Project Report

Qualitative Bivalve Survey of the Sandy River Drainage, Minnesota

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Abstract

Few bivalve surveys have been conducted on tributaries to the Mississippi River upstream of St. Anthony Falls in Minneapolis, Minnesota. A qualitative survey of the Sandy River basin, located primarily in Aitkin County, was conducted during August - September, 1994. The Sandy River drainage, comprised of the West Savanna, Prairie, Tamarack, and Sandy Rivers, was surveyed at thirty-two sites for freshwater bivalves. Pill clams (*Sphaerium*) and nine species of unionids were observed: *Actinonaias ligamentina*, *Anodonta grandis*, *A. imbecillis*, *Anodontoides ferussacianus*, *Lampsilis ovata*, *L. siliquoidea*, *Lasmigona compressa*, *Ligumia recta*, and *Strophitus undulatus*. Numerous populations of *Lampsilis siliquoidea*, *Anodonta grandis*, *Anodontoides ferussacianus*, and *Sphaerium* were observed throughout the drainage. Populations of *Lasmigona compressa*, *Ligumia recta*, and *Anodonta imbecillis* were scattered between tributaries. Very few *Lampsilis ovata* and *Strophitus undulatus* were observed; only one dead *Actinonaias ligamentina* was found. Greatest unionid diversity occurred in the Prairie River, which is located in a state forest. Highest CPUEs were recorded at sites in the West Savanna River, situated primarily in the Savanna Portage State Park. Lowest unionid diversity and CPUEs were observed in channelized reaches of the Sandy River.

Introduction

Freshwater mussels (unionids) are used to assess anthropogenic impact on streams throughout the United States (Bedford et al. 1968, Fikes and Tubb 1971, Slooff, et al. 1983, Thorp and Covich 1991). In the Sandy River drainage, the West Savanna and Prairie Rivers are relatively undisturbed by human development, whereas the Tamarack and Sandy Rivers have had much of their riparian areas developed for use as pasture, growing row crops, or community development. The Minnesota Pollution Control Agency, Minnesota Dept. of Natural Resources, Big Sandy Lake Association, Aitkin County Soil & Water Conservation District, and U.S. Army Corp. of Engineers are concerned about the quality of water entering Big Sandy Lake (Wilson et al. 1992). Unionids can be utilized as long-term, stationary indicators of water quality. By observing unionid diversity and frequency between the tributaries, one can obtain evidence on where water and/or habitat quality problems reside in the basin.

Very little is known about the bivalve fauna of the Sandy River drainage. According to records at Minnesota's freshwater mussel repository, the James Ford Bell Museum of Natural History, only one collection has been made from the Sandy River drainage. In 1939, *Ligumia recta* was collected from the Prairie River (Catalogue No. 2200).

The purpose of this project was to conduct a brief, qualitative survey of the unionids in the Sandy River drainage and compare the bivalve fauna between tributaries.

Study Site

The Sandy River basin (1050 km^2), a tributary to the Mississippi River, is located in north central Minnesota. Running through St. Louis, Carlton, and Aitkin Counties, the Sandy River drainage is comprised of four major tributaries: the West Savanna, Prairie, Tamarack, and the Sandy Rivers. The West Savanna and Prairie Rivers and Big Sandy Lake lie on glacial till (moraines) while the Sandy and Tamarack Rivers flow over loamy soils (lacustrine deposits) (personal communication - Steve Gorecky, Minnesota Natural Resources Conservation Service, Soil Conservation). Much of the West Savanna and Prairie Rivers lie within State owned land where there is little human development of the riparian areas. Throughout the West Savanna and upper two-thirds of the Prairie Rivers there are numerous beaver dams which create marsh areas.

The Tamarack and Sandy Rivers flow through more developed land. In addition to flowing through the towns of Wright and Cromwell (populations 162 and 229 respectively), the riparian area of the Tamarack River has been developed into pasture and for growing row crops. The Sandy River flows very close to McGregor (population 447). The upper two-thirds of the Sandy River was channelized in the early 1900's to increase the amount of arable land; the channel is maintained to this day. The riparian area of the Sandy River is being used for pasture and to grow row crops and wild rice. The West Savanna and Tamarack Rivers join the Prairie River at it's lower end and the Prairie and Sandy Rivers empty into a 38 km^2 Army Corp. of Engineer reservoir, comprised primarily of Big Sandy Lake (21 km^2), before the Sandy River joins the Mississippi River (MN Dept. Conserv. 1968). The lower third of the Sandy River is somewhat lentic in nature due to the Big Sandy Lake impoundment.

Materials and Methods

The four major tributaries of the Sandy River drainage, the Prairie, Tamarack, West Savanna, and Sandy Rivers, were qualitatively surveyed for unionids. Most surveying was conducted by two people using snorkeling equipment scanning the stream substrate for bivalves. Sites 5 and 6 were surveyed with SCUBA. Time spent surveying each site ranged from 5 min to 1.5 hr. Larger, flat rocks were occasionally turned over to search for Sphaerids and *Simpsonaias ambigua* (salamander mussel). For many sites one to four individuals of each species were kept as voucher specimens. Voucher specimens were deposited at the James Ford Bell Museum of Natural History. Bivalve nomenclature follows Turgeon et al. (1988).

Water quality samples were collected from a variety of locations in the Sandy River drainage (Figure 1). Water sampling stations consisted of either automated sampling stations (Sigma Streamline 8005L Portable Water Sampler manufactured by American Sigma and a CR10 data recorder, manufactured Campbell Scientific, Inc.) or hand-collection sites. Hand-collected samples were placed on ice and shipped the same day to the EPA laboratory (State and EPA certified) in Duluth, Minnesota.

Results and Discussion

Thirty-two sites were surveyed on the Sandy River basin (Figure 2). Nine species of unionids and the freshwater clam (*Sphaerium*) were observed. The most widespread and commonly occurring species were *Lampsilis siliquoidea*, *Anodontoides ferussacianus*, *Anodonta grandis*, and *Sphaerium*, in decreasing order (Tables 1 and 2). Populations of

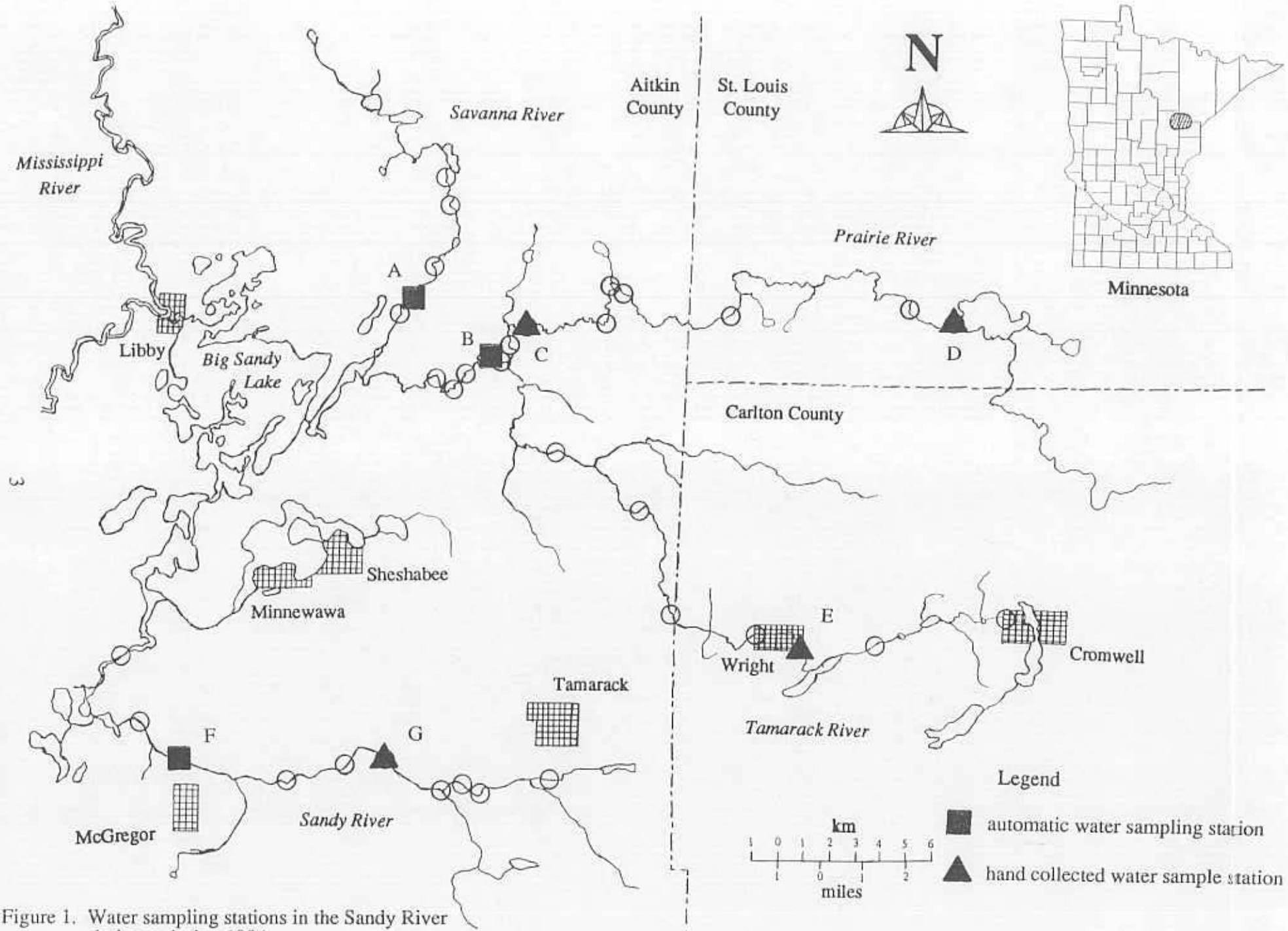

Figure 1. Water sampling stations in the Sandy River drainage during 1994.

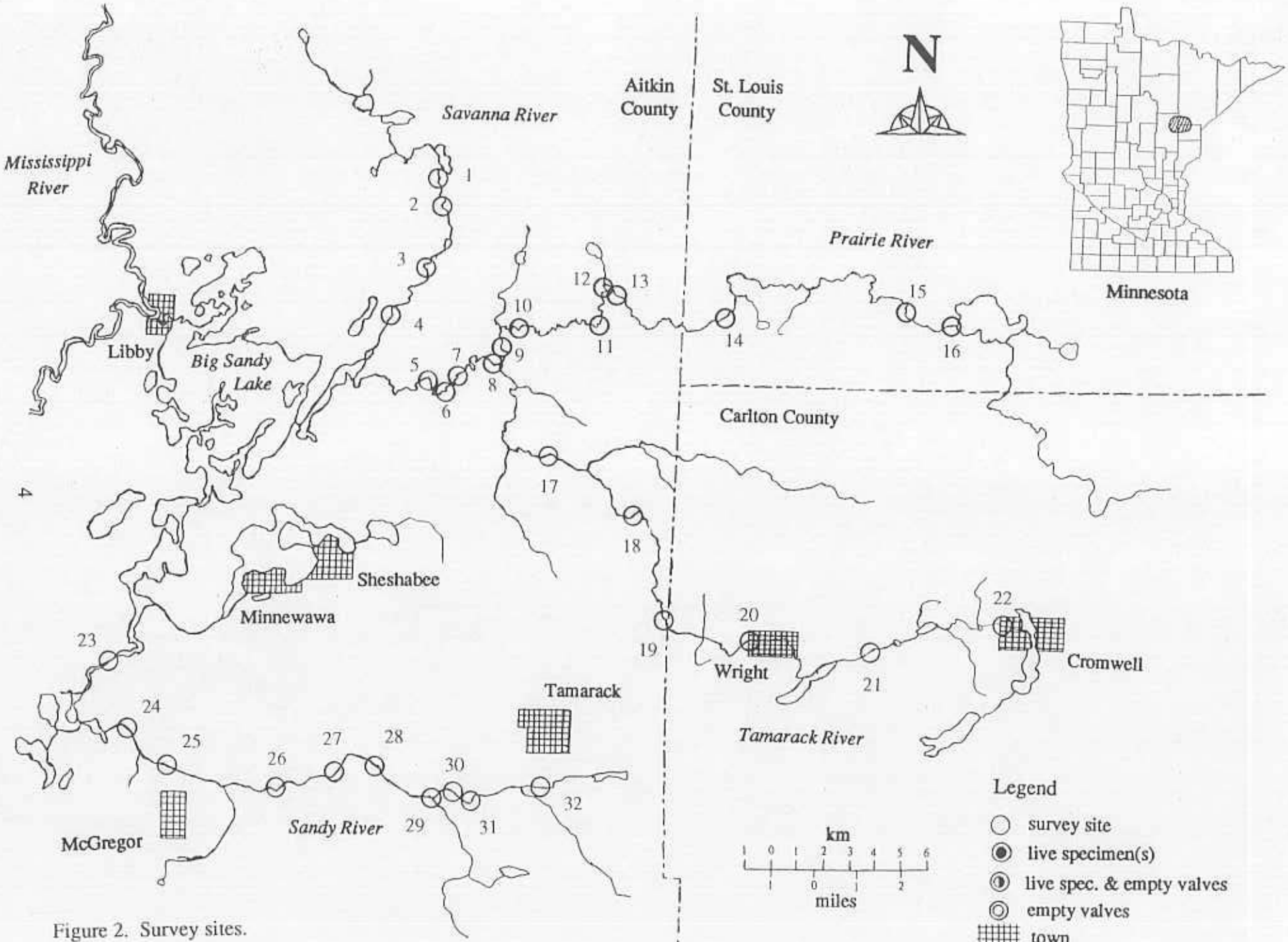

Figure 2. Survey sites.

Table 1. Frequency of bivalves observed at survey sites.

	West Savanna River				Prairie River											
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Actinonaias ligamentina																
Anodonta grandis	3	1	8	12		6		15/5*				6	7/1	25	6	23/12
Anodonta imbecillis	9/2							0/1								
Anodontoides ferussacianus	2	3	7	15			1	15/4	1	1			19	22	7	24/9
Lampsilis ovata						1		1/1								
Lampsilis siliquoidea	9/5	21	35	89/1	1/1	25	19/4	25/10	3/1	44/1		49	42/5	26	10	72/25
Lasmigona compressa		1					1					2	3			
Ligumia recta							23/4	2/1		1/4			1			
Strophitus undulatus												2				
Total live unionids	23	26	50	116	1	32	44	58	4	46	0	59	72	73	23	119
Total live unionid species	4	4	3	3	1	3	4	5	2	3	0	4	5	3	3	3
Sphaerium		35/31		50/10			32		8	10/7			20/10			40/30

* - A slash between numbers indicates the number of live specimens and dead valves observed (i.e., live/dead).

Table 1. Frequency of bivalves observed at survey sites. (continued)

	Tamarack River						Sandy River									
Species	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Actinonaias ligamentina				0/1*												
Anodonta grandis	4		1	5			29/2	11	11		0/11					2/2
Anodonta imbecillis							13	2	0/1							
Anodontoides ferussacianus	1	4	3	6			53/5	3	2/1							1
Lampsilis ovata				0/1												
Lampsilis siliquoidea	5/5	141/28	56/23	7			10		7	0/1	1	13/4	1	0/1		5
Lasmigona compressa			1													
Ligumia recta	1															
Strophitus undulatus																
Total live unionids	11	145	61	18	0	0	105	16	20	0	1	13	1	0	0	8
Total live unionid species	4	2	4	3	0	0	4	3	3	0	1	1	1	0	0	3
Sphaerium	30	42/45	75/41	14/13			81/30	3/1		6					8/8	51/15

* - A slash between numbers indicates the number of live specimens and dead valves observed (i.e., live/dead).

Table 2. Number of bivalves collected per unit hour of effort (CPUE) expended searching each survey sites.

	West Savanna River				Prairie River											
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Actinonaias ligamentina																
Anodonta grandis	9	2	16	24		8		8				6	2	12	4	18
Anodonta imbecillis	27															
Anodontoides ferussacianus	6	6	14	30			1.3	8	2	1.3			5	11	5	19
Lampsilis ovata						1.3		0.5								
Lampsilis siliquoidea	27	42	70	178	1.3	33	25	12	6	59		49	10	13	7	58
Lasmigona compressa		2					1.3					2	1			
Ligumia recta							31	1		1.3			0.2			
Strophitus undulatus												2				
CPUE live unionids	70	52	100	232	1.3	43	57	29	8	61	0	57	18	36	15	95
Sphaerium	70		100			43		16	13			5			32	

Table 2. Number of bivalves collected per unit hour of effort (CPUE) expended searching each survey sites. (continued)

	Tamarack River						Sandy River									
Species	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Actinonaias ligamentina																
Anodonta grandis	4	2	0.7	10			17	15	15							2
Anodonta imbecillis							8	3								
Anodontoides ferussacianus	1	5	2	12			32	4	3							0.8
Lampsilis ovata																
Lampsilis siliquoidea	5	188	37	14			6		9		2	17	3			4
Lasmigona compressa			0.7													
Ligumia recta	1															
Strophitus undulatus																
CPUE live unionids	10	193	40	36	0	0	63	17	27	0	2	17	3	0	0	6
Sphaerium	30	56	50	28			49	4		24					32	41

Lasmigona compressa, *Ligumia recta*, and *Anodonta imbecillis* were scattered between tributaries. Very few *Lampsilis ovata*, *Strophitus undulatus* were observed. One dead *Actinonaias ligamentina* was found. Site location, habitat, date, and survey time are described in Appendix 1.

Distribution of unionids varied between rivers. Diversity was somewhat greater in upstream sites surveyed compared to downstream sites in the West Savanna River. The lower half of the Prairie River held more species of unionids than the upper (Sites 14-16). Downstream sites (17 and 19) were more diverse than upstream sites in the Tamarack River, although Site 20 was unique. Site 20 was the furthest upstream occurrence of *Lampsilis ovata*, and the only location where *Actinonaias ligamentina* was observed. Because the diversity of Site 20 appears unusually high, we recommend the area around this site be surveyed more extensively and proper authorities at the city of Wright be notified of the unique environment just downstream of the city limits. The furthest downstream sites on the Sandy River possessed approximately the same diversity as the furthest upstream site. The central portion of the Sandy River (channelized) either did not hold unionids, or occasionally *Lampsilis siliquoidea* and/or *Sphaerium* were observed.

Qualitative differences between sites warrant further quantitative study. The West Savanna River appears to hold the most diverse and densely populated unionid community of the drainage, whereas channelized portions of the Sandy River appear to be a relatively poor bivalve environment (Table 3).

Table 3. Average number of unionid species, number of unionids/site, and unionid catch per unit effort (CPUE=number observed/hr) observed in tributaries of the Sandy River drainage.

Tributary	Average number of unionid species	Average number of unionids/site ± 1 S.D.	Average unionid CPUE ± 1 S.D.
W. Savanna River	4 ± 1	54 ± 43	114 ± 81
Prairie River	3 ± 2	44 ± 35	35 ± 29
Tamarack River	2 ± 2	39 ± 56	46 ± 74
Sandy River* (unchannelized)	4 ± 1	61 ± 63	40 ± 32
Sandy River (channelized)	1 ± 1	5 ± 8	7 ± 10

* - Sites 23 and 24

The rarity and simplicity of the unionid community in the channelized Sandy River suggests there may be water quality and/or habitat degradation relative to the other tributaries. Water quality variables recorded between March and November, 1994 are summarized in Table 4 and described completely in Appendix 3. The Sandy River has higher concentrations of total phosphorus, nitrates and nitrites, and higher turbidity and total suspended solid levels than average values recorded from minimally impacted rivers in northern Minnesota (McCollor and Heiskary 1993). Heavy silt loads are known to be deleterious to unionids (Marking and Bills 1980). Habitat degradation due to stream channelization has been shown to lower unionid diversity (Stein 1972). If pesticides enter the river they will likely have a negative impact on unionids as well (Havlik and Marking 1987).

Table 4. Water quality measurements (mean ± 1 standard deviation) collected during 1994 from Minnesota Department of Natural Resources water quality stations.

Station	Total Phosphorus (mg/L)	Ortho-phosphorus (mg/L)	Ammonium nitrate (mg/L)	Nitrite and nitrate (mg/L)	Total Kjeldahl nitrogen (mg/L)	Color[1]	pH[2]	Total suspended solids (mg/L)	Turbidity (NTU's)[3]	Alkalinity (mg/L)	Hardness (mg/L)	Suspended volatile solids (mg/L)
A	0.041 ± 0.009	0.009 ± 0.004	0.06 ± 0.04	0.04 ± 0.04	0.88 ± 0.34	124 ± 28	7.4	4 ± 3	2.5 ± 0.7	59 ± 6	63 ± 4	2 ± 1
B	0.053 ± 0.014	0.012 ± 0.005	0.06 ± 0.05	0.10 ± 0.11	0.92 ± 0.31	179 ± 49	7.0	10 ± 7	4.2 ± 1.1	40 ± 15	56 ± 7	2 ± 1.4
C	0.052 ± 0.014	0.011 ± 0.005	0.054 ± 0.043	0.057 ± 0.048	0.95 ± 0.53	168 ± 45	6.9	10 ± 8	4.1 ± 1.1	41 ± 7	48 ± 6	3 ± 0
D	0.036 ± 0.010	0.008 ± 0.006	0.05 ± 0.04	0.09 ± 0.07	0.75 ± 0.20	123 ± 26	7.2	2.5 ± 1.2	2.5 ± 0.8	49 ± 10	59 ± 4	2 ± 1.4
E	0.044 ± 0.008	0.011 ± 0.006	0.05 ± 0.03	0.06 ± 0.07	0.88 ± 0.37	137 ± 30	7.2	4 ± 3	2.2 ± 0.9	55 ± 4	64 ± 5	1.5 ± 0.7
F	0.072 ± 0.027	0.014 ± 0.01	0.14 ± 0.16	0.07 ± 0.08	1.44 ± 0.42	209 ± 65	6.8	13 ± 17	6.7 ± 2.2	44 ± 32	66 ± 27	2 ± 0
G	0.068 ± 0.021	0.013 ± 0.007	0.05 ± 0.04	0.04 ± 0.02	1.2 ± 0.3	222 ± 68	6.7	12 ± 9	4.9 ± 1.8	29 ± 17	48 ± 11	2.5 ± 2

[1] - Pt-Co is an abbreviation for Platinum - Cobalt units.
[2] - One sample collected.
[3]- NTU's is an acronym standing for nephelometric turbidity units.

Species Accounts

Unionids encountered during this survey are discussed in relation to their distribution and habitat. Distribution maps for each species are located in Appendix 2.

Actinonaias ligamentina (Lamarck, 1819) — mucket

A single pair of empty *Actinonaias ligamentina* valves were found during this survey (Site 20). Site 20 is on the Tamarack River situated on the western edge of the small town of Wright (pop. 162). We estimate the valves are 2-3 years old.

The occurrence of *A. ligamentina* in the upper Mississippi River is highly unusual (Graf 1994). According to Bell Museum records, this species is only recorded as far upstream in the Mississippi River as the Rum River drainage. A specimen is also recorded from Cass Lake, however, due to incomplete records, it is unclear whether or not the specimen was collected from the Mississippi River drainage in Cass County. This species is locally common throughout much of the rest of the Mississippi River drainage and eastern Great Lakes (Clarke 1981, Oesch 1984, Cummings and Mayer 1992).

Anodonta grandis (Say, 1829) — giant floater

Anodonta grandis are found in many lakes and rivers throughout the United States and Canada (Clarke 1981, Oesch 1984). It was the third most numerous and frequently encountered species during in this survey (Tables 1 and 2). *A. grandis* were found at a majority of sites in the West Savanna and Prairie Rivers and at approximately half the sites on the Sandy and Tamarack Rivers. These unionids were usually found in areas of low water velocity; especially in pools formed by beaver dams. They generally inhabited substrates comprised of sand and silt.

Anodonta imbecillis (Say, 1829) — paper pondshell

Live *Anodonta imbecillis* were common in the upper West Savanna River and scattered in the lower Sandy River. *A. imbecillis* comprised nearly half the unionids collected at Site 1 on the West Savanna River. CPUE was average to low at Sandy River sites. One pair of empty valves were collected in the Prairie River (Site 8). *A. imbecillis* were found in pools in the West Savanna River and slow moving runs in the lower Sandy River. They generally inhabited sandy substrates, rarely silt.

Anodonta imbecillis is a locally abundant and widespread unionid (Cummings and Mayer 1992). Bell Museum records show this species to be scattered about the center of the state (Graf 1994). It occurs throughout much of the Mississippi River basin, easterly portions of the Great Lakes, and in Gulf Coast drainages west of the Mississippi River to approximately Mexico (Clarke 1981, Oesch 1984).

Anodontoides ferussacianus (I. Lea, 1834) — cylindrical papershell

Anodontoides ferussacianus was the second most frequently encountered and numerous unionid observed during this survey (Tables 1 and 2). These unionids were found at the majority of sites in the West Savanna, Prairie, and Tamarack Rivers and were frequently observed in the lower Sandy River. *A. ferussacianus* were usually found in areas of low water velocity, especially in beaver ponds, and generally inhabited sand and silt substrates.

Anodontoides ferussacianus are often found in small streams (Cummings and Mayer 1992). In west-central Minnesota this species lives in the upper reaches of tributaries to

the Minnesota and Red Rivers (Graf 1994). *A. ferussacianus* is distributed throughout the central and upper Mississippi River, the Great Lakes area, and southern Ontario and Manitoba (Clarke 1981, Oesch 1984).

Lampsilis ovata (Say, 1817) — pocketbook

Lampsilis ovata was rarely observed during this survey. Live *L. ovata* were observed in the lower Prairie River (Sites 6 and 8). One valve was collected at Site 20 on the Tamarack River. In the Prairie River this unionid was observed in the center of the stream under moderate flow, where the substrate was primarily sand, gravel, and rubble.

Lampsilis ovata is a relatively common species. In Minnesota, *L. ovata* is found in many drainages (Graf 1994). This species is common throughout the central and upper Mississippi River drainage, Great Lakes region, and lower Saskatchewan (Clarke 1981, Oesch 1984, Cummings and Mayer 1992).

Lampsilis siliquoidea (Barnes, 1823) — fatmucket

Lampsilis siliquoidea was the most commonly encountered, and widely distributed unionid observed during this survey. They were found at nearly every site and within each of the four rivers, including, in small numbers, channelized portions of the Sandy River. *L. siliquoidea* was usually found in slow moving runs and pools, especially common in beaver ponds, generally inhabiting sand and silt substrates.

Lampsilis siliquoidea is a very common and widely distributed species. It is found in many rivers and lakes in Minnesota (Graf 1994). It is found throughout much of the Mississippi River drainage, Great Lakes area, and lower half of central Canada (Clarke 1981, Oesch 1984).

Lasmigona compressa (I. Lea, 1829) — creek heelsplitter

Lasmigona compressa was uncommonly encountered during this survey. The species was observed at centrally located sites in the West Savanna and Tamarack Rivers. *L. compressa* was observed at three sites in the lower third of the Prairie River. This species usually inhabited substrate comprised of sand, gravel, and rubble with modest water velocity.

Lasmigona compressa has been observed in a variety of tributaries scattered about central Minnesota, east-central United States and Canada, although locally uncommon (Clarke 1981, Cummings and Mayer 1992, Williams et al. 1992, Graf 1994).

Ligumia recta (Lamarck, 1819) — black sandshell

Ligumia recta was observed in the lower portions of the Prairie and Tamarack Rivers. It was relatively uncommon, although 23 were observed at Site 7 on the Prairie River (CPUE=31/hr). The black sandshell has been collected from the Prairie River in the past (Bell Museum of Natural History, Catalogue No. 2200). This species is considered a medium-river species (Cummings and Mayer 1992) and was found during this survey only in the lower one-third of the Prairie and Tamarack rivers. The species frequently occupied sand, gravel, and rubble habitats with moderate current.

Ligumia recta is widespread in North America although relatively uncommon in the midwest (Cummings and Mayer 1992). It is found in many drainages in Minnesota and throughout much of the Mississippi River drainage and the Great Lakes in Canada (Clarke 1981, Oesch 1984, Graf 1994).

Strophitus undulatus (Say, 1817) — squawfoot

Strophitus undulatus was rarely encountered during this survey. Two individuals were found at Site 12. *Strophitus undulatus* inhabits a variety of tributaries in central Minnesota and is widespread and common throughout central and northeast United States and southern Canada in a wide perimeter around the Great Lakes (Clarke 1981, Oesch 1984, Cummings and Mayer 1992, Graf 1994).

Other bivalves

Sphaerids were relatively common in all tributaries of the Sandy River drainage. Sphaerids are generally common and spread throughout most of North America (Clarke 1981, Thorp and Covich 1991).

No exotic bivalves, *Corbicula fluminea* or *Dreissena polymorpha*, were observed.

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