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1993 Annual Status Report

A Summary of Aquatic Vegetation Monitoring at Selected Locations in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

July 1998

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1993 Annual Status Report
A Summary of Aquatic Vegetation Monitoring at Selected Locations in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

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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 Environmental Management Technical 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 multiple-use 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 surveys conducted by field station personnel under direction of the Environmental Management Technical Center during the 1993 growing season. Selected areas in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool on the Illinois River were surveyed. This report satisfies, for 1993, 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 aquatic vegetation collected from the field stations for 1993. This report was developed with funding provided by the Long Term Resource Monitoring Program.

1993 Annual Status Report
A Summary of Aquatic Vegetation Monitoring at Selected Locations in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

by

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Abstract

Aquatic vegetation of the Upper Mississippi River System is monitored as part of the Long Term Resource Monitoring Program. This report summarizes the 1993 effort of monitoring submersed aquatic vegetation (SAV) along permanently established transects in vegetated locations within certain LTRMP study reaches, specifically Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River. Data are collected during two sampling windows, mid-May through mid-June, and mid-July through August. Fifteen species of SAV were found along transects during the 1993 season. The greatest number of species found (12) was in Pool 4 and the fewest number found (2) was in Pool 26. Coon's tail and sago pondweed were the only species found in every study pool during both spring and summer sampling. In all study reaches except La Grange Pool, the frequency of several species of SAV changed between sampling periods, with decreases especially common among several species of pondweeds. Several other species also decreased in Pools 13 and 26 between sampling periods. Conversely, several species increased in frequencies in Pool 8 between periods. The proportion of sites containing SAV declined during the season in Pools 4, 13, and 26, but not in Pool 8 or La Grange Pool.

Introduction

Aquatic vegetation of the Upper Mississippi River System (UMRS) is monitored as part of the Long Term Resource Monitoring Program (LTRMP; U.S. Fish and Wildlife Service 1993). The trends in the status of the vegetation are reported in annual status reports, and the data provides a baseline of information to which future observations can be compared. In combination with other monitoring conducted for the LTRMP, the overall mission is to provide decision makers with scientifically sound and useful information for effective river management. The purpose of this report is to document transect sampling at selected locations in 1993. This report also provides an initial indication of features of submersed aquatic vegetation (SAV) that can be compared to future monitoring efforts.

Historically, submersed macrophytes have played an important role in the UMRS ecosystem. These plant communities provide food for migratory waterfowl (Korschgen et. al. 1988) and improve water quality by stabilizing sediments, filtering out suspended materials, and taking up nutrients that can otherwise support nuisance algal growth (Barko et al. 1991). Submersed aquatic macrophytes also provide nursery areas for young fish, serve as spawning habitat, and support invertebrate populations by providing structure and surface area (Engel 1990).

We have been unable to understand or anticipate many changes in the distribution of SAV within the UMRS, partly because few studies have adequately addressed the questions. Biologists have high interest and concern for this important component, however, especially after the mid- to late-1980s when widespread and sudden declines in the abundance of wild celery *(Vallisneria americana)* from Pools 5 to 19 were observed (E. Nelson and C. Cheap, Winona, Minnesota, unpublished data; C. Korschgen, Northern Prairie Wildlife Research Center, Jamestown, North Dakota, unpublished data; J. Lyons, U.S. Fish and Wildlife Service, McGregor, Iowa, personal communication; R. Anderson, Western Illinois University, Macomb, personal communication; W. Thrune, U.S. Fish and Wildlife Service, La Crosse, Wisconsin, personal communication). Among those especially concerned were biologists familiar with the history of the Illinois River. Submersed aquatic vegetation in much of the river rapidly disappeared during the 1950s and only remnant populations now survive (Talkington and Semonin 1991).

Long-term monitoring can have a substantial role in increasing our understanding of trends in this resource by addressing the following questions:

(1) How temporally and spatially dynamic is SAV in the UMRS?
(2) Are we observing short-term fluctuations in one or more species or is SAV becoming irreparably lost?
(3) Based on patterns observed, what factors most likely contribute to the observed changes?

The 1993 growing season was the third year we conducted field surveys for the LTRMP specifically to collect data on the distribution and relative abundance of SAV throughout each resource trend analysis pool. The objectives for monitoring aquatic vegetation in the UMRS are to

(1) document the distribution of SAV within selected locations of the UMRS,
(2) compare current distribution of SAV with past or future distribution, and
(3) identify environmental factors potentially responsible for both long- and short-term changes in the distribution of SAV.

This report partially fulfills the first and second objectives. Fulfillment of the second objective would be accomplished over the course of the LTRMP beginning in the second year and gaining more significance with each subsequent year. Fulfillment of the third objective requires research in addition to monitoring. Measuring the effect of the environment on abundance and distribution requires focused initiatives to explore plant response to key factors, singly or in combination with one another.

Study Areas

The LTRMP vegetation study areas include river reaches in the UMRS, four on the Mississippi River and one on the Illinois River (Figure 1). Study areas are referred to herein by the navigation pool designations according to the U.S. Army Corps of Engineers lock and dam system. Mississippi River navigation pools studied are Pool 4 (Mississippi River mile [M] 752 to 797), Pool 8 (M679 to 703), Pool 13 (M523 to 557), Pool 26 (M202 to 242), and La Grange Pool of the Illinois River (Illinois River mile [I]80 to 158). River miles for the Mississippi River are measured from the confluence of the Mississippi and Ohio Rivers and for the Illinois River from the confluence of the Mississippi and Illinois Rivers.

These study areas were chosen, in part, to reflect important differences in geomorphology, floodplain land use, and water level management strategies that exist with the UMRS. Qualitatively, Pools 4, 8, and 13 are geomorphically complex with numerous backwaters and richly braided side channels and contain the highest values of total cover for aquatic vegetation (Peck and Smart 1986). Relatively high percentages of the total aquatic area in these study reaches are composed of contiguous (to the main channel) backwaters, and relatively low percentages are composed of main channel (Table 1). Pool 26, in a lower impounded reach, is characterized by relatively low percentages of open water and aquatic vegetation and a high percentage of agriculture in the floodplain. La Grange Pool is similar to Pool 26 in floodplain composition, but is similar to Pools 8 and 13 in composition of the aquatic area. In fact, La Grange Pool has the greatest percentage (52.2%) of contiguous backwaters among the LTRMP study areas, but aquatic vegetation is not present in most of them.

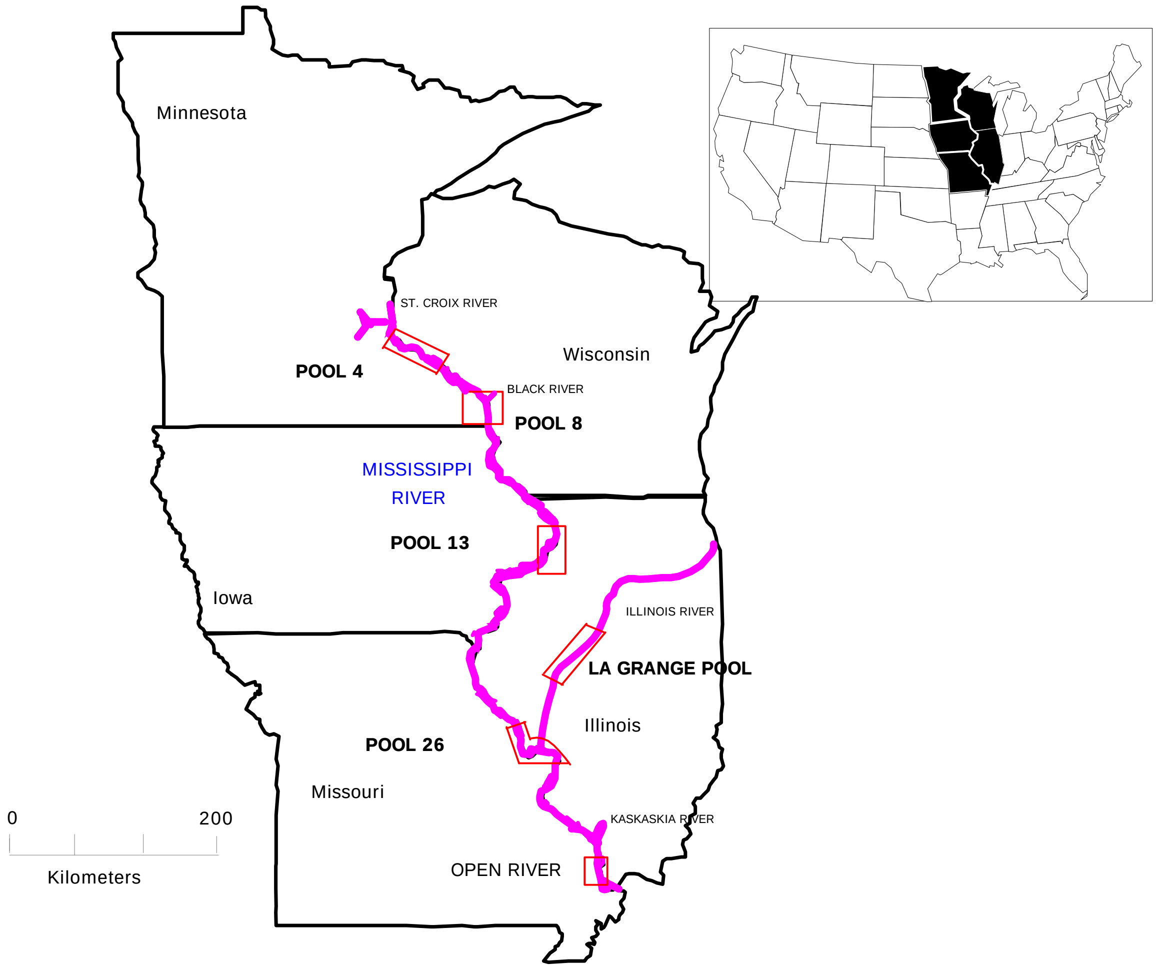

Figure 1. Main stem of the Upper Mississippi River System with the study reaches used in the Long Term Resource Monitoring Program submersed vegetation surveys of 1993 (Pools 4, 8, 13, and 26 and La Grange Pool). The Open River reach was not selected as a study site because of the lack of habitat for submersed vegetation.

During 1993, surveys of SAV were conducted in Pools 4, 8, 13, and 26 of the Mississippi River, and in La Grange Pool of the Illinois River (Figure 1). Permanent transects, most of which were established in 1991, were monitored at several locations throughout each pool where vegetation has grown for most of the postimpoundment period.

In Pool 4, we sampled SAV at 10 contiguous backwater locations (Figure 2). The transect locations were distributed in both the upper and lower portions of the pool, but not in Lake Pepin. Upper pool locations included Dead Slough Lake, Goose Lake, Mud Lake, and Bay City Flats. Lower pool locations (below Lake Pepin) included Big Lake, Robinson Lake, Lower Peterson Lake, and Peterson Lake. We also monitored Rice Lake and Big Lake Bay, part of the Big Lake area. A new set of transects was added in Upper Mud Lake (Appendix A).

Table 1. Key features of the floodplain and aquatic area compositions of the five Mississippi and Illinois River study reaches monitored for vegetation in 1993 for the Long Term Resource Monitoring Program. [a]

		Floodplain composition (%)[b]			Aquatic area composition (%)[c]	
Study reach	Floodplain area (ha)	Open water[d]	Aquatic vegetation[e]	Agriculture	Contiguous backwater	Main channel
Pool 4	28,358	50.5	10.0	12.1	21.3	10.5
Pool 8	19,068	40.1	14.4	0.9	30.6	14.2
Pool 13	34,528	29.7	8.6	27.9	28.5	24.7
Pool 26	51,688	13.4	1.4	65.4	17.3	54.4
La Grange Pool, Illinois River	89,554	15.7	2.2	59.6	52.2	21.3

[a] Table from Gutreuter et al. (1997).

[b] Data on floodplain composition are from Laustrup and Lowenberg (1994).

[c] Aquatic area is that portion of the floodplain that is inundated at normal water elevations. Data on the composition of aquatic areas are from the Long Term Resource Monitoring Program aquatic areas spatial database.

[d] Submersed vegetation, when detectable, was merged with the open water class. Main channel includes area in the navigation channel and main channel border areas.

[e] Aquatic vegetation includes rooted floating aquatics and emergents only.

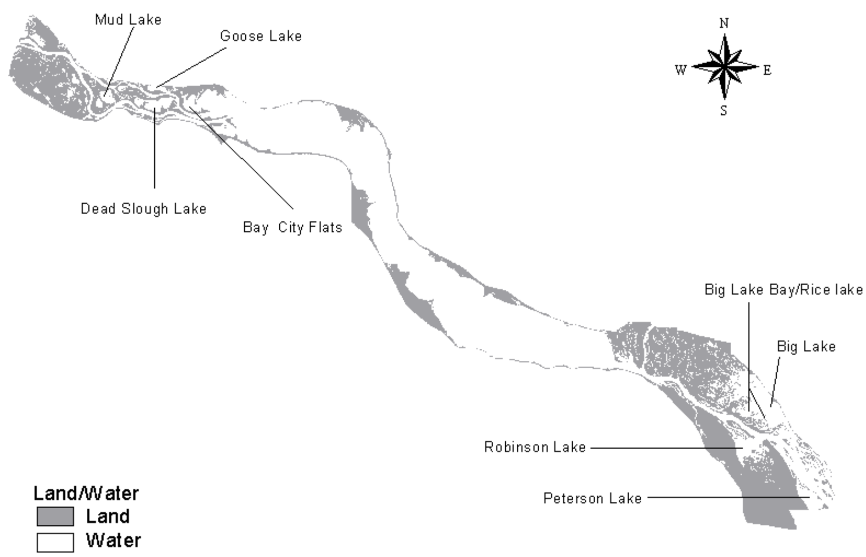

Figure 2. Pool 4, Upper Mississippi River, transect locations for the 1993 monitoring of submersed aquatic vegetation for the Long Term Resource Monitoring Program.

In Pool 8, we sampled SAV at several established locations including Target Lake, Lawrence Lake, a backwater area near Goose Island, Shady Maple, the interior of Horseshoe Island, and a small isolated backwater near Stoddard, Wisconsin (Figure 3). The backwater near Stoddard was first monitored during the second sampling period of 1992. Two additional locations were also monitored for the first year; Blue Lake, a large isolated backwater in the northwest portion of the pool, and the Pool 8 Islands Habitat Rehabilitation and Enhancement Project (HREP) location (Boomerang Island; Appendix A).

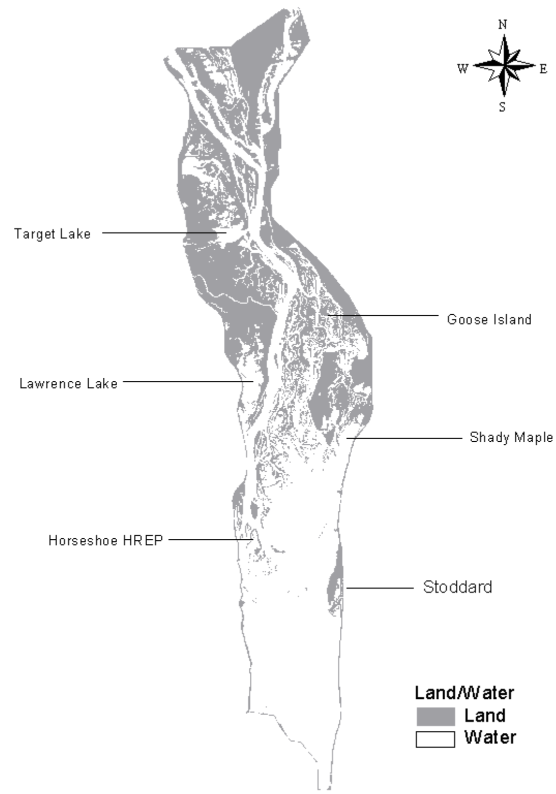

Figure 3. Pool 8, Upper Mississippi River, transect locations for the 1993 monitoring of submersed aquatic vegetation for the Long Term Resource Monitoring Program.

In Pool 13, we sampled SAV at seven locations that were selected in 1991 and were distributed primarily in the middle and lower portions of the pool (Figure 4). Locations included Brown's Lake, Savanna Bay, Spring Lake, Pomme de Terre, Potter's Marsh, Lower Johnson Creek, and an aquatic area along the Johnson Creek Levee (Appendix A).

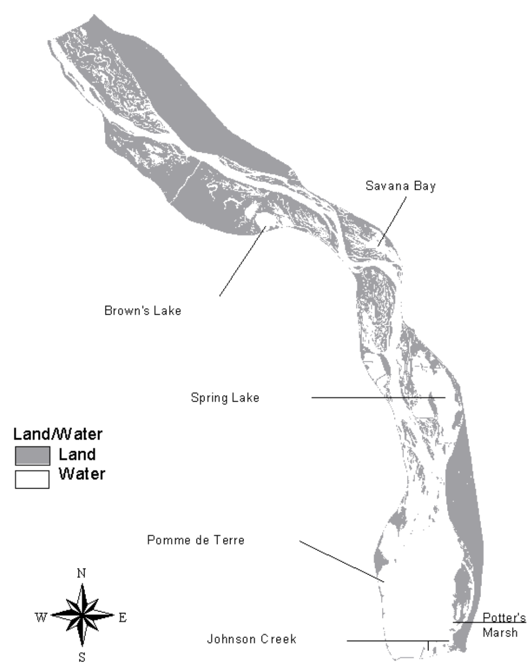

Figure 4. Pool 13, Upper Mississippi River, transect locations for the 1993 monitoring of submersed aquatic vegetation for the Long Term Resource Monitoring Program.

In Pool 26, we sampled SAV at four locations (Figure 5). Transect locations were distributed in Swan Lake, Stump Lake, Fuller Lake, and in the Calhoun Point area, which consists of several backwater lakes, sloughs, and wet-weather ponds. Stump Lake, Fuller Lake, and Calhoun Point areas are managed by the Illinois Department of Natural Resources, which conducts water drainage with control structures and pumping for waterfowl management (Appendix A).

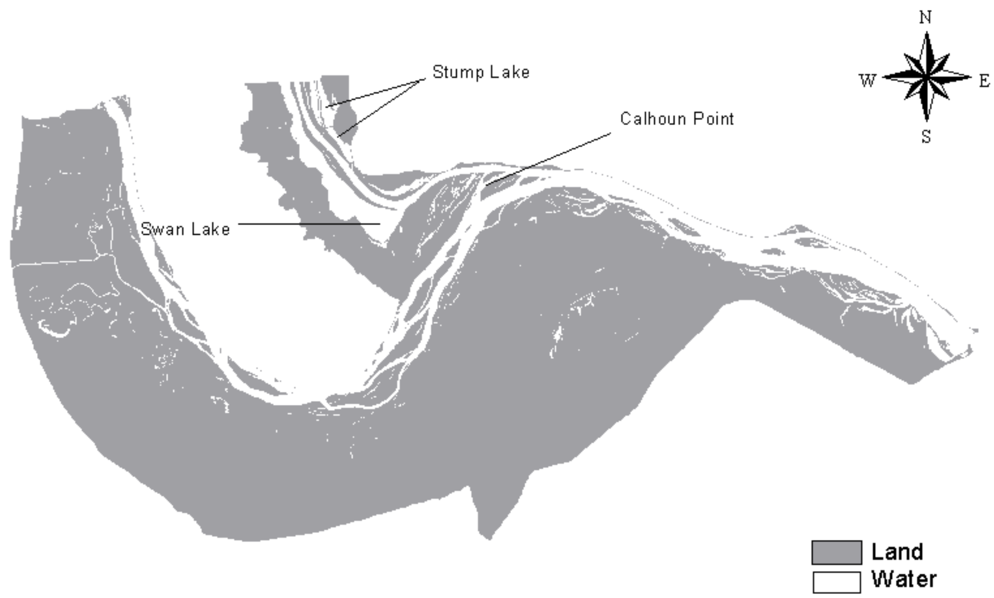

Figure 5. Pool 26, Upper Mississippi River, transect locations for the 1993 monitoring of submersed aquatic vegetation for the Long Term Resource Monitoring Program.

In La Grange Pool, we sampled SAV at three backwater transect locations and one channel border location (Figure 6). The three backwaters, monitored for the third year, are among the few locations where submersed vegetation are still found in this river reach. These backwaters are classified as isolated and are protected from the main stem of the Illinois River by levees. However, Point Lake occasionally receives overflow water from the main channel of the Illinois River and did so during 1993 when the river was at flood stage. Banner Marsh (Bulrush Pond) and Spring Lake are actively managed for fishing and are completely isolated. The fourth location, a channel border location by Grape Island, was monitored for the second year (Appendix A).

Methods

Transect Sampling

We positioned transects at regular intervals, from 50 to 200 m apart depending on the size of the area, and perpendicular to shorelines. In some large backwaters, we positioned transects in groups of three or four and placed several groups throughout the backwater. For example, Peterson Lake (Pool 4) has three transects in the upper portion, three transects in the middle portion, and four transects in the lower portion.

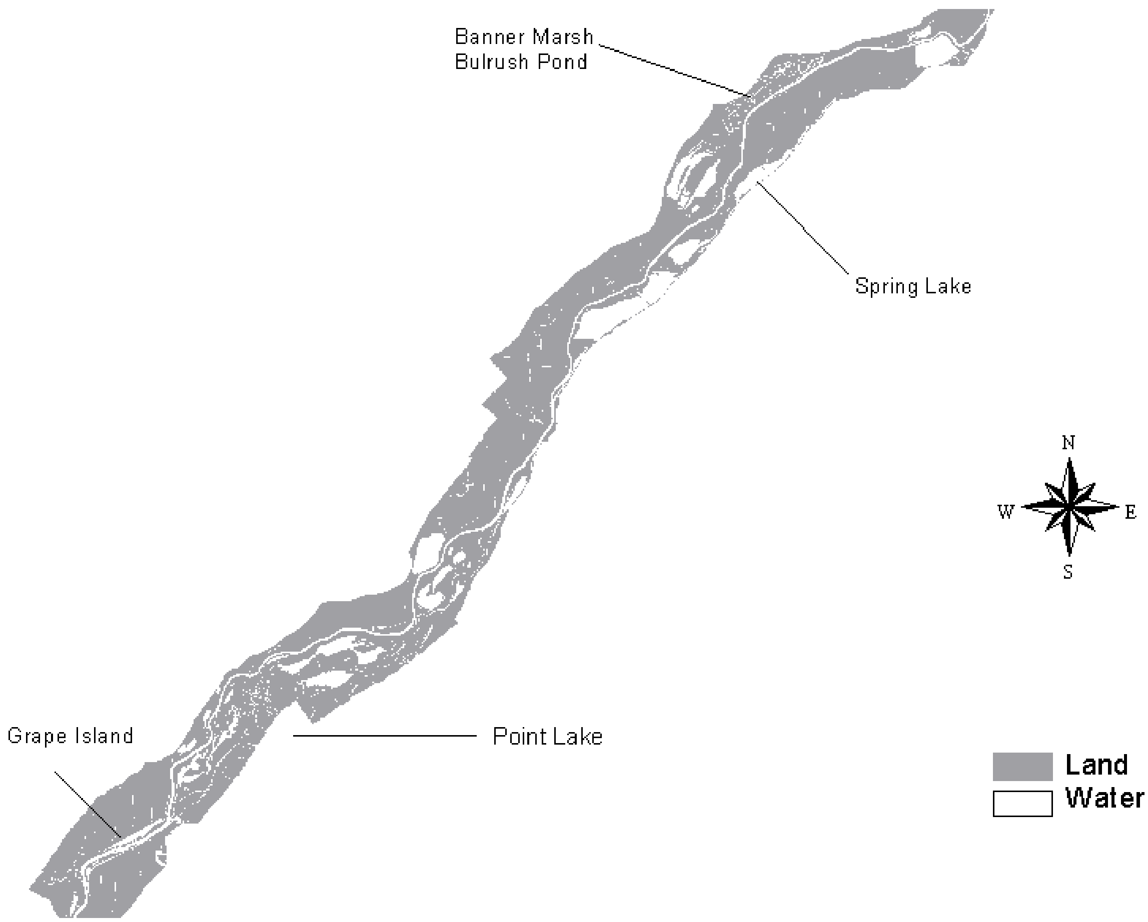

Figure 6. La Grange Pool, Illinois River, transect locations for the 1993 monitoring of submersed aquatic vegetation for the Long Term Resource Monitoring Program.

Transect sampling was performed twice at most locations during the 1993 growing season to observe seasonal changes in species composition and relative frequencies. Spring sampling was conducted between May 15 and June 15, and summer sampling was conducted between July 15 and August 30. In Pool 8, two new locations (Blue Lake and Pool 8 Island HREP) were sampled only during the summer sampling period. In La Grange Pool, Grape Island transect location was sampled only during the spring sampling period.

Sampling along the transects was at regularly spaced intervals (sites) such that a grid-like sampling scheme of evenly distributed sampling sites was imposed over a backwater or vegetated area. Sites were generally 15 m apart in Pools 8, 13, and 26 and in La Grange Pool, but 30 m apart in Pool 4 because several of the backwaters were too large to sample at the 15-m interval (Appendix A). The sampling technique was modified from a technique used by Jessen and Lound (1962). At each site along a transect, a 2-m diameter sampling area was visualized and divided into three portions. We sampled plants once within each of the three portions by casting a long-handled thatching rake to the bottom and twisting it to snag plants—instead of dragging it as did Jessen and Lound. The thatching rake has a 15-inch head with 20, 5-inch-long teeth and samples about 0.1 m^2. The submersed species on the rake were identified and recorded. After all three casts were made, each species recovered was assigned a rating from 1 to 4—instead of from 1 to 5 as did Jessen and Lound—based on the number of times each species appeared on the rake at each sampling site. A rating of 4 was assigned only if a species completely covered the rake teeth on all three casts.

If floating-leaved species were present, they were recorded and assigned a rating based on four cover classes (1–25%, 26–50%, 51–75%, and 76–100% visible vegetative cover within the sample area). Floating-leaved species found during sampling are listed in the taxa list (Appendix B).

Fassett (1966) and Gleason and Cronquist (1991) were the primary keys used for plant identification. Scientific nomenclature and common names were taken from the U.S. Department of Agriculture PLANTS Database on the Internet (www.itis.usda.gov/). A list of common and scientific names of plants is in Table 2.

Table 2. Submersed and floating-leaved aquatic vegetation most likely to be found in the area covered by the Long Term Resource Monitoring Program, arranged alphabetically by common name within family.

Family	Common name[a,b]	Scientific name[a]
Ceratophyllaceae	Coon's tail, coontail	*Ceratophyllum demersum*
Characeae	Chara	*Chara* spp.
Characeae	Nitella	*Nitella* spp.
Haloragaceae	Shortspike watermilfoil, Northern watermilfoil[b]	*Myriophyllum sibiricum* Komarov
Haloragaceae	Spike watermilfoil, Eurasian watermilfoil[b]	*Myriophyllum spicatum* L.
Hydrocharitaceae	Canadian waterweed	*Elodea canadensis*
Hydrocharitaceae	Western waterweed	*Elodea nuttallii* Planch.
Hydrocharitaceae	Wild celery[b], American eelgrass	*Vallisneria americana* Michx.
Lentibulariaceae	Common bladderwort	*Utricularia macrorhiza* Le Conte
Najadaceae	Brittle waternymph	*Najas minor* All.
Najadaceae	Nodding waternymph, bushy pondweed	*Najas flexilis* (Willd.) Rostk. & Schmidt
Najadaceae	Slender waternymph	*Najas gracillima* (A. Braun ex Engelm.) Magnus
Najadaceae	Southern waternymph	*Najas guadalupensis* (Spreng.) Magnus
Nymphaeaceae	American lotus	*Nelumbo lutea* (Willd.) Pers.
Nymphaeaceae	White waterlily	*Nymphaea odorata* Ait.
Nymphaeaceae	Yellow pondlily	*Nuphar lutea* (L.) Sm
Onagraceae	Floating primrosewillow	*Jussiaea repens* L.
Pontederiaceae	Water stargrass, grassleaf mudplantain	*Heteranthera dubia* (Jacq.) MacM.
Potamogetonaceae	Curly pondweed, curlyleaf pondweed	*Potamogeton crispus* L.
Potamogetonaceae	Flatstem pondweed	*Potamogeton zosteriformis* Fern.
Potamogetonaceae	Illinois pondweed	*Potamogeton illinoisensis* Morong.
Potamogetonaceae	Longleaf pondweed, river pondweed[b]	*Potamogeton nodosus* Poir
Potamogetonaceae	Leafy pondweed	*Potamogeton foliosus* Raf.
Potamogetonaceae	Ribbonleaf pondweed	*Potamogeton epihydrus* Raf.
Potamogetonaceae	Richardson’s pondweed	*Potamogeton richardsonii* (Benn.) Rydb.
Potamogetonaceae	Small pondweed	*Potamogeton pusillus* L.
Potamogetonaceae	Sago pondweed	*Potamogeton pectinatus* L.
Potamogetonaceae	Variableleaf pondweed	*Potamogeton gramineus* L.

Table 2. Continued.

Family	Common name[a,b]	Scientific name[a]
Ranunculaceae	Longbeak buttercup	*Ranunculus longirostris* Godron.
Ranunculaceae	White water-crowfoot	*Ranunculus trichophyllus* Chauix.
Zannichelliaceae	Horned pondweed	*Zannichellia palustris* L.

[a] Scientific nomenclature and common names follow the U.S. Department of Agriculture PLANTS Database on the Internet (www.itis.usda.gov/).

[b] Common names most often used by Upper Mississippi River managers are also included if different from the common names listed in the U.S. Department of Agriculture PLANTS Database.

If a species was not collected during the 1991 or 1992 seasons or could not be identified in the field, it was collected for reference and archiving. After drying, pressing, mounting, and labeling, specimens were stored at each field station. Two species of narrow-leaved pondweeds, small pondweed *(Potamogeton pusillus*) and leafy pondweed *(P. foliosus*), collectively referred to as small and leafy pondweeds, were not distinguished from each other during field sampling, and were also combined during analysis. Two species of macroalgae, chara (*Chara* spp.) and nitella (*Nitella* spp.), were included in the analysis with the vascular plants.

Environmental Factors

To acquire information on the relationship between macrophyte presence and sediment texture, we recorded the sediment type most often found for each transect. The sediment types were cataloged subjectively into three broad categories (silt/clay, mostly silt with sand, mostly sand with silt) based on visual and tactile characteristics. Water depth was measured at each transect site with a depth pole.

Statistical Analysis

The frequency of a species is defined as $f_i = j_i/n$ where j_i = number of sample sites containing species *I* on at least one of the three rake casts, and n = total number of sample sites. Relative frequency of a species is defined as $rf_i = e_i/Ef$ where e_i = the number of rake grabs for species *I* and Ef = number of rake grabs for all species. Species of floating-leaved vegetation were not included in the calculations because our primary concern with this sampling methodology is with changes in submersed vegetation. To test for significant changes in frequencies for a species between the two sampling periods, a value for Z was calculated using the following formula:

$$Z = p_1 - p_2 / \sqrt{pq[(1/n_1)+(1/n_2)]}$$

where

$p = j_1 + j_2 / n_1 + n_2$;
q = 1-p;
p_1 and p_2 are the spring and summer proportions, respectively;
n_1 and n_2 equal the number of sampling sites, spring and summer, respectively;
j_1 and j_2 = number of times species j was found during the spring and summer sampling periods, respectively; and
Z-values were calculated for each species and for each location within a pool.

Chi-square tests were used to test for significant changes in the proportion of sites with SAV to the total number of sites sampled between sampling periods. All analysis was done using the Statistical Analysis System (SAS; SAS Institute, Inc., Cary, North Carolina).

Informal Surveys

To gain perspective on the distribution and composition of SAV in habitats other than transect locations, we surveyed many portions of each pool where vegetation was likely to be present. Aerial photographs and bathymetry maps were used to locate sites supporting or likely to support SAV. Pools 4, 8, and 13 were surveyed by boating along channel border habitats and through other areas most likely to support vegetation not covered by transect sampling. If vegetated areas or patches of vegetation were seen at or near the surface, samples were gathered with a rake. An estimate of abundance (rare, common, abundant) was given to each species. Species composition, approximate bed size, water depth, substrate type, and location of the vegetated areas and patches were recorded. Informal surveys were not conducted in Pool 26 or in La Grange Pool because previous surveys revealed that areas with SAV are generally scarce.

Results

All Pools

During 1993, we found 15 species of SAV at sites along transects across study pools (Table 3). One species included was a non-vascular plant belonging to the muskgrass (Characeae) family. We also found several species of floating-leaved plants and have included them in our species list (Appendix B). No additional species were found during informal surveys that were not found at transect locations. The most species found (12) during any one sampling period was at transect sites in Pool 4, during spring sampling, and the fewest found (2) was in Pool 26, during summer sampling. Coon’s tail and sago pondweed were the only species present in every study pool during both spring and summer sampling. Curly pondweed and Eurasian watermilfoil were also prevalent species, present in all but Pool 26. Curly pondweed, however, declined in frequency between spring and summer sampling in all pools and sago pondweed declined in all pools except La Grange Pool, where it was present at a frequency below 5% during both sampling periods.

Many species, including Canadian waterweed, horned pondweed, flatstem pondweed, small and leafy pondweeds, longleaf pondweed, nodding waternymph, and water stargrass were distributed in at least two pools, but usually at frequencies below 10%. We found wild celery in Pools 4 and 13, but at a frequency above 10% only in Pool 4 during summer sampling. Two additional species, western waterweed and chara, were found only in La Grange Pool and at low frequencies.

Spring sampling was dominated by sago pondweed, curly pondweed, and coon’s tail in Pools 4 and 8, with a combined relative frequency greater than 80%. In Pools 13 and 26, coon’s tail and sago pondweed contributed to greater than 70% of the relative frequencies. In La Grange Pool, Eurasian watermilfoil, curly pondweed, and coon’s tail contributed to a combined relative frequency of more than 80%.

Eurasian watermilfoil and coon’s tail dominated summer sampling in Pool 8 with a combined relative frequency greater than 70%. Coon’s tail, flatstem pondweed (or water stargrass), Canadian waterweed, and Eurasian watermilfoil reached a combined relative frequency of more than 80% in Pool 13. Coon's tail and sago pondweed were found at very low frequencies only in the summer sampling in Pool 26. Eurasian watermilfoil had the highest relative frequency, and along with coon’s tail, reached a combined relative frequency greater than 80% in La Grange Pool.

Table 3. Frequencies and relative frequencies (%) of species in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool (LG) of the Illinois River in 1993.[a]

	Spring										Summer									
	4		8		13		26		LG		4		8		13		26		LG	
Species	Freq	Rel Freq	Freq	Rel. Freq	Freq	Rel. Freq	Freq	Rel Freq	Freq	Rel Freq	Freq	Rel Freq	Freq	Rel Freq	Freq	Rel Freq	Freq	Rel Freq	Freq	Rel Freq
Canadian waterweed	5.0	6.8	1.7	1.3	6.2	5.5	1.7	1.1	–[b]	–	7.9	15.3	3.5	3.5	10.1	17.5	–	–	–	–
Chara	–	–	–	–	–	–	–	–	7.6	5.6	–	–	–	–	–	–	–	–	7.0	7.0
Common bladderwort	0.1	0.1	–	–	–	–	–	–	–	–	–	–	3.8	4.6	–	–	–	–	–	–
Coon's tail	9.1	13.7	20.0	17.1	21.5	22.2	43.9	50.1	20.4	13.4	9.3	19.2	32.2	49.6	18.3	33.3	0.9	50.0	22.7	20.4
Curly pondweed	15.5	24.7	26.7	38.3	4.9	3.7	–	–	27.0	16.8	0.9	1.1	5.9	5.3	0.3	0.4	–	–	1.6	1.0
Eurasian watermilfoil	2.2	3.6	15.4	17.2	8.4	7.6	–	–	65.8	53.2	2.5	4.9	22.0	24.4	8.3	14.2	–	–	63.0	61.2
Flatstem pondweed[c]	0.5	0.5	0.3	0.3	–	3.4	–	–	–	–	1.0	1.4	1.0	0.8	11.2	19.7	–	–	–	–
Horned pondweed	0.1	0.1	0.5	0.4	–	–	–	–	4.7	2.3	–	–	–	–	–	–	–	–	–	–
Longleaf pondweed	0.3	0.4	–	–	3.9	4.7	7.4	8.2	2.4	1.0	0.4	0.7	0.7	1.0	1.8	2.1	–	–	2.2	1.8
Nodding waternymph	–	–	0.3	0.3	0.3	0.2	–	–	–	–	0.1	0.3	0.8	0.9	0.5	0.6	–	–	2.2	1.4
Sago pondweed	23.6	42.6	24.0	25.0	46.0	52.3	53.8	40.6	2.4	0.9	7.2	15.0	9.0	9.5	3.4	3.9	1.1	50.0	3.2	1.8
Small and leafy pondweeds	3.7	5.0	–	–	–	–	–	–	0.5	2.0	1.5	2.7	0.1	0.2	–	–	–	–	0.5	0.2
Water stargrass[d]	1.8	1.9	–	–	3.8	3.4	–	–	–	–	2.6	5.2	0.3	0.2	?	?	–	–	–	–
Western waterweed[c]	–	–	–	–	–	–	–	–	9.0	4.7	–	–	–	–	–	–	–	–	7.0	5.3
Wild celery	0.4	0.4	–	–	0.3	0.2	–	–	–	–	14.0	34.0	–	–	5.4	8.2	–	–	–	–

[a] Data are based on all transect locations combined within a pool. Rounding may cause relative frequency columns to not total 100%.
[b] The symbol "–" indicates the species was not found.
[c] Flatstem pondweed relative frequency may also include water stargrass in Pool 13.
[d] Verification of specimen needed for positive identification.

The proportion of sites vegetated with SAV decreased significantly in all pools, but most remarkably in Pools 13 and 26 where summer flooding was more severe (Table 4). The highest proportion of vegetated sites was in La Grange Pool where transects are located in backwaters that are usually protected from high turbidity levels and flows of the Illinois River main channel.

Table 4. Proportion of sites with submersed aquatic vegetation to total number of sites sampled at transect locations during the 1993 spring and summer sampling periods.

Location	Spring	Summer
Pool 4	43.2	29.5 ($p < 0.01$)[a]
Pool 8	57.2	48.3 ($p < 0.01$)
Pool 13	60.8	22.6 ($p < 0.01$)
Pool 26	79.7	2.1 ($p < 0.01$)
La Grange Pool	94.2	82.7 ($p < 0.01$)

[a] Probability values for differences between sampling periods is given in parentheses. P-values are based on Chi-square tests with a 0.05 level of significance.

Water Depths and Substrates

Mean water depths where submersed aquatic plants grew along transects revealed that depths were from 1.1 m in Pool 8 to 2.3 m in Pool 26 during spring sampling and from 1.1 m in Pool 8 to 3.5 m in Pool 26 during summer sampling (Table 5). Water depths were unusually deep in all the pools, especially in Pool 26, because of prolonged summer flooding.

Table 5. Mean depths of submersed aquatic vegetation along sampling transects in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River during the 1993 spring and summer sampling periods.

Location	Mean depth spring sampling	Standard deviation	*N*	Mean depth summer sampling	Standard deviation	*N*
Pool 4	1.5	0.6	395	1.5	0.4	271
Pool 8	1.1	0.4	439	1.1	0.3	516
Pool 13	1.4	0.6	549	1.1	0.4	200
Pool 26	2.3	0.9	458	3.5	0.2	11
La Grange Pool	1.5	0.4	127	1.6	0.5	58

The majority of SAV sites were found on silt substrates throughout all pools. Pools 4 and 13 also reported sand substrate at sites with SAV (Table 6).

Table 6. Relative presence of (%) substrate types along transects containing submersed aquatic vegetation during the 1993 spring and summer sampling periods.

	Relative presence				
Substrate type	**Pool 4** (*n* = 104)	**Pool 8** (*n* = 76)	**Pool 13** (*n* = 124)	**Pool 26** (*n* = 71)	**La Grange Pool** (*n* = 30)
Silt/clay mix	76.9	92.1	66.1	100.0	60.0
Mostly silt with sand	4.8	7.9	15.3	–[a]	26.7
Mostly sand with silt	18.3	–	18.6	–	13.3

[a]The symbol “–” indicates the substrate type was not found.

Pool 4

We found 12 species of SAV along Pool 4 transects during the spring sampling period and 11 during the summer sampling period (Table 7). No additional species were found during informal surveys. More species were found along transects in lower Pool 4 (below Lake Pepin) than in the upper pool (above Lake Pepin; Appendix B). Species with the highest frequencies during spring sampling were sago pondweed (23.6%), curly pondweed (15.5%), and coon’s tail (9.1%). These three contributed to more than 80% of the relative frequencies during the spring sampling period. Both sago pondweed and curly pondweed declined in frequency between spring and summer sampling periods, whereas the frequency of coon’s tail remained similar between sampling periods (Table 7).

Table 7. Frequencies and relative frequencies (%) of species in Pool 4 during the 1993 spring and summer sampling periods.

	Frequencies [a]		Relative frequencies [a]	
Species	**Spring**	**Summer**	**Spring**	**Summer**
Canadian waterweed	5.0	7.9	6.8	15.3
Common bladderwort	0.1	–[b]	0.1	–
Coon's tail	9.1	9.3	13.7	19.2
Curly pondweed	15.5	0.9	24.7	1.1
Eurasian watermilfoil	2.2	2.5	3.6	4.9
Flatstem pondweed	0.5	1.0	0.5	1.4
Horned pondweed	0.1	–	0.1	–
Longleaf pondweed	0.3	0.4	0.4	0.7
Nodding waternymph	–	0.1	–	0.3
Sago pondweed	23.6	7.2	42.6	15.0
Small and leafy pondweeds	3.7	1.5	5.0	2.7
Water stargrass	1.8	2.6	1.9	5.2
Wild celery	0.4	14.0	0.4	34.0

[a] Frequencies and relative frequencies are based collectively on all transect locations where sampling was performed twice during the growing season. Rounding may cause relative frequency columns to not total 100%.
[b] The symbol "–" indicates the species was not found.

During the summer sampling, wild celery was the only species with a frequency greater than 10% and Canadian waterweed, coon's tail, and sago pondweed were the only species with frequencies above 5%. These species had a combined relative frequency greater than 80%. Species encountered rarely (< 2.0%) included water stargrass, wild celery, common bladderwort, and horned pondweed during spring sampling, nodding waternymph during summer sampling, and flatstem and longleaf pondweeds during both sampling periods (Table 7).

Two species with the highest spring frequencies, sago pondweed and curly pondweed, declined significantly (based on z-tests) at several transect locations during the weeks between the spring and summer sampling periods. Sago pondweed declined at upper Pool 4 transect locations including Bay City Flats, Dead Slough Lake, and Mud Lake. Curly pondweed declined at Peterson Lake, Lower Peterson Lake, Big Lake, Robinson Lake, and Big Lake Bay. Small and leafy pondweeds also declined in Robinson Lake. These declines were responsible for the change in the proportion of sites vegetated with SAV between sampling periods (Table 4). Wild celery increased at four lower pool locations: Robinson Lake, Big Lake, Peterson Lake, and lower Peterson Lake; and Canadian waterweed increased in Robinson Lake. No other species revealed significant change between the two sampling periods (Table 8).

Table 8. Locations in Pool 4 where species were present during the 1993 spring and summer sampling periods.

Species	Decreased between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased between spring and summer sampling periods[a]
Canadian waterweed	Big Lake Bay	Big Lake Lake Peterson Lake Lower Peterson	Robinson Lake
Common bladderwort		Big Lake	
Coon's tail		Big Lake Big Lake Bay Lower Peterson Lake Peterson Lake Rice Lake Robinson Lake Upper Mud Lake	
Curly pondweed	Big Lake Big Lake Bay Lower Peterson Lake Peterson Lake Robinson Lake	Peterson Lake Rice Lake	
Eurasian watermilfoil		Big Lake Big Lake Bay Peterson Lake Rice Lake Robinson Lake	
Flatstem pondweed		Big Lake Big Lake Bay Peterson Lake Robinson Lake	
Horned pondweed		Peterson Lake	
Longleaf pondweed		Big Lake Big Lake Bay Rice Lake	
Nodding waternymph		Big Lake	
Sago pondweed	Bay City Flats Dead Slough Lake Mud Lake	Big Lake Big Lake Bay Goose Lake Lower Peterson Lake Peterson Lake Rice Lake Robinson Lake Upper Mud Lake	

Table 8. Continued.

Species	Decreased between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased between spring and summer sampling periods[a]
Small and leafy pondweeds	Robinson Lake	Big Lake Big Lake Bay Peterson Lake Rice Lake Upper Mud Lake	
Water stargrass		Big Lake Lower Peterson Lake Peterson Lake Robinson Lake	
Wild celery			Big Lake Peterson Lake Robinson Lake

[a] Species that increased or decreased in frequency at a location are significant at the 0.05 probability level (based on z-tests).

[b] Species that did not change significantly may have been untestable due to small sample size during one or both sampling periods.

Pool 8

We found eight species at Pool 8 transect locations during the spring sampling period and 11 species at the same transect locations during the summer sampling period. Horned pondweed was found in the spring, but not during the summer. Common bladderwort, longleaf pondweed, small and leafy pondweeds, and water stargrass were found during summer, but not during spring sampling. Thus, a total of 12 species were found during both seasons (Appendix B). Coon's tail, curly pondweed, and sago pondweed reached frequencies of at least 20% during the spring sampling period, but the frequency of sago and curly pondweed decreased to less than 10% by the summer sampling period. Eurasian watermilfoil and coon’s tail both increased in frequency. Species rarely found (frequency less than 2%), including Canadian waterweed, common bladderwort, flatstem pondweed, nodding waternymph, small and leafy pondweeds, and water stargrass, increased slightly as well.

During the spring sampling period, curly pondweed, coon’s tail, and sago pondweed contributed to greater than 80% of the relative frequencies. During the summer sampling period, coon’s tail contributed to nearly 50% of the relative frequencies and when combined with Eurasian watermilfoil and sago pondweed, contributed to more than 80% of the relative frequencies (Table 9).

Significant decreases were noted for sago pondweed in most locations where the species was found including Lawrence Lake, Target Lake, Horseshoe Island, and Goose Island. Curly pondweed declined in overall frequency between the two sampling periods in Lawrence Lake. Significant increases in at least one species occurred in Lawrence Lake, Goose Island, and Stoddard locations (Table 10). Although species both decreased and increased at individual locations, the proportion of sites vegetated with submersed species decreased significantly between spring and summer sampling periods, affected primarily by the decline in the two species with the highest spring frequencies, sago pondweed and curly pondweed (Table 4).

Table 9. Frequencies and relative frequencies (%) of species in Pool 8 during the 1993 spring and summer sampling periods.

	Frequencies[a]		Relative frequencies[a]	
Species	**Spring**	**Summer**	**Spring**	**Summer**
Canadian waterweed	1.7	3.5	1.3	3.5
Common bladderwort	–[b]	3.8	–	4.6
Coon's tail	20.0	32.2	17.1	49.6
Curly pondweed	26.7	5.9	38.3	5.3
Eurasian watermilfoil	15.4	22.0	17.2	24.4
Flatstem pondweed	0.3	1.0	0.3	0.8
Horned pondweed	0.5	–	0.4	–
Longleaf pondweed	–	0.70	–	1.0
Nodding waternymph	0.3	0.8	0.3	0.9
Sago pondweed	24.0	9.0	25.0	9.5
Small and leafy pondweeds	–	0.10	–	0.2
Water stargrass	–	0.30	–	0.2

[a] Frequencies and relative frequencies are based on all locations pooled together that were sampled twice during the season. Rounding may cause relative frequency columns to not total 100%.

[b] The symbol "–" indicates the species was not found.

Table 10. Locations in Pool 8 where species were present during the 1993 spring and summer sampling periods.

Species	**Decreased between spring and summer sampling periods[a]**	**No change between spring and summer sampling periods[b]**	**Increased between spring and summer sampling periods[a]**
Canadian waterweed		Goose Island Horseshoe Island Stoddard Target Lake	Lawrence Lake
Common bladderwort		Lawrence Lake Target Lake	
Coon's tail		Shady Maple Stoddard Target Lake	Goose Island Lawrence Lake
Curly pondweed	Lawrence Lake	Goose Island Horseshoe Island Shady Maple Target Lake	Stoddard

Table 10. Continued.

Species	Decreased between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased between spring and summer sampling periods[a]
Eurasian watermilfoil		Goose Island Horseshoe Island Shady Maple Target Lake	Lawrence Lake
Flatstem pondweed		Goose Island Lawrence Lake Target Lake	
Horned pondweed		Horseshoe Island	
Longleaf pondweed		Goose Island Lawrence Lake	
Nodding waternymph		Horseshoe Island	Lawrence Lake
Sago pondweed	Goose Island Horseshoe Island Lawrence Lake Target Lake	Shady Maple	Stoddard
Small and leafy pondweeds		Lawrence Lake	Stoddard
Water stargrass		Lawrence Lake	

[a] Species that increased or decreased in frequency at a location are significant at the 0.05 probability level (based on z-tests).
[b] Species that did not change significantly may have been untestable due to small sample size during one or both sampling periods.

Pool 13

We found nine species of SAV along Pool 13 transects during the 1993 sampling season (Appendix B). All nine species were found during both sampling periods. No additional species were found during informal surveys. Flatstem pondweed and water stargrass were probably both present, but a distinction between the two was not made while in the field. Sago pondweed and coon's tail had the highest frequencies during spring sampling, at 46% and 21.5%, respectively. Frequencies of all other species in spring were below 10%. By the summer sampling period, sago pondweed had dropped in frequency to 3.4% and most other species remained below 10%. Coon's tail, Eurasian watermilfoil, and nodding waternymph retained similar frequencies between spring and summer sampling, while increases occurred among Canadian waterweed, flatstem pondweed (or water stargrass), and wild celery.

During spring sampling, sago pondweed, coon's tail, and Eurasian watermilfoil, contributed to greater than 80% of the relative frequencies. During summer sampling, flatstem pondweed (or water stargrass), coon's tail, Eurasian watermilfoil, and Canadian waterweed shared more than 80% of the relative frequencies (Table 11).

Many species showed significant decreases in frequencies at some locations where they were present during the 1993 growing season. Thus, the proportion of sites with SAV decreased significantly between spring and summer sampling periods (Table 4). However, the Johnson Creek area (Johnson Creek and Johnson Creek levee locations) was the primary location where species significantly increased (Table 12).

Table 11. Frequencies and relative frequencies (%) of species in Pool 13 during the 1993 spring and summer sampling periods.

	Frequencies[a]		Relative frequencies[a]	
Species	**Spring**	**Summer**	**Spring**	**Summer**
Canadian waterweed	6.2	10.1	5.5	17.5
Coon's tail	21.5	18.3	22.0	33.3
Curly pondweed	4.9	0.3	3.7	0.4
Eurasian watermilfoil	8.4	8.3	7.6	14.2
Longleaf pondweed	3.9	1.8	4.7	2.1
Nodding waternymph	0.3	0.5	0.2	0.6
Sago pondweed	46.0	3.4	52.3	3.9
Wild celery	0.3	5.4	0.2	8.2
Other species[b]	3.8	11.2	3.4	19.7

[a] Frequencies and relative frequencies are based on all locations pooled together that were monitored during both the spring and summer sampling efforts. Rounding may cause the relative frequencies column to not total 100%.

[b] Other species include either or both water stargrass and flatstem pondweed.

Table 12. Locations in Pool 13 where species were present during the 1993 spring and summer sampling periods.

Species	Decreased between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased between spring and summer sampling periods[a]
Canadian waterweed	Pomme de Terre	Potter’s Marsh	Johnson Creek Johnson Creek Levee
Coon's tail	Pomme de Terre Savanna Bay Spring Lake	Brown's Lake Potter's Marsh Savanna Bay	Johnson Creek Johnson Creek Levee
Curly pondweed	Johnson Creek Johnson Creek levee Savanna Bay Spring Lake	Brown’s Lake Pomme de Terre Savanna Bay	
Eurasian watermilfoil	Pomme de Terre Spring Lake	Potter's Marsh	Johnson Creek Johnson Creek Levee
Flatstem pondweed/ water stargrass		Pomme de Terre Potter's Marsh Savanna Bay Spring Lake	Johnson Creek Johnson Creek Levee
Longleaf pondweed	Spring Lake	Brown's Lake Johnson Creek Johnson Creek Levee Pomme de Terre Savanna Bay	

Table 12. Continued.

Species	Decreased between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased between spring and summer sampling periods[a]
Nodding waternymph		Johnson Creek Johnson Creek Levee	
Sago pondweed	Brown's Lake Johnson Creek Johnson Creek Levee Pomme de Terre Potter's Marsh Savanna Bay Spring Lake		
Wild celery		Brown's Lake Potter's Marsh	Johnson Creek Johnson Creek Levee Pomme de Terre

[a] Species that increased or decreased in frequency at a location are significant at the 0.05 probability level (based on z-tests).

[b] Species that did not change significantly may have been untestable due to small sample size during one or both sampling periods.

Informal surveys conducted in July were a reduced effort for Pool 13 because of high water levels associated with the 1993 flood. Between the difficulty of sampling or finding SAV in high water, less than 25 sites with SAV were located. No additional species were found during informal surveys.

Pool 26

We found only four species of SAV during the spring sampling period and only two during the summer sampling period in 1993. Frequencies and relative frequencies were dominated by coon's tail and sago pondweed, with coon's tail owning the highest relative frequency during the spring sampling period. By the summer sampling period, which was still during high water levels associated with the 1993 flood, no species reached a frequency of 2%, making SAV nearly nonexistent at the transect locations (Table 13). The proportion of sites vegetated with SAV was consequently affected between spring and summer sampling by the decreases in frequencies and in species that were originally present during the spring effort (Table 14).

Table 13. Frequencies and relative frequencies (%) of species in Pool 26 during the 1993 spring and summer sampling periods.

	Frequencies[a]		Relative frequencies[a]	
Species	Spring	Summer	Spring	Summer
Canadian waterweed	1.7	–[b]	1.1	–
Coon's tail	43.9	0.9	50.1	50.0
Longleaf pondweed	7.4	–	8.2	–
Sago pondweed	53.7	1.1	40.6	50.0

[a] Frequencies and relative frequencies are based on all locations pooled together that were sampled twice during the season. Rounding may cause the relative frequencies column to not total 100%. Locations that were sampled twice during the season were Calhoun Point, Stump Lake, Swan Lake, and Fuller Lake.

[b] The symbol "–" indicates the species was not found.

Table 14. Locations in Pool 26 where species were present during the 1993 spring and summer sampling periods.

Species	Decreased between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased between spring and summer sampling periods[a]
Canadian waterweed	Stump Lake	Calhoun Point	
Coon's tail	Calhoun Point Fuller Lake Stump Lake		
Longleaf pondweed	Stump Lake		
Sago pondweed	Calhoun Point Stump Lake Swan Lake		

[a] Species that increased or decreased in frequency at a location are significant at the 0.05 probability level (based on z-tests).

[b] Species that did not change significantly may have been untestable due to small sample size during one or both sampling periods.

All species present significantly declined (based on z-tests) between sampling periods at nearly all locations where they occurred. Coon's tail and sago pondweed declined in Fuller and Stump Lakes and at Calhoun Point. Canadian waterweed and longleaf pondweed both declined at Stump Lake (Table 14).

La Grange Pool

We found 10 species of SAV at transect locations in La Grange Pool in 1993. Nine species were found during each sampling period; horned pondweed was found in spring but not in summer, and nodding waternymph was found in summer but not in spring. No species were found at the Grape Island location, which was sampled only during the spring sampling period.

Species frequencies in La Grange Pool were dominated by Eurasian watermilfoil, followed by curly pondweed and coon's tail during the spring sampling period (Table 15). These three species contributed to more than 80% of the relative frequencies during the spring sampling. During the summer sampling period, coon's tail and Eurasian watermilfoil made up more than 80% of the relative frequencies whereas curly pondweed dropped to only 1% relative frequency. All other species were present at frequencies of 10% or less during both sample periods. La Grange Pool backwaters are the only locations within our study areas where we found western waterweed.

Table 15. Frequencies and relative frequencies (%) of species in La Grange Pool, Illinois River, during the 1993 spring and summer sampling periods.

	Frequencies[a]		Relative frequencies[a]	
Species	Spring	Summer	Spring	Summer
Chara	8.4	7.0	5.6	7.0
Coon's tail	22.6	22.7	13.4	20.4
Curly pondweed	30.0	1.6	16.7	1.0
Eurasian watermilfoil	73.1	63.0	53.0	61.2
Horned pondweed	5.2	–[b]	2.3	–

Table 15. Continued.

	Frequencies[a]		Relative frequencies[a]	
Species	**Spring**	**Summer**	**Spring**	**Summer**
Longleaf pondweed	2.6	2.2	1.0	1.8
Nodding waternymph	–	2.2	–	1.4
Sago pondweed	1.6	3.2	1.1	1.8
Small and leafy pondweeds	1.6	0.5	2.0	0.2
Western waterweed	10.0	7.0	4.7	5.3

[a] Frequencies and relative frequencies are based on all locations pooled together that were sampled twice during the season. Rounding may cause the relative frequencies column to not total 100%.
[b] The symbol "–" indicates the species was not found.

Based on z-tests, there was little significant change in species frequencies between sampling periods. The one exception was Eurasian watermilfoil, which declined at the Spring Lake location (Table 16). During the growing season, there was a significant decline in the proportion of sites with SAV. The change was affected primarily by the decline of curly pondweed and Eurasian watermilfoil in Spring Lake.

Table 16. Locations in La Grange Pool, Illinois River, where species were present during the 1993 spring and summer sampling periods.

Species	**Decreased between spring and summer sampling periods[a]**	**No change between spring and summer sampling periods[b]**	**Increased between spring and summer sampling periods[a]**
Chara		Spring Lake	
Coon's tail		Bulrush Pond Point Lake Spring Lake	
Curly pondweed	Spring Lake	Bulrush Pond	
Eurasian watermilfoil	Spring Lake	Bulrush Pond	
Horned pondweed		Bulrush Pond Spring Lake	
Longleaf pondweed		Bulrush Pond	
Nodding waternymph		Bulrush Pond Spring Lake	
Sago pondweed		Bulrush Pond Spring Lake	
Small and leafy pondweeds		Bulrush Pond	
Western waterweed		Point Lake Spring Lake	

[a] Species that increased or decreased in frequency at a location are significant at the 0.05 probability level (based on z-tests).
[b] Species that did not change significantly may have been untestable due to small sample size during one or both sampling periods.

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Appendix A

Locations, Number of Transects and Sites, Sampling Dates, and Distances Between Sites Sampled in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River during the 1991 through 1994 sampling seasons.

Location	Number of transects	Number of sites in spring	Number of sites in summer	Dates sampled in spring	Dates sampled in summer	Distance between sites (m)
Pool 4						
Bay City Flats (M787.0; Catherine Pass)[a]	3	78	70	6/10–11	8/11, 13	30
Big Lake (M758.0)	3	29	26	5/26	7/28	30
Big Lake (M757.5)	5	152	159	6/1, 3	7/29; 8/2, 29	30
Big Lake Bay (M758.5)	3	35	30	5/26	7/26	30
Dead Slough Lake (M789.2, M788.5, M788.0)[b]	9	133	115	6/8, 10	8/4, 9	30
Goose Lake (M788.G)[c]	3	28	24	6/4	8/9	30
Lower Peterson Lake (M753.5)	4	118	132	5/19–20	7/15–16	30
Mud Lake (M791.3)	3	57	51	6/4	8/4	30
Peterson Lake (M754.8, M754.5)	6	56	58	5/17	7/15	30
Robinson Lake (M758.R)	9	187	211	5/20–21, 25	7/20–22	30
Upper Mud Lake (M791.5)	4	42	42			30
Total Pool 4	**48**	**915**	**918**	**15**	**15**	
Pool 8						
Blue Lake (M697.0)	3 (summer)	not sampled	122	not sampled	8/19–20	15
Goose Island (M692.0)	5	114	114	5/26	7/23, 29	15
Horseshoe HREP[d] (M687.0)	5	75	82	6/10	8/11	15

Location	Number of transects	Number of sites in spring	Number of sites in summer	Dates sampled in spring	Dates sampled in summer	Distance between sites (m)
Lawrence Lake (M691.0)	6 (spring) 10 (summer)	247	435	5/20–21, 25; 6/1	7/30; 8/3, 5–6, 10, 24–25	15
Pool 8 Islands (M686.0)	3 (summer)	not sampled	75	not sampled	8/26	15
Shady Maple (M690.0)	3	114	101	6/3	7/22	15
Stoddard (M684.0)	4	48	46	5/27–28	7/20	15
Target Lake (M696.0)	9 (spring) 11 (summer)	169	298	6/8, 11	8/4, 13, 16	15
Total Pool 8	**32 (spring) 44 (summer)**	**767**	**1,273**	**11**	**18**	
Pool 13						
Brown's Lake (M545.1, M544.5)	25	325	308	6/3–4, 8–11	7/30; 8/17–19	15
Johnson Creek Levee (M523.5)	4	88	82	6/14–15	8/11	15
Lower Johnson Creek (M523.0)	2	53	59	5/20	7/26	15
Pomme de Terre (M526.0)	5	78	77	5/19	8/6	15
Potter's Marsh (M524.0)	6	74	75	6/11	8/10	15
Savanna Bay (M541.5, M540.5, M539.5)	12	135	150	5/21, 25–26	7/29–30; 8/3	15
Spring Lake (M534.8, M533.6, M532.0)	12	149	130	5/26, 28; 6/1	8/3, 5	15
Total Pool 13	**66**	**902**	**881**	**16**	**12**	
Pool 26						
Calhoun Point (I003.0)[e,f]	17	157	156	5/25, 27	8/23–24	15
Fuller Lake (I011.5)	2	29	32			
Swan Lake (I005.5)	11	291	146	5/19–20, 24	8/26–27	15

Location	Number of transects	Number of sites in spring	Number of sites in summer	Dates sampled in spring	Dates sampled in summer	Distance between sites (m)
Stump Lake (I010.0)	8	174	194	6/1, 3	8/25–26	15
Total Pool 26	**38 (spring) 32 (summer)**	**651**	**528**	**7**	**6**	
La Grange Pool						
Banner Marsh (I140.7; Bulrush Pond)[d]	2	18	16	6/10	8/11–12	15
Grape Island (I086.4)	3 (spring)	21	not sampled		not sampled	15
Point Lake (I100.0)	6	28	26	6/14–15	8/10	15
Spring Lake (I135.5)	5	144	143	5/23, 25, 27–28; 6/2–3	7/19, 21–22; 8/5, 18	15
Total La Grange Pool	**16 (spring) 13 (summer)**	**211**	**185**	**9**	**8**	

[a] Locally recognized name.
[b] Mississippi River miles, measured from the confluence of the Mississippi and Ohio Rivers.
[c] "G" and "R" to distinguish this lake from another lake with the same river mile.
[d] Habitat Rehabilitation and Enhancement Project.
[e] Illinois River miles, measured from the confluence of the Mississippi and Illinois Rivers.
[f] Pool 26 is located at the confluence of the Illinois and Mississippi Rivers and the portions named here extend up the Illinois River, are managed by the Illinois Department of Natural Resources, and are disignated by Illinois River miles.

Appendix B

Species of Submersed and Floating-leaved Aquatic Macrophytes Occurring at Transect Sites in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River

Species	Pool 4[a]	Pool 8	Pool 13	Pool 26	La Grange Pool
Submersed Aquatic Species					
Canadian waterweed (*Elodea canadensis* L.)	x[b]	x	x	x	–[c]
Chara (*Chara* spp.)	–	–	–	–	x
Common bladderwort (*Utricularia macrorhiza* L.)	x	x	–	–	–
Coon's tail (*Ceratophyllum demersum* L.)	x	x	x	x	x
Curly pondweed (*Potamogeton crispus* L.)	x	x	x	–	x
Eurasian watermilfoil (*Myriophyllum spicatum* L.)	x	x	x	–	x
Flatstem pondweed (*Potamogeton zosteriformis*)	x	x	x	–	–
Horned pondweed (*Zannichellia palustris* L.)	x	x	–	–	x
Longleaf pondweed (*Potamogeton nodosus* Poiret.)	x	x	x	x	x
Nodding waternymph (*Najas flexilis* [Willd.] Rostke & Schmidt)	x	x	x	–	x
Sago pondweed (*Potamogeton pectinatus* [Benn] Rydb.)	x	x	x	x	x
Small and leafy pondweeds (*Potamogeton pusillus; P. foliosus* L.)	x	x	–	–	x
Water stargrass (*Heteranthera dubia* L.)	x	x	?[d]	–	–
Western waterweed (*Elodea nuttallii* [Planch.] St. John)	–	–	–	–	x

Species	Pool 4[a]	Pool 8	Pool 13	Pool 26	La Grange Pool
Wild celery, American eelgrass (*Vallisneria americana* Michx.)	x	–	x	–	–
Floating-leaved Species					
American lotus (*Nelumbo lutea* [Willd.] Pers.)	x	x	x	x	x
American white waterlily (*Nymphaea odorata* Ait.)	x	x	–	–	–
Yellow pondlily (*Nuphar lutea* [L.] Sm.)	x	x	–	–	–
Additional species found during informal surveys not found during transect surveys	0	0	0	0	0
Total per pool					
Submersed aquatic species	**13**	**12**	**9**	**4**	**10**
Floating-leaved species	**3**	**3**	**1**	**1**	**1**

[a] Found in lower Pool 4 (below Lake Pepin) only when so indicated.
[b] The symbol “x” indicates the species was present.
[c] The symbol “–” indicates the species was not found.
[d] Water stargrass was probably present in Pool 13, but was not distinguished from flatstem pondweed.

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13. ABSTRACT (Maximum 200 words)

Aquatic vegetation of the Upper Mississippi River System is monitored as part of the Long Term Resource Monitoring Program. This report summarizes the 1993 effort of monitoring submersed aquatic vegetation (SAV) along permanently established transects in vegetated locations within certain LTRMP study reaches, specifically Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River. Data are collected during two sampling windows, mid-May through mid-June, and mid-July through August. Fifteen species of SAV were found along transects during the 1993 season. The greatest number of species found (12) was in Pool 4 and the fewest number found (2) was in Pool 26. Coon's tail and sago pondweed were the only species found in every study pool during both spring and summer sampling. In all study reaches except La Grange Pool, the frequency of several species of SAV changed between sampling periods, with decreases especially common among several species of pondweeds. Several other species also decreased in Pools 13 and 26 between sampling periods. Conversely, several species increased in frequencies in Pool 8 between periods. The proportion of sites containing SAV declined during the season in Pools 4, 13, and 26, but not in Pool 8 or La Grange Pool.

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The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information for maintaining the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.