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# 2003 Lichen Studies in St. Croix National Scenic Riverway

Final Report

Submitted to  
St. Croix National Scenic Riverway  
National Park Service  
St. Croix Falls, Wisconsin  
PO # R6590RM3026

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## **Summary**

During 2003 a re-study of the lichens of St. Croix National Scenic Riverway was done. In addition to collections for elemental analysis, new complete lichen collections were made at 15 localities for new species records. There are now 282 lichens found in the park and the new species list should replace the list prepared for the 1991 report. This list includes 20 new species for the park. There are eight species in the park that are on the lists of threatened or endangered lichens for Minnesota or Wisconsin. The number of lichen species increases significantly about eight species per degree of latitude from south to north. The most number of species by county were found in Burnett Co., WI.

Lead has decreased significantly overall since the first sampling in 1990, but continues to be higher at Riverside than anywhere else. A local source of lead in this area remains a mystery. Cadmium has not decreased significantly over time, and continues to be elevated at Namekagon Dam. Other lichen species at this locality also have elevated Cd, confirming that there is probably an unknown local source of this element. Unlike the previous two heavy metals, Mn has increased significantly over time, and appears to be very high at Radspur

## **Introduction**

In 1990 a study was done on lichens and air quality in St. Croix National Scenic Riverway (Wetmore 1991). The final report recommended that a re-study of elemental analysis be done every 3-5 years. This report presents the re-study of the elemental analysis and includes a revision of the species list based on additional collecting done in 2003. The nomenclature of lichens over the past 12 years has seen many changes. Many of the larger genera have been split into smaller ones and re-identifications of the old group species have been revised by

monographers leading to narrower species concepts. This report presents a revised total species list for the park based mostly on the North American Checklist (Esslinger & Egan 1995).

Over 345 new collections for the lichen flora were made at 15 new localities (Appendix 1) and vouchers are deposited in the University of Minnesota Herbarium. Field work and species identification was done by the first author. Latitude and county analyses were done by the second author.

Collecting for elemental analysis was done in 2003 at six of the 10 old sites and three new sites. The Namekagon River section in original study was done by canoe and some of those sites could not be visited because of lack of road access in 2003. All of the analysis of elemental data was done by the second author.

### **Lichen Flora**

Appendix 2 lists the 282 species in the park and the 20 new species are indicated by an asterisk. Most of these are a result of new identifications of previous collections (17 of the 20) done, in part, by monographers of the groups. However, there were three species collected in 2003 that were not collected previously in the park (*Multiclavula vernalis*, *Ramalina dilacerata*, and *Staurothele diffractella*). Most of the other name changes are due to the modern smaller generic concepts. This is particularly true in the old genus *Parmelia*. No attempt has been made to correct the old list and this new list should replace the list from 1991.

When the original report was written there was only a list of threatened and endangered lichens for Minnesota (Coffin & Pfannmuller 1988, Minnesota DNR 2004) and the only species in the park on this list was *Parmotrema stuppeum*. Recently a proposed list for Wisconsin was published (Bennett & Wetmore 2004). Table 1 lists eight threatened or endangered lichens on

these two lists that were found in the park and the localities where they were collected. All of these listed species were collected during the previous study and no new collections of these species were made in the 2003 study.

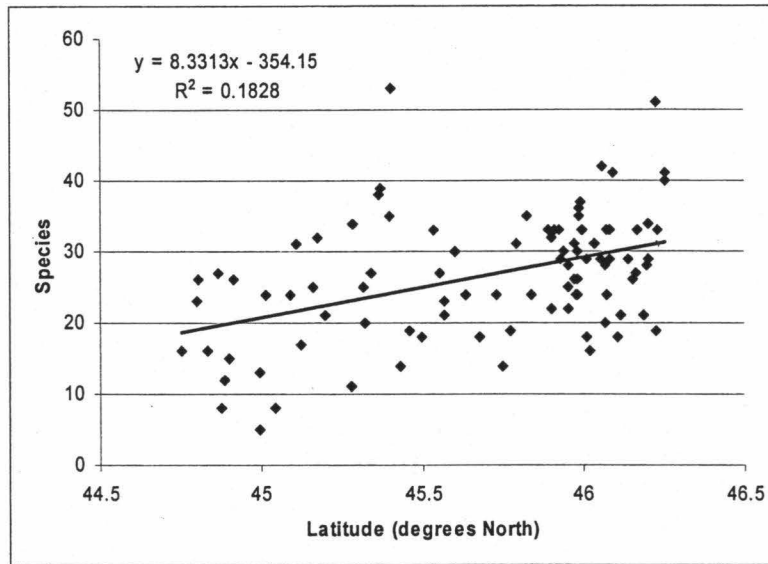
**Table 1. Minnesota and Wisconsin listed rare species in St. Croix National Scenic Riverway\***

Species	Locality
<i>Cladonia decorticata</i>	Listed in WI, found at locality 67 (Polk Co., WI) <i>Taylor Falls</i>
<i>Fuscopannaria leucophaea</i>	Listed in WI, found at locality 69 (Chisago Co., MN) <i>Taylor Falls</i>
<i>Fuscopannaria leucosticta</i>	Listed in WI, found at locality 30 (Douglas Co., WI) <i>Borden Dam</i>
<i>Leptogium arsenei</i>	Listed in WI, found at locality 30 (2 collections) (Douglas Co., WI) <i>Borden Dam</i>
<i>Parmotrema stuppeum</i>	Listed in MN & WI, found at locality 70 (Chisago Co., MN) <i>Arrowhead</i>
<i>Phaeophyscia melanchra</i>	Listed in WI (as <i>Physciella melanchra</i> ), found at locality 24 and 64 (Washburn & Polk Co., WI)
<i>Ramalina unifolia</i>	Listed in WI, found at locality 31 and 52 (Douglas Co. and Burnett Co., WI and Pine Co., MN)
<i>Usnea rubicunda</i>	Listed in MN, found at locality 44 and 89 (Pine Co. and Washington Co., MN) (Listed as extinct in WI and not found in SACN in WI) <i>Zale Tamit Brook</i>

\*The locality number is at the beginning of each locality in Appendix 1.

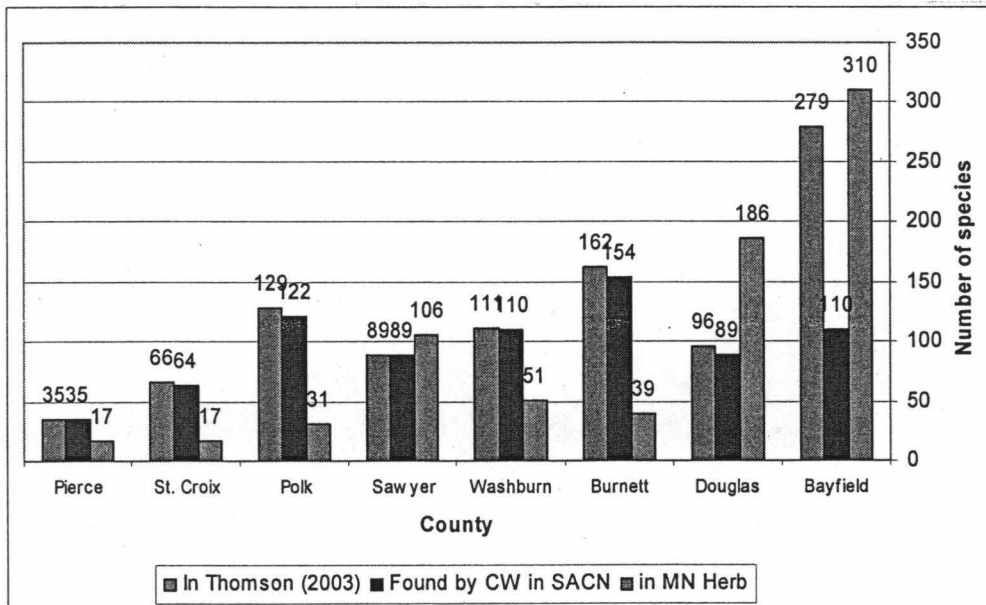
The number of species per locality decreases slightly from north to south along the river (Fig. 1). The average at the north end is 25 and at the south end the average is 15. The number of species per locality varies considerably due to the different ecology of each locality. The decrease in species numbers from north to south is mostly due to the natural trend in species numbers from north to south in the Great Lakes region (Bennett & Wetmore 1999) and not air quality. The largest number of species occurs at the Taylors Falls and Namekagon Dam because TF has abundant exposed rocks, which are good habitats for crustose species, and ND has a mixed, diverse habitat of forest and rocky openings.

**Figure 1. Number of species at each locality from south to north\***



\*A significant but weak regression through the points is shown, and the equation data given at the top. The number of species increases a little over 8 species per degree of latitude. Based on data for 93 localities from 1990 & 2003.

**Figure 2. Number of species known from Wisconsin counties the park is in, from south to north\***



\*Data are from Thomson 2003 for Wisconsin counties (tabulated by JPB), this report, and those found in the University of Minnesota Herbarium.

In two of the eight Wisconsin counties (Bayfield and Douglas) the park is in, the park contains less than half of the number of species in those counties according to Thomson (2003)

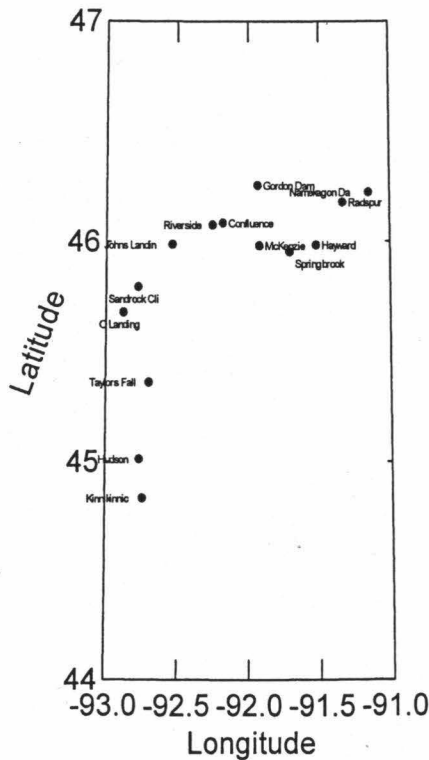
(Fig. 2). In the remaining six counties, the park either adds significantly to the county flora (Burnett, Washburn, Polk, St. Croix and Pierce), or is close to the number found in Thomson (Sawyer).

## Elemental analysis

### Methods

Collections of five species were made for elemental analysis at as many of the old localities as possible and at three new localities (Fig. 3) (Appendix 3). The species collected were *Cladina rangiferina*, *Evernia mesomorpha*, *Hypogymnia physodes*, *Parmelia sulcata*, and *Punctelia rudecta* (Table 2). Not all species were available at all localities and some of the localities where *P. rudecta* were found in the previous localities the species could not be found during the present study. Ten to 20 grams of each species were collected at each locality.

**Figure 3. Elemental analysis collection localities**



Lichens were air dried and cleaned of all bark and detritus under a dissecting microscope but thalli were not washed. Three samples of each collection were submitted for analysis. Some replicates of each species were ground before being divided for analysis and are so marked in the tables. Analysis was done for sulfur and multi-element analysis by the Research Analytical Laboratory at the University of Minnesota. In the sulfur analysis a ground and pelleted 100-150 mg sample was prepared for total sulfur by dry combustion and measurement of evolved sulfur dioxide on a LECO Sulfur Determinator, Model SC-132, by infrared absorption. Multi-element determination for Ca, Mg, Na, K, P, Fe, Mn, Al, Cu, Zn, Cd, Cr, Ni, Pb, and B were determined simultaneously by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry. For the ICP one gram of dried plant material was dry ashed in a 20 ml high form silica crucible at 485 degrees Celsius for 10-12 hrs. Crucibles were covered during the ashing as a precaution against contamination. The dry ash was boiled in 2N HCl to improve the recovery of Fe, Al and Cr and followed by transfer of the supernatant to 7 ml plastic disposable tubes for direct determination by ICP.

## Results

The number of lichen samples by locality and species across the two study periods are shown in Table 2. The largest number of samples is for *Punctelia rufescens* because this is the only species sampled both times. The other species were sampled only in 2003.

The elemental analyses are presented in three sections: the first compares *Punctelia rufescens* over two sampling periods, the second all five species in 2003, and the third the substrate differences for *Parmelia* and *Punctelia* in 2003. Table 3 presents the element means for *Punctelia* for the three sampling years. The entire elemental data set for 2003 is in Appendix 4.



**Table 2. Number of lichen samples by locality in geographic order, northeast to southwest**

Locality	Cladina	Evernia	Hypogymnia	Parmelia	Punctelia	Total
Namekagon Dam South (2003)		3	3	3	3	12
Namekagon Dam West (1990 & 2003)				3	6	9
Radspur (2003)			1	3		4
Hayward (2003)	3	3	3	3		12
Springbrook (1990)					3	3
McKenzie (1990)					3	3
Gordon Dam (1990 & 2003)				6	9	15
Confluence (2003)	6	3	3	3		12
Riverside (1990 & 2003)					6	6
Johns Landing (1990 & 2003)				3	6	9
Sandrock (2003)				3		3
O Landing (1990 & 2003)					6	6
Taylor's Falls (1988)					3	3
Hudson (1988)					3	3
Kinnikinnic (1988 & 2003)					6	6
Total	9	9	10	27	54	109

**Table 3. Element means of *Punctelia rudecta* by year (ppm)\***

Element	1988	1990	2003	F prob
<b>Al</b>	<b>831</b>	<b>748</b>	<b>472</b>	0.000
<b>B</b>	<b>1.34</b>	<b>2.65</b>	<b>3.76</b>	0.000
<b>Ca</b>	<b>93674</b>	<b>85165</b>	<b>60427</b>	0.008
Cd	0.62	0.77	0.57	0.281
<b>Cr</b>	<b>0.91</b>	<b>1.35</b>	<b>1.08</b>	0.008
<b>Cu</b>	<b>3.44</b>	<b>4.02</b>	<b>5.19</b>	0.000
<b>Fe</b>	<b>393</b>	<b>645</b>	<b>466</b>	0.003
K	3047	2545	2789	0.142
Mg	672	727	578	0.082
<b>Mn</b>	<b>24.7</b>	<b>31.7</b>	<b>88.2</b>	0.002
<b>Na</b>	<b>28.4</b>	<b>26.9</b>	<b>35.0</b>	0.001
Ni	1.28	1.49	1.22	0.098
<b>P</b>	<b>1391</b>	<b>680</b>	<b>868</b>	0.000
<b>Pb</b>	<b>10.8</b>	<b>20.0</b>	<b>7.8</b>	0.000
<b>S</b>	<b>1326</b>	<b>926</b>	<b>887</b>	0.000
Zn	30.1	33.5	38.0	0.770
Sample size	9	21	24	54

\*Elements in bold are significantly different between years at the 0.05 probability level, as determined by the F probabilities from analyses of variance.

The following elements have decreased over time: Al, Ca, Fe, P, Pb and S. These are a mixture of soil (Al, Ca and Fe), nutrient (P and S), and pollutant (Pb and maybe S) elements.

The following elements have increased over time: B, Cr, Cu, Mn, and Na. These are a mixture of soil (B, Cr and Na) and heavy metal (Cu and Mn) elements.

The following elements did not change significantly over time: Cd, K, Mg, Ni and Zn. These are a mixture of nutrient (K and Mg) and heavy metal (Cd, Ni and Zn) elements.

All elements were significantly different ( $P < 0.001$ ) among species in 2003 (Table 4). Twelve of the 16 elements were highest in *Parmelia sulcata*. One element, Ca, was highest in *Punctelia rudecta*, S was highest in *Evernia mesomorpha*, and Cd and Mn were highest in *Hypogymnia physodes*.

Table 4. Element means by species in 2003 (ppm)\*

Element	Cladina	Evernia	Hypogymnia	Parmelia	Punctelia
Al	459	633	491	<b>868</b>	472
B	1.71	2.74	3.23	<b>6.03</b>	3.76
Ca	926	2541	31822	4068	<b>60427</b>
Cd	0.22	0.30	<b>2.12</b>	0.69	0.57
Cr	0.88	1.32	0.88	<b>1.48</b>	1.08
Cu	2.14	3.23	4.47	<b>6.66</b>	5.19
Fe	422	728	530	<b>904</b>	466
K	1998	2596	3085	<b>4492</b>	2789
Mg	403	443	960	<b>1005</b>	578
Mn	71	47	<b>285</b>	221	88
Na	25.2	35.1	28.5	<b>37.1</b>	35.0
Ni	0.90	1.56	1.28	<b>1.58</b>	1.22
P	639	708	716	<b>1670</b>	868
Pb	no data	2.18	5.93	<b>8.29</b>	7.80
S	932	<b>1648</b>	1400	1562	887
Zn	23	39	77	<b>77</b>	38
Sample size	9	9	10	27	24

\*The highest mean for each element is in bold font

Most elements across species in 2003 were significantly different ( $P < 0.05$ ) among localities except Al, Fe, and S. This suggested there may be geographic patterns to the elements. All the localities except Kinnikinnic were arrayed in a predominant west to east transect, so the means across species were regressed against longitude (Table 5). Only one element, Cd, shows a trend, increasing from west to east. All other elements have higher values somewhere along the west to east riverway in the study area. Cadmium was highest in *Punctelia rudecta* at Namekagon Dam (Figs. 4 & 5).

**Table 5. Linear regression parameters of elements against longitude, based on 79 samples**

Element	Intercept	T prob	Slope	T prob	R <sup>2</sup>
Al	-8375	0.064	-97.9	0.046	0.051
B	23.6	0.483	0.212	0.562	0.004
Ca	-346249	0.552	-4032	0.525	0.005
Cd	40.1	0.001	0.428	0.001	0.133
Cr	-11.5	0.086	-0.138	0.059	0.046
Cu	-6.30	0.844	-0.123	0.724	0.002
Fe	-2677	0.574	-36.2	0.485	0.006
K	11478	0.607	89.1	0.714	0.002
Mg	-5815	0.314	-71.3	0.257	0.017
Mn	5540	0.017	58.7	0.020	0.069
Na	172.8	0.322	1.51	0.425	0.008
Ni	-0.610	0.944	-0.021	0.822	0.001
P	-1924	0.861	-32.7	0.785	0.001
Pb	19.5	0.766	0.134	0.850	0.001
S	3601	0.610	25.3	0.742	0.001
Zn	631.6	0.273	6.28	0.317	0.013

Figure 4. Cadmium in *Punctelia rudecta* in 2003

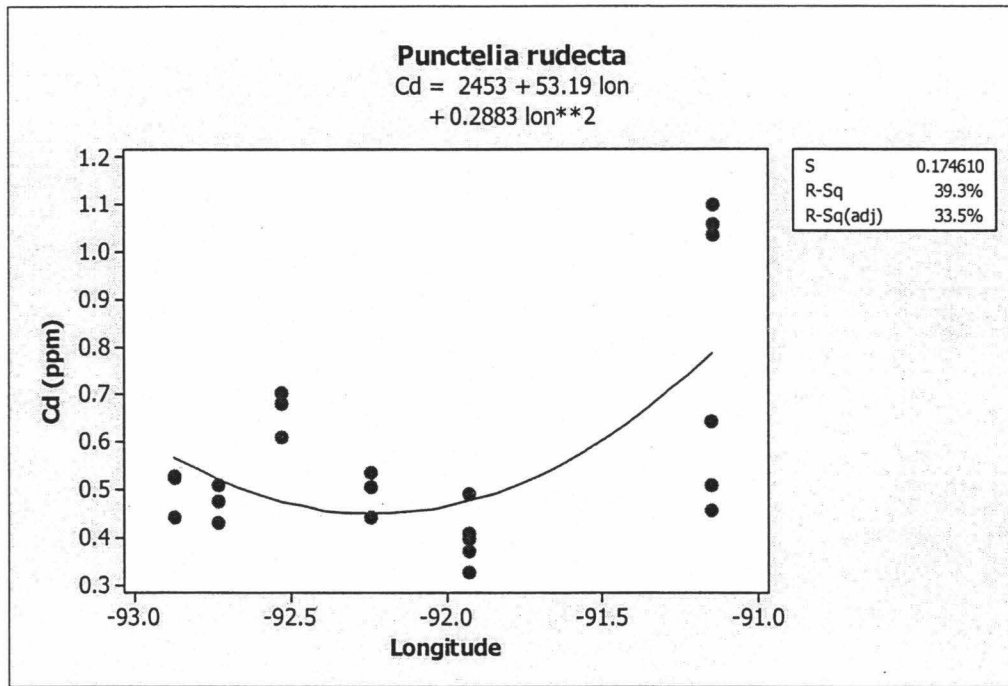


Figure 5. Cadmium (ppm) in all species in 2003

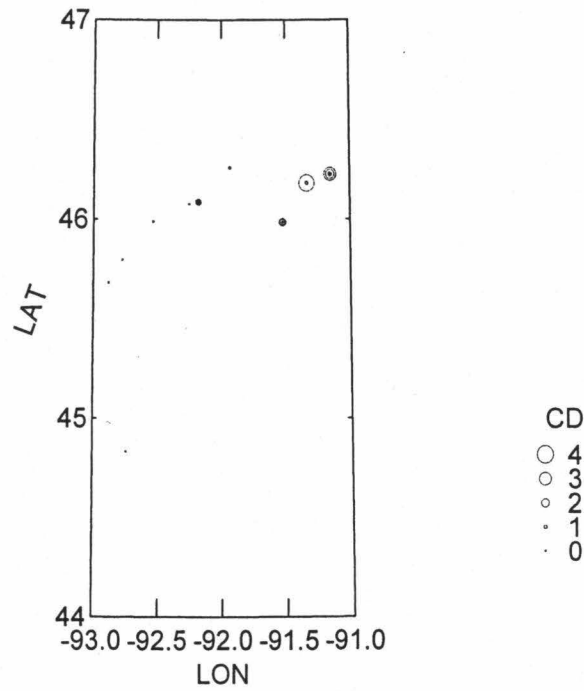
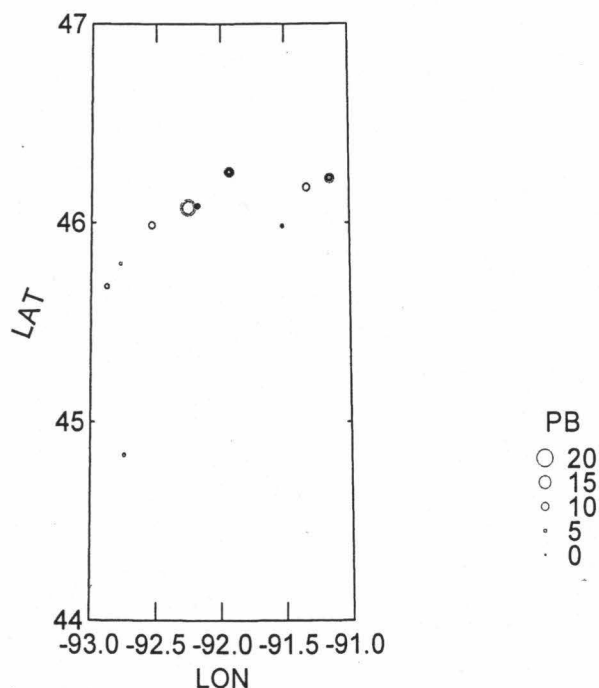


Figure 6. Lead (ppm) in all species in 2003



Interestingly, Cd was not highest at the same localities where Pb was highest (Fig 6), indicating they are not coming from the same source.

Samples of *Parmelia* and *Punctelia* from hardwood and evergreen tree types were taken at Gordon Dam in 2003 to determine the effect of substrate type on elemental content (Table 6). The data were analyzed by a two-way analysis of variance. The lichen species were significantly different for all elements, with all elements being higher in *Parmelia* except Ca. Sulfur and Zn did not differ significantly depending on tree type but all other elements did. However, there were significant interactions between tree type and lichen species for most elements except Cu, Mn, Pb and S. In general, Al, B, Ca, Cr, Cu, Fe, Mg, Na, Ni, Pb and Zn were higher in lichens on hardwoods, and Cd, K, Mn, P and S were higher in lichens on evergreens.

Table 6. Element content of *Parmelia* and *Punctelia* on different tree types (ppm)\*

Element	<i>Parmelia</i>		<i>Punctelia</i>		F probabilities		
	Balsam fir	Hardwood	Conifer	Hardwood	Species	Tree type	Sp x tree type
Al	663	1020	404	322	0	0	0
B	6.86	7.51	2.58	6.35	0	0	0.003
Ca	2829	6788	45442	99039	0	0.001	0.003
Cd	0.817	0.335	0.420	0.377	0	0	0
Cr	1.289	1.848	0.814	0.850	0	0.001	0.002
Cu	6.15	7.74	4.25	5.94	0	0	0.708
Fe	802	1117	420	312	0	0.018	0
K	6070	4241	2321	2512	0	0	0
Mg	1008	1356	462	562	0	0.001	0.026
Mn	271	1753	63	14	0	0.004	0.234
Na	30.6	34.9	20.7	32.7	0	0	0.005
Ni	1.08	1.62	0.96	1.06	0	0	0.004
P	2899	1597	603	736	0	0	0
Pb	9.23	11.67	4.58	6.99	0	0	0.969
S	1686	1658	855	650	0	0.185	0.304
Zn	73.3	84.6	22.2	17.2	0	0.195	0.007
Sample size	3	3	3	3			

\*Means significantly different are in bold font. Means not significantly different for any source of variation are in italic font.

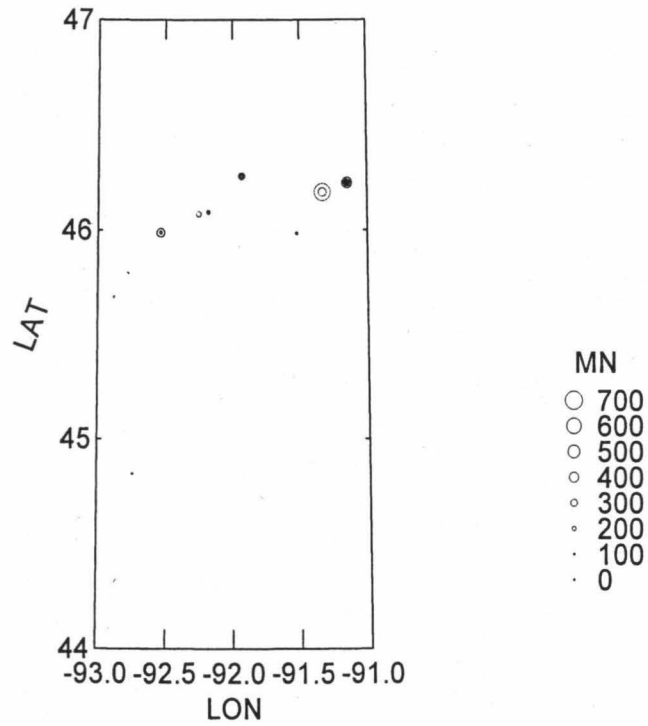
## Discussion of Elemental Analyses

Lead has decreased significantly overall since the first sampling in 1990, but continues to be higher at Riverside than anywhere else. This site was located miles from the nearest major highway. A local source of lead in this area continues to be a mystery.

Cadmium has not decreased significantly over time, and continues to be elevated at Namekagon Dam. Other lichen species at this locality also have elevated Cd, confirming that there is probably an unknown local source of this element.

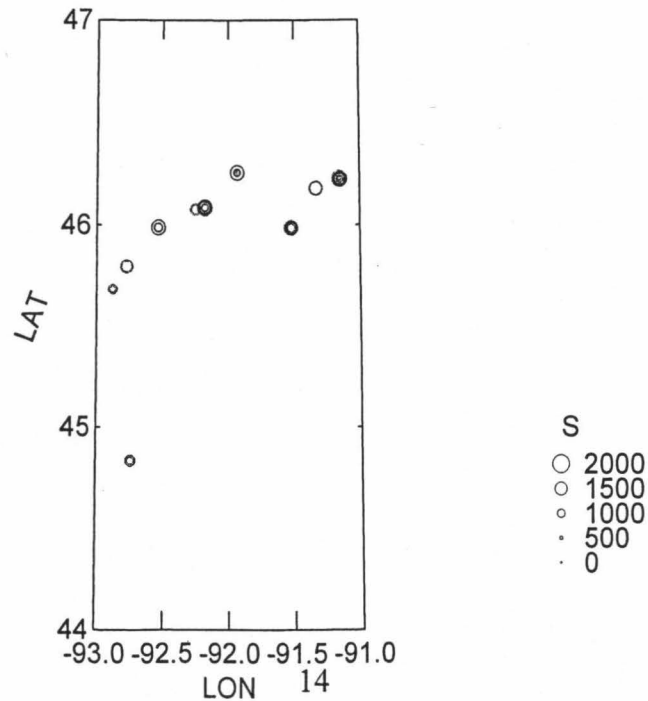
Unlike the previous two heavy metals, Mn has increased significantly over time, and appears to be very high at Radspur (Fig. 7).

Figure 7. Manganese (ppm) in all species in 2003



Sulfur, a pollutant from power plant stacks, has declined significantly over time. It appears to be slightly higher at the more northeastern localities (Fig. 8).

Figure 8. Sulfur (ppm) in all lichens in 2003



Other elements that have changed over time included a mixture of soil, nutrient and heavy metals with no obvious patterns.

Elements vary significantly between species, with *Parmelia sulcata* having most of the highest concentrations, followed by the two other foliose species. This suggests that this species is probably the best one to continue sampling, although *Punctelia* and *Hypogymnia* are good for some elements as well.

Spatial patterns of some elements, particularly Cd and Mn, continue to show odd high values in the northeast part of the park. More detailed work on these elements in this region is needed to elucidate a possible cause of this pattern.

The substrate study at Gordon Dam indicates that most elements are higher in lichens on hardwoods, which is contrary to expected. Evergreens are thought to intercept more air flow because they have higher foliage areas, and thus there would be higher concentrations in throughfall under the canopy. However, some of the elements in this study were higher under evergreens and they are some of the ones of greater interest: Cd and Mn. It appears that tree type can significantly affect element content of lichens, and this must be taken into account in future studies. Some lichen species should be collected under one type of canopy, while others may have to be collected under both.

### **Acknowledgements**

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## APPENDIX 1

All localities of collections by C. Wetmore in St. Croix National Scenic Riverway. Localities are listed and numbered in order first from the headwaters of the Namekagon river south to the St. Croix and then from the headwaters of the St. Croix down to Hastings. Localities where no collections were made (elemental analysis only) are not numbered. Numbers at the end of each locality are Wetmore collection numbers at that locality. Localities where latitude and longitude were obtained from maps instead of GPS are in brackets ([ ]). NEW refers to new localities in 2003.

### **Namekagon River**

Bayfield County, Wisc., Namekagon Dam area at Lake Namekagon (7 mi NE of Cable). Lakeshore on bay E of bridge. Sec. 8, T43N, R6W. 46°13'18"N, 91°08'49"W. 16 July 2003. CHEMICAL ANALYSIS ONLY 2003. NEW

1. Bayfield County, Wisc., Namekagon Dam area at Lake Namekagon (7 mi NE of Cable). At west end of lake near shore with sugar maple and basswood and some yellow birch and pines. Sec. 8, T43N, R6W. 46°13'26"N, 91°08'59"W. 5 July 1990. 66221-662766 CHEMICAL ANALYSIS 1990, 2003.

2. Bayfield County, Wisc., South of Lake Tahkodah along Namekagon River (4 mi NE of Cable). In lowland with alder, balsam fir, and quaking aspen. Sec. 3, T43N, R7W. [46°13'43"N, 91°13'09"W]. 6 July 1990. 66277-66313.

3. Bayfield County, Wisc. 3 mi E of Cable at Namekagon River near Fivemile Creek. On ridge in swamp with Thuja, jack pine, quaking aspen and white pine. Sec. 15, T43N, R7W. 46°12'07"N, 91°13'35"W. 16 July 2003. 88962-88991. NEW.

4. Bayfield County, Wisc., 1 mile east of Cable. On rock outcrop along Namekagon River with some white pine and white spruce in lowland. Sec. 20, T43N, R7W. [46°12'01"N, 91°16'05"W]. 6 July 1990. 66314-66349.

5. Bayfield County, Wisc., 1.5 miles southwest of Cable along Namekagon River. In ash bog with some balsam fir. Sec. 24, T43N, R8W. [46°11'11"N, 91°18'46"W]. 7 July 1990. 66350-66372.

Bayfield County, Wisc. On W side of Namekagon River in lowland (0.5 mi W of Radspur). Lowland forest with balsam fir. Sec. 26, T43N, R8W. 46°10'38"N, 91°19'44"W 16 July 2003 CHEMICAL ANALYSIS ONLY 2003. NEW.

6. Bayfield County, Wisc. 0.5 mile north of county line on Namekagon River north of Pacwawong Lake. In ash bog with *Thuja* and balsam fir. Sec. 35, T43N, R8W. [46°09'52"N, 91°19'41"W]. 7 July 1990. 66373-66402.

7. Sawyer County, Wisc. 1 mile southwest of Pacwawong Lake. Along river with red maple, black ash and balsam fir. Sec. 9, T42N, R8W. [46°08'27"N, 91°22'06"W]. 7 July 1990. 66403-

66439.

8. Sawyer County, Wisc. Namekagon River at Larsen Landing. Along river in balsam fir and pines with openings and large red and white pines. Sec. 21, T42N, R8W. 46°06'27"N, 91°23'03"W. 16 July 2003. NEW 88992,89010.

9. Sawyer County, Wisc. 2 miles north of Phipps Flowage (6.5 mi NE of Hayward). In red maple and balsam fir area below steep hills. Sec. 29, T42N, R8W. [46°05'30"N, 91°24'15"W]. 8 July 1990. 66440-66489.

10. Sawyer County, Wisc. Just south of Phipps Dam along Namekagon River (4 miles NE of Hayward). In area by river with balsam fir, red maple and black ash. Sec. 6, T41N, R8W. 46°03'25"N, 91°25'17"W. 8 July 1990. 66490-66536.

11. Sawyer County, Wisc. 2 miles southwest of Hayward Dam near state nursery. On slope above river with big tooth aspen and jack pine. Sec. 33, T41N, R9W. [45°59'39"N, 91°30'10"W]. 9 July 1990. 66537-66569.

12. Sawyer County, Wisc. 2.5 miles SW of Hayward near Namekagon River. Jack pine and few quaking aspens, elev. Sec. 32, T41N, R9W. 45°58'58"N, 91°31'09"W. 17 July 2003. 89011,89038. CHEMICAL ANALYSIS 2003. NEW

13. Sawyer County, Wisc. Just east of county line on Namekagon River 4 miles southwest of Hayward. On point with black ash and few elm. Sec. 7, T40N, R9W. [45°58'14"N, 91°32'08"W]. 9 July 1990. 66570-66604

14. 66605-66641 - Washburn County, Wisc., Just west of county road E crossing of Namekagon River (6 miles WSW of Hayward). On hillside with red pine, quaking aspen and oaks, maple, and birch. Sec. 34, T41N, R10W. 45°59'07"N, 91°35'42"W. 10 July 1990. 66570-66604.

15. Washburn County, Wisc., 0.5 miles west of Brinkman Lake along Namekagon River above Trannus Creek (3 miles NE of Springbrook). On upland with jack pine, red oak, bur oak and quaking aspen. Sec. 32, T41N, R10W. 45°59'01"N, 91°39'04"W. 10 July 1990. 66642-66668.

16. Washburn County, Wisc., 1 mile west of Springbrook along Namekagon River. In low area with black ash, nettle and skunk cabbage. Sec. 15, T40N, R11W. [45°57'05"N, 91°42'23"W]. 10 July 1990. 66669-66695. CHEMICAL ANALYSIS. 1990

17. Washburn County, Wisc., 1.5 miles northeast of Earl along Namekagon River. In jack pine plantation with some red oak and quaking aspen, and in logged area back from river. Sec. 20, T40N, R11W. [45°55'55"N, 91°44'45"W]. 10 July 1990. 66696-66726.

18. Washburn County, Wisc. West side of the big bend on Namekagon River 2.5 mi N of Earl. Slope above river in mixed hardwoods with quaking aspen, white birch, and some pines and oaks, elev. 1060 ft. Sec. 20, T40N, R11W. 45°56'29"N, 91°45'53"W. 17 July 2003. 89039,89068.

19. Washburn County, Wisc. Northwest edge of Earl opposite campground along Namekagon River. On ridge with red pine, quaking aspen, and some red oak. Sec. 30, T40N, R11W. [45°54'41"N, 91°46'23"W]. 11 July 1990. 66727-66762
20. Washburn County, Wisc. 1.5 miles east of Trego along Namekagon River. On hillside and ridge on northeast side of river with jack pine and red oak. Sec. 36, T40N, R12W. [45°54'10"N, 91°47'17"W]. 11 July 1990. 66763-66799
21. Washburn County, Wisc. K Landing on Namekagon River (5 mi NW of Trego). Small bog near parking lot with black ash, alder and hardwoods on slopes at sides, elev. 1000 ft. Sec. 18, T40N, R12W. 45°57'09"N, 91°53'31"W. 18 July 2003. 89069,89098.
22. Washburn County, Wisc. West of McKenzie Creek along Namekagon River (7 miles NW of Trego). On low point with basswood and few white pine and red maple. Sec. 1, T40N, R12W. 45°58'49"N, 91°55'03"W]. 12 July 1990. 66800-66833. CHEMICAL ANALYSIS. 1990
23. Washburn County, Wisc. North of Island Lake along Namekagon River (9 miles NW of Trego). On ridgetop with jack pine, big tooth aspen and some white birch. Sec. 35, T41N, R13W. [45°59'32"N, 91°56'47"W]. 12 July 1990. 66834-66871.
24. Washburn County, Wisc. Whispering Pines Landing along Namekagon River (11 miles northwest of Trego). In bog with black ash and basswood. Sec. 27, T41N, R13W. WP13 46°00'36"N, 91°58'52"W. 12 July 1990. 66872-66891.
25. Washburn County, Wisc. Half mile southwest of Pear Lake off highway 11 (12 miles northwest of Trego). On ridge and hillside above Namekagon River with jack pine and quaking aspen. Sec. 17, T41N, R13W. [46°02'06"N, 92°00'49"W]. 13 July 1990. 66892-66922.
26. Burnett County, Wisc., Half mile southeast of McDowel Bridge along Namekagon River (15 miles northwest of Trego). On gentle north facing slope with red maple and white birch. Sec. 12, T41N, R14W. [46°03'13"N, 92°03'37"W]. 13 July 1990. 66923-66951.
27. Burnett County, Wisc. Near Barkers Road at curve in Namekagon River (17 mi NW of Trego). High ridge above river with red, white, and jack pines and few quaking aspen, elev. 970 ft. Sec. 1, T4N, R14W. 46°04'09"N, 92°03'35"W. 18 July 2003. 89099,89121.
28. Burnett County, Wisc., Just south of Namekagon Road bridge over Namekagon River (10 miles south of Dairyland). On hill with jack pine, red pine and red oak. Sec. 33, T42N, R14W. 46°04'57"N, 92°06'48"W. 17 July 1990. 67144-67172.
29. Burnett County, Wisc. Just south of confluence of St. Croix and Namekagon Rivers (9 miles south of Dairyland). On upland with open young red oak. Sec. 36, T42N, R15W. 46°04'59"N, 92°10'34"W. 17 July 1990. 67173-67206. CHEMICAL ANALYSIS 2003.

## St Croix River

30. Douglas County, Wisc., Just below Gordon Dam on St. Croix River (5 miles west of Gordon). In *Thuja* and black ash bog near river. Sec. 36, T44N, R13W. 46°15'15"N, 91°55'47"W. 16 July 1990. 66952-66994 and 22 July 2003. 89122. CHEMICAL ANALYSIS 1990, 2003.

31. Douglas County, Wisc., Scott Bridge on St. Croix River (7 miles west of Gordon). Along roadside in quaking aspen, white spruce and balsam fir. Sec. 35, T44N, R13W. 46°15'18"N, 91°57'40"W. 16 July 1990. 66995-67036.

32. Douglas County, Wisc., Along railroad grade by St. Croix River southwest of Scott Bridge (17 miles east of Dairyland). In young growth of ash, alder and brush near river. Sec. 8, T43N, R13W. 46°13'32"N, 92°01'15"W. 16 July 1990. 67037-67055.

33. Douglas County, Wisc., At county road T and St. Croix River (5 miles east southeast of Dairyland). On steep hillside with big tooth aspen and few red oak and maple. Sec. 23, T43N, R14W. 46°11'39"N, 92°04'26"W. 16 July 1990. 67056-67085.

34. Douglas County, Wisc., Schoen Park on St. Croix River (5 miles south southeast of Dairyland). Near stream with white pine and quaking aspen. Sec. 33, T43N, R14W. 46°10'03"N, 92°07'01"W. 17 July 1990. 67086-67120.

35. Burnett County, Wisc. Dry Landing on St. Croix River. Lowland with oak, quaking aspen, and balsam fir, elev. 940 ft. Sec. 4, T42N, R14W. 46°09'16"N, 92°07'16"W. 23 July 2003. 89123 – 89149.

36. Burnett County, Wisc. CCC bridge over St. Croix River (7 miles south of Dairyland). In floodplain with scattered black ash, silver maple and brush. Sec. 16, T42N, R14W. 46°06'58"N, 92°07'59"W. 17 July 1990. 67121-67143.

37. Burnett County, Wisc. South of Big Island in St. Croix River (8.27 mi NE of Danbury). Upland in mature quaking aspen with few white birch, oaks and pines, elev. 980 ft. Sec. 34, T42N, R15W. 46°04'15"N, 92°13'25"W. 23 July 2003. 89150,89177.

38. Burnett County, Wisc. Riverside at highway 35 bridge (10 miles south southwest of Dairyland). On south side of St. Croix ) River in bog with basswood, ash and balsam fir. Sec. 33, T42N, R15W. 46°04'28"N, 92°14'52"W. 18 July 1990. 67207-67241. CHEMICAL ANALYSIS 1990, 2003.

39. Burnett County, Wisc. Above Pansy Landing across from Upper Tamarack River (5.5 miles northeast of Danbury). On upland with mixed forest of white pine, oaks and some balsam fir. Sec. 1, T41N, R16W. 46°04'04"N, 92°18'56"W. 18 July 1990. 67242-67268.

40. Burnett County, Wisc. 2 miles northeast of Danbury. On hillside above St. Croix River with red maple, red oak and few quaking aspen. Sec. 22, T41N, R16W. 46°01'17"N, 92°20'38"W. 18

July 1990. 67269-67285.

41. Burnett County, Wisc. 3 miles west of Danbury at highway 77 bridge. In low area by St. Croix River with black ash, basswood and silver maple. Sec. 25, T41N, R17W. 46°00'42"N, 92°26'32"W. 18 July 1990. 67286-67316.

42. Burnett County, Wisc. 1 mile southwest of Sioux Portage campground (7 miles southwest of Danbury). In upland with red oak, basswood and jack pine. Sec. 4, T40N, R17W. 45°58'17"N, 92°28'22"W. 3 Sept. 1990. 67499-67524.

43. Burnett County, Wisc. Pease Hill above St. Croix River. Hill with oak, quaking aspen and some basswood, elev. 1000 ft. Sec. 5, T40N, R17W. 45°58'31"N, 92°30'01"W. 24 July 2003. 89178,89203.

44. Pine County, Minn., St. Croix State Park. At Johns Landing camp at northeast end of park. In ash bog west of camp with black ash and some red maple and white pine. Sec. 31, T41N, R18W. 45°59'09"N, 92°31'51"W. 28 Aug. 1990. 67317-67356. CHEMICAL ANALYSIS 1990, 2003.

45. Pine County, Minn., St. Croix State Park. Above main campground on ridge with jack pine, oaks and some big tooth aspen. Sec. 14, T40N, R18W. 45°57'15"N, 92°34'06"W. 28 Aug. 1990. 67388-67413.

46. Burnett Co., Wisc., Norway Point Landing (13 miles west of Webster). In bog with Thuja, black ash, yellow birch and some red maple and balsam fir. Sec. 30, T40N, R18W. 45°55'23"N, 92°38'12"W. 3 Sept. 1990. 67525-67565.

47. Pine Co., Minn., St. Croix State Park. 1 mile north of St. Croix River above Sand Creek Landing. On ridge with old quaking aspen, basswood and some oaks. Sec. 24, T40N, R19W. [45°56'27"N, 92°39'05"W]. 28 Aug. 1990. 67357-67387.

48. Burnett County, Wisc., Above Nelson Landing (15 miles west of Webster). In oak woods on highland with red oak and few pines. Sec. 2, T39N, R19W. 45°54'04"N, 92°40'54"W. 3 Sept. 1990. 67566-67588.

49. Burnett County, Wisc., Fox Landing northwest of Grantsburg (16 miles west of Webster). In lowland near St. Croix River with ash, red maple and some basswood. Sec. 3, T39N, R19W. 45°53'29"N, 92°42'42"W. 4 Sept. 1990. 67589-67624.

50. Burnett County, Wisc., At East Brook at end of Paint Mine Road (5 miles north northwest of Grantsburg). On ridge above stream with white pine, red pine, jack pine and few hardwoods. Sec. 29, T39N, R19W. 45°50'31"N, 92°44'22"W. 4 Sept. 1990. 67625-67649.

51. Burnett County, Wisc., Sonderbeck Landing across St. Croix River from Snake River (5 miles west northwest of Grantsburg). In lowland with quaking aspen, white birch and brush. Sec. 31, T39N, R19W. 45°49'25"N, 92°45'42"W. 4 Sept. 1990. 67650-67686.

52. Burnett County, Wisc., Sandrock Cliff Access and campground (5 miles west of Grantsburg). Around sandstone cliffs and on top with hardwoods in low areas and pines on top. Sec. 7, T38N, R19W. 45°47'35"N, 92°46'11"W. 4 Sept. 1990. 67687-67716. CHEMICAL ANALYSIS 2003.
53. Burnett County, Wisc. Highway 70 at St. Croix River. In low area N of highway with white pine and dead pines, elev. 820 ft. Sec. 13, T38N, R20W. 45°46'28"N, 92°46'31"W. 25 July 2003. 89204,89225.
54. Burnett County, Wisc., Southwest of Raspberry Landing (7 miles west southwest of Grantsburg). On hillside of St. Croix River with streams, maples, oaks and some ash and basswood. Sec. 26, T38N, R20W. 45°45'06"N, 92°47'45"W. 5 Sept. 1990. 67717-67732.
55. Pine Co. Minn., Stevens Creek Access to St. Croix River at southeast corner of county. Just northeast of landing along river with basswood and silver maple. Sec. 33, T38N, R20W. [45°43'49"N, 92°50'35"W]. 29 Aug. 1990. 67414-67439.
56. Burnett Co., Wisc., County Road O Landing (4 miles east of Rush City, Minn.) In bottomland near St. Croix River with maples, ash and basswood. Sec. 20, T37N, R20W. 45°40'41"N, 92°52'27"W. 5 Sept. 1990. 67733-67752. CHEMICAL ANALYSIS 1990, 2003.
57. Chisago Co., Minn., Wild River State Park. South of Landers Landing. In ash bog back from St. Croix River with black ash, red maple, and basswood. Sec. 6, T36N, R20W. [45°38'07"N, 92°53'42"N]. 29 Aug. 1990. 67440-67465.
58. Polk County, Wisc., 5 miles east northeast of Harris, Minn. near St. Croix River. In open old fields and in open patches of quaking aspen at edge. Sec. 18, T36N, R20W. 45°36'04"N, 92°52'52"W. 5 Sept. 1990. 67753-67784.
59. Polk County, Wisc., Sunrise Landing 2 miles north of Sunrise, Minn. Along St. Croix River in open areas with green ash and bur oak. Sec. 32, T36N, R20W. WP43 45°34'05"N, 92°52'09"W. 5 Sept. 1990. 67785-67808.
60. Polk County, Wisc. Across St. Croix River from Wild River State Park (Minn.) (2 mi NE of Sunrise). On upland with oaks, quaking aspen, and jack pine, elev. 840 ft. Sec. 34, T36N, R20W. 45°34'00"N, 92°49'28"W. 25 July 2003. 89226-89251.
61. Chisago Co., Minn., Wild River State Park. 5 miles east of Sunrise at St. Croix River. In steep gullies between road and river with basswood and sugar maple. Sec. 31, T36N, R19W & Sec. 6, T35N, R19W. 45°33'23"N, 92°45'29"W. 29 Aug. 1990. 67466-67498.
62. Polk Co., Wisc., Nevers Dam Landing (1.5 miles south of Wolf Creek). Around old gravel pit near river with few elms. Sec. 9, T35N, R19W. 45°32'09"N, 92°43'22"W. 6 Sept. 1990. 67809-67843.
63. Polk Co., Wisc., 7 miles northwest of St. Croix Falls. In small gullies up from St. Croix River with basswood, silver maple and black ash. Sec. 27, T35N, R19W. 45°29'46"N, 92°42'14"W. 6

Sept. 1990. 67844-67862.

64. Polk Co., Wisc., 3.5 miles north of St. Croix Falls. On hillside across road from river in stand of big tooth aspen, basswood and sugar maple. Sec. 1, T34N, R19W. 45°27'32"N, 92°39'34"W. 6 Sept. 1990 67863-67884.

65. Chisago County, Minn., 2.3 mi N of Taylors Falls along St. Croix River. Gentle slope with basswood and sugar maple in deep shade, Sec. 18, T34N, R18W. 45°25'57"N, 92°39'03"W. 26 July 2003. 89252-89266.

66. Chisago County, Minn., Minnesota Interstate Park. Taylors Falls. Around ledges near river with hardwoods and few white pines. Sec. 30, T34N, R18W. 45°23'56"N, 92°39'05"W. 22 Sept. 1988. 62585-62623.

67. Polk County, Wisc., Wisconsin Interstate Park. Around rocky knobs and cliffs near St. Croix River east of Taylors Falls with oaks, pines and rocks. Sec. 30, T34N, R18W. WP51 45°24'01"N, 92°38'53"W. 28 Sept. 1988. 62701-62761.

68. Polk County, Wisc., Island in St. Croix River 3 miles south of Taylors Falls just north of Rice Lake. Open oak woods around rock hill with bur oak, black oak, elm and silver maple near shore. Sec. 10, T33N, R19W. [45°21'46"N, 92°41'38"W]. 11 Oct. 1988. 63085-63131. CHEMICAL ANALYSIS. 1988.

69. Chisago County, Minn., Four miles south of Taylors Falls just west of Franconia. In valley up from St. Croix River with elm, basswood, oak and ash. Sec. 10, T33N, R19W. 45°22'03"N, 92°42'29"W. 22 Sept. 1988. 62624-62670.

70. Chisago County, Minn. 1.5 miles NNW of Osceola, Wisc. At head of valley leading down to St. Croix River in pasture with hardwoods and stream. Sec. 16, T33N, R19W. 45°20'31"N, 92°43'24"W. 22 Sept. 1988. 62671-62700.

71. Chisago County, Minn., Across St. Croix River from Osceola, Wisc. On roadbank with rock outcrop and sumac. Sec. 28, T33N, R19W. 45°19'14"N, 92°43'20"W. 30 Sept. 1988. 62787-62811.

72. Polk County, Wisc., At southern edge of Osceola. Along ridge and steep hillside above St. Croix River with maples, oaks and some white pine and rocks. Sec. 28, T33N, R19W. 45°19'00"N, 92°42'54"W. 30 Sept. 1988. 62762-62786.

73. Washington County, Minn., Three miles northeast of Scandia, half mile north of railroad bridge. On slopes above St. Croix River with oaks, maples, basswood and rock outcrops. Sec. 7, T32N, R19W. [45°17'07"N, 92°45'50"W]. 30 Sept. 1988. 62812-62849.

74. Washington County, Minn., St. Croix River S of Cedar Bend (9.8 mi SSW of Taylors Falls). Rock cliffs in deep shade of sugar maple, oak, and basswood, elev. 700 ft. Sec. 7, T32N, R19W. 45°16'51"N, 92°45'49"W. 26 July 2003. 89267,89281.



75. St. Croix County, Wisc., Across St. Croix River from Marine on St. Croix, Minn. In low area with hardwoods (white birch, basswood, oaks, maples). Sec. 6, T31N, R19W. 45°11'51"N, 92°45'38"W. 4 Oct. 1988. 62850-62873.
76. Washington Co., Minn., Two miles south of Marine on St. Croix behind research lab. In ash bog along stream with ash, basswood, red maple and elm. Sec. 18, T31N, R19W. 45°10'21"N, 92°45'41"W. 4 Oct. 1988. 62907-62940.
77. St. Croix Co., Wisc., Near Apple River Falls and hydroplant 11 miles north of Hudson. Around ridge and down to Apple River on steep hillside with oaks, aspens, white birch and white pines. Sec. 21, T31N, R19W. 45°09'29"N, 92°42'52"W. 18 Oct. 1988. 63234-63258.
78. Washington Co., Minn., 5 miles NE of Stillwater near St. Croix River. In mixed hardwood forest on gentle hills south of railroad, Sec. 1, T30N, R20W. [45°07'20"N, 92°44'50"W]. 13 Oct. 1973. 21972-22002.
79. St. Croix Co., Wisc., 5 miles southwest of Somerset. On banks of valley into St. Croix River along abandoned railroad grade with quaking aspen, oaks and white birch. Sec. 7, T30N, R19W. 45°06'21"N, 92°44'24"W. 4 Oct. 1988. 62874-62906.
80. Washington County, Minn., Two miles north of Stillwater along highway 95. Along cliffs above road southeast of Arcola Trail in oaks and rocks. Sec. 14, T30N, R20W. 45°05'28"N, 92°46'50"W. 5 Oct. 1988. 62941-62965.
81. St. Croix County, Wisc., At wayside park along highway 35, 1.5 miles southeast of Houlton. On steep shady banks of St. Croix River (11) below park with oaks, elm and few aspen. Sec. 35, T30N, R20W. 45°02'32"N, 92°46'22"W. 6 Oct. 1988. 63015-63022.
82. St. Croix County, Wisc., Just north of Hudson in deep valley of stream into St. Croix River. Along hillside and valley bottom with oaks, maples and aspens. Sec. 12, T29N, R20W. 45°00'43"N, 92°45'33"W. 18 Oct. 1988. 63207-63233. CHEMICAL ANALYSIS. 1988.
83. Washington Co., Minn., Three miles north of Lakeland along bank above railroad (across from Hudson, Wisc.). Around gravel bank with oaks and honey locust and on bottomland with elm and aspen. Sec. 14, T29N, R20W. 44°59'47"N, 92°46'45"W. 5 Oct. 1988. 62966-62971.
84. St. Croix Co., Wisc., North of Hudson at east end of Lake Mallalieu. On hillside above swamp southeast of road with elm, quaking aspen, basswood and oaks. Sec. 18, T29N, R19W. 44°59'39"N, 92°43'35"W. 5 Oct. 1988. 62972-62986.
85. Washington County, Minn., Along North Point Douglas Road at north edge of Afton. In old gravel pit west of St. Marys Point with some juniper and big tooth aspen. Sec. 15, T28N, R20W. 44°54'46"N, 92°47'19"W. 5 Oct. 1988. 62987-63014.

86. St. Croix Co., Wisc. Across river from Afton, Minn. Along valley and ridge above St. Croix River with oaks and basswood. Sec. 23, T28N, R20W. 44°54'02"N, 92°45'34"W. 6 Oct. 1988. 63023-63037.
87. St. Croix County, Wisc. Near Black Bass Bar on St. Croix River (5.5 mi S of Hudson). Low area with black cherry, elm, and red oak around sides, Sec. 25, T28N, R20W. 44°52'58"N, 92°45'33"W. 23 Aug. 2003. 90054,90067.
88. Washington County, Minn., 1.5 mi S of Afton. Upper slopes of valley into St. Croix River with black cherry, quaking aspen, red and white oak, and some white birch, Sec. 26, T28N, R20W. 44°52'38"N, 92°46'32"W. 23 Aug. 2003. 90068,90080.
89. Washington County, Minn., Afton State Park. East of highway along upper end of Trout Brook. In valley with elm, willow, aspen and rocks. Sec. 34, T28N, R20W. 44°51'50"N, 92°47'59"W. 13 Oct. 1988. 63132-63164.
90. Pierce County, Wisc. Kinnickinnic State Park. Along stream bottom with willow, boxelder, silver maple and elm. Sec. 13, T27N, R20W. 44°49'55"N, 92°44'09"W. 6 Oct. 1988. 63068-63084. CHEMICAL ANALYSIS 1988, 2003.
91. Pierce County, Wisc. Four miles northeast of Prescott. Along top of gully and ridge above St. Croix River with oaks, quaking aspen and sumac. Sec. 23, T27N, R20W. [44°48'23"N, 92°46'31"W]. 6 Oct. 1988. 63038-63067.
92. Washington County, Minn. Three miles north of Prescott, Wisc. at Control Data Park. Along ridges and hillside of valley of St. Croix River with oaks, elms and juniper. Sec. 27, T27N, R20W. 44°47'57"N, 92°47'51"W. 13 Oct. 1988. 63165-63188.
93. Washington County, Minn. Just north of Hastings north of Point Douglas. On hillside above St. Croix River and along abandoned railroad grade with elm and oaks. Sec. 9, T26N, R20W. 44°45'08"N, 92°48'50"W. 13 Oct. 1988. 63189-63206.

## APPENDIX 2

Total species list for St. Croix National Scenic Riverway. New records for the park have a "\*" before the names.

*Acarospora americana* Magn.  
*Acarospora fuscata* (Schrader) Arn.  
*Acarospora immersa* Fink  
*Acrocordia cavata* (Ach.) Harris  
*Acrocordia megalospora* (Fink) Harris  
*Amandinea dakotensis* (Magn.) P. May & Sheard  
*Amandinea polyspora* (Willey) E. Lay & P. May  
*Amandinea punctata* (Hoffm.) Coppins & Scheid.  
*Anaptychia palmulata* (Michaux) Vainio  
\**Anisomeridium nyssaegenum* (Ellis & Everh.) Harris  
*Arthonia caesia* (Flotow) Körber  
*Arthonia patellulata* Nyl.  
*Arthonia punctiformis* Ach.  
*Arthonia radiata* (Pers.) Ach.  
*Aspicilia caesiocinerea* (Nyl. ex Malbr.) Arn.  
*Aspicilia cinerea* (L.) Körber  
*Bacidia polychroa* (Th. Fr.) Körber  
*Bacidia rubella* (Hoffm.) Massal.  
*Bacidia sabuletorum* (Schreb.) Lettau  
*Bacidia schweinitzii* (Fr. ex Michener) A. Schneider  
*Bacidia suffusa* (Fr.) A. Schneider  
*Bacidia trachona* (Ach.) Lettau  
*Bacidina inundata* (Fr.) Vezda  
*Bryoria furcellata* (Fr.) Brodo & Hawksw.  
*Bryoria trichodes* (Michaux) Brodo & Hawksw.  
*Buellia dialyta* (Nyl.) Tuck.  
*Buellia polyspora* (Willey) Vainio  
*Buellia schaereri* de Not.  
*Buellia stigmaea* Tuck.  
*Buellia stillingiana* J. Steiner  
*Calicium abietinum* Pers.  
*Calicium trabinellum* (Ach.) Ach  
\**Caloplaca ahtii* Søchting  
*Caloplaca arenaria* (Pers.) Müll. Arg.  
\**Caloplaca brunneola* Wetm.  
*Caloplaca cerina* (Ehrh. ex Hedwig) Th. Fr.  
*Caloplaca chrysophthalma* Degel.  
*Caloplaca citrina* (Hoffm.) Th. Fr.  
*Caloplaca feracissima* Magn.  
*Caloplaca flavorubescens* (Hudson) Laund.

*Caloplaca flavovirescens* (Wulfen) Dalla Torre & Sarnth.  
*Caloplaca holocarpa* (Hoffm. ex Ach.) Wade  
*Caloplaca microphyllina* (Tuck.) Hasse  
 \**Caloplaca oxfordensis* Fink  
*Caloplaca sideritis* (Tuck.) Zahlbr.  
 \**Caloplaca subsoluta* (Nyl.) Zahlbr.  
*Caloplaca vitellinula* (Nyl.) Oliv.  
*Candelaria concolor* (Dickson) Stein  
*Candelaria fibrosa* (Fr.) Müll. Arg.  
*Candelariella efflorescens* Harris & Buck  
*Candelariella vitellina* (Hoffm.) Müll. Arg.  
*Candelariella xanthostigma* (Ach.) Lettau  
*Canomaculina subtinctoria* (Zahlbr.) Elix  
*Catapyrenium lachneum* (Ach.) Sant.  
*Catapyrenium tuckermanii* (Rav. ex Mont.) Thoms.  
*Cetraria americana* (Spreng.) ined.  
*Cetraria orbata* (Nyl.) Fink  
*Chaenotheca brunneola* (Ach.) Müll. Arg.  
*Chaenotheca ferruginea* (Turner & Borrer) Mig.  
*Chaenothecopsis debilis* (Turner & Borrer ex Sm.) Tibell  
*Chrysothrix candelaris* (L.) Laund.  
*Cladina mitis* (Sandst.) Hustich  
*Cladina rangiferina* (L.) Nyl.  
*Cladonia borealis* Stenroos  
*Cladonia botrytes* (K. Hagen) Willd.  
*Cladonia caespiticia* (Pers.) Flörke  
*Cladonia cervicornis* (Ach.) Flotow  
*Cladonia chlorophaea* (Flörke ex Sommerf.) Sprengel  
*Cladonia coniocraea* (Flörke) Sprengel  
*Cladonia crispata* (Ach.) Flotow  
*Cladonia cristatella* Tuck.  
*Cladonia cryptochlorophaea* Asah.  
*Cladonia cylindrica* (Evans) Evans  
*Cladonia decorticata* (Flörke) Sprengel  
*Cladonia furcata* (Hudson) Schrader  
*Cladonia gracilis* (L.) Willd.  
*Cladonia grayi* G. Merr. ex Sandst.  
*Cladonia macilenta* Hoffm.  
*Cladonia multiformis* G. Merr.  
*Cladonia parasitica* (Hoffm.) Hoffm.  
*Cladonia peziziformis* (With.) Laund.  
*Cladonia phyllophora* Hoffm.  
*Cladonia pleurota* (Flörke) Schaerer  
*Cladonia polycarpoides* Nyl.  
*Cladonia pyxidata* (L.) Hoffm.  
*Cladonia ramulosa* (With.) Laund.

*Cladonia rei* Schaerer  
*Cladonia robbinsii* Evans  
*Cladonia scabriuscula* (Delise) Nyl.  
*Cladonia squamosa* Hoffm.  
 \**Cladonia subulata* (L.) F. Wigg.  
*Cladonia symphyrcarpia* (Flörke) Fr.  
*Coccocarpia palmicola* (Spreng.) Arvid. & Galloway  
*Collema conglomeratum* Hoffm.  
*Collema subflaccidum* Degel.  
*Cresponea chloroconia* (Tuck.) Egea & Torrente  
*Cyphelium lucidum* (Th. Fr.) Th. Fr.  
*Cyphelium tigillare* (Ach.) Ach.  
*Dermatocarpon miniatum* (L.) W. Mann  
*Dimelaena oreina* (Ach.) Norman  
*Dimerella lutea* (Dickson) Trevisan  
 \**Diploschistes muscorum* (Scop.) R. Sant.  
*Diploschistes scruposus* (Schreber) Norman  
*Endocarpon pusillum* Hedwig  
*Eopyrenula intermedia* Coppins  
*Evernia mesomorpha* Nyl.  
*Flavoparmelia baltimorensis* (Gyelnik & Fáriss) Hale  
*Flavoparmelia caperata* (L.) Hale  
*Flavopunctelia flaventior* (Stirton) Hale  
*Flavopunctelia soledica* (Nyl.) Hale  
*Fuscopannaria leucophaea* (Vahl) Jørg.  
*Fuscopannaria leucosticta* (Tuck.) Jørg.  
*Graphis scripta* (L.) Ach.  
*Heterodermia hypoleuca* (Muhl.) Trevisan  
*Heterodermia speciosa* (Wulfen) Trevisan  
*Hyperphyscia adglutinata* (Flörke) Mayrh. & Poelt  
*Hyperphyscia syncolla* (Tuck. ex Nyl.) Kalb  
*Hypocenomyce anthracophila* (Nyl.) James & Schneider  
*Hypocenomyce friesii* (Ach.) James & Gotth. Schneider  
*Hypocenomyce scalaris* (Ach.) Choisy  
*Hypogymnia physodes* (L.) Nyl.  
*Imshaugia placorodia* (Ach.) S. Meyer  
*Julella sericea* (Massal.) Coppins  
*Lecania nylanderiana* Massal.  
*Lecanora albella* var. *rubescens* (Imsh. & Brodo) Lumbsch  
*Lecanora allophana* Nyl.  
*Lecanora dispersa* (Pers.) Sommerf.  
*Lecanora hybocarpa* (Tuck.) Brodo  
*Lecanora impudens* Degel.  
*Lecanora muralis* (Schreber) Rabenh.  
*Lecanora opiniconensis* Brodo  
*Lecanora polytropa* (Hoffm.) Rabenh.

*Lecanora pulicaris* (Pers.) Ach.  
*Lecanora strobilina* (Sprengel) Kieffer  
*Lecanora symmicta* (Ach.) Ach.  
*Lecanora thysanophora* Harris in Harris & Tonsb.  
*Lecidea nylanderii* (Anzi) Th. Fr.  
*Lecidea plebeja* Nyl.  
*Lecidella euphorea* (Flörke) Hertel  
*Lepraria lobificans* Nyl.  
*Lepraria neglecta* (Nyl.) Erichsen  
*Leptogium arsenei* Sierk  
*Leptogium burnetiae* C. W. Dodge  
*Leptogium byssinum* (Hoffm.) Zwackh ex Nyl.  
*Leptogium cyanescens* (Rabenh.) Körber  
*Leptogium saturninum* (Dickson) Nyl.  
*Lichinella cribellifera* (Nyl.) Moreno & Egea  
*\*Lithothelium hyalosporum* (Nyl.) Aptroot  
*Lobaria pulmonaria* (L.) Hoffm.  
*Lobaria quercizans* Michaux  
*Loxospora elatina* (Ach.) Massal.  
*\*Maronea constans* (Nyl.) Hepp  
*Megaspora verrucosa* (Ach.) Hafellner & Wirth  
*Melanelia olivacea* (L.) Essl.  
*Melanelia septentrionalis* (Lyngé) Essl.  
*Melanelia subargentifera* (Nyl.) Essl.  
*Melanelia subaurifera* (Nyl.) Essl.  
*Micarea melaena* (Nyl.) Hedl.  
*Micarea prasina* Fr.  
*\*Multiclavula vernalis* (Schwein.) R. Petersen  
*Mycobilimbia hypnorum* (Lib.) Kalb & Hafellner  
*Mycocalicium subtile* (Pers.) Szat.  
*Myelochroa aurulenta* (Tuck.) Elix & Hale  
*Myelochroa galbina* (Ach.) Elix & Hale  
*Nephroma helveticum* Ach.  
*Nephroma parile* (Ach.) Ach.  
*Normandina pulchella* (Borrer) Nyl.  
*Ochrolechia arborea* (Kreyer) Almb.  
*Ochrolechia trochophora* (Vainio) Oshio  
*Opegrapha varia* Pers.  
*Pachyphiale fagicola* (Hepp) Zwackh  
*Parmelia squarrosa* Hale  
*Parmelia sulcata* Taylor  
*Parmotrema crinitum* (Ach.) Choisy  
*Parmotrema margaritatum* (Hue) Hale  
*Parmotrema stuppeum* (Taylor) Hale  
*Peltigera canina* (L.) Willd.  
*Peltigera didactyla* (With.) Laund.

*Peltigera elisabethae* Gyelnik  
*Peltigera evansiana* Gyelnik  
*Peltigera horizontalis* (Hudson) Baumg.  
*Peltigera lepidophora* (Vainio) Bitter  
*Peltigera membranacea* (Ach.) Nyl.  
*Peltigera neckeri* Hepp ex Müll. Arg.  
*Peltigera polydactylon* (Necker) Hoffm.  
*Peltigera praetextata* (Flörke ex Sommerf.) Zopf  
*Peltigera rufescens* (Weiss) Humb.  
*Pertusaria amara* (Ach.) Nyl.  
*Pertusaria consocians* Dibben  
*Pertusaria ophthalmiza* (Nyl.) Nyl.  
*Pertusaria plittiana* Erichsen  
*Pertusaria pustulata* (Ach.) Duby  
*Pertusaria trachythallina* Erichsen  
*Pertusaria velata* (Turner) Nyl.  
*Phaeocalicium curtisii* (Tuck.) Tibell  
*Phaeocalicium polyporaeum* (Nyl.) Tibell  
*Phaeophyscia adiastrata* (Essl.) Essl.  
*Phaeophyscia cernohorskyi* (Nádv.) Essl.  
*Phaeophyscia chloantha* (Ach.) Moberg  
*Phaeophyscia ciliata* (Hoffm.) Moberg  
*Phaeophyscia hirsuta* (Mereschk.) Essl.  
*Phaeophyscia hirtella* Essl.  
*Phaeophyscia hispidula* (Ach.) Essl.  
*Phaeophyscia imbricata* (Vain.) Essl.  
*Phaeophyscia melanchra* (Hue) Hale  
*Phaeophyscia nigricans* (Flörke) Moberg  
*Phaeophyscia orbicularis* (Necker) Moberg  
*Phaeophyscia pusilloides* (Zahlbr.) Essl.  
*Phaeophyscia rubropulchra* (Degel.) Essl.  
*Physcia adscendens* (Fr.) H. Olivier  
*Physcia aipolia* (Ehrh. ex Humb.) Fürnr.  
*Physcia americana* G. Merr.  
*Physcia caesia* (Hoffm.) Fürnr.  
*Physcia dubia* (Hoffm.) Lettau  
*Physcia millegrana* Degel.  
*Physcia phaea* (Tuck.) Thoms.  
*Physcia stellaris* (L.) Nyl.  
*Physcia subtilis* Degel.  
*Physconia detersa* (Nyl.) Poelt  
*\*Physconia leucoleiptes* (Tuck.) Essl.  
*\*Placynthiella dasaea* (Stirton) Tønsberg  
*Placynthiella icmalea* (Ach.) Coppins & James  
*Placynthiella uliginosa* (Schrader) Coppins & James  
*Placynthium nigrum* (Hudson) Gray

*Platismatia tuckermanii* (Oakes) Culb. & C. Culb.  
*Porpidia albocaerulescens* (Wulfen) Hertel & Knoph  
*Porpidia crustulata* (Ach.) Hertel & Knoph  
*Psilolechia lucida* (Ach.) Choisy  
*Psora pseudorussellii* Timdal  
*Punctelia bolliana* (Müll. Arg.) Krog  
*Punctelia hypoleucites* (Nyl.) Krog  
*Punctelia perreticulata* (Räs.) Wilh. & Ladd  
*Punctelia rudecta* (Ach.) Krog  
*Pyxine sorediata* (Ach.) Mont.  
*Ramalina americana* Hale  
*\*Ramalina dilacerata* (Hoffm.) Hoffm.  
*Ramalina intermedia* (Delise ex Nyl.) Nyl.  
*\*Ramalina sinensis* Jatta  
*Ramalina unifolia* Thoms.  
*Rhizocarpon grande* (Flörke ex Flotow) Arnold  
*Rhizocarpon rubescens* Th. Fr.  
*Rinodina subminuta* Magn.  
*Sarcogyne regularis* Körber  
*Scoliciosporum chlorococcum* (Stenh.) Vezda  
*Spilonema revertens* Nyl.  
*\*Staurothele diffractella* (Nyl.) Tuck.  
*Stenocybe pullatula* (Ach.) Stein  
*Stereocaulon paschale* (L.) Hoffm.  
*Stereocaulon saxatile* Magn.  
*Strangospora pinicola* (Massal.) Körber  
*\*Strigula americana* Harris  
*Strigula stigmatella* (Ach.) Harris  
*Strigula submuriformis* (Harris) Harris  
*Thelocarpon laureri* (Flotow) Nyl.  
*Trapelia involuta* (Taylor) Hertel  
*\*Trapelia obtogens* (Th. Fr.) Hertel  
*Trapelia placodioides* Coppins & James  
*Trapeliopsis flexuosa* (Fr.) Coppins & James  
*Trapeliopsis granulosa* (Hoffm.) Lumbsch  
*Trapeliopsis viridescens* (Schrader) Coppins & James  
*Umbilicaria mammulata* (Ach.) Tuck.  
*Usnea hirta* (L.) F. Wigg.  
*Usnea mutabilis* Stirton  
*Usnea rubicunda* Stirton  
*Usnea subfloridana* Stirton  
*Verrucaria fuscella* (Turner) Winch  
*Verrucaria glaucovirens* Grummann  
*Verrucaria margacea* (Wahlenb.) Wahlenb.  
*Verrucaria muralis* Ach.  
*Verrucaria nigrescens* Pers.



*Verrucaria nigrescentoidea* Fink  
*Xanthoparmelia conspersa* (Ehrh. ex Ach.) Hale  
*Xanthoparmelia cumberlandia* (Gyelnik) Hale  
*Xanthoparmelia plittii* (Gyelnik) Hale  
*Xanthoparmelia somloënsis* (Gyelnik) Hale  
*Xanthoparmelia tasmanica* (Hook. f. & Taylor) Hale  
*Xanthoria elegans* (Link) Th. Fr.  
*Xanthoria fallax* (Hepp) Arn.  
\**Xanthoria fulva* (Hoffm.) Poelt & Petutschnig  
\**Xanthoria hasseana* Räs.  
*Xanthoria sorediata* (Vainio) Poelt  
\**Xanthoria ulophyllodes* Räs.

282 species

20 new

## APPENDIX 3

### Elemental analysis localities

Localities are listed in order first from the headwaters of the Namekagon river south to the St. Croix and then from the headwaters of the St. Croix down to Hastings. The **bold** words are those used in the elemental analysis tables. Lat. Long. in brackets ([ ]) were determined from the map program and not by GPS. Numbers at the end of each locality are Wetmore collection numbers at that locality.

#### **Namekagon River**

Bayfield County, Wisc., **Namekagon Dam South**. Namekagon Dam area at Lake Namekagon (7 mi NE of Cable). Lakeshore on bay E of bridge, elev. 1410 ft. Sec. 8, T43N, R6W. 46°13'18"N, 91°08'49"W. 16 July 2003. CHEMICAL ANALYSIS ONLY 2003. NEW

Bayfield County, Wisc., **Namekagon Dam West**. Namekagon Dam area at Lake Namekagon (7 mi NE of Cable). At west end of lake near shore with sugar maple and basswood and some yellow birch and pines, elev. 1410 ft. Sec. 8, T43N, R6W. 46°13'26"N, 91°08'59"W. 5 July 1990. 66221-662766 CHEMICAL ANALYSIS 1990, 2003.

Bayfield County, Wisc. **West of Radspur**. On W side of Namekagon River in lowland (0.5 mi W of Radspur). Lowland forest with balsam fir, 1285 ft. Sec. 26, T43N, R8W. 46°10'38"N, 91°19'44"W 16 July 2003. CHEMICAL ANALYSIS ONLY 2003. NEW.

Sawyer County, Wisc. **SW of Hayward**. 2.5 miles SW of Hayward near Namekagon River. Jack pine and few quaking aspens, elev. 1175 ft. Sec. 32, T41N, R9W. 45°58'58"N, 91°31'09"W. 17 July 2003. 89011,89038. CHEMICAL ANALYSIS 2003. NEW

Washburn County, Wisc., **Springbrook**. 1 mile west of Springbrook along Namekagon River. In low area with black ash, nettle and skunk cabbage, elev. 1090 ft. Sec. 15, T40N, R11W. [45°57'08"N, 91°42'21"W]. 10 July 1990. 66669-66695. CHEMICAL ANALYSIS. 1990

Washburn County, Wisc. **McKenzie Creek**. West of McKenzie Creek along Namekagon River (7 miles NW of Trego). On low point with basswood and few white pine and red maple elev. 990 ft. Sec. 1, T40N, R12W. [45°58'49"N, 91°55'04"W]. 12 July 1990. 66800-66833. CHEMICAL ANALYSIS. 1990

Burnett County, Wisc. **Confluence**. Just south of confluence of St. Croix and Namekagon Rivers (9 miles south of Dairyland). On upland with open young red oak, elev. 980 ft. Sec. 36, T42N, R15W. 46°04'59"N, 92°10'34"W. 17 July 1990. 67173-67206. CHEMICAL ANALYSIS 2003.

#### **St Croix River**

Douglas County, Wisc., **Gordon Dam**. Just below Gordon Dam on St. Croix River (5 miles west of Gordon). In Thuja and black ash bog near river, elev. 1030 ft. Sec. 36, T44N, R13W. 46°15'15"N, 91°55'47"W 16 July 1990. 66952-66994. CHEMICAL ANALYSIS 1990, 2003.

Burnett County, Wisc. **Riverside**. Riverside at highway 35 bridge (10 miles south southwest of Dairyland). On south side of St. Croix ) River in bog with basswood, ash and balsam fir, elev. 900 ft. Sec. 33, T42N, R15W. 46°04'28"N, 92°14'52"W. 18 July 1990. 67207-67241. CHEMICAL ANALYSIS 1990, 2003.

Pine County, Minn., St. Croix State Park. **Johns Landing**. At Johns Landing camp at northeast end of park. In ash bog west of camp with black ash and some red maple and white pine, elev. 885 ft. Sec. 31, T41N, R18W. 45°59'09"N, 92°31'51"W. 28 Aug. 1990. 67317-67356. CHEMICAL ANALYSIS 1990, 2003.

Burnett County, Wisc., **Sandrock Cliffs**. Sandrock Cliff Access and campground (5 miles west of Grantsburg). Around sandstone cliffs and on top with hardwoods in low areas and pines on top, elev. 820 ft. Sec. 7, T38N, R19W. 45°47'35"N, 92°46'11"W. 4 Sept. 1990. 67687-67716. CHEMICAL ANALYSIS 2003.

Burnett Co., Wisc , **O Landing**. County Road O Landing (4 miles east of Rush City, Minn.) In bottomland near St. Croix River with maples, ash and basswood elev. 800 ft. Sec. 20, T37N, R20W. 45°40'41"N, 92°52'27"W. 5 Sept. 1990. 67733-67752. CHEMICAL ANALYSIS 1990, 2003.

Polk County, Wisc., **Taylor's Falls**. Island in St. Croix River 3 miles south of Taylor's Falls just north of Rice Lake. Open oak woods around rock hill with bur oak, black oak, elm and silver maple near shore, elev. 750 ft. Sec. 10, T33N, R19W. [45°21'44"N, 92°41'37"W]. 11 Oct. 1988. 63085-63131. CHEMICAL ANALYSIS. 1988.

St. Croix County, Wisc., **N of Hudson**. Just north of Hudson in deep valley of stream into St. Croix River. Along hillside and valley bottom with oaks, maples and aspens, elev. 730 ft. Sec. 12, T29N, R20W. 45°00'43"N, 92°45'33"W. 18 Oct. 1988. 63207-63233. CHEMICAL ANALYSIS. 1988.

Pierce County, Wisc. **Kinnickinnic SP**. Along stream bottom with willow, boxelder, silver maple and elm, elev. 680 ft. Sec. 13, T27N, R20W. 44°49'55"N, 92°44'09"W. 6 Oct. 1988. 63068-63084. CHEMICAL ANALYSIS 1988, 2003.

### Appendix 4. Elemental data for 2003\*

Loc	Species	lat	lon	elev	Al	B	Ca	Cd	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	S	Zn
Confluence	CLRA	46.083	-92.18	980	474.61	1.55	771.90		0.83	1.78	422.62	1483.60	344.35	65.34	21.88	0.71	403.58		1240.00	17.84
Confluence	CLRA	46.083	-92.18	980	534.24	1.59	811.48		0.81	1.79	490.35	1468.50	365.57	73.56	21.63	0.79	430.97		980.00	18.99
Confluence	CLRA	46.083	-92.18	980	471.45	1.58	834.23		0.71	1.69	401.42	1595.50	363.17	85.61	19.91	0.60	476.26		920.00	18.74
Confluence	EVME	46.083	-92.18	980	838.36	3.21	1603.20	0.24	1.41	3.44	868.30	2627.50	485.58	50.24	36.72	1.63	663.78	2.21	1870.00	39.88
Confluence	EVME	46.083	-92.18	980	864.28	3.26	1507.20	0.24	1.57	3.72	932.71	2849.10	498.15	50.12	40.27	1.67	728.52	2.25	1570.00	40.50
Confluence	EVME	46.083	-92.18	980	804.06	3.08	1282.90	0.21	1.40	3.50	826.36	2566.90	465.55	45.02	37.36	1.55	648.81	2.29	1750.00	39.40
Confluence	HYPH	46.083	-92.18	980	662.23	2.89	24865.00	1.40	0.96	4.77	631.98	2733.40	883.01	199.63	23.44	1.46	576.81	4.30	1650.00	76.83
Confluence	HYPH	46.083	-92.18	980	730.35	3.07	25733.00	1.63	1.15	4.88	717.86	2558.90	826.61	190.10	30.89	1.56	555.49	6.06	1560.00	82.64
Confluence	HYPH	46.083	-92.18	980	697.53	3.02	20872.00	1.05	1.01	4.29	668.78	2493.90	816.90	182.21	23.55	1.41	543.03	4.87	1590.00	67.50
Confluence	PASU	46.083	-92.18	980	1136.80	4.89	2996.00	0.84	1.41	5.89	946.95	3018.90	625.21	149.61	29.10	1.95	928.81	7.75	1400.00	100.35
Confluence	PASU	46.083	-92.18	980	1029.40	4.95	2954.90	0.77	1.42	5.87	848.51	2964.60	597.81	121.10	27.36	1.96	905.57	6.80	1600.00	89.13
Confluence	PASU	46.083	-92.18	980	938.63	4.76	2969.30	0.76	1.30	5.80	777.89	3047.60	611.02	136.05	29.52	1.77	905.87	6.55	1510.00	86.47
Confluence2	CLRA	46.083	-92.18	980	410.67	1.38	815.89	0.14	0.59	1.73	346.66	1730.00	340.87	72.42	21.54	0.63	503.14		790.00	18.65
Confluence2	CLRA	46.083	-92.18	980	434.21	1.43	795.43		0.64	2.06	371.34	1753.80	354.64	72.23	22.70	0.71	512.02		750.00	20.34
Confluence2	CLRA	46.083	-92.18	980	425.25	1.37	809.60		0.65	1.73	361.51	1714.10	345.24	74.84	24.90	0.66	503.55		770.00	19.39
G Dam Bfir	PASU	46.254	-91.93	1030	646.80	7.08	2775.20	0.78	1.27	6.08	766.55	6146.10	1004.20	251.25	30.82	1.04	2919.30	8.73	1730.00	75.93
G Dam Bfir	PASU	46.254	-91.93	1030	712.67	6.99	2790.40	0.84	1.36	6.30	865.07	6071.90	1033.80	291.37	32.10	1.11	2911.20	9.56	1650.00	72.88
G Dam Bfir	PASU	46.254	-91.93	1030	630.39	6.50	2921.60	0.83	1.23	6.07	774.96	5993.20	986.39	271.33	28.76	1.09	2866.80	9.40	1680.00	70.96
G Dam con	PURU	46.254	-91.93	1030	347.36	2.69	53203.00	0.40	0.73	4.20	341.68	2183.00	419.37	36.20	17.88	0.89	504.77	4.07	875.00	17.91
G Dam con	PURU	46.254	-91.93	1030	436.37	2.44	40738.00	0.49	0.87	4.06	466.83	2435.90	585.44	131.80	22.11	0.97	685.15	4.36	980.00	26.43
G Dam con	PURU	46.254	-91.93	1030	428.19	2.61	42387.00	0.37	0.84	4.49	454.03	2346.20	383.58	21.64	22.02	1.03	620.39	5.30	710.00	22.11
G Dam hard	PURU	46.254	-91.93	1030	323.63	6.71	121132.00	0.40	0.89	6.30	325.19	2042.60	472.95	10.84	33.89	1.13	554.51	7.15	750.00	20.06
G Dam hard	PURU	46.254	-91.93	1030	313.48	5.64	83764.00	0.41	0.83	5.91	286.21	2708.40	646.01	17.78	31.32	1.02	744.98	7.50	390.00	16.05
G Dam hard	PURU	46.254	-91.93	1030	330.05	6.69	92222.00	0.33	0.83	5.61	325.28	2785.80	567.97	13.69	32.84	1.04	909.22	6.33	810.00	15.45
G Dam hard	PASU	46.254	-91.93	1030	981.79	8.25	7130.10	0.34	2.05	7.68	1035.20	4260.40	1301.70	170.13	33.49	1.77	1613.30	11.01	1695.00	78.41
G Dam hard	PASU	46.254	-91.93	1030	1055.20	6.27	6409.20	0.33	1.80	7.92	1192.20	4156.20	1436.60	178.84	35.91	1.64	1581.10	12.13	1570.00	86.40
G Dam hard	PASU	46.254	-91.93	1030	1024.90	8.02	6825.50	0.34	1.70	7.61	1124.10	4309.00	1330.80	176.25	35.28	1.45	1597.90	11.88	1710.00	89.09
Hayward	CLRA	45.983	-91.52	1175	474.74	2.20	1110.60	0.38	1.63	2.94	465.90	2680.95	489.22	57.56	32.10	1.42	921.72		1015.00	29.24
Hayward	CLRA	45.983	-91.52	1175	421.29	2.02	1205.90	0.18	1.08	2.72	441.33	2727.00	495.12	68.33	29.60	1.19	987.00		940.00	30.55
Hayward	CLRA	45.983	-91.52	1175	485.34	2.29	1183.10	0.17	1.01	2.84	500.49	2826.00	529.18	70.19	32.43	1.37	1013.30		980.00	29.73
Hayward	EVME	45.983	-91.52	1175	673.58	2.66	5139.20	0.42	1.39	3.63	739.39	2455.90	451.47	38.93	39.09	1.67	578.06	2.26	1510.00	49.03
Hayward	EVME	45.983	-91.52	1175	677.25	2.49	4533.70	0.36	1.30	3.39	722.88	2266.30	424.51	35.33	36.91	1.43	536.98	2.26	1580.00	45.33
Hayward	EVME	45.983	-91.52	1175	731.66	2.74	5873.70	0.41	1.36	3.67	788.61	2215.90	445.87	36.91	37.57	1.63	518.89	2.30	1760.00	44.46

Loc	Species	lat	lon	elev	Al	B	Ca	Cd	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	S	Zn
Hayward	HYPH	45.983	-91.52	1175	559.52	3.11	32223.00	1.54	1.09	4.47	588.00	2556.10	971.91	151.30	32.04	1.94	557.30	4.68	1210.00	72.62
Hayward	HYPH	45.983	-91.52	1175	526.01	3.11	29923.00	1.59	0.94	4.68	536.74	3261.50	955.54	145.22	32.53	1.78	659.50	4.13	1500.00	75.68
Hayward	HYPH	45.983	-91.52	1175	469.72	3.00	35188.00	1.94	0.89	4.56	479.56	2967.00	895.48	152.37	30.29	1.63	616.40	4.15	1350.00	79.31
Hayward	PASU	45.983	-91.52	1175	1012.60	5.46	4125.30	0.64	1.58	6.30	966.11	3189.20	692.02	94.93	35.66	2.59	1043.80	5.53	1580.00	100.22
Hayward	PASU	45.983	-91.52	1175	1051.60	4.96	4401.20	0.75	1.62	6.17	954.55	3210.80	680.40	97.53	37.48	2.32	1048.70	5.60	1380.00	107.02
Hayward	PASU	45.983	-91.52	1175	1054.90	5.32	4428.80	1.40	2.24	7.03	990.85	3375.00	718.12	100.14	37.12	2.84	1096.90	5.76	1450.00	101.74
Johns	PURU	45.986	-92.53	885	574.77	2.84	34338.00	0.61	1.08	4.97	528.28	3932.00	667.25	159.57	30.29	1.18	1337.70	8.39	880.00	45.53
Johns	PURU	45.986	-92.53	885	600.14	2.83	32837.00	0.71	1.59	4.78	577.60	3406.90	716.78	127.49	27.87	1.64	1147.60	7.88	1030.00	53.50
Johns	PURU	45.986	-92.53	885	448.57	2.95	42210.00	0.68	0.89	4.94	403.33	3664.30	584.08	164.23	26.04	1.03	1221.50	8.98	1100.00	39.49
Johns	PASU	45.986	-92.53	885	750.96	6.50	6308.80	0.40	1.41	7.20	757.49	5619.40	1206.20	337.26	36.19	1.33	1946.40	8.91	1670.00	90.03
Johns	PASU	45.986	-92.53	885	769.32	6.45	6912.10	0.41	1.41	7.28	774.94	5430.90	1188.70	357.14	35.17	1.31	1860.60	9.38	1760.00	91.02
Johns	PASU	45.986	-92.53	885	782.31	6.02	6179.40	0.39	1.49	7.21	806.81	5610.90	1183.00	344.58	36.28	1.46	1965.70	9.19	1600.00	86.90
Kinnikinnic	PURU	44.832	-92.74	680	588.08	3.19	51476.00	0.48	1.33	5.54	524.33	2638.30	789.42	24.05	35.70	1.35	907.84	5.66	1310.00	33.40
Kinnikinnic	PURU	44.832	-92.74	680	500.82	3.28	63221.00	0.51	1.32	4.97	435.00	2072.30	699.90	16.55	30.21	1.56	570.20	4.41	1160.00	27.86
Kinnikinnic	PURU	44.832	-92.74	680	594.64	3.00	49882.00	0.43	1.27	5.42	550.31	2501.30	799.53	19.92	30.14	1.29	817.58	5.04	850.00	33.91
Nam Dam So	EVME	46.222	-91.15	1410	355.38	2.34	1064.20	0.34	1.46	2.69	520.95	2817.90	401.32	49.39	29.32	2.38	918.10		1670.00	32.66
Nam Dam So	EVME	46.222	-91.15	1410	349.21	2.19	916.47	0.19	0.97	2.32	552.66	2697.00	400.75	51.23	26.85	0.97	913.19		1570.00	29.40
Nam Dam So	EVME	46.222	-91.15	1410	406.36	2.73	952.10	0.30	1.05	2.68	596.18	2871.10	411.48	62.59	31.51	1.11	864.44	1.72	1550.00	34.39
Nam Dam So	HYPH	46.222	-91.15	1410	263.73	3.53	51718.00	2.19	0.67	4.07	346.75	3010.30	1038.00	316.21	24.90	0.57	824.89	6.59	1110.00	80.87
Nam Dam So	HYPH	46.222	-91.15	1410	341.73	3.33	36055.00	3.03	0.71	4.13	507.97	3177.00	1028.80	409.30	25.39	0.60	784.19	8.10	1290.00	81.60
Nam Dam So	HYPH	46.222	-91.15	1410	358.13	3.46	33411.00	3.05	0.71	4.35	488.97	3337.70	1047.80	447.69	29.41	0.54	847.18	8.32	1305.00	80.50
Nam Dam So	PURU	46.222	-91.15	1410	367.51	3.29	57159.00	1.04	0.84	4.57	399.18	3507.10	460.32	187.81	39.25	0.96	1329.40	6.83	870.00	30.68
Nam Dam So	PURU	46.222	-91.15	1410	301.92	3.32	61479.50	1.06	0.73	4.90	315.15	3600.75	455.54	142.43	29.98	0.92	1360.50	7.04	780.00	29.55
Nam Dam So	PURU	46.222	-91.15	1410	294.65	3.53	64595.00	1.10	0.73	4.72	331.32	3313.40	447.81	166.67	28.20	0.93	1284.50	7.27	790.00	26.91
Nam Dam So	PASU	46.222	-91.15	1410	848.87	5.67	4161.60	0.76	1.36	5.66	1006.80	4108.90	858.02	235.63	31.38	1.37	1653.50	11.80	1380.00	84.42
Nam Dam So	PASU	46.222	-91.15	1410	1107.75	4.93	4515.95	0.96	1.61	5.54	1213.00	2684.10	662.96	188.91	31.36	1.68	1014.10	11.95	1520.00	94.57
Nam Dam So	PASU	46.222	-91.15	1410	873.82	5.55	4037.00	0.76	1.33	5.71	1002.40	4125.10	852.24	247.44	29.90	1.36	1642.80	11.63	1380.00	90.57
Nam Dam W	PURU	46.224	-91.15	1410	234.10	4.35	91588.00	0.51	0.78	5.73	221.79	1854.10	438.25	20.05	49.39	1.16	371.77	7.69	540.00	13.17
Nam Dam W	PURU	46.224	-91.15	1410	320.35	4.81	101510.00	0.64	0.91	6.50	291.52	1742.10	423.94	21.14	55.19	1.37	313.57	9.29	560.00	13.67
Nam Dam W	PURU	46.224	-91.15	1410	362.04	3.77	72174.00	0.46	1.11	4.98	377.00	2240.20	603.24	23.10	53.93	1.45	495.19	5.79	470.00	19.23
Nam Dam W	PASU	46.224	-91.15	1410	905.02	6.37	2403.00	0.83	1.53	8.09	1002.10	5103.10	1084.00	298.69	60.14	1.74	1402.10	5.53	1880.00	61.38
Nam Dam W	PASU	46.224	-91.15	1410	926.48	6.28	2487.20	0.84	1.55	8.27	1019.70	5076.30	1085.30	294.30	60.90	1.75	1459.10	5.62	1720.00	62.34
Nam Dam W	PASU	46.224	-91.15	1410	913.40	6.21	2363.50	0.84	1.60	8.30	1032.00	5030.00	1078.20	296.33	61.68	1.85	1411.10	5.62	1420.00	62.17
O Landing	PURU	45.678	-92.87	800	754.00	5.18	93150.00	0.53	1.47	6.84	693.02	2391.30	598.43	38.43	42.34	1.57	798.32	7.31	740.00	22.50
O Landing	PURU	45.678	-92.87	800	504.04	4.82	88780.00	0.44	1.23	6.58	492.15	2634.00	632.72	40.56	37.74	1.40	918.56	5.45	1205.00	22.67

Loc	Species	lat	lon	elev	Al	B	Ca	Cd	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	S	Zn
O Landing	PURU	45.678	-92.87	800	621.00	4.84	89148.00	0.53	1.35	6.83	584.12	2480.80	629.01	49.22	42.98	1.52	858.14	6.30	990.00	24.55
Radspur	HYPH	46.177	-91.33	1285	298.03	3.83	28230.00	3.77	0.70	4.48	338.56	4751.20	1136.20	655.68	32.48		1198.20	8.11	1430.00	70.10
Radspur	PASU	46.177	-91.33	1285	532.75	6.97	2581.60	0.90	0.91	6.77	540.14	5047.90	861.38	341.16	28.92	0.83	1938.60	9.61	1490.00	71.10
Radspur	PASU	46.177	-91.33	1285	543.11	6.67	2628.50	0.99	0.96	6.76	558.00	4932.10	821.36	347.80	28.24	0.83	1893.80	9.27	1675.00	71.28
Radspur	PASU	46.177	-91.33	1285	551.85	7.40	2567.20	0.93	0.89	6.96	551.10	4993.20	860.20	350.94	27.02	0.86	1958.10	10.40	1450.00	70.04
Riverside	PURU	46.074	-92.25	900	765.09	2.80	8864.90	0.54	1.46	3.83	826.23	3388.10	611.24	227.23	42.19	1.29	1018.70	19.32	1090.00	122.62
Riverside	PURU	46.074	-92.25	900	633.82	2.51	6440.40	0.44	1.30	4.02	676.92	3618.40	639.27	225.82	39.90	1.21	1102.50	13.79	1360.00	115.07
Riverside	PURU	46.074	-92.25	900	689.58	2.22	7944.00	0.51	1.45	3.82	762.13	3443.10	610.46	230.43	39.28	1.43	962.44	16.10	1040.00	118.89
Sandrock	PASU	45.793	-92.77	820	1022.20	5.04	4326.00	0.32	1.87	6.50	1141.90	4848.50	1563.80	111.00	53.08	1.75	1994.00	4.96	1490.00	35.28
Sandrock	PASU	45.793	-92.77	820	840.52	4.60	3759.80	0.30	1.55	5.39	908.93	4488.60	1435.40	76.02	43.79	1.49	1818.20	4.55	1240.00	31.28
Sandrock	PASU	45.793	-92.77	820	783.92	4.62	3872.90	0.32	1.40	5.62	838.27	4450.30	1367.70	107.35	44.22	1.40	1720.10	4.60	1540.00	30.05

\*Empty cells = measurements were below detection limits of the instrument. CLRA = *Cladina rangiferina*; EVME = *Evernia mesomorpha*; HYPH = *Hypogymnia physodes*; PASU = *Parmelia sulcata*; PURU = *Punctelia rudecta*. Elevation is in feet.

