana</i>), all rooted floating-leaf species, American lotus (<i>Nelumbo lutea</i>), and white waterlily (<i>Nymphaea odorata</i>).</p>



## 2002 Results in Pool 13 of the Upper Mississippi River

### Sampling Efforts

Sampling was conducted in a total of 27 working days from June 17 to August 12, 2002. Of the 580 sites targeted, 579 were sampled ([Figure 11](#)).

### Submersed Aquatic Vegetation

Submersed aquatic vegetation (SAV) was encountered at about 43% of the shallow water areas poolwide ([Table 7](#); [Figure 12](#)). The frequencies of SAV varied among strata sampled. Isolated backwaters had the highest percent frequency of SAV with 66.7%. Contiguous backwaters (51.5%), impounded areas (44.5%), secondary channels (10%), and main channel borders (7.1%) followed in decreasing order.

A total of 14 SAV species were collected in Pool 13. All 14 species of SAV were present in contiguous backwaters. Main channel border and secondary channel sites contained the least number of SAV species with five and four, respectively. Coontail (24.5%) was the most frequently encountered species poolwide followed by sago pondweed (22.8%) and wild celery (16.2%). Eurasian watermilfoil was found in all but the secondary channel stratum.

### Rooted Floating–Leaf Vegetation

American lotus and white water lily were the only two rooted floating-leaf species encountered in Pool 13 and together covered about 7.3% of the shallow water areas or areas where water depth measured 3 m or less at flat-pool condition.

The percent frequency of rooted floating-leaf species was highest in the contiguous backwaters (42.0%) followed by isolated backwaters (33.3%). American lotus was sampled at all but the main channel border sites, while white water lily was sampled only in contiguous and isolated backwaters and impounded sites and at lower frequencies.

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**Table 7.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 13, Upper Mississippi River System, 2002.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 200		Isolated backwater <i>n</i> = 30		Impounded <i>n</i> = 209	
	Freq	AI	Freq	AI	Freq	AI
chara ( <i>Chara</i> spp.)	1.0 ± 0.7	0.1 ± 0.1	-	-	0.5 ± 0.5	0.1 ± 0.1
coontail ( <i>Ceratophyllum demersum</i> )	42.0 ± 3.5	8.5 ± 0.8	50.0 ± 9.3	7.3 ± 1.6	14.4 ± 2.4	2.4 ± 0.6
pondweed, curly ( <i>Potamogeton crispus</i> )	17.5 ± 2.7	2.5 ± 0.5	16.7 ± 6.9	1.9 ± 0.9	4.3 ± 1.4	0.6 ± 0.2
pondweed, flatstem ( <i>P. zosteriformis</i> )	1.5 ± 0.9	0.1 ± 0.1	-	-	-	-
pondweed, horned ( <i>Zannichellia palustris</i> )	2.0 ± 1.0	0.3 ± 0.2	-	-	-	-
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	20.0 ± 2.8	2.6 ± 0.4	13.3 ± 6.3	1.2 ± 0.6	1.9 ± 1.0	0.2 ± 0.1
pondweed, longleaf ( <i>P. nodosus</i> )	7.0 ± 1.8	0.8 ± 0.2	-	-	3.8 ± 1.3	0.3 ± 0.1
pondweed, sago ( <i>P. pectinatus</i> )	31.0 ± 3.3	4.4 ± 0.5	50.0 ± 9.3	7.4 ± 1.4	18.2 ± 2.7	2.6 ± 0.4
stargrass, water ( <i>Heteranthera dubia</i> )	10.0 ± 2.1	1.0 ± 0.2	-	-	13.4 ± 2.4	1.5 ± 0.3
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	23.0 ± 3.0	2.9 ± 0.4	3.3 ± 3.3	0.2 ± 0.2	12.9 ± 2.3	1.8 ± 0.4
waternymph, nodding ( <i>Najas flexilis</i> )	16.5 ± 2.6	2.6 ± 0.5	-	-	1.0 ± 0.7	0.1 ± 0.1
waternymph, southern ( <i>N. guadalupensis</i> )	3.0 ± 1.2	0.3 ± 0.1	3.3 ± 3.3	0.2 ± 0.2	1.9 ± 1.0	0.3 ± 0.2
waterweed, Canadian ( <i>Elodea canadensis</i> )	12.5 ± 2.3	2.0 ± 0.5	6.7 ± 4.6	0.6 ± 0.4	5.7 ± 1.6	0.9 ± 0.3
wildcelery ( <i>Vallisneria americana</i> )	3.5 ± 1.3	0.6 ± 0.3	-	-	33.5 ± 3.3	9.4 ± 1.1

Table 7. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 2002.

all submersed species	51.5 ± 3.5	12.0 ± 1.1	66.7 ± 8.8	11.6 ± 1.7	44.5 ± 3.4	12.7 ± 1.2
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	40.0 ± 3.5	11.3 ± 1.6	26.7 ± 8.2	2.7 ± 0.8	12.4 ± 2.3	5.5 ± 1.3
waterlily, white ( <i>Nymphaea odorata</i> )	7.5 ± 1.9	1.4 ± 0.5	10.0 ± 5.6	1.0 ± 0.6	5.3 ± 1.5	1.3 ± 0.5
all rooted floating-leaf species	42.0 ± 3.5	12.3 ± 1.6	33.3 ± 8.8	3.3 ± 0.9	14.8 ± 2.5	6.5 ± 1.4

Table 7. Continued.

Common name (Scientific name)	Main channel border <i>n</i> = 70		Secondary channel <i>n</i> = 70		Pool 13 <i>n</i> = 579	
	Freq	AI	Freq	AI	Freq	AI
chara ( <i>Chara</i> spp.)	-	-	-	-	0.6 ± 0.3	0.1 ± <0.1
coontail ( <i>Ceratophyllum demersum</i> )	-	-	4.3 ± 2.4	0.4 ± 0.2	24.5 ± 1.7	4.5 ± 0.4
pondweed, curly ( <i>Potamogeton crispus</i> )	-	-	-	-	9.1 ± 1.2	1.2 ± 0.2
pondweed, flatstem ( <i>P. zosteriformis</i> )	-	-	-	-	0.5 ± 0.3	0.1 ± <0.1
pondweed, horned ( <i>Zannichellia palustris</i> )	-	-	-	-	0.7 ± 0.4	0.1 ± 0.1
pondweed, leafy/small ( <i>Potamogeton foliosus/pusillus</i> )	-	-	-	-	8.7 ± 1.2	1.1 ± 0.2
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	2.9 ± 2.0	0.4 ± 0.3	4.4 ± 0.9	0.4 ± 0.1
pondweed, sago ( <i>P. pectinatus</i> )	7.1 ± 3.1	1.0 ± 0.5	4.3 ± 2.4	0.6 ± 0.3	22.8 ± 1.8	3.2 ± 0.3
stargrass, water ( <i>Heteranthera dubia</i> )	1.4 ± 1.4	0.1 ± 0.1	-	-	9.5 ± 1.3	1.0 ± 0.2
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	1.4 ± 1.4	0.2 ± 0.2	-	-	14.1 ± 1.5	1.8 ± 0.2
waternymph, nodding ( <i>Najas flexilis</i> )	-	-	-	-	6.3 ± 1.0	1.0 ± 0.2
waternymph, southern ( <i>N. guadalupensis</i> )	-	-	-	-	2.1 ± 0.6	0.3 ± 0.1
waterweed, Canadian ( <i>Elodea canadensis</i> )	1.4 ± 1.4	0.1 ± 0.1	-	-	7.5 ± 1.1	1.2 ± 0.2
wildcelery ( <i>Vallisneria americana</i> )	1.4 ± 1.4	0.2 ± 0.2	1.4 ± 1.4	0.1 ± 0.1	16.2 ± 1.5	4.4 ± 0.5

Table 7. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 2002.

all submersed species	7.1 ± 3.1	1.0 ± 0.5	10.0 ± 3.6	1.1 ± 0.4	43.0 ± 2.1	10.7 ± 0.7
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	-	-	1.4 ± 1.4	1.0 ± 1.0	21.3 ± 1.7	6.6 ± 0.8
waterlily, white ( <i>Nymphaea odorata</i> )	-	-	-	-	5.6 ± 1.0	1.1 ± 0.3
all rooted floating-leaf species	-	-	1.4 ± 1.4	1.0 ± 1.0	23.5 ± 1.7	7.5 ± 0.8

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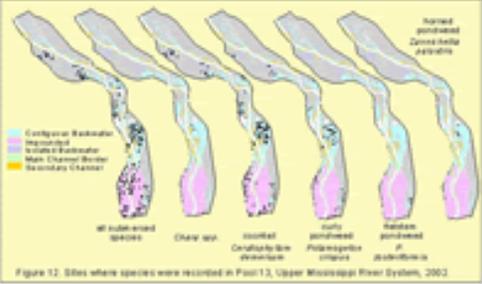
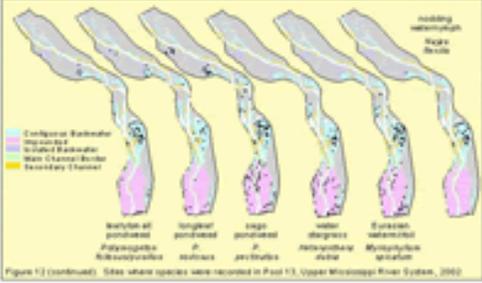
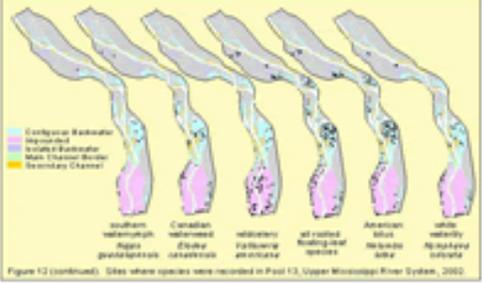


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#### Vegetation - Stratified Random Sampling 2002

**Figure 12.** Sites where species were recorded in Pool 13, Upper Mississippi River System, 2002.

Image Preview	Figure - Description
 <p>Figure 12 (continued). Sites where species were recorded in Pool 13, Upper Mississippi River System, 2002.</p>	<p><a href="#">Figure 12</a>. Species: all submersed species, <i>Chara</i> spp., coontail (<i>Ceratophyllum demersum</i>), curly pondweed (<i>Potamogeton crispus</i>), flatstem pondweed (<i>P. zosteriformis</i>), and horned pondweed (<i>Zannichellia palustris</i>).</p>
 <p>Figure 12 (continued). Sites where species were recorded in Pool 13, Upper Mississippi River System, 2002.</p>	<p><a href="#">Figure 12</a>. Continued. Species: leafy/small pondweed (<i>Potamogeton foliosus/pusillus</i>), longleaf pondweed (<i>P. nodosus</i>), sago pondweed (<i>P. pectinatus</i>), water stargrass (<i>Heteranthera dubia</i>), Eurasian watermilfoil (<i>Myriophyllum spicatum</i>), and nodding waterlily (<i>Najas flexilis</i>).</p>
 <p>Figure 12 (continued). Sites where species were recorded in Pool 13, Upper Mississippi River System, 2002.</p>	<p><a href="#">Figure 12</a>. Continued. Species: southern waterlily (<i>Najas guadalupensis</i>), Canadian waterweed (<i>Elodea canadensis</i>), wildcelery (<i>Vallisneria spiralis</i>), all rooted floating-leaf species, American lotus (<i>Nelumbo lutea</i>), and white waterlily (<i>Nymphaea odorata</i>).</p>

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## 2002 Results in Pool 26 of the Upper Mississippi River

### Sampling Efforts

Sampling in Pool 26 of the Upper Mississippi River and lower Illinois River was conducted from June 18 to August 28, 2002. Of the 420 sites targeted, 417 were sampled ([Figure 13](#)).

### Submersed Aquatic Vegetation

Submersed aquatic vegetation (SAV) was encountered in about 6% of the sites sampled in isolated backwaters of the lower Illinois River ([Table 8](#); [Figure 14](#)). About 2% of the isolated backwater sites on the Mississippi River had SAV. Impounded, contiguous backwaters, secondary channels, and main channel borders lacked SAV.

Five species of SAV were encountered on Pool 26 ([Table 8](#)). Sago pondweed and southern water nymph were the most frequently observed SAV (2%). Abundance of SAV was low ([Table 8](#)). An abundance index of 0.1 was encountered in the isolated backwaters of the lower Illinois and Mississippi Rivers.

### Rooted Floating–Leaf Vegetation

American lotus and floating primrose-willow were the only two species of rooted floating-leaf vegetation (RFLV) encountered ([Table 8](#)). About 3% of the sites on Pool 26 had RFLV. The RFLV comprised 7% and 12.3% of the isolated backwaters of the Illinois and Mississippi Rivers, respectively. Impounded, secondary channels and main channel borders lacked RFLV. However, new germinates and isolated plants were identified in these areas.

American lotus was the most common species encountered on Pool 26 (2.5%; [Table 8](#)). The average cover was low, 1.1%. Floating primrose-willow occurred in 1.1% of the sites on Pool 26. American lotus was the only species of RFLV encountered in the contiguous backwaters of the Mississippi River and floating primrose-willow was the

only species encountered in isolated backwaters of the Mississippi River. Both species were recorded in the isolated backwaters of the Illinois River.

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**Table 8.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 26, Upper Mississippi River System, 2002.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 73		Isolated backwater, Illinois River <i>n</i> = 97		Isolated backwater, Mississippi River <i>n</i> = 53	
	Freq	AI	Freq	AI	Freq	AI
pondweed, leafy ( <i>Potamogeton foliosus</i> )	-	-	1.0 ± 1.0	0.1 ± 0.1	-	-
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	1.0 ± 1.0	0.1 ± 0.1	-	-
pondweed, sago ( <i>P. pectinatus</i> )	-	-	4.1 ± 2.0	0.4 ± 0.2	1.9 ± 1.9	0.1 ± 0.1
stargrass, water ( <i>Heteranthera dubia</i> )	-	-	2.1 ± 1.5	0.2 ± 0.1	-	-
waternymph, southern ( <i>Najas guadalupensis</i> )	-	-	4.1 ± 2.0	0.6 ± 0.3	-	-
all submersed species	-	-	6.2 ± 2.5	1.0 ± 0.4	1.9 ± 1.9	0.1 ± 0.1
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	4.1 ± 2.3	2.1 ± 1.4	6.2 ± 2.5	2.7 ± 1.4	-	-
primrose-willow, floating ( <i>Ludwigia peploides</i> )	-	-	1.0 ± 1.0	0.1 ± 0.1	13.2 ± 4.7	1.3 ± 0.5
all rooted floating-leaf species	4.1 ± 2.3	2.1 ± 1.4	7.2 ± 2.6	2.8 ± 1.4	13.2 ± 4.7	1.3 ± 0.5

**Table 8.** Continued.

Common name (Scientific name)	Impounded <i>n</i> = 40		Main channel border, Illinois River <i>n</i> = 17		Main channel border, Mississippi River <i>n</i> = 28	
	Freq	AI	Freq	AI	Freq	AI
pondweed, leafy ( <i>Potamogeton foliosus</i> )	-	-	-	-	-	-

Table 8. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 2002.

pondweed, longleaf ( <i>P. nodosus</i> )	-	-	-	-	-	-
pondweed, sago ( <i>P. pectinatus</i> )	-	-	-	-	-	-
stargrass, water ( <i>Heteranthera dubia</i> )	-	-	-	-	-	-
waternymph, southern ( <i>Najas guadalupensis</i> )	-	-	-	-	-	-
all submersed species	-	-	-	-	-	-
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	-	-	-	-	-	-
primrose-willow, floating ( <i>Ludwigia peploides</i> )	-	-	-	-	-	-
all rooted floating-leaf species	-	-	-	-	-	-

Table 8. Continued.

Common name (Scientific name)	Secondary channel <i>n</i> = 21		Pool 26 <i>n</i> = 329	
	Freq	AI	Freq	AI
pondweed, leafy ( <i>Potamogeton foliosus</i> )	-	-	0.4 ± 0.4	<0.1 ± <0.1
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	0.4 ± 0.4	<0.1 ± <0.1
pondweed, sago ( <i>P. pectinatus</i> )	-	-	1.7 ± 0.8	0.2 ± 0.1
stargrass, water ( <i>Heteranthera dubia</i> )	-	-	0.8 ± 0.5	0.1 ± <0.1
waternymph, southern ( <i>Najas guadalupensis</i> )	-	-	1.5 ± 0.8	0.2 ± 0.1
all submersed species	-	-	2.4 ± 0.9	0.4 ± 0.1
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	-	-	2.6 ± 0.9	1.1 ± 0.5
primrose-willow, floating ( <i>Ludwigia peploides</i> )	-	-	1.1 ± 0.5	0.1 ± <0.1
all rooted floating-leaf species	-	-	3.7 ± 1.0	1.2 ± 0.5

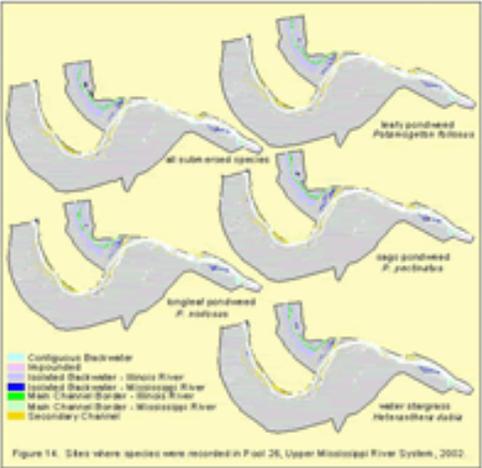
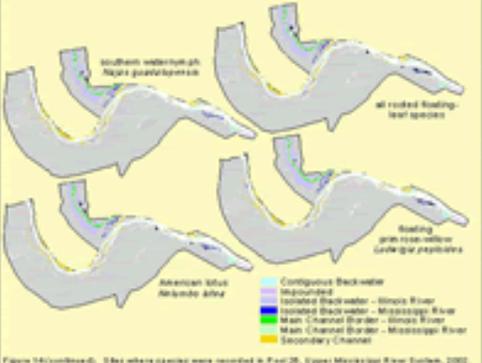


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**Figure 14.** Sites where species were recorded in Pool 26, Upper Mississippi River System, 2002.

Image Preview	Figure - Description
 <p>Figure 14. Sites where species were recorded in Pool 26, Upper Mississippi River System, 2002.</p>	<p><a href="#">Figure 14.</a> Species: all submersed species, leafy pondweed (<i>Potamogeton foliosus</i>), longleaf pondweed (<i>P. nodosus</i>), sago pondweed (<i>P. pectinatus</i>), and water stargrass (<i>Heteranthera dubia</i>).</p>
 <p>Figure 14(Continued). Sites where species were recorded in Pool 26, Upper Mississippi River System, 2002.</p>	<p><a href="#">Figure 14.</a> Continued. Species: southern water nymph (<i>Najas guadalupensis</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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## 2002 Results in Alton Pool of the Illinois River

### Sampling Efforts

Sampling was conducted from June 12 to August 20, 2002. Of the 513 sites targeted, 509 were sampled ([Figure 15](#)).

### Submersed Aquatic Vegetation

No submersed aquatic vegetation was recorded in Alton Pool in 2002.

### Rooted Floating–Leaf Vegetation

No rooted floating-leaf vegetation was recorded in Alton Pool in 2002.

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## 2002 Results in La Grange Pool of the Illinois River

### Sampling Efforts

Sampling in La Grange Pool was conducted from June 17 to August 9, 2002. Of the 430 sites targeted, 428 were sampled ([Figure 16](#)).

### Submersed Aquatic Vegetation

Submersed aquatic vegetation (SAV) was not collected in the contiguous and isolated backwaters of La Grange Pool in 2002. However, SAV was recorded at 79.9% of the isolated lake sites ([Table 9](#); [Figure 17](#)). Beds of SAV were found throughout most of the lake areas, except in the areas with extreme water depths. Isolated lakes housed all of the species recorded within the pool. Eurasian watermilfoil (72.9%) was the most frequently recorded species in isolated lakes of La Grange Pool followed by coontail (57.6%), common bladderwort (11.9%), and chara (11.9%).

### Rooted Floating–Leaf Vegetation

White waterlily, American lotus, and wingleaf primrose-willow were the three rooted floating-leaf species recorded. The three species together covered about 18% of the isolated lakes and 0.3% of contiguous backwaters. The percent frequency of rooted floating-leaf species was the highest in the isolated lake stratum (37.3%). American lotus dominated the isolated lakes and contiguous backwaters followed by wingleaf primrose-willow. White waterlily was only sampled in the isolated lake stratum.

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**Table 9.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in La Grange Pool, Illinois River, 2002.

Common name (Scientific name)	Contiguous backwater <i>n</i> = 100		Isolated backwater <i>n</i> = 139		Lake <i>n</i> = 59	
	Freq	AI	Freq	AI	Freq	AI
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	-	-	-	11.9 ± 4.2	1.1 ± 0.4
chara ( <i>Chara</i> spp.)	-	-	-	-	11.9 ± 4.2	1.4 ± 0.5
coontail ( <i>Ceratophyllum demersum</i> )	-	-	-	-	57.6 ± 6.5	10.2 ± 1.9
pondweed, curly ( <i>Potamogeton crispus</i> )	-	-	-	-	5.1 ± 2.9	0.4 ± 0.2
pondweed, horned ( <i>Zannichellia palustris</i> )	-	-	-	-	6.8 ± 3.3	0.8 ± 0.4
pondweed, leafy ( <i>Potamogeton foliosus</i> )	-	-	-	-	8.5 ± 3.7	0.8 ± 0.3
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	-	-	5.1 ± 2.9	0.9 ± 0.5
pondweed, sago ( <i>P. pectinatus</i> )	-	-	-	-	6.8 ± 3.3	0.7 ± 0.4
stargrass, water ( <i>Heteranthera dubia</i> )	-	-	-	-	3.4 ± 2.4	0.5 ± 0.3
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	-	-	-	-	72.9 ± 5.8	18.0 ± 2.4
watermilfoil, northern ( <i>M. sibiricum</i> )	-	-	-	-	10.2 ± 4.0	1.3 ± 0.6
waternymph, brittle ( <i>Najas minor</i> )	-	-	-	-	8.5 ± 3.7	1.2 ± 0.6
waternymph, nodding ( <i>N. flexilis</i> )	-	-	-	-	10.2 ± 4.0	1.1 ± 0.5
all submersed species	-	-	-	-	79.7 ± 5.3	21.5 ± 2.7
	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>

Table 9. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 2002.

lotus, American ( <i>Nelumbo lutea</i> )	3.0 ± 1.7	0.3 ± 0.2	1.4 ± 1.0	0.1 ± 0.1	25.4 ± 5.7	10.3 ± 3.0
primrose-willow, wingleaf ( <i>Ludwigia decurrens</i> )	1.0 ± 1.0	0.3 ± 0.3	-	-	-	-
waterlily, white ( <i>Nymphaea odorata</i> )	-	-	-	-	13.6 ± 4.5	7.8 ± 3.2
all rooted floating-leaf species	4.0 ± 2.0	0.6 ± 0.3	1.4 ± 1.0	0.1 ± 0.1	37.3 ± 6.3	18.0 ± 4.0

Table 9. Continued.

Common name (Scientific name)	Main channel border <i>n</i> = 80		Secondary channel <i>n</i> = 50		La Grange Pool* <i>n</i> = 369	
	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> )	-	-	-	-	-	-
stargrass, water ( <i>Heteranthera dubia</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	-	-	-	-	-	-

Table 9. Percent frequency, abundance index (AI), cover, and standard error...ed floating–leaf vegetation in Pool 4, Upper Mississippi River System, 2002.

	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>	<b>Freq</b>	<b>Cover</b>
lotus, American ( <i>Nelumbo lutea</i> )	2.5 ± 1.8	0.3 ± 0.2	-	-	1.9 ± 0.8	0.2 ± 0.1
primrose-willow, wingleaf ( <i>Ludwigia decurrens</i> )	-	-	-	-	0.3 ± 0.3	0.1 ± 0.1
waterlily, white ( <i>Nymphaea odorata</i> )	-	-	-	-	-	-
all rooted floating–leaf species	2.5 ± 1.8	0.3 ± 0.2	-	-	2.2 ± 0.8	0.3 ± 0.1

\* Lakes are not influenced by the Illinois River and, therefore, were not included in the La Grange Pool percent frequency and abundance index.

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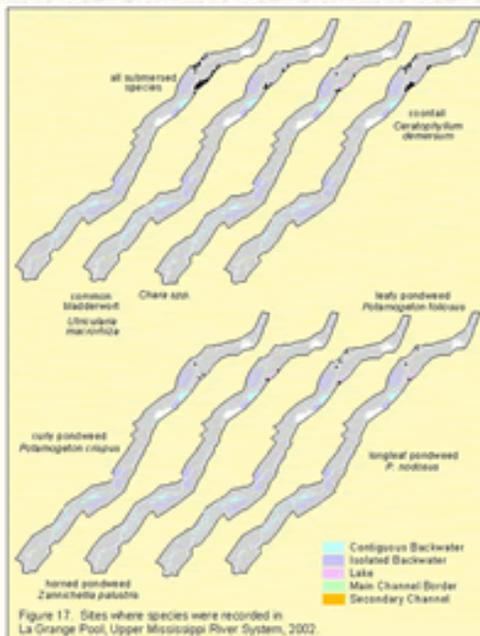
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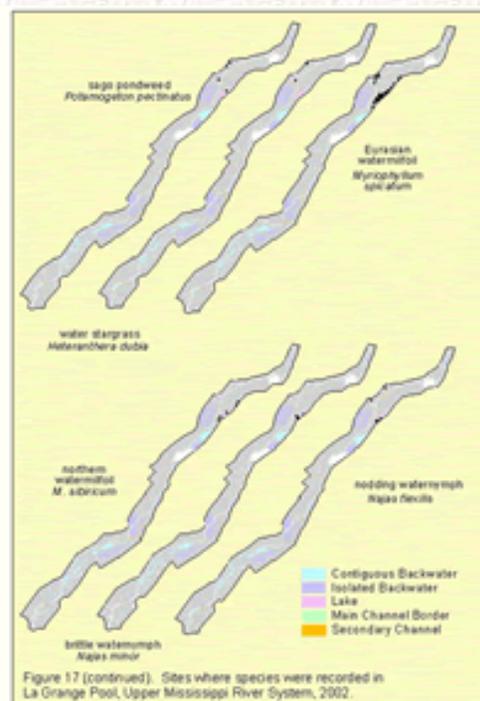
**Figure 17.** Sites where species were recorded in La Grange Pool, Upper Mississippi River System, 2002.

## Image Preview

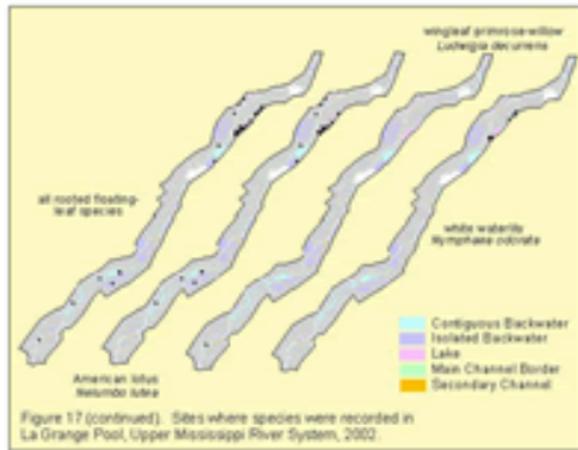


## Figure - Description

[Figure 17](#). Species: all submersed species, common bladderwort (*Utricularia macrorhiza*), *Chara* spp., coontail (*Ceratophyllum demersum*), curly pondweed (*Potamogeton crispus*), horned pondweed (*Zannichellia palustris*), leafy pondweed (*Potamogeton foliosus*), and longleaf pondweed (*P. nodosus*).



[Figure 17](#). Continued. Species: sago pondweed (*Potamogeton pectinatus*), water stargrass (*Heteranthera dubia*), Eurasian watermilfoil (*Myriophyllum spicatum*), northern watermilfoil (*M. sibiricum*), brittle waterlily (*Najas minor*), and nodding waterlily (*N. flexilis*).



[Figure 17](#). Continued. Species: all rooted floating–leaf species, American lotus (*Nelumbo lutea*), wingleaf primrose-willow (*Ludwigia decurrens*), and white waterlily (*Nymphaea odorata*).

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## Summary

### Longitudinal distribution

- Vegetation stratified random sampling was conducted in Pools 4, 5, 7, 8, 12, 13, and 26 and Alton and La Grange Pools in 2002. Pools 5, 7, and 12 and Alton Pool were sampled to help determine how representative the key pools were of the Upper Mississippi River System (UMRS).
- The estimated percent frequencies of submersed aquatic vegetation in the shallow water areas in Pools 4, 8, 13, 26, and La Grange Pool were 35%, 53.4%, 43.0%, 2.3%, and 0%, respectively (Tables [2](#), [5](#), [7](#), [8](#), and [9](#)). The longitudinal pattern of [submersed aquatic vegetation](#) is the same as revealed in the previous 4 years from 1998 to 2001. Pools 5 (28.5%), 7 (39.3%), and 12 (12.8%) and Alton Pool (0%) also showed the same general pattern (Tables [3](#), [4](#), and [6](#)).
- 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 2002, but we have no reason to suspect a deviation from the normal pattern occurred in 2002.
- The estimated percent frequencies of rooted floating-leaf vegetation in Pools 4, 5, 7, 8, 12, 13, and 26 and Alton and La Grange Pools were 10.0%, 9.8%, 12.2%, 18.4%, 10.4%, 23.5%, 3.5%, 0%, and 0.3%, respectively ([Tables](#)).
- Rooted floating-leaf species shifted in dominance from white water lily (Pools 4, 5, 7, and 8) to American lotus (Pools 12, 13, and 26). This same longitudinal pattern has occurred since 1998.

### 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, wildcelery, water stargrass, and Canadian waterweed.
- Submersed aquatic vegetation was widely distributed throughout Pools 5 and 7 ([Figures 4](#) and [6](#)). Rooted floating-leaf vegetation was somewhat more limited in distribution in the lower ends of each pool. The most common submersed species in Pool 5 included sago pondweed, water stargrass, Canadian waterweed, and coontail. The most common submersed species in Pool 7 included coontail and Canadian waterweed.
- 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 8](#)). The most common submersed species included Canadian waterweed, coontail, and water stargrass.
- In Pool 12, submersed and rooted floating-leaf vegetation was restricted mostly to the lower half of the pool ([Figure 10](#)). The most common submersed species included coontail and sago pondweed.
- 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 12](#)). 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 14](#)).
- No submersed or rooted floating-leaf species were found in the connected channels and backwaters of Alton Pool.

- 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 17](#)). 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 5 years of SRS percent frequency data, the spatial extents of [submersed aquatic vegetation](#) in the five key pools have remained stable since 1998.
- In Pool 8, the amount of submersed vegetation per site, based on the abundance index, displayed a steady decrease from 1999 to 2001, but rebounded in 2002. Pool 13 increased steadily from 1999 to 2002.
- Pool 13 has shown a slight increase in the frequency of [rooted floating-leaf vegetation](#) from 1998 to 2002 while the other pools have remained stable.
- Two exotic submersed species have been recorded, Eurasian watermilfoil and curly pondweed. Both species have been recorded in Pools 4, 5, 7, 8, 11, 12, 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

<a href="#">1.</a>	Aquatic area strata and the number of sites sampled by pool, 2002.
<a href="#">2.</a>	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 4, Upper Mississippi River System, 2002
<a href="#">3.</a>	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 5, Upper Mississippi River System, 2002
<a href="#">4.</a>	Percent frequency, abundance index (AI), cover and standard errors of submersed and rooted floating–leaf vegetation in Pool 7, Upper Mississippi River System, 2002
<a href="#">5.</a>	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 8, Upper Mississippi River System, 2002
<a href="#">6.</a>	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 12, Upper Mississippi River System, 2002
<a href="#">7.</a>	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 13, Upper Mississippi River System, 2002
<a href="#">8.</a>	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 26, Upper Mississippi River System, 2002
<a href="#">9.</a>	Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in La Grange Pool, Illinois River, 2002

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 2002 stratified random sampling in Pools 4, 5, 7, 8, 12, 13, and 26 of the Upper Mississippi River and Alton and La Grange Pools of the Illinois River.<sup>a</sup>

Common name	Scientific name	Species code	Family
<b><i>Submersed</i></b>			
bladderwort, common	<i>Utricularia macrorhiza</i> Le Conte synonymy <i>U. vulgaris</i> L.	UTMA	Lentibulariaceae
buttercup, longbeak	<i>Ranunculus longirostris</i> Godr. <sup>b</sup>	RALO2	Ranunculaceae
chara	<i>Chara</i> spp.	CH?AR	Characeae
coontail, coon's tail	<i>Ceratophyllum demersum</i> L.	CEDE4	Ceratophyllaceae
pondweed, curly (curlyleaf)	<i>Potamogeton crispus</i> L.	POCR3	Potamogetonaceae
pondweed, flatstem	<i>P. zosteriformis</i> Fern.	POZO	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, 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
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
<b><i>Rooted floating-leaf</i></b>			
lotus, American	<i>Nelumbo lutea</i> Willd.	NELU	Nelumbonaceae
pond-lily, yellow	<i>Nuphar variegata</i> Durand <sup>c</sup>	NULU	Nymphaeaceae
primrose-willow, floating	<i>Ludwigia peploides</i> (Kunth) Raven	LUPE5	Onagraceae
primrose-willow, wingleaf	<i>L. decurrens</i>	LUDE4	Onagraceae
waterlily, white	<i>Nymphaea odorata</i> Ait. synonymy <i>N. tuberosa</i> Paine	NYTU	Nymphaeaceae

<sup>a</sup>Scientific 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.

<sup>b</sup>*Ranunculus longirostris* and *R. trichophyllus* were combined (Voss 1985).

<sup>c</sup>Scientific nomenclature follows Gleason and Cronquist (1991). *Nuphar lutea* (L.) Sm. 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, 2002.

Stratum description	Stratum numeric code	Stratum letter code	Pool 4	Pool 8	Pool 13	Pool 26	La Grange Pool
2002 sampling season							
Main channel border, Illinois River	1502	MCB-I	-	-	-	40	-
Main channel border	1503	MCB	-	100	70	50	80
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	-	174	200	80	100
Contiguous backwater, upper	1511	BWC-U	100	-	-	-	-
Contiguous backwater, lower	1512	BWC-L	180	-	-	-	-
Lake Pepin, upper	1513	TDL-U	75	-	-	-	-
Lake Pepin, lower	1514	TDL-L	75	-	-	-	-
Impounded	1520	IMP	-	224	209	40	-
Isolated backwater	1530	BWI	30	26	30	57	139
Isolated backwater, Illinois	1531	BWI-I	-	-	-	100	-
Lake	1532	LK	-	-	-	-	59
Total for 2002 sampling season			630	644	579	417	428

**Table 1b.** Aquatic area strata and the number of sites sampled by nontarget pool, 2002.

Stratum description	Stratum numeric code	Stratum letter code	Pool 5	Pool 7	Pool 12	Alton Pool
2002 sampling season						
Main channel border	1503	MCB	71	71	153	201

Table 1. All pools

Secondary channel	1504	SC	50	48	50	104
Contiguous backwater	1510	BWC	110	102	120	204
Impounded	1520	IMP	173	171	81	-
Total for 2002 sampling season			404	392	404	509

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## Figures

<a href="#">1.</a>	Aquatic area strata and sampling points in Pool 4, Upper Mississippi River System, 2002.
<a href="#">2.</a>	Sites where species were recorded in Pool 4, Upper Mississippi River System, 2002.
<a href="#">3.</a>	Aquatic area strata and sampling points in Pool 5, Upper Mississippi River System, 2002.
<a href="#">4.</a>	Sites where species were recorded in Pool 5, Upper Mississippi River System, 2002.
<a href="#">5.</a>	Aquatic area strata and sampling points in Pool 7, Upper Mississippi River System, 2002.
<a href="#">6.</a>	Sites where species were recorded in Pool 7, Upper Mississippi River System, 2002.
<a href="#">7.</a>	Aquatic area strata and sampling points in Pool 8, Upper Mississippi River System, 2002.
<a href="#">8.</a>	Sites where species were recorded in Pool 8, Upper Mississippi River System, 2002.
<a href="#">9.</a>	Aquatic area strata and sampling points in Pool 12, Upper Mississippi River System, 2002.
<a href="#">10.</a>	Sites where species were recorded in Pool 12, Upper Mississippi River System, 2002.
<a href="#">11.</a>	Aquatic area strata and sampling points in Pool 13, Upper Mississippi River System, 2002.
<a href="#">12.</a>	Sites where species were recorded in Pool 13, Upper Mississippi River System, 2002.
<a href="#">13.</a>	Aquatic area strata and sampling points in Pool 26, Upper Mississippi River System, 2002.
<a href="#">14.</a>	Sites where species were recorded in Pool 26, Upper Mississippi River System, 2002.
<a href="#">15.</a>	Aquatic area strata and sampling points in Alton Pool, Upper Mississippi River System, 2002
<a href="#">16.</a>	Aquatic area strata and sampling points in La Grange Pool, Upper Mississippi River System, 2002.
<a href="#">17.</a>	Sites where species were recorded in La Grange Pool, Upper Mississippi River System, 2002.

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**Figure 1.** Aquatic area strata and sampling points in Pool 4, Upper Mississippi River System, 2002.

### Image Preview



### Figure - Description

[Figure 1.](#)

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**Figure 3.** Aquatic area strata and sampling points in Pool 5, Upper Mississippi River System, 2002.

Image Preview

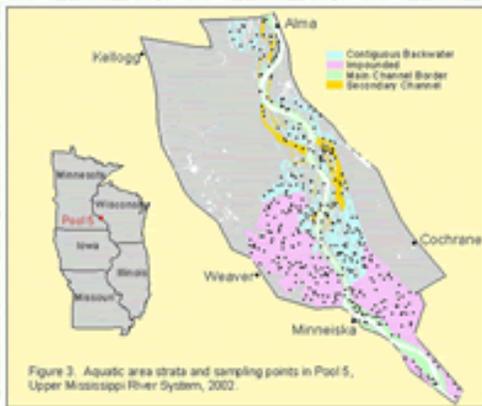


Figure - Description

[Figure 3.](#)

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**Figure 5.** Aquatic area strata and sampling points in Pool 7, Upper Mississippi River System, 2002.

Image Preview



Figure - Description

[Figure 5.](#)

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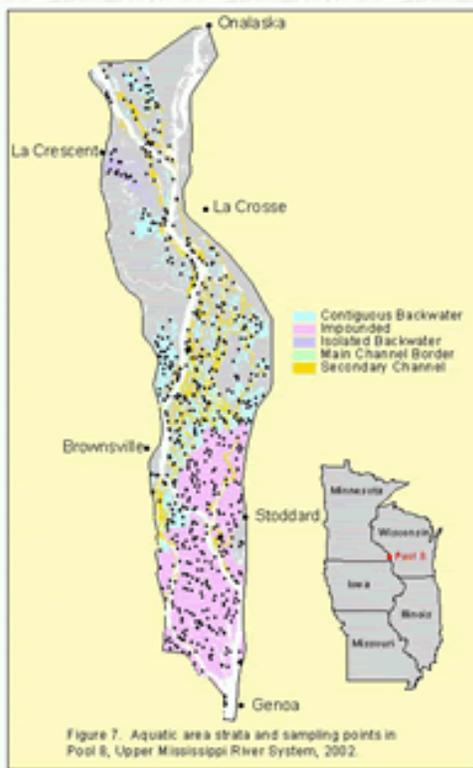
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**Figure 7.** Aquatic area strata and sampling points in Pool 8, Upper Mississippi River System, 2002.

### Image Preview



### Figure - Description

[Figure 7.](#)

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**Figure 9.** Aquatic area strata and sampling points in Pool 12, Upper Mississippi River System, 2002.

### Image Preview



### Figure - Description

[Figure 9.](#)

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**Figure 11.** Aquatic area strata and sampling points in Pool 13, Upper Mississippi River System, 2002.

Image Preview	Figure - Description
	<p><a href="#">Figure 11.</a></p>

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**Figure 13.** Aquatic area strata and sampling points in Pool 26, Upper Mississippi River System, 2002.

#### Image Preview



#### Figure - Description

[Figure 13.](#)

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**Figure 15.** Aquatic area strata and sampling points in Alton Pool, Upper Mississippi River System, 2002.

### Image Preview



### Figure - Description

[Figure 15.](#)

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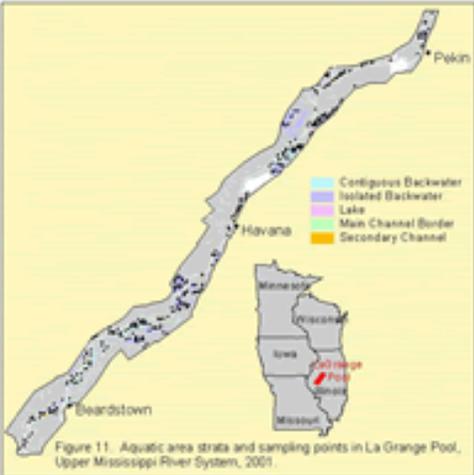


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**Figure 16.** Aquatic area strata and sampling points in La Grange Pool, Upper Mississippi River System, 2002.

Image Preview	Figure - Description
 <p>Figure 11. Aquatic area strata and sampling points in La Grange Pool, Upper Mississippi River System, 2001</p>	<p><a href="#">Figure 16.</a></p>

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