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2001-P001

1998 Annual Status Report

Submersed and Floating-leaf Vegetation
in Pools 4, 8, 13, and 26 and La Grange Pool
of the Upper Mississippi River System

May 2001

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1998 Annual Status Report

Submersed and Rooted Floating–leaf Vegetation in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

by

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May 2001

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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 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 stratified random sampling surveys conducted in 1998 by field station personnel under the direction of the UMESC. Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River were surveyed. This report satisfies, for 1998, 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 for 1998. This report was developed with funding provided by the Long Term Resource Monitoring Program.

1998 Annual Status Report

Submersed and Rooted Floating–Leaf Vegetation in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

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Abstract: Aquatic vegetation was investigated in five navigation pools in the Upper Mississippi River System using a new protocol named "stratified random sampling" or SRS protocol for the first time in 1998. The five pools were Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River. The results on submersed aquatic vegetation and rooted floating–leaf aquatic vegetation were summarized in this report. The percent frequencies of submersed aquatic vegetation in shallow water areas (≤ 3 m deep at flat-pool condition) in the five pools were 36.6%, 47.6%, 42%, 6.1%, and 0%, respectively. The aquatic area strata that were directly influenced by the flow in the main channel, such as the main channel borders and secondary channels, had lower percent frequencies of submersed aquatic vegetation than the aquatic area strata that were less directly influenced by the flow in the main channel, such as the contiguous and isolated backwaters. The percent covers of rooted floating–leaf vegetation were 4.1%, 7.5%, 6.5%, 0.9%, and 0%. The majority of aquatic vegetation that was recorded in Pool 26 was from one isolated backwater area. Aquatic vegetation was not recorded at any of the sampling sites in La Grange Pool.

Key words: Annual report, aquatic, floating–leaf, Illinois River, La Grange, LTRMP, Mississippi River, submersed vegetation.

Introduction

Aquatic vegetation in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River of the Upper Mississippi River System (UMRS) was sampled using a new protocol named "stratified random sampling" or SRS for the first time in 1998. The objective of the sampling was to accurately characterize the quantity and distribution of aquatic macrophytes in individual aquatic area strata as well as in the entire pools. Although emergent macrophytes, filamentous alga, and duckweeds were included in the investigation, they are not reported in this document because our focus was on submersed and rooted floating–leaf vegetation. However, the entire set of field data is available on the Internet hosted by the U.S. Geological Survey Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin (http://www.umesc.er.usgs.gov/).

Study Areas

Navigation Pool 4 is 73.3 km (44 river miles) long and includes 14,700 ha (36,300 acres) of aquatic habitat. It is 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. 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. The shallow water areas are divided into nine strata (Table 1; Figure 1) in sampling and analysis.

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. The shallow water areas are divided into five strata (Table 1; Figure 2) for sampling and analysis.

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)

Table 1. Strata of shallow water areas (≤3 m deep at flat-pool condition) and the target number of sites sampled in 1998.

Stratum description	Stratum numeric code	Stratum letter code	Pool 4	Pool 8	Pool 13	Pool 26	La Grange Pool
Main channel border - Illinois River	1502	MCB-I	–	–	–	50	–
Main channel border	1503	MCB	–	70	70	140	120
Secondary channel	1504	SC	–	100	70	90	40
Main channel border – upper Pool 4	1505	MCB-U	10	–	–	–	–
Main channel border – lower Pool 4	1506	MCB-L	50	–	–	–	–
Secondary channel – upper Pool 4	1507	SC-U	49	–	–	–	–
Secondary channel – lower Pool 4	1508	SC-L	71	–	–	–	–
Contiguous backwater	1510	BWC	–	175	170	50	190
Contiguous backwater – upper Pool 4	1511	BWC-U	75	–	–	–	–
Contiguous backwater – lower Pool 4	1512	BWC-L	160	–	–	–	–
Lake Pepin – upper	1513	TDL-U	65	–	–	–	–
Lake Pepin – lower	1514	TDL-L	35	–	–	–	–
Impounded	1520	IMP	–	175	210	30	–
Isolated backwater	1530	BWI	35	30	30	30	200
Isolated backwater – Illinois River	1531	BWI	–	–	–	160	–
Total			550	550	550	550	550

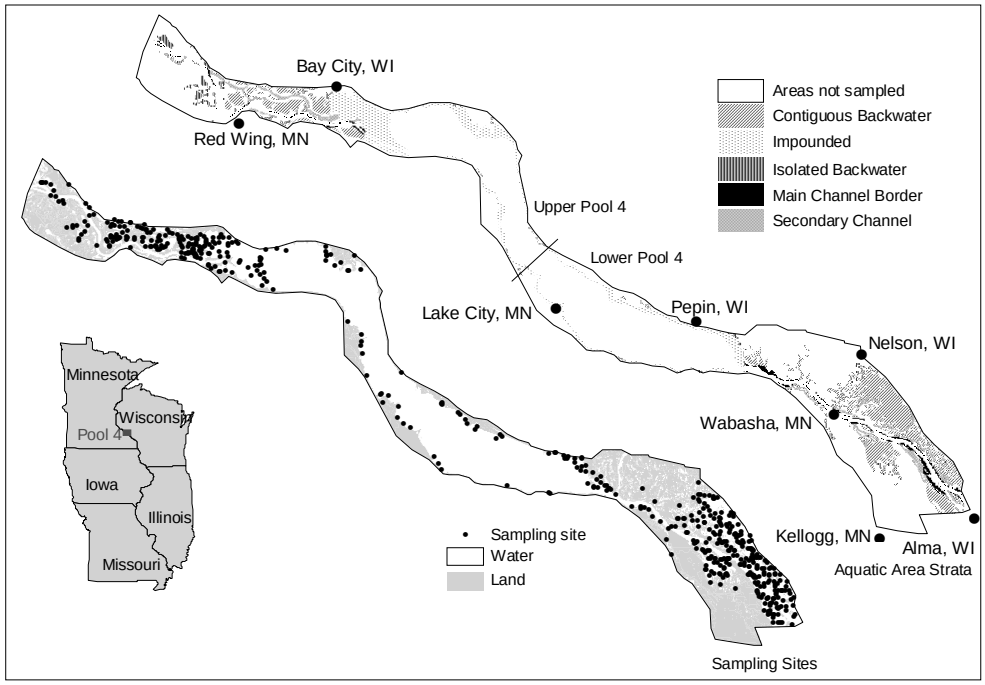

Figure 1. Sampling sites and aquatic area strata in Pool 4, Upper Mississippi River System, 1998.

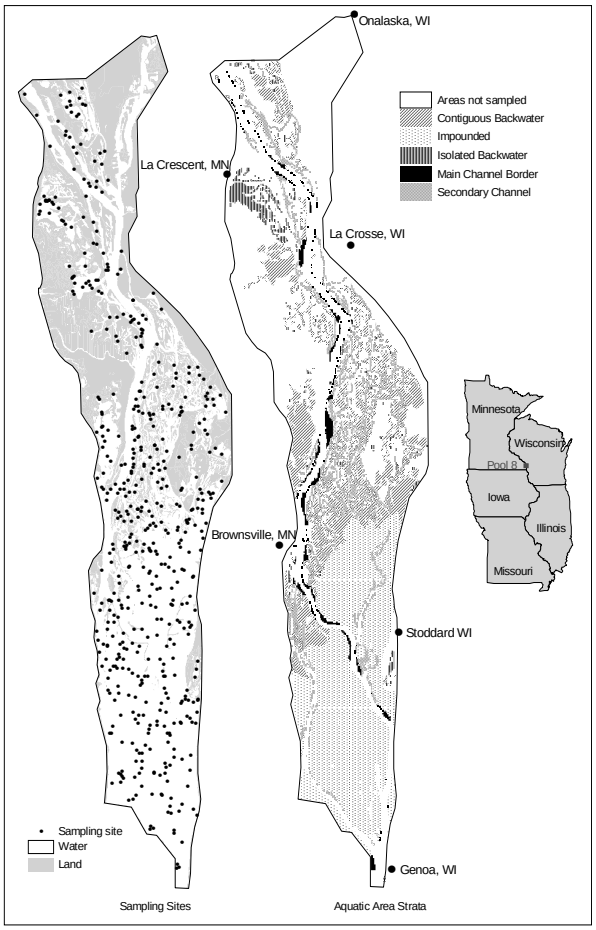

Figure 2. Sampling sites and aquatic area strata in Pool 8, Upper Mississippi River System, 1998.

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. The shallow water areas are divided into five strata (Table 1; Figure 3) for sampling and analysis.

The 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 (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 so as to decrease sedimentation and allow management for waterfowl. Likewise, many of the secondary channels of the Mississippi River are isolated from the river on the up-stream side to create backwaters

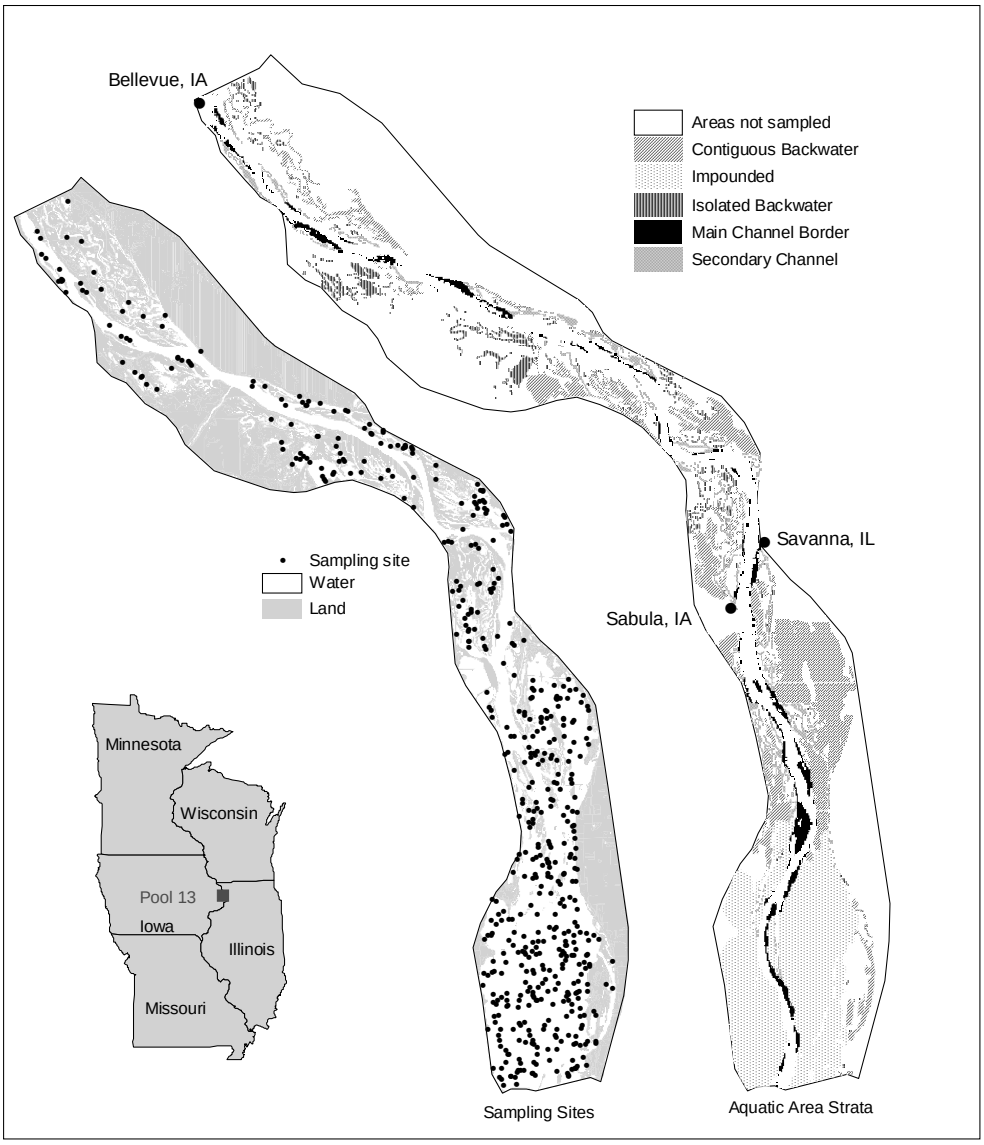

Figure 3. Sampling sites and aquatic area strata in Pool 13, Upper Mississippi River System, 1998.

into seven strata (Table 1; Figure 4) in sampling and analysis.

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 to enhance waterfowl habitat management. Major tributaries include the Sangmon, Mackinaw, and LaMoine Rivers. The shallow water areas are divided into four strata (Table 1; Figure 5) in sampling and analysis.

Methods

Sampling procedures are described in detail in Yin et al. (2000). A brief description of the overall design follows.

Stratification

Sampling sites were distributed in shallow water areas where water depth was ≤3 m deep at flat-pool condition. Deeper water areas were assumed not to

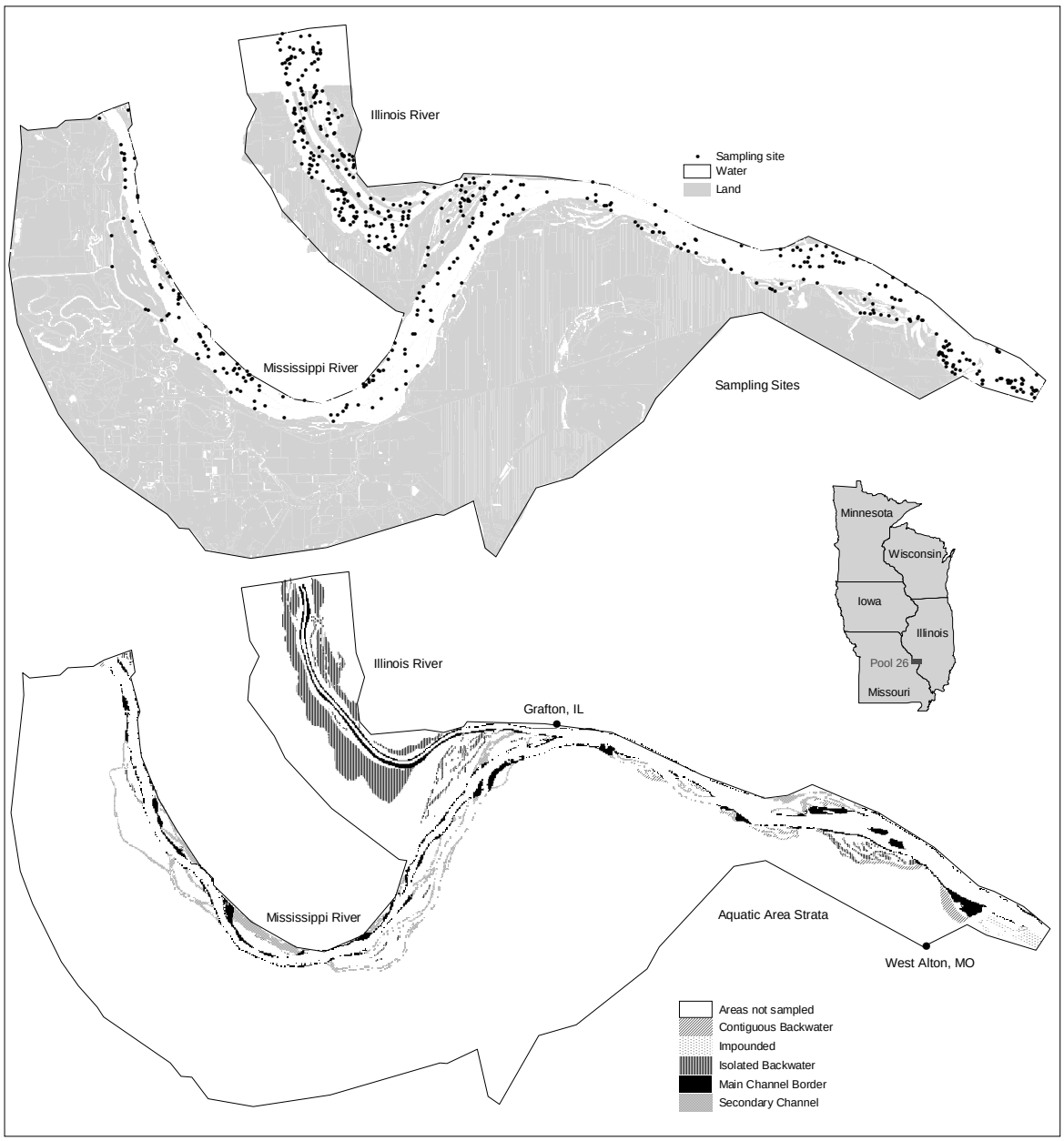

Figure 4. Sampling sites and aquatic area strata in Pool 26, Upper Mississippi River System, 1998.

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 (Table 1) 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 sites because of safety concerns and accessibility difficulties.

Site Selection

Sites to be investigated were selected from a computer program using a random number generator. A 50- $\times$ 50-m grid was generated and overlaid onto the stratified aquatic areas. Nodes of the grid were geo-spatially registered (Universal Transverse

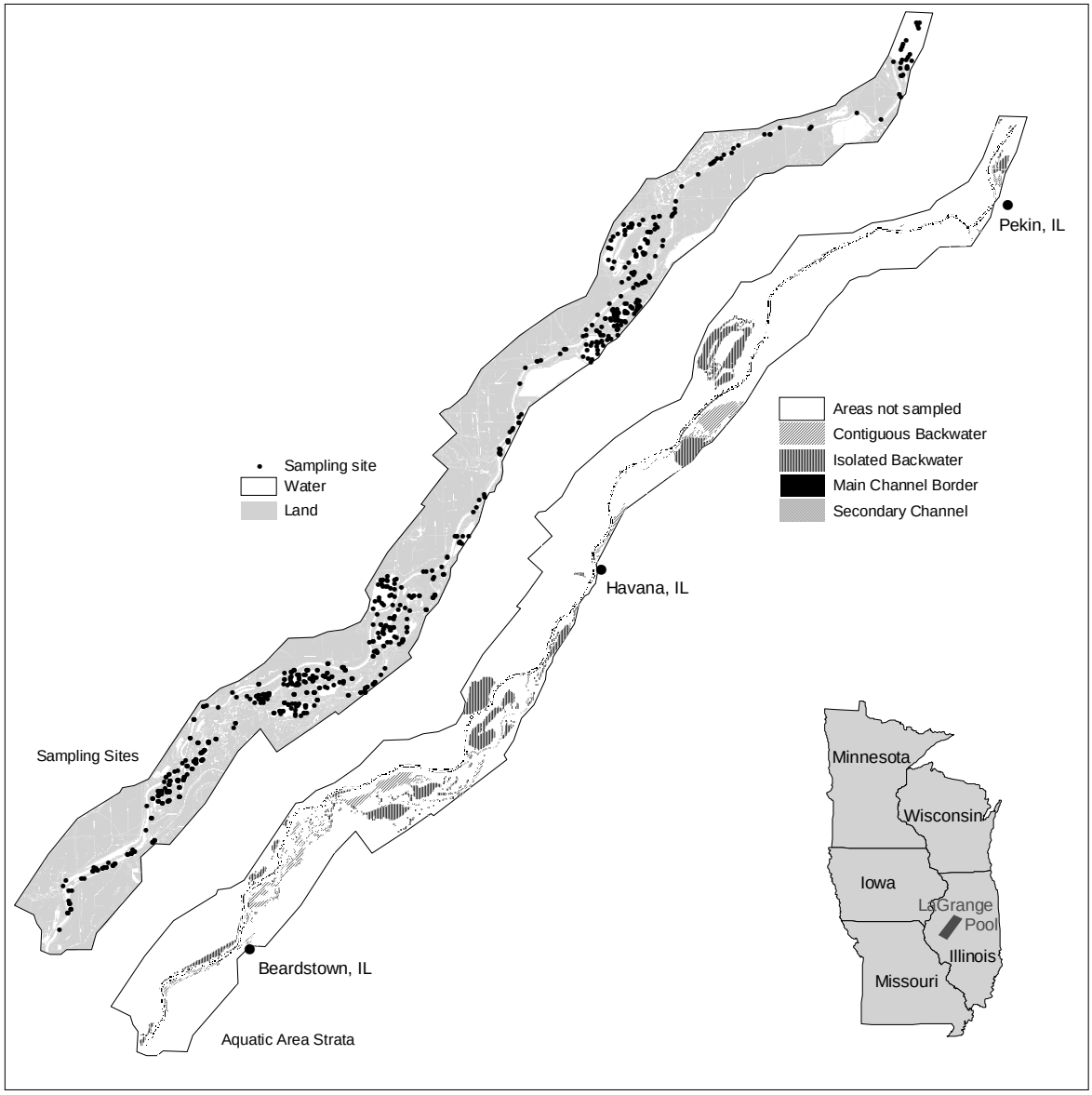

Figure 5. Sampling sites and aquatic area strata in La Grange Pool, Upper Mississippi River System, 1998.

Mercator coordinates), and nodes that fell in the sampling strata were eligible for selection as sites.

Equipment and Definitions

Submersed aquatic vegetation was collected using a long-handled, double-headed rake (Figure 6) 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

Figure 6. Vegetation collecting rake.

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/life forms: submersed and rooted floating–leaf.

Site and Subsampling Areas

Most sites were investigated with the field crew standing in a 5-m (16-ft) boat or an airboat. Each site was represented by a 2-m wide buffer, about 44 m^2 in area, extending off the perimeter of the boat. Six subsampling areas were clustered at each site; each of them was an imaginary (no marked boundary) rectangle of 1.5 m long and 0.36 m wide (the width of the rake head). Four of the subsampling areas were located off the corners of the boat and the other two were located off the left and right sides (Figure 7).

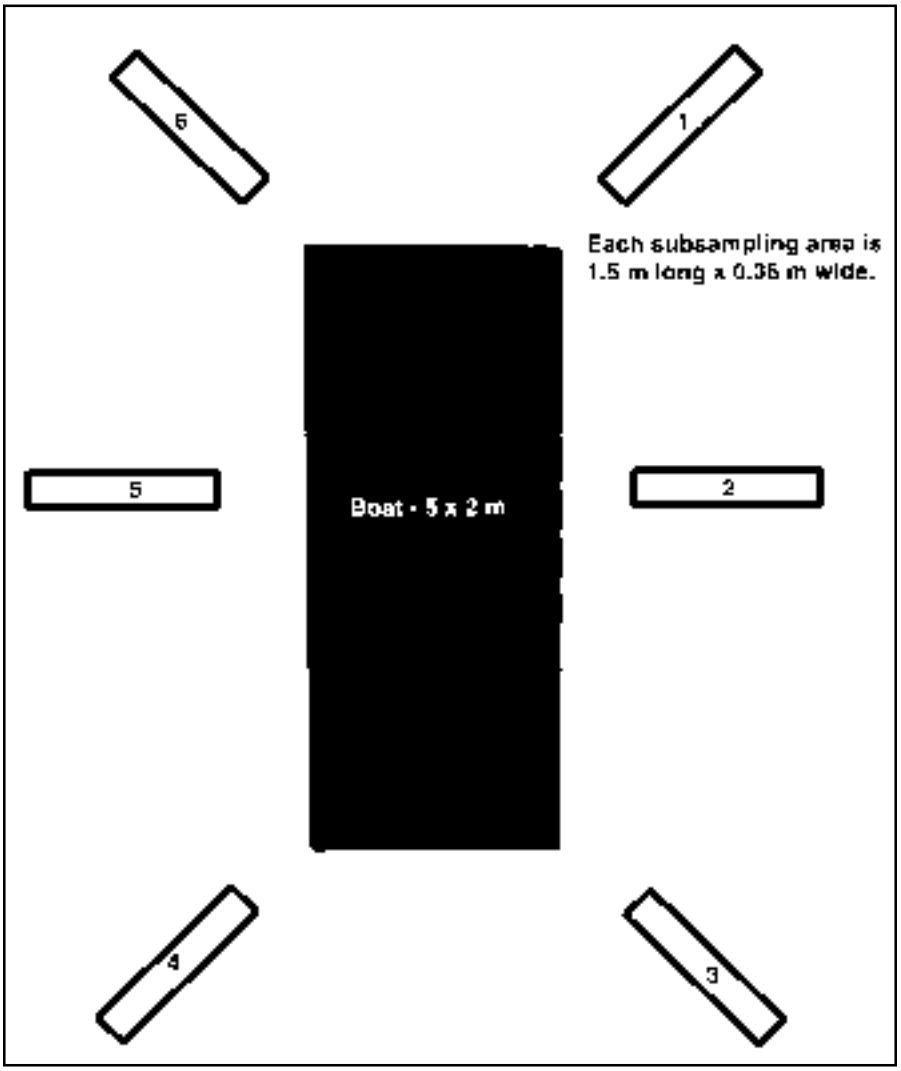

Figure 7. Placement of the six subsampling areas around the boat.

Navigation to Sampling Sites

The field crew navigated in a boat 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.

Sampling and Data Recording

Individual species and different life forms of aquatic vegetation 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 based on their thickness on the rake teeth (Table 2). When present, rooted floating–leaf and emergent species were given a percent cover rating (Table 3). 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 (Appendix) are based on those found in the U.S. Department of Agriculture's

Table 2. Plant 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

Table 3. Vegetation cover ratings

Percent cover	Cover rating
81–100	5
61–80	4
41–60	3
21–40	2
1–20	1
None	0

PLANTS Database on the Internet (http://plants.usda.gov/plants/).

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.

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

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

$$(\overline{F} = \frac{\sum_{j=1}^{m} F_j * S_j}{\sum_{j=1}^{m} S_j})$$

where m is the total number of strata, F 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/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:

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

where V_i is the presence/absence (1,0) and R_i is the plant density ranking (0,1,2,3,4,5) data for the i^{th} subsampling areas at the site (i=1,2,3,4,5,6). Data are treated before computation so that V_i=1 if R_i>=1 and, vice versa, R_i>=1 if V_i=1. The abundance index for a stratum is computed as the simple average of all its sites $(A = \frac{\sum_{j=1}^{n} A_j}{n})$. The abundance index for a pool is computed as the average of all shallow water strata, weighted by acreage:

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

where m is the total number of strata, 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:

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

where m is the total number of sites in the stratum, L_j is the cover rating at individual sites, and A is the mid-point of the corresponding percent cover (Table 3). Percent cover in a pool is computed as the average of all shallow water strata, weighted by acreage:

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

where m is the total number of strata, C_j is percent cover in stratum j, and S_j is the acreage of stratum j.

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Appendix

Aquatic vegetation species found during stratified random sampling in Pools 4, 8, 13, and 26 of the Mississippi River and La Grange Pool of the Illinois River, 1998[a]

Common name	Scientific name	Species Code	Family	Life form[b]
Coontail, coon's tail	*Ceratophyllum demersum* L.	CEDE4	Ceratophyllaceae	S
Chara	*Chara* spp.	CH?AR	Characeae	S
Watermilfoil	*Myriophyllum* spp.	MY?RI	Haloragaceae	S
Northern watermilfoil, shortspike watermilfoil	*M. sibiricum* Komarov	MYSI	Haloragaceae	S
Eurasian watermilfoil, spike watermilfoil	*M. spicatum* L.	MYSP2	Haloragaceae	S
Canadian waterweed	*Elodea canadensis* Michx.	ELCA7	Hydrocharitaceae	S
Wild celery, American eelgrass	*Vallisneria americana* Michx.	VAAM3	Hydrocharitaceae	S
	Utricularia macrorhiza Le Conte synomny			
Common bladderwort	*U. vulgaris* L.	UTMA	Lentibulariaceae	S
Bushy pondweed, slender naiad, nodding waternymph	*Najas flexilis* (Willd.) Rostk. and Schmidt	NAFL	Najadaceae	S
Southern waternymph	*N. guadalupensis* (Spreng.) Magnus	NAGU	Najadaceae	S
American lotus	*Nelumbo lutea* Willd.	NELU	Nelumbonaceae	F
Yellow pond-lily	*Nuphar variegata* Durand.[c]	NULU	Nymphaeaceae	F
White waterlily	*Nymphaea odorata* Ait. synomny *N. tuberosa* Paine	NYTU	Nymphaeaceae	F
Water stargrass, grassleaf mudplantain	*Heteranthera dubia* (Jacq.) MacM. synonymy *Zosterella dubia* Jacq.	ZODU	Pontederiaceae	S
Leafy/small pondweed	*Potamogeton foliosus* Raf./*P. pusillus* L.	NLPW	Potamogetonaceae	S
Curly pondweed, curlyleaf pondweed	*P. crispus* L.	POCR3	Potamogetonaceae	S
Leafy pondweed	*P. foliosus* Raf.	POFO3	Potamogetonaceae	S
Longleaf pondweed, American pondweed	*P. nodosus* Poir	PONO2	Potamogetonaceae	S
Sago pondweed	*P. pectinatus* L.	POPE6	Potamogetonaceae	S
Small pondweed, slender pondweed	*P. pusillus* L.	POPU7	Potamogetonaceae	S
Richardson's pondweed	*P. richardsonii* (Benn.) Rydb.	PORI2	Potamogetonaceae	S
Flatstem pondweed	*P. zosteriformis* Fern.	POZO	Potamogetonaceae	S
Longbeak buttercup	*Ranunculus longirostris* Godr.[d]	RALO2	Ranunculaceae	S
Horned pondweed	*Zannichellia palustris* L.	ZAPA	Zannichelliaceae	S

[a]Scientific nomenclature and common names follow the U.S. Department of Agriculture's Internet PLANTS Database (1996). Common names used by Upper Mississippi River managers are also included.

[b]F = rooted floating–leaf S = submersed

[c]Scientific nomenclature follows Gleason and Cronquist (1991). *Nuphar lutea* spp. *variegata* in PLANTS database.

[d]*Ranunculus longirostris* and *R. trichophyllus* were combined (Voss 1985).

Chapter 1. Results in Pool 4, Upper Mississippi River

Sampling Efforts

Sampling began June 22 and ended August 11, 1998. Of the 550 sites targeted for sampling at the beginning of the season, 545 were actually sampled. Five sites were not sampled because dense emergent vegetation and low water impeded access.

Submersed Vegetation

The status of submersed aquatic vegetation (SAV) varied between different sections of Pool 4 and the different strata sampled (Table 1.1; Figure 1.1). The SAV was scarce in and above Lake Pepin, but a much greater abundance (measured by both percent frequency of occurrence and the abundance index) was found in lower Pool 4, below Lake Pepin. When comparisons were made between strata, the greatest abundance was found in the isolated backwaters, followed by the contiguous backwaters. The distribution of SAV along the main and secondary channels was limited. Poolwide, about 36.6% of the shallow water areas supported SAV. Considering the acreage of SAV, contiguous backwaters below Lake Pepin were the primary habitat for SAV in Pool 4.

Species richness of submersed plants seemed to be closely correlated with abundance. That is, where there was greater abundance, there was generally more species. A total of 17 submersed plant species/taxon were recorded in the entire pool. The isolated backwaters and the contiguous backwaters below Lake Pepin were rich in species.

Where SAV was scarce, such as in and above Lake Pepin and along the main and secondary channels, sago pondweed (*Potamogeton pectinatus*) was generally the most abundant species. Coontail (*Ceratophyllum demersum*) and sago pondweed were the most abundant species in the isolated backwaters, although Canadian waterweed (*Elodea canadensis*) also thrived in that stratum. Coontail and Canadian waterweed were also the most abundant species in the contiguous backwaters below Lake Pepin, closely followed by wild celery (*Vallisneria americana*). Lower Pool 4, especially the contiguous backwaters, was the most important habitat for wild celery—a species that is known to produce high quality food (tubers) for migrating waterfowl in the fall.

Rooted Floating–leaf Vegetation

White waterlily (*Nymphaea odorata*), American lotus (*Nelumbo lutea*), and yellow pond-lily (*Nuphar variegata*) were the three rooted floating–leaf species recorded (Table 1.2; Figure 1.1). White waterlily was recorded above and below Lake Pepin but not in Lake Pepin, American lotus was recorded below Lake Pepin, and yellow pond-lily was recorded at two contiguous backwater sites below Lake Pepin. Poolwide, rooted floating–leaf vegetation covered about 4.1% of the shallow water area.

Table 1.1. Percent frequency, abundance index (AI), and standard errors of submersed vegetation in Pool 4, Upper Mississippi River System, 1998.

Common name	Scientific name	Contiguous backwater–upper *n* = 75		Contiguous backwater–lower *n* = 158		Isolated backwater *n* = 32		Lake Pepin–upper *n* = 65		Lake Pepin–lower *n* = 35		Main channel border–upper *n* = 10	
		Freq	AI	Freq	AI	Freq	AI	Freq	AI	Freq	AI	Freq	AI
Bladderwort, common	*Utricularia macrorhiza*	–	–	*	*	–	–	–	–	–	–	–	–
Buttercup, longbeak	*Ranunculus longirostris*	–	–	–	–	3.1 ± 3.1	0.3 ± 0.3	–	–	–	–	–	–
Chara	*Chara* spp.	–	–	4.4 ± 1.6	0.5 ± 0.2	6.3 ± 4.3	0.7 ± 0.5	–	–	–	–	–	–
Coontail	*Ceratophyllum demersum*	4.0 ± 2.3	0.6 ± 0.4	42.4 ± 3.9	7.1 ± 0.9	81.3 ± 7.0	18.8 ± 2.3	–	–	–	–	–	–
Horned pondweed	*Zannichellia palustris*	–	–	3.2 ± 1.4	0.3 ± 0.1	–	–	–	–	–	–	–	–
Pondweed, curly	*Potamogeton crispus*	–	–	19.6 ± 3.2	2.0 ± 0.4	6.3 ± 4.3	0.4 ± 0.3	–	–	–	–	–	–
Pondweed, flatstem	*P. zosteriformis*	–	–	15.2 ± 2.9	1.4 ± 0.3	15.6 ± 6.5	1.6 ± 0.7	–	–	–	–	–	–
Pondweed, leafy/small	*P. foliosus/P. pusillus*	1.3 ± 1.3	0.3 ± 0.3	27.2 ± 3.6	3.0 ± 0.4	37.5 ± 8.7	5.7 ±1.4	–	–	–	–	–	–
Pondweed, longleaf	*P. nodosus*	1.3 ± 1.3	0.1 ± 0.1	10.1 ± 2.4	1.7 ± 0.4	18.8 ± 7.0	2.3 ± 0.9	–	–	–	–	–	–
Pondweed, Richardson's	*P. richardsonii*	–	–	0.6 ± 0.6	<0.1 ± <0.1	3.1 ± 3.1	0.2 ± 0.2	–	–	–	–	–	–
Pondweed, sago	*P. pectinatus*	30.7 ± 5.4	4.0 ± 0.7	19.6 ± 3.2	2.1 ± 0.4	65.6 ± 8.5	9.6 ± 1.4	18.5 ± 4.8	2.1 ± 0.6	8.6 ± 4.8	1.0 ± 0.6	–	–
Watermilfoil, Eurasian	*Myriophyllum spicatum*	–	–	22.2 ± 3.3	2.7 ± 0.4	6.3 ± 4.3	0.8 ± 0.6	–	–	–	–	–	–
Waternymph, nodding	*Najas flexilis*	–	–	5.1 ± 1.7	1.1 ± 0.5	31.3 ± 8.3	4.4 ± 1.2	–	–	–	–	–	–
Waternymph, southern	*N. guadalupensis*	–	–	–	–	3.1 ± 3.1	0.2 ± 0.2	–	–	–	–	–	–
Water stargrass	*Heteranthera dubia*	–	–	31.0 ± 3.7	3.5 ± 0.5	18.8 ± 7.0	2.2 ± 0.9	–	–	–	–	–	–
Waterweed, Canadian	*Elodea canadensis*	–	–	45.6 ± 4.0	7.5 ± 0.9	53.1 ± 9.0	13.9 ± 3.7	1.5 ± 1.5	0.1 ± 0.1	–	–	–	–
Wild celery	*Vallisneria americana*	–	–	37.3 ± 3.9	5.8 ± 0.7	–	–	–	–	–	–	–	–
All submersed species		32.0 ± 5.4	4.2 ± 0.8	68.4 ± 3.7	15.1 ± 1.3	84.4 ± 6.5	27.9 ±4.1	18.5 ± 4.8	2.1 ± 0.6	8.6 ± 4.8	1.0 ± 0.6	–	–

Table 1.1. Continued.

Common name	Scientific name	Main channel border–lower *n* = 50		Secondary channel–upper *n* = 49		Secondary channel–lower *n* = 71		upper Pool 4 *n* = 199		lower Pool 4 *n* = 314		Pool 4 *n* = 545	
		Freq	AI	Freq	AI	Freq	AI	Freq	AI	Freq	AI	Freq	AI
Bladderwort, common	*Utricularia macrorhiza*	–	–	–	–	–	–	–	–	*	*	*	*
Buttercup, longbeak	*Ranunculus longirostris*	–	–	–	–	–	–	–	–	–	–	0.1 ± 0.3	<0.1 ± <0.1
Chara	*Chara* spp.	–	–	–	–	–	–	–	–	2.6 ± 1.5	0.3 ± 0.2	1.6 ± 1.2	0.2 ± 0.1
Coontail	*Ceratophyllum demersum*	–	–	–	–	18.3 ± 4.6	2.5 ± 0.7	1.0 ± 0.8	0.1 ± 0.1	27.1 ± 3.7	4.5 ± 0.9	18.2 ± 2.9	3.2 ± 0.7
Horned pondweed	*Zannichellia palustris*	–	–	–	–	–	–	–	–	1.9 ± 1.3	0.2 ± 0.1	1.0 ± 1.0	0.1 ± 0.1
Pondweed, curly	*Potamogeton crispus*	2.0 ± 2.0	0.2 ± 0.2	–	–	12.7 ± 4.0	1.2 ± 0.4	–	–	13.2 ± 3.0	1.3 ± 0.3	7.3 ± 2.3	0.7 ± 0.3
Pondweed, flatstem	*P. zosteriformis*	–	–	–	–	5.6 ± 2.8	0.5 ± 0.3	–	–	9.6 ± 2.7	0.9 ± 0.3	5.7 ± 2.1	0.5 ± 0.2
Pondweed, leafy/small	*P. foliosus/P. pusillus*	–	–	–	–	5.6 ± 2.8	0.4 ± 0.2	0.3 ± 0.5	0.1 ± 0.1	16.7 ± 3.3	1.8 ± 0.4	10.5 ± 2.6	1.2 ± 0.3
Pondweed, longleaf	*P. nodosus*	–	–	–	–	5.6 ± 2.8	0.5 ± 0.3	0.3 ± 0.5	<0.1 ± <0.1	6.6 ± 2.3	1.0 ± 0.4	4.4 ± 1.9	0.7 ± 0.3
Pondweed, Richardson's	*P. richardsonii*	–	–	–	–	–	–	–	–	0.4 ± 0.6	<0.1 ± <0.1	0.3 ± 0.5	<0.1 ± <0.1
Pondweed, sago	*P. pectinatus*	4.0 ± 2.8	0.7 ± 0.5	4.1 ± 2.9	0.3 ± 0.2	16.9 ± 4.5	1.9 ± 0.6	19.5 ± 4.9	2.3 ± 0.6	15.6 ± 3.4	1.7 ± 0.4	19.4 ± 4.2	2.3 ± 0.5
Watermilfoil, Eurasian	*Myriophyllum spicatum*	–	–	–	–	7.0 ± 3.1	0.9 ± 0.4	–	–	13.9 ± 3.1	1.7 ± 0.4	7.6 ± 2.4	0.9 ± 0.3
Waternymph, nodding	*Najas flexilis*	–	–	–	–	–	–	–	–	3.0 ± 1.6	0.7 ± 0.4	2.9 ± 1.4	0.5 ± 0.3
Waternymph, southern	*N. guadalupensis*	–	–	–	–	–	–	–	–	–	–	0.1 ± 0.3	<0.1 ± <0.1
Water stargrass	*Heteranthera dubia*	2.0 ± 2.0	0.1 ± 0.1	–	–	19.7 ± 4.8	2.4 ± 0.7	–	–	20.8 ± 3.5	2.4 ± 0.5	11.8 ± 2.7	1.3 ± 0.3
Waterweed, Canadian	*Elodea canadensis*	–	–	–	–	18.3 ± 4.6	2.4 ± 0.7	1.0 ± 1.4	0.1 ± 0.1	29.0 ± 3.8	4.7 ± 0.8	18.0 ± 3.1	3.1 ± 0.7
Wild celery	*Vallisneria americana*	4.0 ± 2.8	0.6 ± 0.4	–	–	18.3 ± 4.6	3.2 ± 1.0	–	–	24.5 ± 3.7	3.8 ± 0.7	13.0 ± 2.8	2.0 ± 0.5
All submersed species		8.0 ± 3.9	1.3 ± 0.6	4.1 ± 2.9	0.3 ± 0.2	32.4 ± 5.6	6.9 ± 1.5	19.8 ± 4.9	2.4 ± 0.6	46.5 ± 3.9	10.0 ± 1.3	36.6 ± 4.4	7.5 ± 1.1

*Species observed in site but not in subsampling areas.

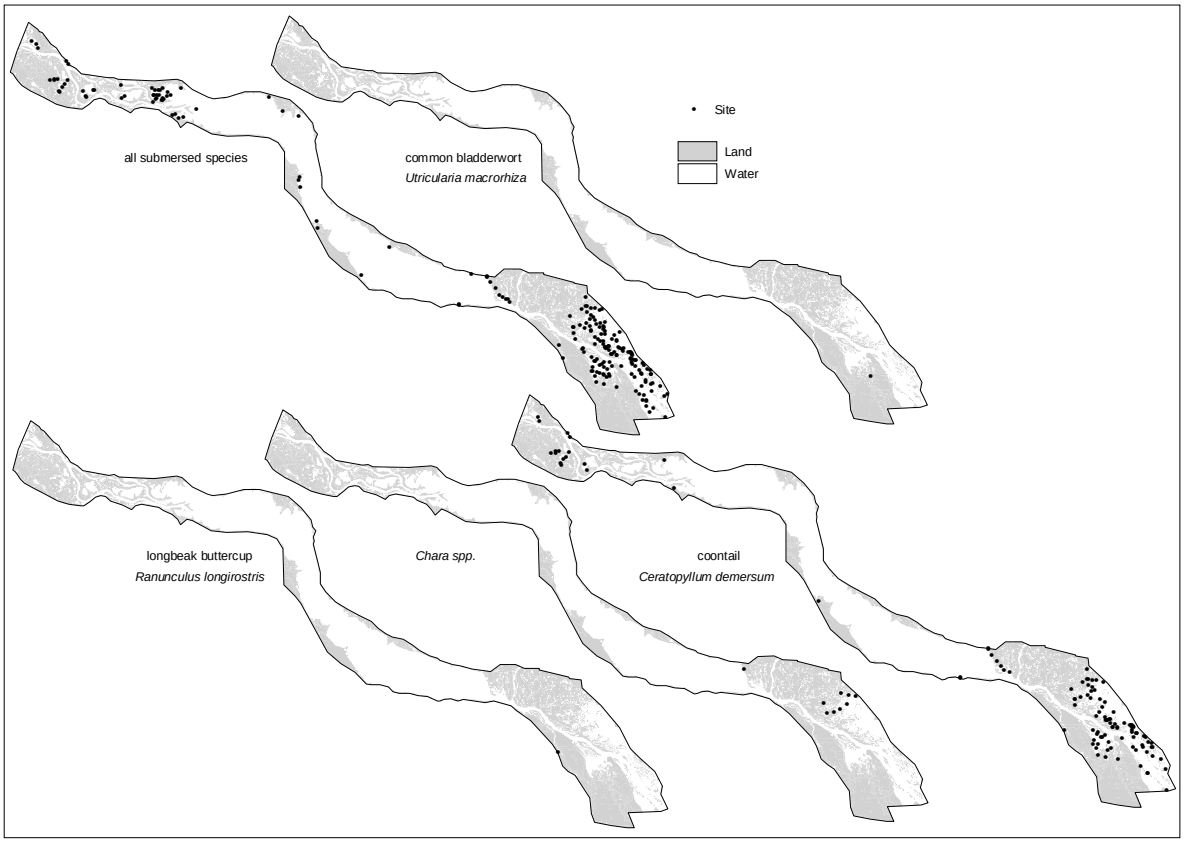

Figure 1.1. Sampling sites where species were recorded within Pool 4, Upper Mississippi River System, 1998.

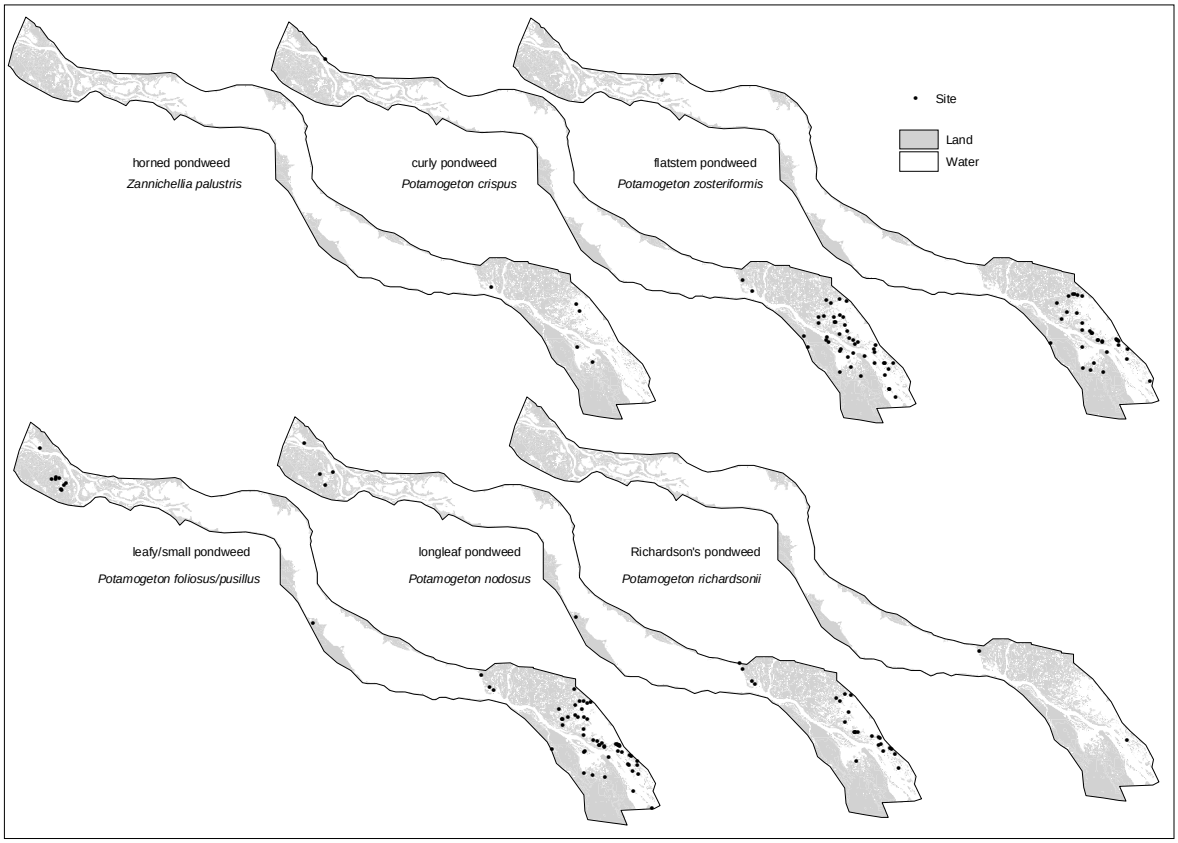

Figure 1.1. Continued.

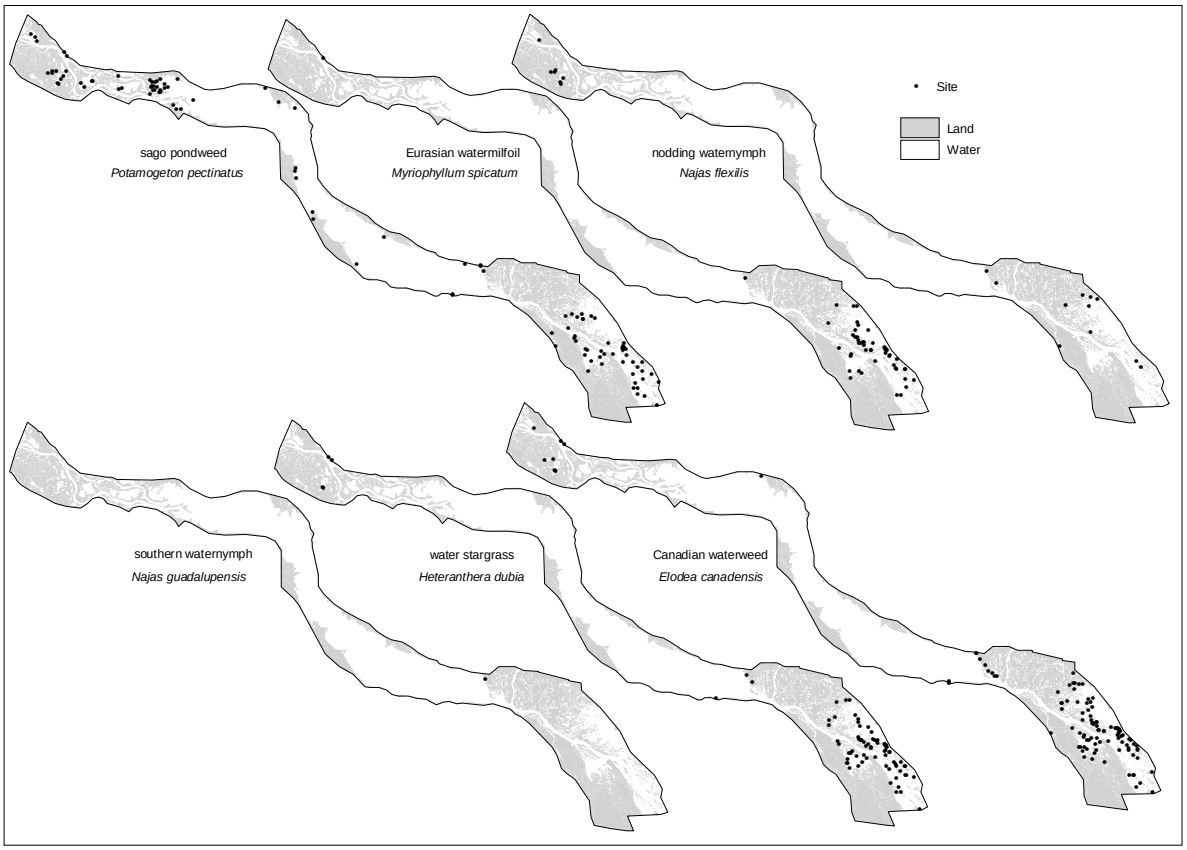

Figure 1.1. Continued.

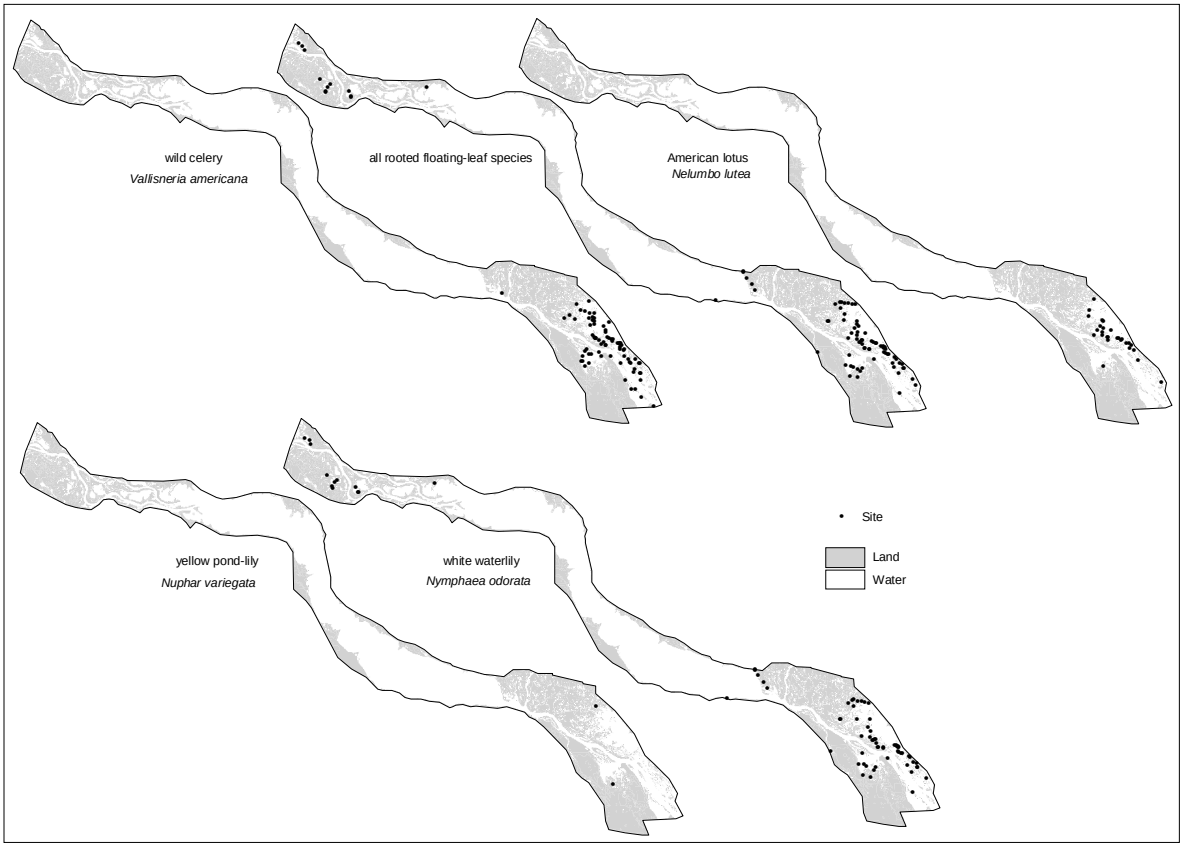

Figure 1.1. Continued.

Table 1.2. Percent frequency, estimated cover, and standard errors for rooted floating–leaf vegetation in Pool 4, Upper Mississippi River System, 1998.

		Contiguous backwater–upper *n* = 75		Contiguous backwater–lower *n* = 158		Isolated backwater *n* = 32		Lake Pepin–upper *n* = 65		Lake Pepin–lower *n* = 35		Main channel border–upper *n* = 10	
Common name	**Scientific name**	**Frequency**	**Cover**	**Frequency**	**Cover**	**Frequency**	**Cover**	**Frequency**	**Cover**	**Frequency**	**Cover**	**Frequency**	**Cover**
American lotus	*Nelumbo lutea*	–	–	14.6 ± 2.8	7.0 ±1.6	–	–	–	–	–	–	–	–
Yellow pond–lily	*Nuphar variegata*	–	–	0.6 ± 0.6	0.1 ± 0.1	–	–	–	–	–	–	–	–
White waterlily	*Nymphaea odorata*	4.0 ± 2.3	3.6 ± 2.1	22.8 ± 3.3	5.9 ± 1.3	53.1 ± 9.0	18.4 ± 5.0	–	–	–	–	–	–
All rooted floating–leaf species		4.0 ± 2.3	3.6 ± 2.1	32.3 ± 3.7	9.0 ± 1.6	53.1 ± 9.0	18.4 ± 5.0	–	–	–	–	–	–

		Main channel border–lower *n* = 50		Secondary channel– upper *n* = 49		Secondary channel–lower *n* = 71		upper Pool 4 *n* = 199		lower Pool 4 *n* = 314		Pool 4 *n* = 545	
		–	–	–	–	1.4 ± 1.4	0.1 ± 0.1	–	–	8.7 ± 2.6	4.2 ± 1.5	4.6 ± 2.0	2.2 ± 1.1
Yellow pond–lily	*Nuphar variegata*	–	–	–	–	–	–	–	–	0.4 ± 0.6	<0.1 ± <0.1	0.3 ± 0.5	<0.1 ± <0.1
White waterlily	*Nymphaea odorata*	–	–	–	–	5.6 ± 3.7	2.5 ± 1.6	1.0 ± 0.8	0.9 ± 0.7	14.1 ± 3.1	3.8 ± 1.2	10.1 ± 2.5	3.2 ± 1.1
All rooted floating–leaf species		–	–	–	–	5.6 ± 2.8	2.5 ± 1.6	1.0 ± 0.8	0.9 ± 0.7	19.7 ± 3.5	5.6 ± 1.5	13.1 ± 2.8	4.1 ± 1.3

Chapter 2. Results in Pool 8, Upper Mississippi River

Sampling Efforts

Sampling began June 23 and ended July 21, 1998. Of the 550 sites targeted for sampling at the beginning of the season, 545 were actually sampled. Four sites could not be accessed because dense emergent vegetation and low water inhibited access. One site could not be reached because a barge was docked on the site on the day of sampling.

Submersed Vegetation

The status of submersed aquatic vegetation (SAV) in Pool 8 varied among the strata sampled. Isolated backwaters had the highest abundance of SAV (Table 2.1; Figure 2.1). Contiguous backwaters, secondary channels, impounded areas, and main channel border areas followed in decreasing order. Sizable beds were found throughout most of the shallow water areas, except in the main channel border areas and the lower impounded areas of the pool where sizable beds were generally absent. The SAV covered about 47.6% of the shallow water areas poolwide.

Except for the main channel border areas, each of the other four strata sampled harbored a rich assemblage of submersed plant species. A total of 16 species were recorded in the entire pool. Coontail (*Ceratophyllum demersum*) and Canadian waterweed (*Elodea canadensis*) were the two most abundant species in the contiguous backwaters while coontail and leafy/small pondweed (*Potamogeton foliosus*/*P. pusillus*) were most abundant in isolated backwaters. No species was significantly more abundant in the impounded areas and main and secondary channels.

Rooted Floating–leaf Vegetation

White waterlily (*Nymphaea odorata*), American lotus (*Nelumbo lutea*), and yellow pond-lily (*Nuphar variegata*) were the three rooted floating–leaf species recorded (Table 2.2; Figure 2.1). The percent cover of rooted floating–leaf species was the highest in the isolated backwaters. American lotus and white waterlily were scattered in much of the isolated and contiguous backwaters, while yellow pond-lily had a much more limited distribution in contiguous and isolated backwaters. The three species together covered about 7.5% of the shallow water areas.

Table 2.1. Percent frequency, abundance index (AI), and standard errors of submersed vegetation in Pool 8, Upper Mississippi River System, 1998.

		Contiguous backwater *n* = 173		Isolated backwater *n* = 28		Impounded *n* = 175		Main channel border *n* = 69		Secondary channel border *n* = 100		Pool 8 *n* = 545	
Common name	**Scientific name**	**Freq**	**AI**	**Freq**	**AI**	**Freq**	**AI**	**Freq**	**AI**	**Freq**	**AI**	**Freq**	**AI**
Bladderwort, common	*Utricularia macrorhiza*	7.5 ± 2.0	1.1 ± 0.3	17.9 ± 7.4	2.6 ± 1.2	–	–	–	–	–	–	2.7 ± 1.0	0.4 ± 0.2
Chara	*Chara* spp.	0.6 ± 0.6	0.1 ± 0.1	10.7 ± 6.0	1.3 ± 0.8	–	–	–	–	–	–	0.6 ± 0.5	0.1 ± 0.1
Coontail	*Ceratophyllum demersum*	61.1 ± 3.7	12.1 ± 1.2	92.9 ± 5.0	21.9 ± 3.0	4.0 ± 1.5	0.3 ± 0.2	4.3 ± 2.5	0.3 ± 0.2	18.0 ± 3.9	2.3 ± 0.5	24.8 ± 2.4	4.6 ± 0.6
Horned pondweed	*Zannichellia palustris*	1.7 ± 1.0	0.2 ± 0.1	–	–	–	–	1.4 ± 1.4	0.1 ± 0.1	1.0 ±1.0	0.1 ± 0.1	0.7 ± 0.5	0.1 ± 0.1
Pondweed, curly	*Potamogeton crispus*	30.6 ± 3.5	3.6 ± 0.5	25.0 ± 8.3	3.1 ± 1.3	2.3 ± 1.1	0.2 ± 0.1	–	–	8.0 ± 2.7	0.8 ± 0.3	11.6 ± 2.1	1.3 ± 0.3
Pondweed, flatstem	*P. zosteriformis*	23.7 ± 3.2	2.5 ± 0.4	7.1 ± 5.0	0.9 ± 0.7	0.6 ± 0.6	0.1 ± 0.1	–	–	6.0 ± 2.4	0.7 ± 0.4	7.9 ± 1.7	0.8 ± 0.2
Pondweed, leafy/small	*P. foliosus/pusillus*	41.0 ± 3.8	5.8 ± 0.6	78.6 ± 7.9	10.7 ± 1.3	0.6 ± 0.6	0.1 ± 0.1	–	–	9.0 ± 2.9	1.0 ±0.3	15.7 ± 2.0	2.2 ± 0.3
Pondweed, longleaf	*P. nodosus*	10.4 ± 2.3	1.3 ± 0.4	3.6 ± 3.6	0.5 ± 0.5	1.7 ± 1.0	0.1 ± 0.1	–	–	2.0 ± 1.4	0.2 ± 0.2	4.1 ± 1.4	0.5 ± 0.2
Pondweed, Richardson's	*P. richardsonii*	–	–	–	–	0.6 ± 0.6	<0.1 ± <0.1	–	–	1.0 ± 1.0	0.1 ± 0.1	0.4 ± 0.5	<0.1 ± <0.1
Pondweed, sago	*P. pectinatus*	31.8 ± 3.6	3.9 ± 0.5	28.6 ± 8.7	3.3 ± 1.2	12.6 ± 2.5	1.9 ± 0.5	5.8 ± 2.8	1.1 ± 0.6	14.0 ± 3.5	1.7 ± 0.4	18.3 ± 2.9	2.4 ± 0.5
Watermilfoil, Eurasian	*Myriophyllum spicatum*	23.7 ± 3.2	3.1 ± 0.5	–	–	1.1 ± 0.8	0.1 ± 0.1	1.4 ± 1.4	0.1 ± 0.1	5.0 ± 2.2	0.7 ± 0.3	7.8 ± 1.7	1.0 ± 0.2
Watermilfoil, northern	*M. sibiricum*	–	–	3.6 ± 3.6	0.4 ± 0.4	–	–	–	–	–	–	0.1 ± 0.2	<0.1 ± <0.1
Waternymph, nodding	*Najas flexilis*	12.7 ± 2.5	1.8 ± 0.4	35.7 ± 9.2	4.1 ± 1.2	–	–	–	–	–	–	4.8 ± 1.3	0.6 ± 0.2
Water stargrass	*Heteranthera dubia*	24.9 ± 3.3	3.0 ± 0.5	–	–	13.7 ± 2.6	1.9 ± 0.4	4.3 ± 2.5	0.7 ± 0.4	18.0 ± 3.9	2.4 ± 0.6	16.4 ± 2.9	2.2 ± 0.5
Waterweed. Canadian	*Elodea canadensis*	53.2 ± 3.8	8.6 ± 0.8	39.3 ± 9.4	8.2 ± 2.2	20.0 ± 3.0	2.0 ± 0.4	2.9 ± 2.0	0.4 ± 0.3	26.0 ± 4.4	4.5 ± 1.1	29.8 ± 3.4	4.3 ± 0.6
Wild celery	*Vallisneria americana*	6.4 ± 1.9	0.6 ± 0.2	–	–	12.0 ± 2.5	1.6 ± 0.4	7.2 ± 3.1	1.2 ± 0.6	12.0 ± 3.3	1.4 ± 0.4	9.8 ± 2.4	1.2 ± 0.4
All submersed species		81.5 ± 3.0	21.2 ± 1.4	96.4 ± 3.6	28.4 ± 4.2	32.6 ± 3.6	5.2 ± 0.7	14.5 ± 4.3	2.6 ± 0.9	34.0 ± 4.8	7.0 ± 1.3	47.6 ± 3.5	10.6 ± 1.0

Table 2.2. Percent frequency, estimated cover, and standard errors of rooted floating–leaf vegetation in Pool 8, Upper Mississippi River System, 1998.

		Contiguous backwater *n* = 173		Isolated backwater *n* = 28		Impounded *n* = 175		Main channel border *n* = 69		Secondary channel border *n* = 100		Pool 8 *n* = 545	
Common name	**Scientific name**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**
American lotus	*Nelumbo lutea*	22.5 ± 3.2	1.3 ± 2.0	3.6 ± 3.6	0.4 ± 0.4	0.6 ± 0.6	0.5 ± 0.5	1.4 ± 1.4	0.7 ± 0.7	4.0 ± 2.0	1.2 ± 0.7	7.2 ± 1.6	3.5 ± 1.0
Pond-lily, yellow	*Nuphar variegata*	2.9 ± 1.3	0.5 ± 0.3	3.6 ± 3.6	0.4 ± 0.4	–	–	–	–	–	–	0.9 ± 0.6	0.2 ± 0.1
Water lily, white	*Nymphaea odorata*	29.5 ± 3.5	10.5 ± 1.7	67.9 ± 9.0	42.5 ± 7.6	*	*	–	–	4.0 ± 2.0	0.4 ± 0.2	11.1 ± 1.8	4.5 ± 0.9
All rooted floating–leaf species		45.1 ± 3.8	20.1 ± 2.3	67.9 ± 9.0	42.5 ± 7.6	0.6 ± 0.6	0.5 ± 0.5	1.4 ± 1.4	0.7 ± 0.7	6.0 ± 2.4	1.4 ± 0.7	16.0 ± 2.0	7.5 ± 1.3

*Observed in the site but not in the sub-sampling areas.

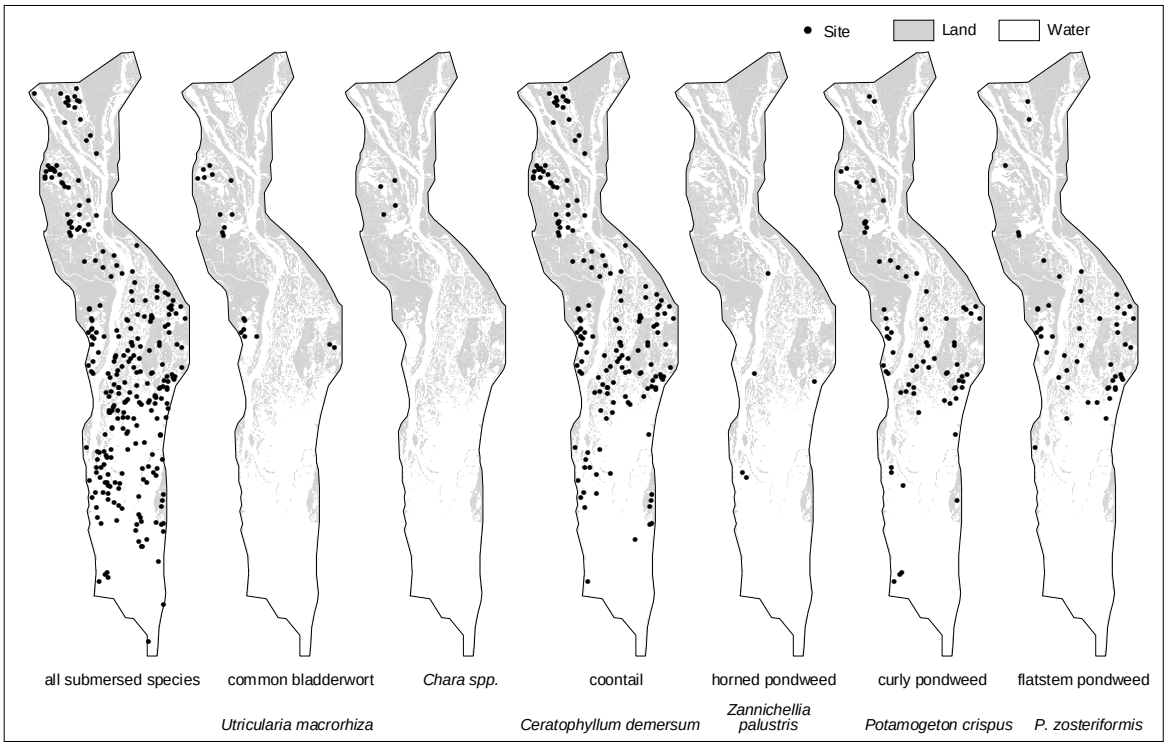

Figure 2.1. Sampling sites where species were recorded within Pool 8, Upper Mississippi River System, 1998.

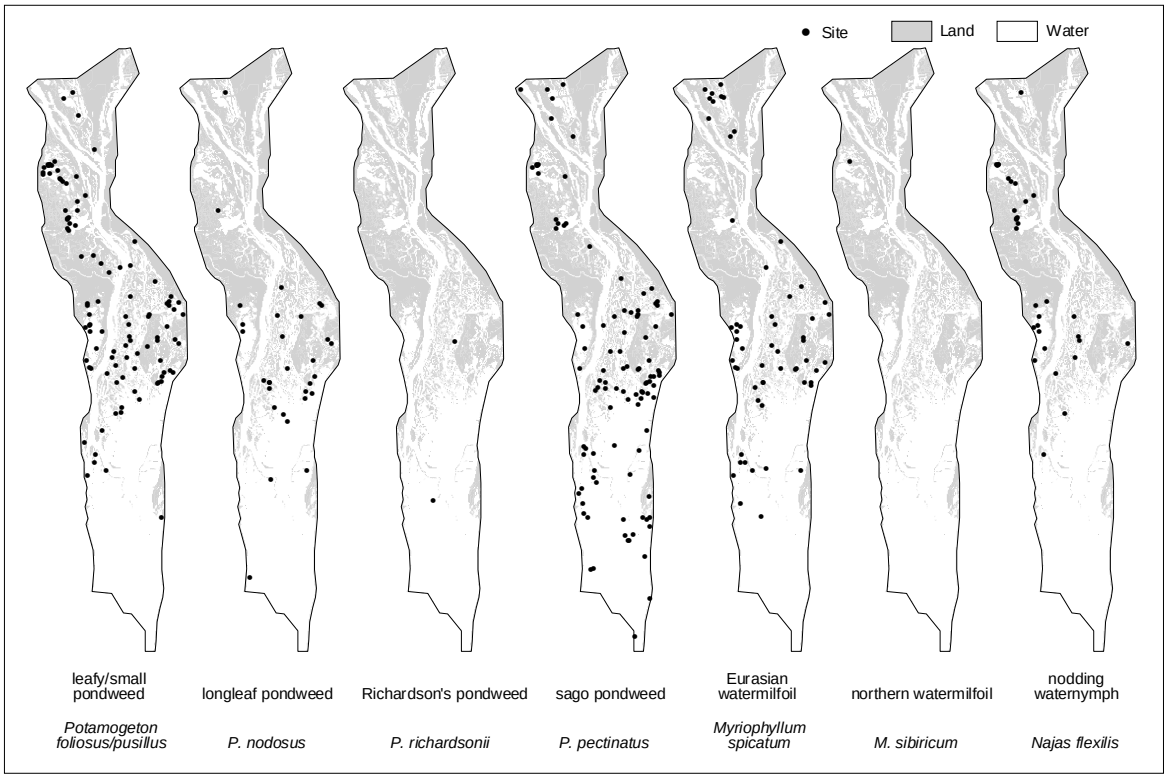

Figure 2.1. Continued.

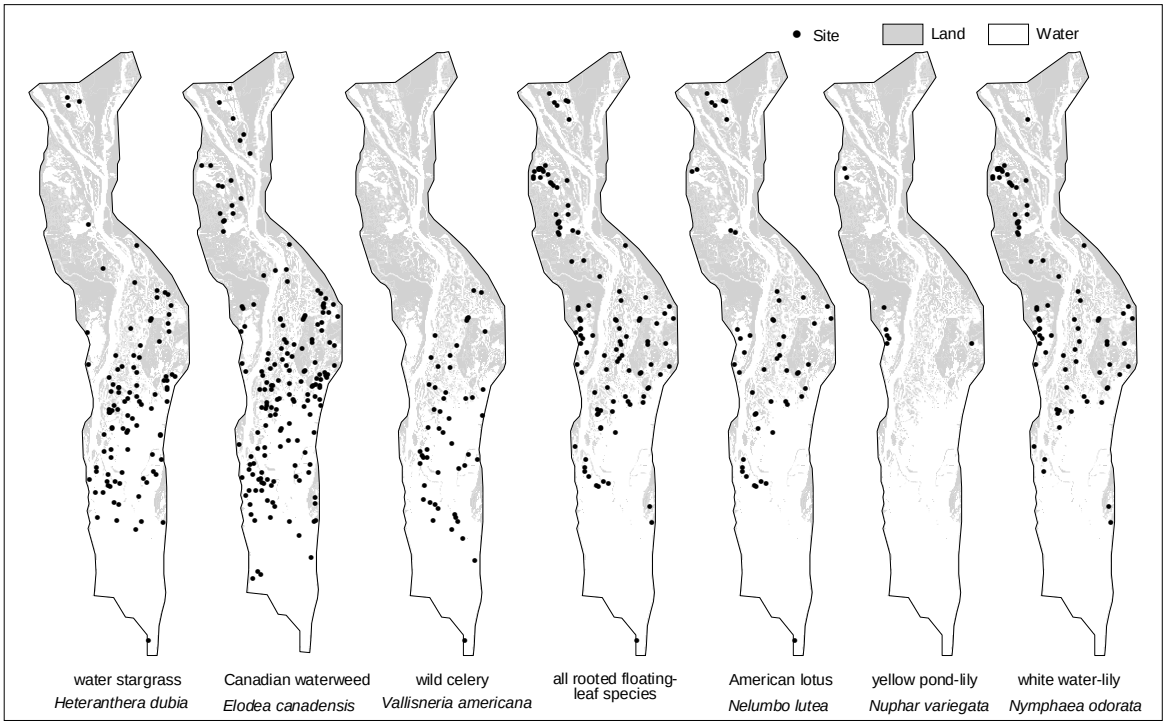

Figure 2.1. Continued.

Chapter 3. Results in Pool 13, Upper Mississippi River

Sampling Efforts

Sampling began June 24 and ended July 29, 1998. Of the 550 sites targeted for investigation at the beginning of the season, 549 were actually sampled. One isolated backwater site was not accessible.

Submersed Aquatic Vegetation

The submersed aquatic vegetation (SAV) was recorded throughout most of the shallow water areas, but much less frequently in the northern portion of the pool (Table 3.1; Figure 3.1). Isolated backwaters had the highest abundance of SAV, measured by both percent frequency of occurrence and the abundance index. Contiguous backwaters, impounded areas, secondary channels, and main channel border areas followed in decreasing order. However, most of the SAV were recorded in impounded areas and contiguous backwaters. About 42% of the shallow water areas in the pool supported SAV.

A total of 14 submersed aquatic plant species were recorded. Isolated backwaters, contiguous backwaters, and impounded areas all supported a diverse assemblage of species; main channel border areas and secondary channels supported fewer species. Coontail (*Ceratophyllum demersum*) was the most abundant species in the isolated and contiguous backwaters, wild celery (*Vallisneria americana*) and water stargrass (*Heteranthera dubia*) were the most abundant species in the impounded areas, and sago pondweed (*Potamogeton pectinatus*) was the most abundant species along the main channel border areas and in the secondary channels.

Rooted Floating–leaf Vegetation

American lotus (*Nelumbo lutea*) and white waterlily (*Nymphaea odorata*) were the two rooted floating–leaf species recorded (Table 3.2; Figure 3.1). The two species had a similar distribution in the pool. Together they covered about 6.5% of the shallow water areas, mostly in contiguous backwaters. However, the percent cover of rooted floating–leaf vegetation was higher in isolated backwaters than in the contiguous backwaters. Rooted floating–leaf vegetation was not recorded in main channel border areas.

Table 3.1. Percent frequency, abundance index (AI), and standard errors of submersed aquatic vegetation in Pool 13, Upper Mississippi River System, 1998.

		Contiguous backwater *n* = 170		Isolated backwater *n* = 29		Impounded *n* = 210		Main channel border *n* = 70		Secondary channel *n* = 70		Pool 13 *n* = 549	
Common name	**Scientific name**	**Freq.**	**AI**	**Freq.**	**AI**	**Freq.**	**AI**	**Freq.**	**AI**	**Freq.**	**AI**	**Freq.**	**AI**
Bladderwort, common	*Utricularia macrorhiza*	–	–	6.9 ± 4.8	1.1 ± 0.8	–	–	–	–	–	–	0.4 ± 0.5	0.1 ± 0.1
Chara	*Chara.* spp.	–	–	3.4 ± 3.4	0.5 ± 0.5	–	–	–	–	–	–	0.2 ± 0.4	<0.1 ± <0.1
Coontail	*Ceratophyllum demersum*	39.4 ± 3.8	6.9 ± 0.8	65.5 ± 9.0	11.9 ± 2.3	16.7 ± 2.6	2.0 ± 0.4	1.4 ± 1.4	0.1 ± 0.1	7.1 ± 3.1	0.9 ± 0.4	25.3 ± 3.2	4.0 ± 0.6
Pondweed, curly	*Potamogeton crispus*	14.7 ± 2.7	1.6 ± 0.3	24.1 ± 8.1	2.4 ± 0.9	1.4 ± 0.8	0.1 ± 0.1	–	–	2.9 ± 0.2	0.3 ± 0.2	7.3 ± 2.0	0.7 ± 0.2
Pondweed, flatstem	*P. zosteriformis*	1.2 ± 0.8	0.1 ± 0.1	–	–	–	–	–	–	–	–	0.4 ± 0.5	<0.1 ± <0.1
Pondweed, leafy/small	*P. foliosus/pusillus*	5.9 ± 1.8	0.6 ± 0.2	31.0 ± 8.7	4.2 ± 1.3	1.4 ± 0.8	0.2 ± 0.1	–	–	–	–	4.5 ± 1.6	0.5 ± 0.2
Pondweed, longleaf	*P. nodosus*	4.7 ± 1.6	0.6 ± 0.2	10.3 ± 5.8	1.0 ± 0.6	6.2 ± 1.7	0.6 ± 0.2	–	–	–	–	4.9 ± 1.7	0.5 ± 0.2
Pondweed, sago	*P. pectinatus*	28.8 ± 3.5	3.3 ± 0.4	55.2 ± 9.4	7.6 ± 1.4	16.7 ± 2.6	1.9 ± 0.3	4.3 ± 2.4	0.6 ± 0.4	8.6 ± 3.4	0.8 ± 0.4	21.4 ± 3.1	2.5 ± 0.4
Watermilfoil, Eurasian	*Myriophyllum spicatum*	7.1 ± 2.0	0.7 ± 0.2	–	–	16.2 ± 2.5	2.0 ± 0.3	1.4 ± 1.4	0.2 ± 0.2	2.9 ± 0.4	0.4 ± 0.2	9.8 ± 2.3	1.1 ± 0.3
Waternymph, nodding	*Najas flexilis*	6.5 ± 1.9	0.8 ± 0.3	3.4 ± 3.4	0.5 ± 0.5	1.0 ± 0.8	0.1 ± <0.1	–	–	–	–	2.8 ± 1.3	0.3 ± 0.2
Waternymph, southern	*N. guadalupensis*	1.8 ± 1.0	0.2 ± 0.1	3.4 ± 3.4	0.2 ± 0.2	3.3 ± 1.2	0.4 ± 0.1	–	–	–	–	2.2 ± 1.2	0.2 ± 0.1
Water stargrass	*Heteranthera dubia*	14.7 ± 2.7	1.5 ± 0.3	–	–	27.1 ± 3.1	3.9 ± 0.5	–	–	4.3 ± 2.4	0.4 ± 0.2	17.1 ± 2.9	2.2 ± 0.4
Waterweed, Canadian	*Elodea canadensis*	10.0 ± 2.3	1.5 ± 0.4	3.4 ± 3.4	0.6 ± 0.6	7.1 ± 1.8	0.7 ± 0.2	1.4 ± 1.4	0.1 ± 0.1	2.9 ± 0.3	0.3 ± 0.2	7.1 ± 2.0	0.9 ± 0.3
Wild celery	*Vallisneria americana*	3.5 ± 1.4	0.3 ± 0.1	–	–	29.5 ± 3.2	5.6 ± 0.7	1.4 ± 1.4	0.1 ± 0.1	1.4 ± 1.4	0.1 ± 0.1	14.2 ± 2.6	2.5 ± 0.5
All submersed species		52.4 ± 3.8	9.4 ± 0.9	69.0 ± 8.7	16.2 ± 2.6	42.4 ± 3.4	8.7 ± 0.9	7.1 ± 3.1	0.8 ± 0.4	12.9 ± 4.0	1.6 ± 0.6	42.0 ± 3.7	8.2 ± 0.9

Table 3.2. Percent frequency, estimated cover, and standard errors of rooted floating–leaf vegetation in Pool 13, Upper Mississippi River System, 1998.

		Contiguous backwater *n* = 170		Isolated backwater *n* = 29		Impounded *n* = 210		Main channel border *n* = 70		Secondary channel *n* = 70		Pool 13 *n* = 549	
Common name	**Scientific name**	**Freq.**	**Cover**	**Freq.**	**Cover**	**Freq.**	**Cover**	**Freq.**	**Cover**	**Freq.**	**Cover**	**Freq.**	**Cover**
American lotus	*Nelumbo lutea*	28.2 ± 3.5	13.2 ± 2.2	31.0 ± 8.7	21.0 ± 6.7	8.6 ± 1.9	3.4 ± 1.0	–	–	2.9 ± 2.0	0.3 ± 0.2	15.5 ± 2.7	7.3 ± 1.7
White waterlily	*Nymphaea odorata*	7.6 ± 2.0	1.2 ± 0.5	13.8 ± 6.5	2.8 ± 1.5	5.2 ± 1.5	1.5 ± 0.6	–	–	–	–	5.7 ± 1.8	1.2 ± 0.6
All rooted floating–leaf species		30.6 ± 3.5	12.1 ± 2.1	34.5 ± 9.0	16.6 ± 5.8	9.0 ± 2.0	3.0 ± 0.9	–	–	2.9 ± 2.0	0.3 ± 0.2	16.7 ± 2.8	6.5 ± 1.6

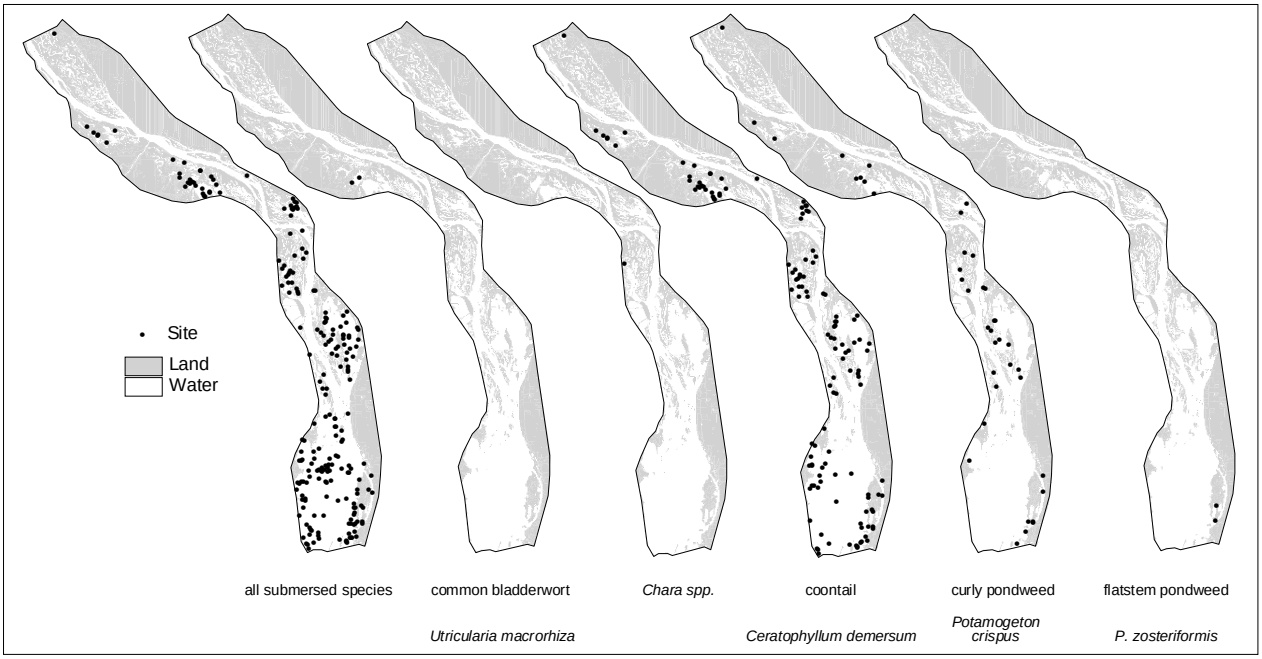

Figure 3.1. Sampling sites where species were recorded within Pool 13, Upper Mississippi River System, 1998.

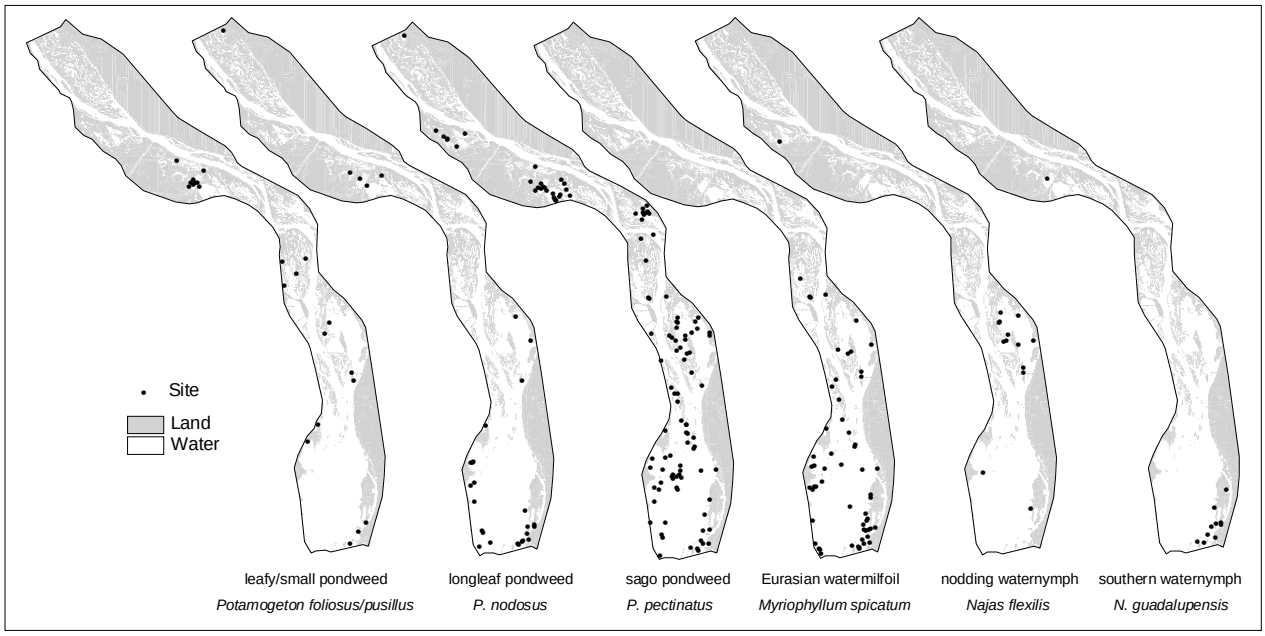

Figure 3.1. Continued.

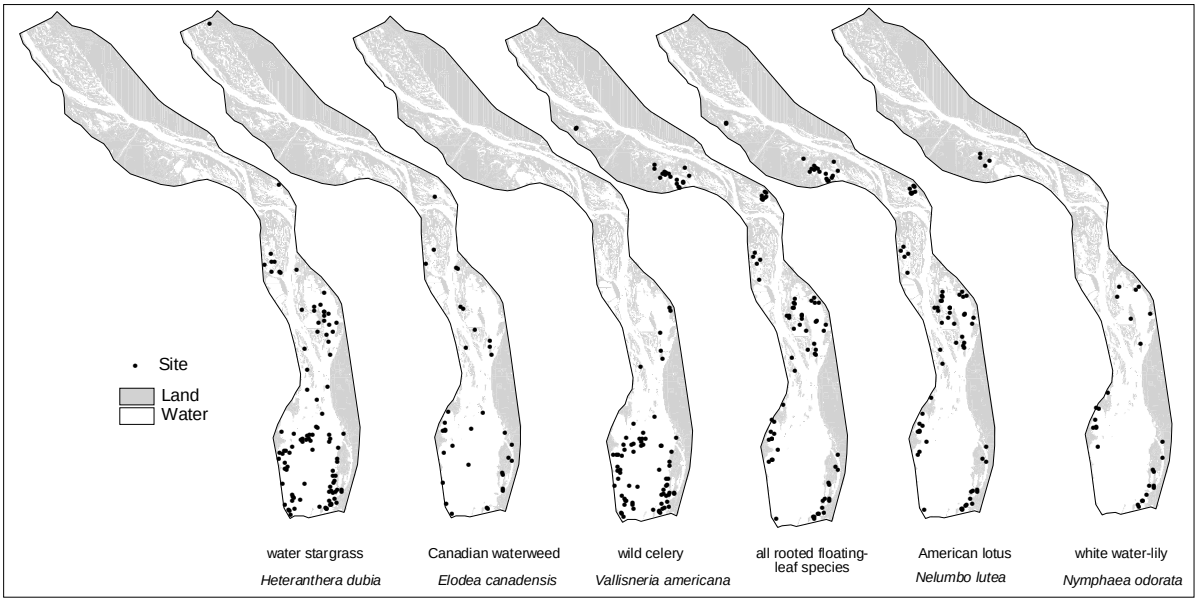

Figure 3.1. Continued.

Chapter 4. Results in Pool 26, Upper Mississippi River

Sampling Efforts

Sampling began June 15 and ended August 10, 1998. All of the 550 sites targeted for sampling at the beginning of the season were sampled.

Submersed Vegetation

Only one sizable bed of submersed aquatic vegetation (SAV) was found in Pool 26. It was located in an isolated backwater of the Illinois River locally known as the Stump Lake (Table 4.1; Figure 4.1). The existence of SAV outside the Stump Lake was negligible—coontail (*Ceratophyllum demersum*) was recorded at two sites while sago pondweed (*Potamogeton pectinatus*) was recorded at one site. No SAV was recorded along the Mississippi River and its backwater areas above the confluence with the Illinois River. The SAV in Stump Lake consisted of six species, among which sago pondweed and coontail were most abundant. Although localized in distribution, SAV was estimated to cover about 6.1% of the shallow water areas in Pool 26.

Rooted Floating–Leaf Vegetation

American lotus (*Nelumbo lutea*) and floating primrose-willow (*Ludwigia peploides*) were the two rooted floating–leaf species recorded in Pool 26 (Table 4.2; Figure 4.1). No rooted floating–leaf vegetation was recorded along the Mississippi River and its backwater areas above the confluence with the Illinois River. Although very localized in distribution, the two species together covered about 0.9% of the shallow water areas.

Table 4.1. Percent frequency, abundance index (AI), and standard errors of submersed vegetation in Pool 26, Upper Mississippi River System, 1998.

		Contiguous backwater *n* = 50		Isolated backwater Mississippi River *n* = 30		Isolated backwater Illinois River *n* = 160		Impounded *n* = 30		Main channel border Mississippi River *n* = 140		Main channel border Illinois River *n* = 50		Secondary channel *n* = 90		Pool 26 *n* = 550	
Common name	**Scientific name**	**Freq**	**AI**	**Freq**	**AI**	**Freq**	**AI**	**Freq**	**AI**	**Freq**	**AI**	**Freq**	**AI**	**Freq**	**AI**	**Freq**	**AI**
Coontail	*Ceratophyllum demersum*	2.0 ± 2.0	0.1 ± 0.1	3.3 ± 3.3	0.5 ± 0.5	13.1 ± 2.7	2.0 ± 0.4	–	–	–	–	–	–	–	–	4.8 ± 2.0	0.7 ± 0.3
Pondweed, leafy	*Potamogeton. foliosus*	–	–	–	–	5.6 ± 1.8	0.8 ± 0.3	–	–	–	–	–	–	–	–	1.9 ± 1.3	0.3 ± 0.2
Pondweed, longleaf	*P. nodosus*	–	–	–	–	7.5 ± 2.1	1.3 ± 0.5	–	–	–	–	–	–	–	–	2.6 ± 1.5	0.5 ± 0.6
Pondweed, sago	*P. pectinatus*	–	–	–	–	16.3 ± 2.9	3.7 ± 0.8	–	–	–	–	–	–	–	–	5.6 ± 2.1	1.3 ± 0.6
Pondweed, small	*P. pusillus*	–	–	–	–	2.5 ± 1.2	0.3 ± 0.2	–	–	–	–	–	–	–	–	0.9 ± 0.9	0.1 ± 0.1
Water stargrass	*Heteranthera dubia*	–	–	–	–	3.1 ± 1.4	0.3 ± 0.1	–	–	–	–	–	–	–	–	1.1 ± 0.1	0.1 ± 0.1
Waterweed, Canadian	*Elodea canadensis*	–	–	–	–	4.4 ± 1.6	0.5 ± 0.2	–	–	–	–	–	–	–	–	1.5 ± 1.2	0.2 ± 0.2
All submersed species		2.0 ± 2.0	0.2 ± 0.2	3.3 ± 3.3	0.5 ± 0.5	16.9 ± 3.0	6.3 ± 1.4	–	–		–	–	–	–	–	6.1 ±2.2	2.2 ± 1.0

Table 4.2. Percent frequency, estimated cover, and standard errors of rooted floating–leaf vegetation in Pool 26, Upper Mississippi River System, 1998.

		Contiguous backwater *n* = 50		Isolated backwater Mississippi River *n* = 30		Isolated backwater Illinois River *n* = 160		Impounded *n* = 30		Main channel border Mississippi River *n* = 140		Main channel border Illinois River *n* = 50		Secondary channel *n* = 90		Pool 26 *n* = 550	
Common name	**Scientific name**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**
American lotus	*Nelumbo lutea*	2.0 ± 2.0	1.0 ± 1.0	–	–	7.5 ± 2.1	1.3 ± 0.4	–	–	–	–	–	–	–	–	2.7 ±1.5	0.5 ± 0.3
Primrose-willow, floating	*Ludwigia peploides*	4.0 ± 2.8	0.4 ± 0.3	3.3 ± 3.3	1.0 ± 1.0	6.3 ± 1.9	1.3 ± 0.6	–	–	–	–	–	–	–	–	2.5 ±1.4	0.5 ± 0.4
All rooted floating–leaf species		6.0 ± 3.4	1.4 ± 1.0	3.3 ± 3.3	1.0 ± 1.0	1.3 ± 2.5	2.1 ± 0.7	–	–	–	–	–	–	–	–	4.4 ±1.9	0.9 ± 0.5

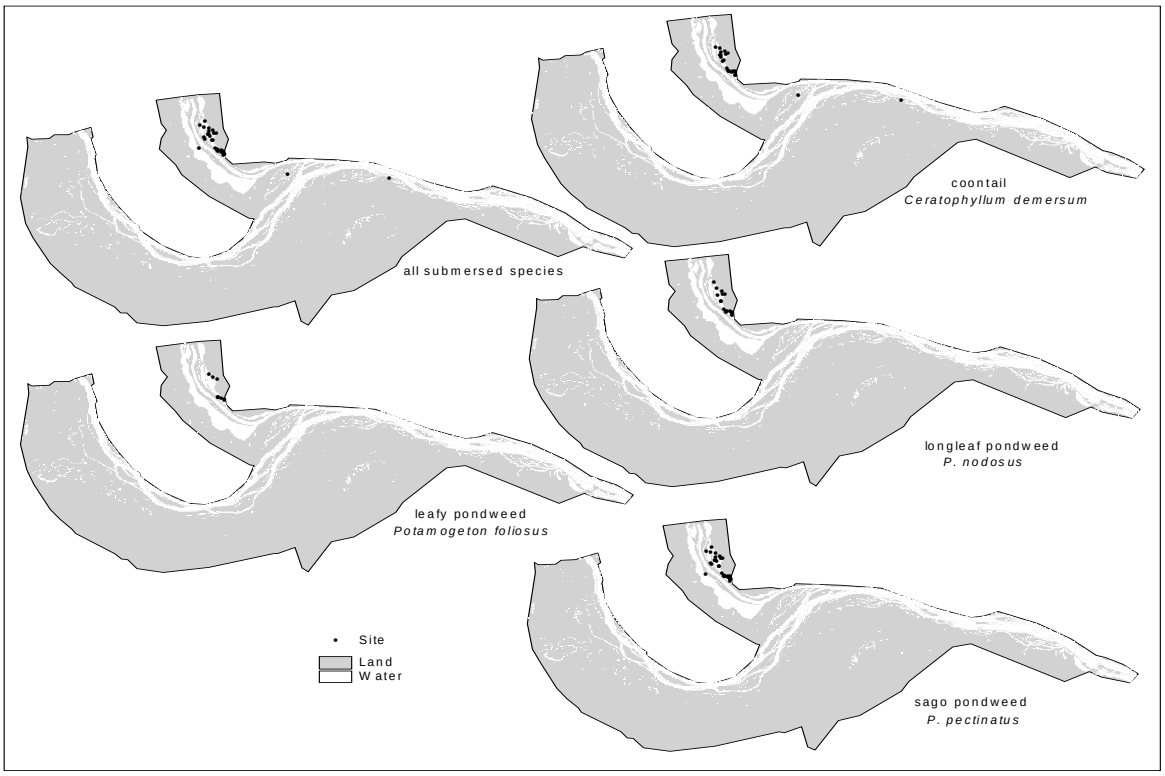

Figure 4.1. Sampling sites where species were recorded within Pool 26, Upper Mississippi River System, 1998.

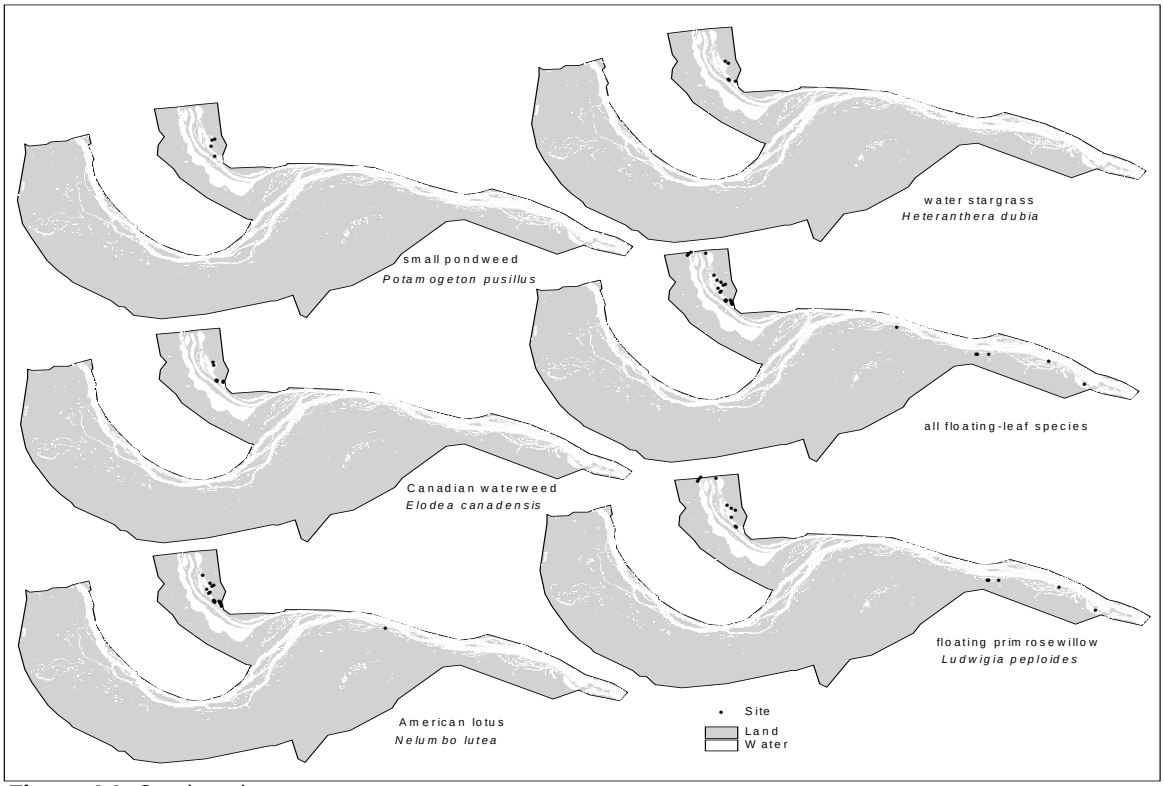

Figure 4.1. Continued.

Chapter 5. Results in La Grange Pool, Illinois River

Sampling Efforts

Sampling began June 7 and ended August 4, 1998. Of the 550 sites targeted for sampling at the beginning of the season, 526 were actually sampled. Twenty-four sites were not sampled because of unforeseen inaccessibility, lack of permission from private landowners, equipment failure, and oversight in tracking sampling sites.

Submersed Vegetation

No submersed aquatic vegetation (SAV) was recorded at the sampling sites. Some small beds of sago pondweed (*Potamogeton pectinatus*) were observed along the main channel border and secondary channel border areas during informal surveys. However, the amount of SAV was negligible poolwide.

Rooted Floating–leaf Vegetation

One species (primrose-willow, [*Ludwigia peploides*]) was recorded at one isolated backwater site (Figure 5.1), which indicates that the amount of rooted floating–leaf vegetation was negligible poolwide.

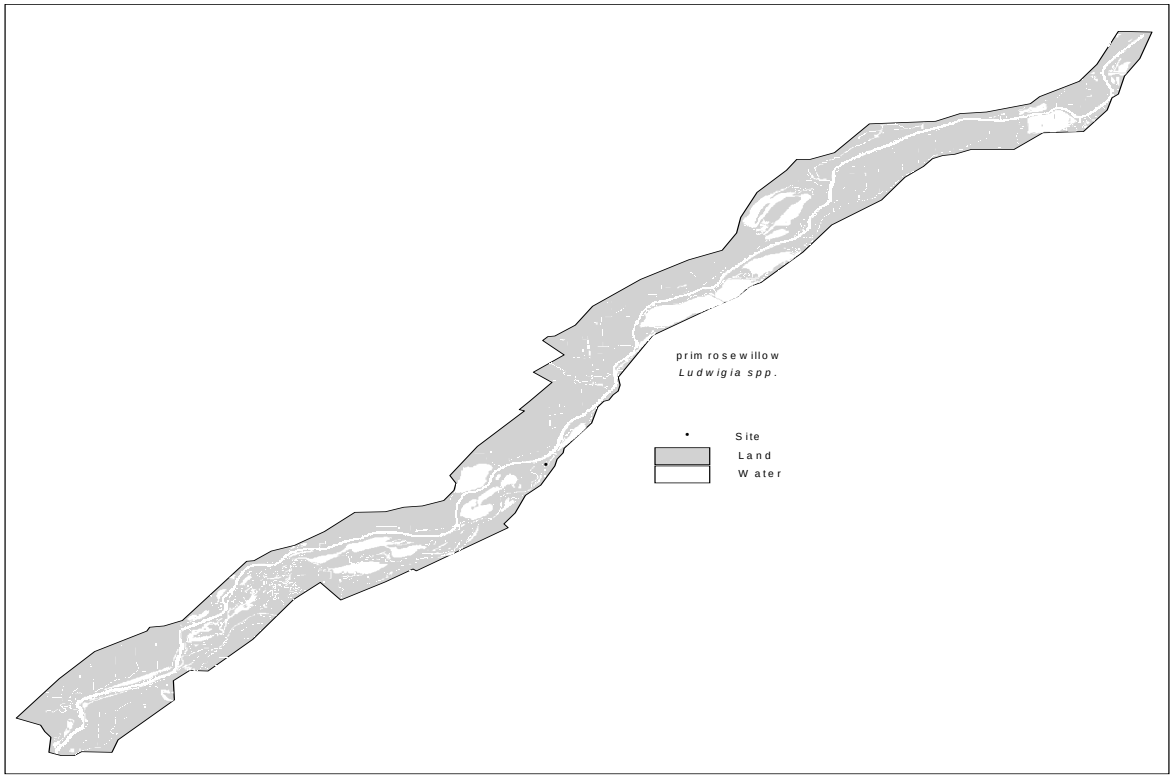

Figure 5.1. Sampling sites where species were recorded in La Grange Pool, Upper Mississippi River System, 1998.

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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.