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Aquatic Vegetation Monitoring in Pool 8 of the Upper Mississippi River System May–August 1995

October 1997

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Aquatic Vegetation Monitoring in Pool 8 of the Upper Mississippi River System May–August 1995

by

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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 was prepared under Strategy 2.2.4, *Monitor and Evaluate Aquatic and Terrestrial Vegetation*, Task 2.2.4.6, *Evaluate and Summarize Present-Day Annual Results* of the Operating Plan (USFWS 1993) and was developed with funding provided by the Long Term Resource Monitoring Program.

Aquatic Vegetation Monitoring in Pool 8 of the Upper Mississippi River System May–August 1995

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Heidi A. Langrehr

Abstract

The Long Term Resource Monitoring Program conducted monitoring of submersed aquatic vegetation in Pool 8 of the Upper Mississippi River System in 1995. A rapid assessment technique was used to sample 45 transects in eight backwaters during two sampling windows (spring and summer). Sixteen species from 10 families were recorded. The number of species increased from spring (13) to summer (15). *Zannichellia palustris* L. was found only during the spring sampling period, while *Vallisneria americana* L., *Heteranthera dubia* (Jacq.) MacM., and *Najas flexilis* (Willd.) Rostk. & Schmidt were found only in summer. Lawrence Lake had the most species (15), and the Boomerang Island area had the least (6). Frequency of vegetated sites increased from spring to summer in Pool 8. The two isolated backwater areas had the highest percentage of submersed, vegetated sites. The most frequently recorded submersed species during transect sampling were *Ceratophyllum demersum* L. and *Potamogeton pectinatus* L. An informal survey of Pool 8 was conducted between the two transect sampling windows. Two hundred forty-three submersed plant beds were located. One species, *Myriophyllum sibiricum* Komarov, was found only during the informal survey in an isolated backwater area. *Potamogeton pectinatus* and *P. nodosus* Poir. were the most frequently recorded species.

Introduction

The Upper Mississippi River System (UMRS) is an important ecological and economic resource, which provides habitat for a wide diversity of plants and animals. Aquatic vegetation is an integral component of the UMRS. It can influence the surrounding habitat by slowing velocities and allowing suspended sediment to settle out, stabilizing sediments, acting as either a source or a sink for nutrients, and producing oxygen as well as contributing to respiration (Carpenter and Lodge 1986). Aquatic vegetation also provides food and shelter for a variety of organisms found on the river. The location and composition of aquatic vegetation in the UMRS is influenced by current velocity, depth, suspended sediments, water chemistry and clarity, water temperature, nutrient availability, and sediment composition as well as other factors (Barko et al. 1986).

The Long Term Resource Monitoring Program (LTRMP) initiated monitoring of aquatic vegetation in 1991 (USFWS 1993). Four pools on the Mississippi River (Pools 4, 8, 13, and 26) and the La Grange Pool of the Illinois River were chosen for aquatic vegetation monitoring (Figure 1). The Wisconsin Department of Natural Resources was responsible for collecting data in Pool 8, UMRS in 1995. The objectives of the vegetation monitoring program included documentation of the distribution of species within selected areas, comparison of present and past distribution, and identification of potential environmental factors influencing distribution of species (Rogers and Owens 1995). Fulfillment of the third objective should suggest direction for focused research to examine plant responses to environmental factors.

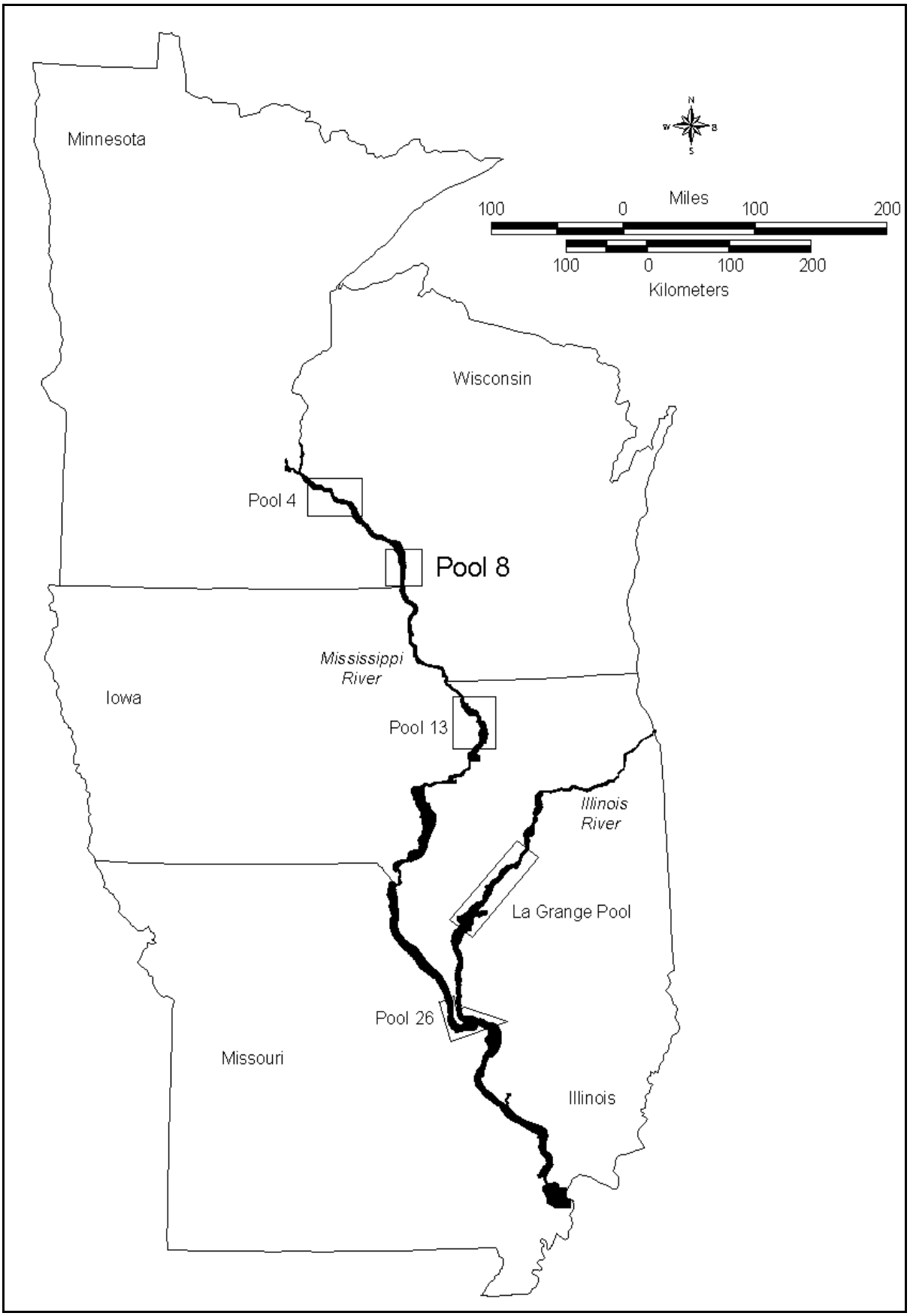

Figure 1. Mainstem of the Upper Mississippi River System and the Long Term Resource Monitoring Program study reaches for submersed aquatic vegetation.

Study Area

Navigation Pool 8 is located between Lock and Dam 8 (Genoa, Wisconsin) and Lock and Dam 7 (Dresbach, Minnesota). It is 38.8 km (23.3 river miles) long and covers about 8,421 ha (20,800 acres). Major tributaries into Pool 8 include the Black, Root, and La Crosse Rivers. Pool 8 has three distinct zones (Swanson and Sohmer 1978). The upper reach retains many pre-dam construction features. High bank islands are adjacent to the main channel with many sloughs in the backwaters. The middle portion contains braided channels as well as small backwater sloughs. The lower area of Pool 8 is a large, open expanse of water.

Five backwaters within Pool 8 were initially chosen for transect monitoring in 1991 (Figure 2). These areas are Target Lake, a Goose Island backwater, Lawrence Lake, Shady Maple, and the Horseshoe area. In subsequent years, three more areas were added: Blue Lake, the Boomerang area, and a Stoddard backwater area. Site selection included various habitat types. Five contiguous backwater areas (Target Lake, Goose Island, Lawrence Lake, Shady Maple, and Horseshoe), two isolated backwater areas (Blue Lake and Stoddard), and one impoundment area (Boomerang) were sampled (Appendix A).

Methods

Transect Survey Method

Two approaches were used to monitor aquatic macrophytes; a rapid assessment technique and an informal survey. The first approach involved setting up transects within selected areas of Pool 8. Areas were chosen based on historical or current presence of submersed vegetation. Transects were placed perpendicular to the shoreline at 50- to 200-m intervals (depending on the size of the backwater). In some backwaters, transects were grouped with open areas between each group. The transects began and ended at either the shore or an emergent bed. The only exception was the interior of Boomerang Island. At this location, the transects bordered the open expanse of the impounded area, therefore 26 sites were sampled along each transect. Upper Lawrence Lake transects were considerably shorter during the summer sampling period due to a dense growth of *Zizania aquatica* L. (wildrice) along the perimeter of the lake. Sites were sampled at 15-m intervals along each transect creating an evenly distributed gridlike pattern.

The sampling procedures were modified from a technique used by Jessen and Lound (1962). At each site, a long-handled thatching rake was used to sample the aquatic macrophytes. The thatching rake had a 15-inch head with 20, 5-inch teeth. A 2-m circle was visualized and one grab was made within each third of the circle for a total of three grabs. Each rake grab sampled approximately 0.1 m^2 of the sediment surface. The rake was lowered to the sediment, twisted 180E and lifted out of the water. All macrophytes on the rake head were identified to species and recorded. After all three casts were made, each species was assigned a rating from one to four. The rating was based on the number of grabs a species appeared on at a sampling site. A rating of four was assigned 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 the amount of visible vegetative cover within the sampling area (1 = 1–25%, 2 = 26–50%, 3 = 51–75%, and 4 = 76–100%). During spring sampling, if floating-leaved species were not visible but were collected on the rake, they were rated with the same method as the submersed macrophytes.

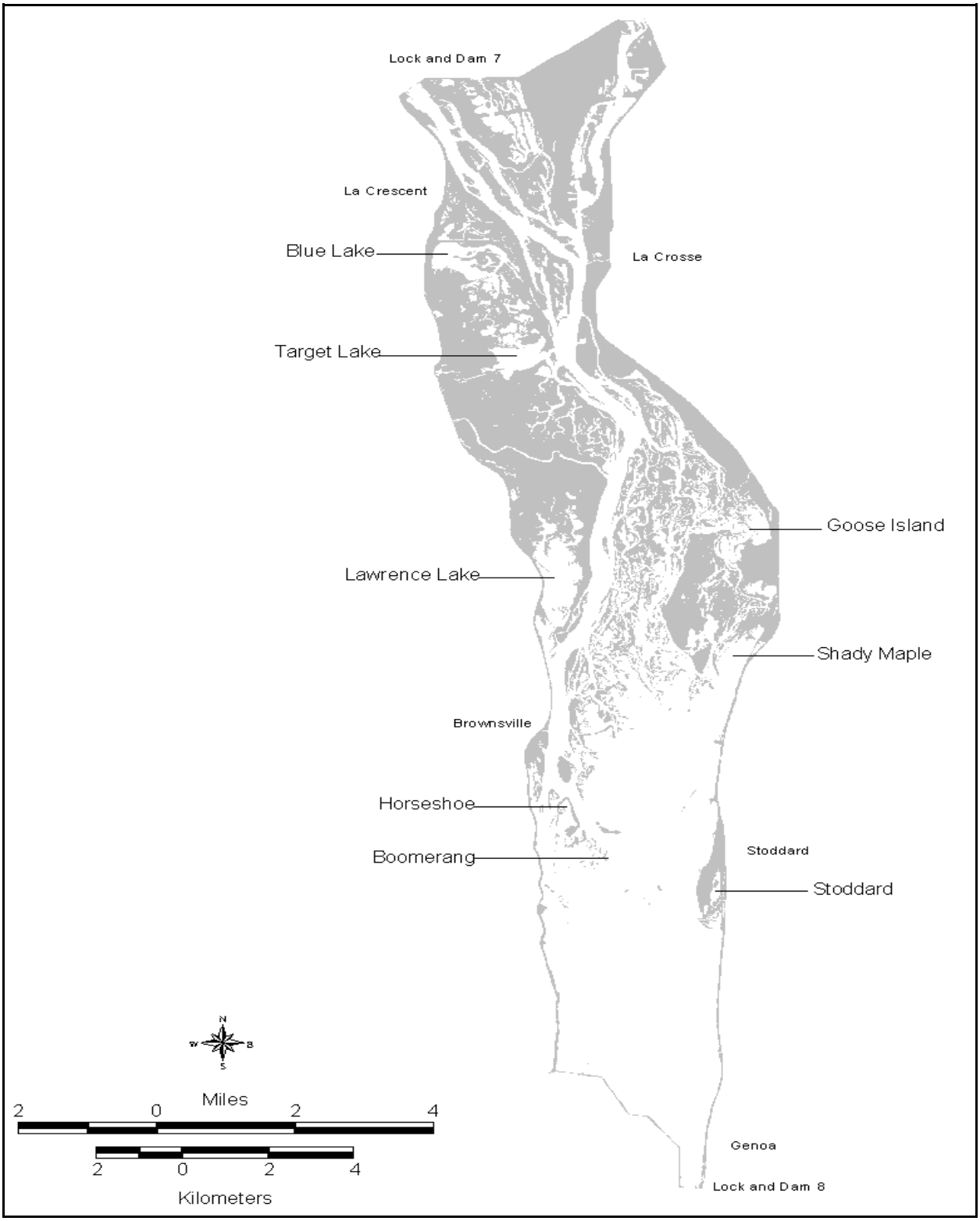

Figure 2. Transect locations in Pool 8, Upper Mississippi River System.

Water depth was measured to the nearest tenth of a meter by using a depth pole. Three broad categories (silt–clay, mostly silt with some sand, mostly sand with some silt) were used to subjectively describe sediments based on visual and tactile characteristics. Transect locations were sampled twice during the growing season to observe seasonal changes in species composition and frequency.

Fassett (1957) and Gleason and Cronquist (1991) were the primary keys used for plant identification. To ensure all the field stations were using the same scientific nomenclature and common names, the U.S. Department of Agriculture's Internet Plant Database (USDA, NRCS 1996) was used as the standard. Three exceptions were made to the database common names. American wildcelery (*Vallisneria americana* Michx.), Eurasian watermilfoil (*Myriophyllum spicatum* L.), and water star grass (*Heteranthera dubia* [Jacq.] MacM.) were used rather than the database common names because they are widely recognized among Mississippi River managers.

At least one sample of each species recorded was collected for reference and archiving. When possible, flowers or fruits were included in the collection. After drying, pressing, mounting, and labeling, specimens were stored at the field station. Two species of narrow-leaved pondweed (*Potamogeton pusillus* L. [small pondweed] and *P. foliosus* Raf. [leafy pondweed]) were not distinguished from each other during field sampling, therefore they were combined during analysis as well.

Statistical Analysis

The frequency of a species was defined as $f_i = j_i / n$ where j_i = the number of sample sites containing species *i* on at least one of the three rake casts, and n = the total number of sample sites. Relative frequency of a species was defined as $rf_i = e_i / Ef$ where e_i = the number of rake grabs for species *i*, and Ef = the number of rake grabs for all species. Species of floating-leaved vegetation were omitted from the relative frequency calculations since our primary concern was associated with changes in submersed vegetation.

The maximum depth of plant growth was defined as the depth of the deepest sampling point containing submersed vegetation. Mean depth was defined as sd/n where sd = the sum of all the plant depths and n = the total number of sites. Mode was the most frequently recorded depth in an area (all transects combined). Mean depth and mode were calculated using only sites containing submersed vegetation. No attempt was made to normalize depth data by elevation or discharge.

To test for significant changes in frequencies for a species between the two sampling periods, a value for *z* was calculated with the following formula:

$$z = p_1 \,!\, p_2 \,/\, \sqrt{pq[(1/n_1)+(1/n_2)]}$$

where p_1 and p_2 are the spring and summer percentages, respectively, of sites containing species *j*, $q = 1 \,!\, p$, and n_1 and n_2 equal the number of sites sampled during the spring and summer sampling period. The value for p was calculated by $p = (j_1 + j_2)/(n_1 + n_2)$ where j_1 and j_2 are the number of occurrences for species *j* during the spring and summer sampling periods, respectively. For each species, *z*-values were calculated by location within the pool. Chi-square tests were used to detect significant changes in the percentage of sites with submersed aquatic vegetation between sampling periods. All analysis was done using the Statistical Analysis System (SAS; SAS Institute, Inc., Cary, North Carolina).

Informal Survey Method

The second approach was an informal survey. It was used to obtain information about the distribution of submersed macrophytes throughout Pool 8. The survey was conducted by boating slowly through Pool 8 looking for beds, sampling with a long-handled rake, and checking for vegetation with a Lowrance X70A depth finder. Aerial photos and bathymetry maps were used to locate areas likely to contain submersed vegetation and survey efforts were concentrated in these zones. Submersed aquatic macrophyte beds that were observed or located by raking or depth finder were qualitatively described. The description included listing species present (including floating-leaved), and estimating bed size, percent plant cover, and relative abundance of species. Relative abundance was estimated by assigning a category to each species (rare, common, and abundant). Depth and sediment type were recorded from the center of the bed. A Universal Transverse Mercator coordinate was also taken from the center of the bed by a Rockwell PLGR+ global positioning system receiver (NAD27 datum). As much of the pool as possible was covered between June 15–July 14.

Results and Discussion

Transect Survey Method

Sampling was conducted twice during the 1995 growing season to record seasonal changes within each location: May 15 to June 7 (spring) and July 20 to August 23 (summer). A total of 1,291 sites (spring) and 1,250 sites (summer) were sampled along 45 transects in eight backwaters (Appendix A). Sixteen species from 10 families were recorded during transect sampling: 13 submersed species and 3 floating-leaved species (Table 1). One species, *Myriophyllum sibiricum* Komarov, was found during the informal survey but was not recorded during transect sampling.

Table 1. Species recorded during transect and informal sampling in Pool 8, Upper Mississippi River System, 1995.

Family	Species	Common name	Life form
Ceratophyllaceae	*Ceratophyllum demersum* L.	coon's tail	submersed
Haloragidaceae	*Myriophyllum sibiricum* Komarov[a]	shortspike watermilfoil	submersed
Haloragidaceae	*Myriophyllum spicatum* L.	Eurasian watermilfoil	submersed
Hydrocharitaceae	*Elodea canadensis* Michx.	Canadian waterweed	submersed
Hydrocharitaceae	*Vallisneria americana* Michx.	American wildcelery	submersed
Lentibulariaceae	*Utricularia macrorhiza* Leconte.	common bladderwort	submersed
Najadaceae	*Najas flexilis* (Willd.) Rostk. & Schmidt	nodding waternymph	submersed
Nelumbonaceae	*Nelumbo lutea* Willd.	American lotus	floating leaf
Nymphaeaceae	*Nuphar lutea* (L.) Sm.	yellow pondlily	floating leaf
Nymphaeaceae	*Nymphaea odorata* Aiton	American white waterlily	floating leaf
Pontederiaceae	*Heteranthera dubia* (Jacq.) MacM.	water star grass	submersed
Potamogetonaceae	*Potamogeton crispus* L.	curly pondweed	submersed
Potamogetonaceae	*Potamogeton nodosus* Poir.	longleaf pondweed	submersed
Potamogetonaceae	*Potamogeton pectinatus* L.	sago pondweed	submersed
Potamogetonaceae	*Potamogeton pusillus* L./*foliosus* Raf.[b]	small/leafy pondweed	submersed
Potamogetonaceae	*Potamogeton zosteriformis* Fern.	flatstem pondweed	submersed
Zannichelliaceae	*Zannichellia palustris* L.	horned pondweed	submersed

[a]Recorded only during informal survey.

[b]Species were combined because of difficulty in differentiating without flowers or fruits.

Lawrence Lake contained the highest number of species in both spring (11) and summer (15; Table 2). The Boomerang Island area had the lowest number of species (three and four, respectively). Six of the eight backwaters increased in the number of submersed species recorded from spring to summer.

Table 2. Total number of species recorded at each location by sampling period during transect sampling in Pool 8, Upper Mississippi River System, 1995.

	Number of species[a]		
Location	**Spring**	**Summer**	**Total**
Blue Lake	6:2	7:2	7:2
Target Lake	7:1	10:2	10:2
Goose Island area	7:1	10:2	10:2
Lawrence Lake	8:3	12:3	12:3
Shady Maple	4:1	7:2	7:2
Horseshoe Island area	4:0	6:2	7:2
Boomerang Island area	3:0	2:2	4:2
Stoddard area	5:1	5:2	5:2
Total for Pool 8	10:3	12:3	13:3

[a]Submersed:floating leaf.

The two isolated backwater areas (Blue Lake and Stoddard) had the highest percentage of submersed vegetated sites in both spring and summer (>94%; Table 3). Shady Maple had the lowest percentage of submersed vegetated sites (15%) in spring, whereas the Boomerang Island area had the lowest in summer (13%). Three backwaters showed a significant increase in submersed vegetated sites from spring to summer (Target Lake, Goose Island area, and Shady Maple), while one had a significant decrease (Boomerang Island area). Overall, Pool 8 showed a significant increase in submersed vegetated sites. Significance was based on chi-square tests ($P < 0.05$).

Table 3. Frequency of submersed vegetated sites by location and sampling period for transect sampling in Pool 8, Upper Mississippi River System, 1995.

Location	***n*[a]**	**Spring**	***n*[a]**	**Summer**
Blue Lake	124	0.95	118	0.99
Target Lake	291	0.51	298	0.73 *
Goose Island area	118	0.29	113	0.62 *
Lawrence Lake	422	0.74	386	0.68
Shady Maple	102	0.15	104	0.29 *
Horseshoe Island area	82	0.21	80	0.26
Boomerang Island area	104	0.47	104	0.13 *
Stoddard area	48	1.00	47	0.98
Pool 8	1,291	0.57	1,250	0.62 *

[a]*n* = number of sites sampled.

*Chi-square test was used to determine significant seasonal differences (probability values less than 0.05 were considered significant).

Ceratophyllum demersum L. (coon's tail) was the most frequent species recorded along transects in Pool 8 for both spring (34%) and summer (48%) sampling periods (Appendix B). It had the greatest frequency and relative frequency in four of eight backwaters in spring and five of eight in summer (Appendixes B and C). Three species—*Potamogeton pectinatus* L. (sago pondweed), *P. crispus* L. (curly pondweed), and *Nymphaea odorata* Aiton. (white waterlily)—were recorded in all eight backwaters. *Vallisneria americana* (American wildcelery), an important food source for diving ducks, was found in only one backwater at a frequency less than 0.01. The transects may be located in areas not suitable for this species since it was recorded elsewhere in Pool 8. *Nymphaea odorata* (white waterlily) was the most frequently recorded floating-leaved species in six of eight backwaters in spring and five of eight in summer.

The *z*-test was used to detect significant increases or decreases in species frequency from the spring to summer sampling period. Nine species showed a significant change (either an increase or a decrease) in at least one backwater (Table 4). *Potamogeton crispus* showed a significant decrease in frequency in four of the eight backwaters. The literature documents *P. crispus* as an early season plant that has its peak biomass in spring and begins to die back in midsummer (Sastroutomo 1981; Nichols and Shaw 1986). *Nelumbo lutea* Willd. (American lotus) showed the opposite effect with a significant increase from spring to summer in all six backwaters where it was recorded.

Table 4. Number of locations where a significant increase or decrease in species frequency occurred between the spring and summer sampling periods in Pool 8, Upper Mississippi River System, 1995. Significance is based on *z*-tests. Locations are reported in Appendix B.

	Number of locations		
Species	Significant decrease	No significant change	Significant increase
Ceratophyllum demersum	0	3	4
Elodea canadensis	0	5	0
Heteranthera dubia	0	5	0
Myriophyllum spicatum	1	4	1
Najas flexilis	0	1	4
Nelumbo lutea	0	0	6
Nuphar lutea	0	3	0
Nymphaea odorata	0	5	3
Potamogeton crispus	4	4	0
Potamogeton nodosus	0	4	0
Potamogeton pectinatus	1	4	3
Potamogeton pusillus/foliosus	1	5	0
Potamogeton zosteriformis	0	3	0
Utricularia macrorhiza	0	1	2
Vallisneria americana	0	1	0
Zannichellia palustris	0	1	0

The maximum depth at which submersed plants were recorded was in Lawrence Lake (2.0 m in spring, 1.7 m in summer; Table 5). The most frequently recorded depths (mode) during transect sampling in Pool 8 were 0.8 m (spring) and 0.7 m (summer).

Table 5. Maximum, mean, and mode depth of submersed plants by location and time period for transect sampling in Pool 8, Upper Mississippi River System, 1995.

Location	*n*[a]		Maximum		Mean		Mode	
	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer
Blue Lake	118	117	1.0	0.8	0.7	0.6	0.8	0.6
Target Lake	147	217	1.9	1.1	1.5	0.8	1.3	0.7
Goose Island area	34	70	1.2	0.6	1.1	0.4	1.1	0.5
Lawrence Lake	310	264	2.0	1.7	1.0	1.0	1.0	0.7
Shady Maple	15	30	1.3	1.0	0.9	0.5	1.0	0.2
Horseshoe Island area	17	21	0.7	0.7	0.4	0.3	0.2	0.1
Boomerang Island area	49	13	0.9	1.5	0.6	0.5	0.6	0.4
Stoddard area	48	46	1.1	0.9	0.7	0.6	0.7	0.6
Pool 8	738	778	2.0	1.7	1.0	0.7	0.8	0.7

[a]*n* = number of sites.

Informal Survey Method

Two hundred forty-three beds were located in Pool 8 during the informal survey. Seventeen species from 10 families were recorded: 14 submersed species and 3 floating-leaved species (Table 1). For analysis, Pool 8 was divided into three reaches. The upper reach was located above river mile (RM) 695, the middle reach was between RM 695 and RM 690, and the lower reach was below RM 690. The middle reach contained the highest number of submersed species (13; Table 6); however, the number of submersed species in the other two reaches was only slightly less (11 species each). The number of species is reported to broadly observe differences between the reaches. It is not meant to indicate that these are the only species that occur in Pool 8.

Table 6. Number of species recorded, by reach, during the informal survey in Pool 8, Upper Mississippi River System, 1995 (upper = above river mile [RM] 695, middle = between RM 695 and RM 690, lower = below RM 690).

Reach	Number of species[a]
Upper	11:3
Middle	13:3
Lower	11:2
Pool 8	14:3

[a]Submersed:floating leaf.

Potamogeton pectinatus was the most frequently recorded species in all three reaches (Table 7). *Vallisneria americana* occurred in the middle and lower reaches at frequencies of 0.26 and 0.38, respectively. The most frequent floating-leaved species was *Nelumbo lutea* in the upper and lower reaches and *Nymphaea odorata* in the middle reach. The maximum depth at which submersed plants were recorded for the informal survey was 1.3 m.

Table 7. Frequency of species recorded, by reach, during the informal survey in Pool 8, Upper Mississippi River System, 1995 (upper = above river mile [RM] 695, middle = between RM 695 and RM 690, lower = below RM 690).

Species	Upper (n^a = 44)	Middle (n^a = 123)	Lower (n^a = 76)	Pool 8 (n^a = 243)
Ceratophyllum demersum	0.41	0.43	0.09	0.32
Elodea canadensis	0.18	0.18	0.08	0.15
Heteranthera dubia	—	0.17	0.30	0.18
Myriophyllum sibiricum	0.02	—	—	<0.01
Myriophyllum spicatum	0.27	0.26	0.37	0.30
Najas flexilis	0.02	0.07	—	0.04
Nelumbo lutea	0.41	0.37	0.20	0.32
Nuphar lutea	0.07	0.02	—	0.02
Nymphaea odorata	0.34	0.69	0.17	0.47
Potamogeton crispus	0.41	0.53	0.46	0.49
Potamogeton nodosus	0.23	0.85	0.50	0.63
Potamogeton pectinatus	0.89	0.93	0.97	0.94
Potamogeton pusillus/foliosus	0.27	0.32	0.08	0.23
Potamogeton zosteriformis	0.18	0.26	0.04	0.18
Utricularia macrorhiza	0.05	0.01	—	0.01
Vallisneria americana	—	0.26	0.38	0.25
Zannichellia palustris	—	0.10	0.04	0.06

[a]*n* = number of sites sampled.

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Appendix A. Location description, river mile, number of transects, distance between transects and sites, number of sites, and sampling dates of aquatic vegetation monitoring conducted during the 1995 sampling season for Pool 8, Upper Mississippi River System.

Location	Approximate river mile	Habitat	Number of transects	Distance between transects (m)	Number of sites[a]	Sampling dates
Blue Lake	697	isolated backwater	3	100	124:118	5/31:8/14, 16
Target Lake	696	contiguous backwater	11	50:100	291:298	5/15–17, 22:7/20, 25–28
Goose Island area	692	contiguous backwater	5	100	118:113	5/23:8/8
Lawrence Lake	691	contiguous backwater	10	200	422:386	5/30, 6/1, 5–7: 8/17–18, 21–23
Shady Maple	690	contiguous backwater	3	100	102:104	5/26:8/9
Horseshoe area	687	contiguous backwater	5	100	82:80	5/25:8/4
Boomerang area	686	impounded	4	100	104:104	5/24:8/1
Stoddard area	684	isolated backwater	4	100	48:47	5/16:8/3

[a]Spring:summer.

Appendix B. Frequency of species by location and sampling period in Pool 8, Upper Mississippi River System, 1995. Significant increases or decreases in frequency of species are based on *z*-tests (*). Significance level is greater than 1.96 at the 0.05 probability level (all *z*-values are absolute).

Species	Blue Lake		Target Lake		Goose Island area	
	Spring (n^a = 124)	Summer (n^a = 118)	Spring (n^a = 291)	Summer (n^a = 298)	Spring (n^a = 118)	Summer (n^a = 113)
Ceratophyllum demersum	0.88	0.99 *	0.35	0.61 *	0.10	0.35 *
Elodea canadensis	0.01	0.03	0.03	0.06	—	0.01
Heteranthera dubia	—	—	—	<0.01	—	0.01
Myriophyllum spicatum	—	—	0.02	<0.01	0.08	0.29 *
Najas flexilis	—	0.17 *	—	0.04 *	—	0.02
Nelumbo lutea	—	—	—	0.14 *	—	0.21 *
Nuphar lutea	0.02	0.03	—	—	—	—
Nymphaea odorata	0.81	0.86	0.01	0.32 *	0.11	0.37 *
Potamogeton crispus	0.39	0.16 *	0.01	0.02	0.01	0.04
Potamogeton nodosus	—	—	—	0.01	0.02	0.06
Potamogeton pectinatus	0.06	0.16 *	0.27	0.44 *	0.12	0.10
Potamogeton pusillus/foliosus	0.73	0.41 *	0.11	0.14	0.01	0.04
Potamogeton zosteriformis	—	—	—	—	0.02	0.04
Utricularia macrorhiza	0.01	0.09 *	0.01	0.02	—	—
Vallisneria americana	—	—	—	—	—	—
Zannichellia palustris	—	—	—	—	—	—

Appendix B. Continued.

Species	Lawence Lake		Shady Maple		Horseshoe area	
	Spring (n^a = 422)	Summer (n^a = 386)	Spring (n^a = 102)	Summer (n^a = 104)	Spring (n^a = 82)	Summer (n^a = 80)
Ceratophyllum demersum	0.42	0.55 *	0.01	0.03	—	0.01
Elodea canadensis	0.02	0.02	—	—	—	—
Heteranthera dubia	—	0.01	—	0.01	—	—
Myriophyllum spicatum	0.36	0.26 *	0.04	0.09	0.01	0.01
Najas flexilis	—	0.05 *	—	—	—	0.06 *
Nelumbo lutea	0.01	0.09 *	—	0.05 *	—	0.21 *
Nuphar lutea	0.09	0.11	—	—	—	—
Nymphaea odorata	0.40	0.47 *	0.01	0.01	—	0.03
Potamogeton crispus	0.23	0.06 *	0.02	0.02	0.02	0.04
Potamogeton nodosus	0.01	0.01	—	0.01	—	—
Potamogeton pectinatus	0.23	0.26	0.08	0.18 *	0.17	0.24
Potamogeton pusillus/foliosus	0.04	0.05	—	0.03	—	—
Potamogeton zosteriformis	0.02	0.01	—	—	—	0.01
Utricularia macrorhiza	—	0.01 *	—	—	—	—
Vallisneria americana	—	<0.01	—	—	—	—
Zannichellia palustris	—	—	—	—	0.01	—

Appendix B. Continued.

Species	Boomerang Island area		Stoddard area		Pool 8	
	Spring (n^a = 104)	Summer (n^a = 104)	Spring (n^a = 48)	Summer (n^a = 47)	Spring (n^a = 1,291)	Summer (n^a = 1,250)
Ceratophyllum demersum	—	—	0.94	0.91	0.34	0.48 *
Elodea canadensis	—	—	0.77	0.79	0.04	0.05
Heteranthera dubia	—	0.01	—	—	—	<0.01 *
Myriophyllum spicatum	0.01	—	—	—	0.13	0.12
Najas flexilis	—	—	—	—	—	0.05 *
Nelumbo lutea	—	0.19 *	—	—	<0.01	0.11 *
Nuphar lutea	—	—	—	0.02	0.03	0.04
Nymphaea odorata	—	0.02	0.27	0.36	0.23	0.36 *
Potamogeton crispus	0.15	— *	0.54	0.06 *	0.15	0.05 *
Potamogeton nodosus	—	—	—	—	<0.01	0.01 *
Potamogeton pectinatus	0.33	0.12 *	0.08	0.11	0.20	0.25 *
Potamogeton pusillus/foliosus	—	—	0.06	0.09	0.11	0.10
Potamogeton zosteriformis	—	—	—	—	0.01	0.01
Utricularia macrorhiza	—	—	—	—	<0.01	0.02 *
Vallisneria americana	—	—	—	—	—	<0.01
Zannichellia palustris	—	—	—	—	<0.01	—

[a]*n* = number of sites sampled.

Appendix C. Relative frequency of species (does not include floating-leaved species) by location and sampling period in Pool 8, Upper Mississippi River System, 1995.

	Blue Lake		Target Lake		Goose Island area		Lawrence Lake		Shady Maple	
Species	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**
Ceratophyllum demersum	0.48	0.63	0.46	0.52	0.28	0.41	0.36	0.53	0.05	0.07
Elodea canadensis	<0.01	0.01	0.03	0.04	—	0.01	0.01	0.01	—	—
Heteranthera dubia	—	—	—	<0.01	—	0.01	—	<0.01	—	0.02
Myriophyllum spicatum	—	—	0.02	<0.01	0.19	0.30	0.30	0.17	0.25	0.23
Najas flexilis	—	0.06	—	0.03	—	0.02	—	0.05	—	—
Potamogeton crispus	0.15	0.07	0.01	0.01	0.02	0.02	0.14	0.03	0.10	0.04
Potamogeton nodosus	—	—	—	<0.01	0.04	0.08	0.01	<0.01	—	0.02
Potamogeton pectinatus	0.02	0.06	0.34	0.29	0.42	0.07	0.14	0.17	0.60	0.57
Potamogeton pusillus/foliosus	0.35	0.14	0.13	0.11	0.02	0.05	0.03	0.03	—	0.06
Potamogeton zosteriformis	—	—	—	—	0.04	0.03	0.01	<0.01	—	—
Utricularia macrorhiza	<0.01	0.03	0.01	0.01	—	—	—	0.01	—	—
Vallisneria americana	—	—	—	—	—	—	—	<0.01	—	—
Zannichellia palustris	—	—	—	—	—	—	—	—	—	—

Appendix C. Continued.

	Horeshoe Island area		Boomerang Island area		Stoddard area		Pool 8	
Species	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**
Ceratophyllum demersum	—	0.04	—	—	0.45	0.52	0.39	0.52
Elodea canadensis	—	—	—	—	0.31	0.38	0.04	0.04
Heteranthera dubia	—	—	—	0.06	—	—	—	<0.01
Myriophyllum spicatum	0.03	0.02	0.01	—	—	—	0.14	0.08
Najas flexilis	—	0.25	—	—	—	—	—	0.04
Potamogeton crispus	0.07	0.10	0.19	—	0.21	0.03	0.13	0.03
Potamogeton nodosus	—	—	—	—	—	—	<0.01	0.01
Potamogeton pectinatus	0.86	0.57	0.80	0.94	0.02	0.03	0.18	0.18
Potamogeton pusillus/foliosus	—	—	—	—	0.01	0.04	0.11	0.07
Potamogeton zosteriformis	—	0.02	—	—	—	—	0.01	<0.01
Utricularia macrorhiza	—	—	—	—	—	—	<0.01	0.01
Vallisneria americana	—	—	—	—	—	—	—	<0.01
Zannichellia palustris	0.03	—	—	—	—	—	<0.01	—

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13. ABSTRACT (Maximum 200 words) The Long Term Resource Monitoring Program conducted monitoring of submersed aquatic vegetation in Pool 8 of the Upper Mississippi River System in 1995. A rapid assessment technique was used to sample 45 transects in eight backwaters during two sampling windows (spring and summer). Sixteen species from 10 families were recorded. The number of species increased from spring (13) to summer (15). *Zannichellia palustris* L. was found only during the spring sampling period, while *Vallisneria americana* L., *Heteranthera dubia* (Jacq.) MacM., and *Najas flexilis* (Willd.) Rostk. & Schmidt were found only in summer. Lawrence Lake had the most species (15), and the Boomerang Island area had the least (6). Frequency of vegetated sites increased from spring to summer in Pool 8. The two isolated backwater areas had the highest percentage of submersed, vegetated sites. The most frequently recorded submersed species during transect sampling were *Ceratophyllum demersum* L. and *Potamogeton pectinatus* L. An informal survey of Pool 8 was conducted between the two transect sampling windows. Two hundred forty-three submersed plant beds were located. One species, *Myriophyllum sibiricum* Komarov, was found only during the informal survey in an isolated backwater area. *Potamogeton pectinatus* and *P. nodosus* Poir. were the most frequently recorded species.			
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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.