



Large Rivers Water Quality Monitoring

2009 and 2010 Summary Report

Natural Resource Data Series NPS/GLKN/NRDS—2011/164



ON THE COVER

Top: U.S. Army Corps of Engineers dredging operation at Spring Lake, Mississippi River, at river mile 822. Photo by D. VanderMeulen. Bottom: Winter scene of the Namekagon River near Trego, Wisconsin. Photo by R. Ferrin.



Large Rivers Water Quality Monitoring

2009 and 2010 Summary Report

Natural Resource Data Series NPS/GLKN/NRDS—2011/164

David VanderMeulen

National Park Service
Great Lakes Inventory and Monitoring Network
401 North Hamilton Street
Saint Croix Falls, Wisconsin 54024

May 2011

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols, and the data were analyzed and interpreted within the guidelines of the protocols. Additionally, this report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Great Lakes Inventory and Monitoring Network website (http://science.nature.nps.gov/im/units/GLKN/monitor/LargeRiversWQ/WQ_LargeRivers.cfm) and the Natural Resource Publications Management website (www.nature.nps.gov/publications/nrpm/).

Please cite this publication as:

VanderMeulen, D. 2011. Large rivers water quality monitoring: 2009 and 2010 summary report. Natural Resource Data Series NPS/GLKN/NRDS—2011/164. National Park Service, Fort Collins, Colorado.

Contents

	Page
Contents	iii
Figures.....	v
Tables.....	vii
Appendices.....	ix
Abstract	xi
Acknowledgements.....	xiii
Introduction.....	1
Methods.....	3
Sampling Locations	3
Mississippi National River and Recreation Area.....	3
St. Croix National Scenic Riverway	3
Field Methods	6
Analytical Laboratories	7
Data Handling.....	7
Quality Assurance and Quality Control.....	8
Results and Discussion	9
Mississippi National River and Recreation Area.....	9
Impairments	9
Flow	9
Water Quality.....	10
Designated Uses, Water Quality Standards, and Data Comparisons.....	12
St. Croix National Scenic Riverway	20
Impairments	20
Flow	20
Water Quality.....	21
Temporal Variability – Comparison of Seasons.....	27
Spatial Variability – Comparison of Sites	32

Contents (continued)

	Page
Designated Uses and Water Quality Standards	33
Quality Assurance and Quality Control.....	37
Comments and Recommendations.....	39
Mississippi National River and Recreation Area.....	39
St. Croix National Scenic Riverway	40
Literature Cited	43

Figures

	Page
Figure 1. Location of water quality monitoring sites and streamflow gaging stations in the Mississippi National River and Recreation Area.....	4
Figure 2. Location of water quality monitoring sites in St. Croix National Scenic Riverway	5
Figure 3. Historic and recent mean monthly Mississippi River discharge at Anoka, MN during the 2006, 2008, and 2010 water quality monitoring seasons and during the period of flow record..	10
Figure 4. Total phosphorus concentration at Mississippi National River and Recreation Area water quality monitoring sites in 2010.	11
Figure 5. Chlorophyll-a concentration at Mississippi National River and Recreation Area water quality monitoring sites in 2010.....	11
Figure 6. Mean total phosphorus concentrations, June through September 2010, for National Park Service (NPS) and Metropolitan Council Environmental Services (MCES) water quality monitoring sites	17
Figure 7. Mean chlorophyll-a concentrations, June through September 2010, for National Park Service (NPS) and Metropolitan Council Environmental Services (MCES) water quality monitoring sites	18
Figure 8. Mean total suspended solids concentrations, June through September 2010, for National Park Service (NPS) and Metropolitan Council Environmental Services (MCES) water quality monitoring sites	19
Figure 9. Historic (1902-2008) and more recent (2009-2010) mean monthly St. Croix River discharge at St. Croix Falls, Wisconsin.	21

Tables

	Page
Table 1. St. Croix National Scenic Riverway water quality monitoring sites.	3
Table 2. Dates of water quality sampling Mississippi National River and Recreation Area (MISS) and St. Croix National Scenic Riverway (SACN) in 2009 and 2010.	6
Table 3. Water quality parameters measured and abbreviations used in text.	7
Table 4. Mean values of measured parameters at Mississippi National River and Recreational Area, April to November, 2010	13
Table 5. Minnesota state water quality standards (MnRule 7050.0220) for monitored variables, based on designated use classifications (MnRule 7050.0200) that apply to Mississippi National River and Recreation Area water quality monitoring sites	14
Table 6. Draft river nutrient criteria by River Nutrient Region for Minnesota.....	15
Table 7. Minnesota water clarity and eutrophication standards for rivers applicable at Mississippi National River and Recreation Area water quality monitoring sites ^{1,2}	16
Table 8. Active U.S. Geological Survey (USGS) streamflow gage sites at St. Croix National Scenic Riverway.....	20
Table 9. Range and mean values of field and laboratory variables measured at St. Croix National Scenic Riverway, 2009.	23

Appendices

	Page
Appendix A. Descriptive statistics for monitoring sites in the Mississippi National River and Recreation Area, Minnesota, as entered in NPStoret.	47
Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret.....	55
Appendix C. Mean values (N=3) of field and laboratory variables measured at six mainstem sites on the St. Croix River in April, July, and October for 2007-2010.....	79

Abstract

The Great Lakes Inventory and Monitoring Network (Network or GLKN hereafter) monitored water quality at a number of sites on the Mississippi River, as well as sites on the St. Croix River and its tributaries. Water quality monitoring at the two national parks associated with these large rivers – Mississippi National River and Recreation Area and St. Croix National Scenic Riverway – is a subset of a larger water quality monitoring effort by Network staff at national parks in the western Great Lakes region. The primary objective of this monitoring program is to monitor water quality in order to describe the current status and trends of common limnological parameters on large rivers and select tributaries. GLKN staff hopes to be able to provide early warnings of change, which may then provide justification for increased monitoring, research, or management action.

Monthly water quality sampling was conducted on the St. Croix River and select tributaries in 2009 and on the Mississippi River in 2010 during ice-free months (April through November). Additional samples were collected at select sites on the St. Croix River in April, July, and November 2010.

Field measurements included depth profiles of temperature, pH, conductivity, and dissolved oxygen; and water clarity. Water samples were collected for laboratory analyses of nutrients (total phosphorus, total nitrogen, nitrate+nitrite-nitrogen, ammonium-nitrogen, dissolved silica), major ions (calcium, sodium, magnesium, potassium, sulfate, chloride), dissolved organic carbon, alkalinity, and total chlorophyll-*a*. When applicable, flow measurements at or nearby Network monitoring sites were obtained from active flow gages operated by the United States Geological Survey or the United States Army Corps of Engineers.

In this report monitoring results from 2009 at SACN and results from 2010 at MISS are compared with federal, regional, and site-specific water quality standards, when applicable. Some of these standards are proposed and under review, while others have been approved by the State of Minnesota and/or Wisconsin. All data collected in 2009 and 2010 are included in appendices.

Results indicate that at the Mississippi National River and Recreation Area, relatively poor water quality conditions in the Minnesota River are negatively impacting water quality in the Mississippi River, causing exceedances of water quality standards at downstream sites. At the St. Croix National Scenic Riverway, water quality at sites in the upper river is relatively unimpacted and near EPA reference conditions while Lake St. Croix in the lower river is being impacted by excess nutrients (phosphorus). Tributaries to the St. Croix River including the Snake, Apple, Willow and Kinnickinnic rivers also appear to be impacted by excess nutrients.

Park-specific comments and recommendations relating to the sampling season are provided. The Network expects to continue monitoring at St. Croix National Scenic Riverway in 2011 and at Mississippi National River and Recreation Area in 2012. Future monitoring will be used to assess current condition as it relates to water quality standards, and to continue to develop a long-term dataset to assess for trends in water quality over time.

Acknowledgements

Substantial support for the water quality work in 2009 and 2010 was provided by staff of Mississippi National River and Recreational Area and St. Croix National Scenic Riverway. Material support included use of boats, lab and office equipment and space, and field sampling equipment. I would like to extend special thanks to primary field staff from the parks (Lark Weller and Michelle Prosser) and to Richard Damstra from the Great Lakes I&M Network. I would also like thank Dean Tucker from NPS-WRD in Ft. Collins, CO, for his patience and guidance with water quality database issues. Lastly, I would like to thank Joan Elias from the Great Lakes I&M Network for her review and suggestions that improved this document.

Introduction

The Great Lakes Inventory and Monitoring Network measured water quality variables and collected water samples for laboratory analysis at the St. Croix National Scenic Riverway (SACN) in 2009 and at SACN and the Mississippi National River and Recreation Area (MISS) in 2010. The Network's large rivers water quality monitoring protocol (Magdalene et al. 2008a) was first implemented at MISS in 2006, with subsequent monitoring at SACN in 2007, and both MISS and SACN in 2008. Reports summarizing those efforts are described in Elias and Sieracki (2007), VanderMeulen and Elias (2008), and VanderMeulen (2009), respectively.

The large rivers water quality monitoring protocol encompasses the following:

- core suite (temperature, dissolved oxygen, conductivity, pH, water clarity)
- water level/flow
- advanced suite (alkalinity, dissolved organic carbon, silica, chloride, sulfate, calcium, sodium, potassium, magnesium, total chlorophyll-*a*, total phosphorus, total nitrogen, ammonium-nitrogen, nitrate+nitrite-nitrogen, total suspended solids)
- primary productivity (as estimated by total chlorophyll-*a* measurements)
- nutrient dynamics (as measured by the phosphorus and nitrogen species)
- diatoms (not included within the water quality monitoring protocol, but closely tied to it; Ramstack et al. 2008)

The overall goal of the monitoring program for water quality of large rivers is to contribute to an understanding of the health of ecosystems and provide insights on water resources issues in the parks. The Network's objectives for monitoring water quality of rivers, listed in order of priority, are:

- Monitor flow to determine changes in mean monthly and mean annual flow.
- Monitor mean annual concentrations of core and advanced suite parameters, accounting for seasonality in water quality conditions.
- Relate current water quality conditions to known historical conditions.
- Analyze water quality parameters for trends, and correlate any observed trends with potential causes (such as weather, climate, land use, point sources, exotic species, and atmospheric deposition).

This report summarizes the Network's activities related to water quality monitoring at SACN in 2009 and 2010 and MISS in 2010. Water quality monitoring is scheduled to alternate annually between MISS and SACN, but additional funding provided by SACN allowed for quarterly monitoring in 2010 at six sites on the St. Croix River in what normally would have been an off-year. This quarterly monitoring facilitates continuity of our sampling effort and will enhance our ability to analyze interannual variability and detect trends in future years. Results from previous years (Elias and Sieracki 2007, VanderMeulen and Elias 2008, VanderMeulen 2009) can be found on the GLKN website (<http://science.nature.nps.gov/im/units/glkn/index.cfm>).

Methods

Sampling Locations

Mississippi National River and Recreation Area

The Network selected five sites for long-term monitoring (Figure 1). These sites are all located on the mainstem of the Mississippi River. The sites were selected in consultation with staff from other monitoring agencies, such as the Minnesota Pollution Control Agency (MPCA) and the Metropolitan Council Environmental Services (MCES), primarily to fill spatial gaps in monitoring coverage (Magdalene et al. 2008a). The sites, identified by river mile UM880, UM868, etc., are described in detail in Magdalene et al. (2008a) and Elias and Sieracki (2007).

St. Croix National Scenic Riverway

The Network originally selected 11 sites for long-term monitoring, and added two sites after the first month of sampling in 2007, for a total of 13 water quality monitoring sites (Table 1; Figure 2). During the site selection process, three upper SACN sites and three lower SACN sites on the St. Croix River were randomly chosen (Table 1). The remaining seven sites were chosen non-randomly in consultation with members of the St. Croix Basin Water Resources Team (Basin Team), which is composed of federal, state, and regional water resources professionals. Water quality monitoring at these seven sites is designed to fill spatial gaps in monitoring coverage, and to serve as integrator sites for contributions from select large tributaries. All SACN sites are described in detail by Magdalene et al. (2008a) and VanderMeulen and Elias (2008); and the site selection process is explained in Magdalene et al. (2008a).

Table 1. St. Croix National Scenic Riverway water quality monitoring sites.

Site	Description
SACNa	added in 2007; relatively pristine, integrator for upper St. Croix River
SACNb	added in 2007; relatively pristine, Namekagon River above Hayward, WI
SACN01	randomly selected; Namekagon River
SACN02	randomly selected; integrator site
SACN03	Snake River; high priority tributary site
SACN04	randomly selected; integrator site
SACN05	integrator for river north of St. Croix Falls
SACN06	Apple River; high priority tributary site
SACN07	randomly selected site, Lake St. Croix (Bayport, MN)
SACN08	Willow River (Lake Mallalieu); high priority tributary site
SACN09	randomly selected site, Lake St. Croix (Hudson, WI)
SACN10	Kinnickinnic River; high priority tributary site
SACN11	randomly selected site; Lake St. Croix (Prescott, WI)

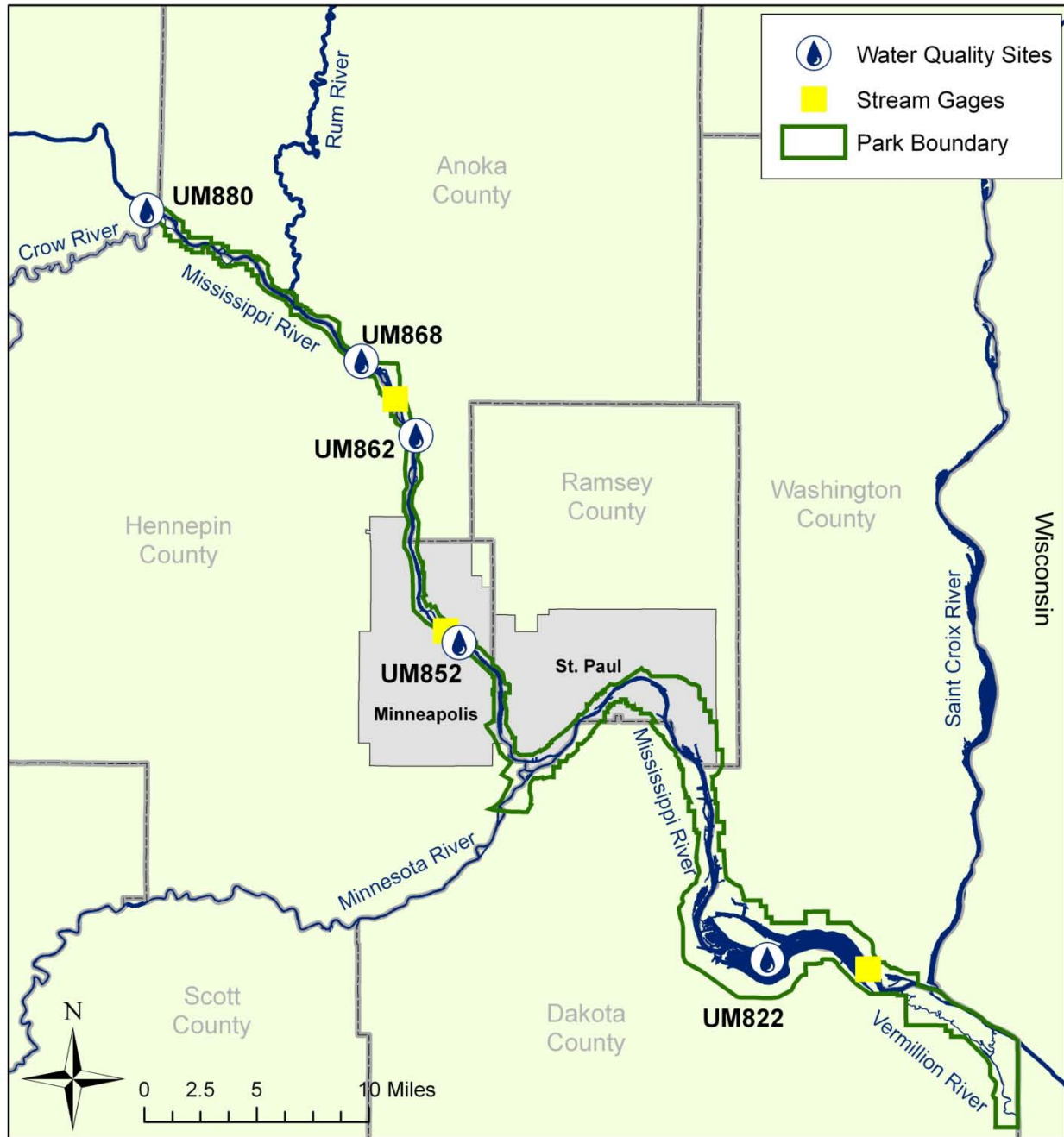


Figure 1. Location of water quality monitoring sites and streamflow gaging stations in the Mississippi National River and Recreation Area.

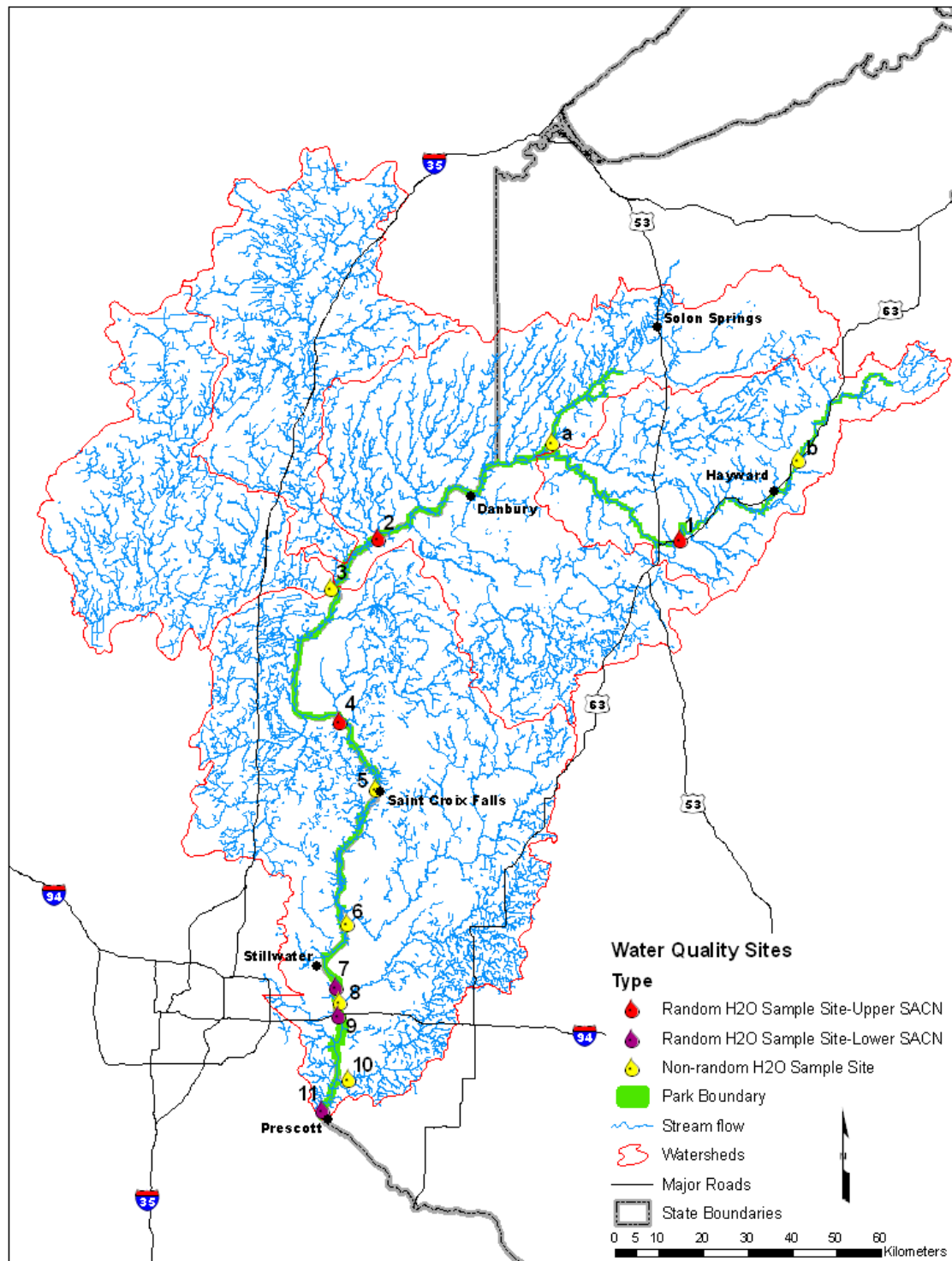


Figure 2. Location of water quality monitoring sites in St. Croix National Scenic Riverway, including sites on the Namekagon River (b,1), St. Croix River (a, 2,4,5), Snake River (3), Apple River (6), Lake St. Croix (7,9,11), Willow River (Lake Mallalieu-8), and the Kinnickinnic River (10).

Field Methods

At SACN and MISS Network staff conducted monthly water quality sampling at each site throughout the open water season in 2009 and 2010, respectively (Table 2). Quarterly (core and advanced suite) samples were also collected at all sites in April, July, and October for SACN and MISS in 2009 and 2010, respectively. Quarterly samples were also collected at SACN at six sites (1, 2, 4, 7, 9, and 11) in 2010. Samples were not collected in March (per Magdalene et al. 2008a) due to unsafe, iced-up conditions on the rivers. Whenever feasible, monitoring was conducted at approximately the deepest part of the channel and the centroid of flow. In a few instances high water, unsafe currents, boat traffic, or weather prohibited sampling in the center of the channel, and sampling occurred closer to the riverbank.

Table 2. Dates of water quality sampling Mississippi National River and Recreation Area (MISS) and St. Croix National Scenic Riverway (SACN) in 2009 and 2010.

SACN (2009)	SACN (2010**)	MISS (2010)
4/6 - 4/9*	4/5, 4/7*	4/6 - 4/8*
5/4 - 5/7	-	5/10 - 5/11
6/8 - 6/11	-	6/8 - 6/9
7/6 - 7/9*	7/8 - 7/9*	7/6 - 7/7*
8/4 - 8/7	-	8/11 - 8/12
9/9 - 9/12	-	9/9 - 9/10
10/6 - 10/9*	10/5 - 10/6*	10/7 - 10/8*
11/2 - 11/5	-	11/8 - 11/9

* Core and advanced suite

** Sites 1, 2, 4, 7, 9, and 11 only

Profile data on temperature, dissolved oxygen concentration, specific conductance, and pH were collected near the surface and at 0.5 or 1 m intervals with a Hydrolab multiprobe. At each site, Network staff also measured water clarity using a transparency tube and/or Secchi disc, took a GPS reading, recorded environmental conditions (e.g., wind speed and direction, wave height, sky cover, air temperature), and noted field personnel and instrumentation.

The multiprobe was calibrated daily for specific conductance and pH, and prior to sampling at each site for dissolved oxygen and depth. The temperature probe was checked with a NIST-calibrated thermometer prior to the season and was found to read within acceptable limits (Ledder and Elias 2008). A brass chain with precise length markers was used to check previously marked depth increments on the nylon rope attached to the Secchi Disc.

Water samples for laboratory analysis were collected at a depth of 0-2 m using an integrated tube sampler (MPCA 2004; WDNR 2004). When the water was 1-2 m deep, the tube sampler was deployed on an angle to collect a sample from the full water column. When the water was < 1 m deep, an elbow-deep grab sample was collected. Water was composited in a 9 L high density polyethylene carboy that had been cleaned in the lab prior to sampling and rinsed three times with sample water on-site. See Magdalene et al. (2008b) for details on collection and handling of water samples.

Water samples were collected for analysis of nutrients, total chlorophyll-*a* (chl-*a*), and total suspended solids (TSS) during all site visits (Table 3). The remaining parameters were measured three times (April, July, and October) during the sampling season. Also, in July a near-bottom water sample was collected with a Van Dorn Sampler for analysis of total phosphorus. This sampling was only conducted at thermally-stratified lake-like sites at SACN; at MISS water is well-mixed throughout the water column at all sites and near-bottom water samples were not collected.

Analytical Laboratories

GLKN contracted with White Water Associates (WWA) and the St. Croix Watershed Research Station (SCWRS) for analytical laboratory services. The SCWRS is the field research station of the Science Museum of Minnesota and is also responsible for analyzing samples collected for the Network's protocol to monitor diatoms (Ramstack et al. 2008). WWA analyzed samples for major ions, dissolved organic carbon (DOC), dissolved silica (SiO₂), and TSS; SCWRS analyzed samples for nutrients and chl-*a*. The Natural Resources Research Institute analyzed a limited number of nutrient and chl-*a* samples collected in 2009 as a quality assurance/quality control measure as the Network transitioned to the SCWRS. All samples were processed and handled according to standard operating procedures (Magdalene et al. 2008b) and as detailed in the 2007 annual water quality report (VanderMeulen and Elias 2008).

Table 3. Water quality parameters measured and abbreviations used in text. **Bold** font indicates parameters measured in April, July, and October; remaining parameters were measured monthly.

Parameter	Abbreviation	Parameter	Abbreviation
Alkalinity	Alk	Total Nitrogen	TN
Calcium	Ca⁺²	Ammonium-Nitrogen	NH ₄ -N
Chloride	Cl⁻	Nitrate+Nitrite-Nitrogen	NO ₃ +NO ₂ -N
Total Chlorophyll- <i>a</i>	Chl- <i>a</i>	Total Suspended Solids	TSS
Dissolved Organic Carbon	DOC	Specific Conductance	SC25
Magnesium	Mg⁺²	Dissolved Oxygen	DO
Potassium	K⁺	pH	pH
Silica	SiO₂	Temperature	Temp
Sodium	Na⁺	Secchi Disc Depth	Secchi
Sulfate	SO₄⁻²	Transparency Tube	T-tube
Total Phosphorus	TP		

Data Handling

Methods for using laboratory data below detection limit in statistical analyses are numerous and diverse (e.g., Helsel 1990, Helsel and Cohen 1988). Although statistical analyses were not conducted on water quality data collected in 2009 and 2010, summary statistics such as mean and standard deviation were calculated. The following rules for censored data results were applied:

- For values < detection limit, value assigned = 0.5 x detection limit

- For values > detection limit but < lower reporting limit, values assigned = 0.5 x lower reporting limit
- For values > upper reporting limit (only applicable to transparency tube readings), values assigned = 1.1 x upper reporting limit

Data below detection or lower quantification limits were included in summary statistics for MISS (Table 4). Sixty five percent (26 out of 40) of the values reported for NH₄-N at MISS were below the laboratory reporting and/or detection limit (11 and 4 ug/L, respectively), and one value for T-tube at site UM880 was above upper reporting limit (>120 cm). Data below detection or lower quantification limits, and above detection limits were included in summary statistics for SACN on multiple occasions (Table 9 and Appendix C) in 2009 and 2010. Most values below detection and reporting limits were for TSS and NO₃ + NO₂-N on the upper river and for NH₄-H across all sites. In addition, many values for transparency tube measurements were above the detection limit (>120 cm) for all sites and both years for SACN.

Quality Assurance and Quality Control

Steps to ensure quality assurance and quality control (QA/QC) were undertaken routinely, according to standard operating procedures (Ledder and Elias 2008) for monitoring water quality. The measurement sensitivity of the Hydrolab sonde was calculated prior to the field season; the sonde was calibrated daily following acceptance criteria and a calibration log was maintained with the instrument; measurements taken in the field with the sonde were saved electronically and backed-up on paper data sheets; duplicate field measurements were taken at the rate of approximately 10%; duplicate water samples were collected at the rate of approximately 10%; and equipment blanks were obtained prior to and during the field season to ensure Network staff were not introducing any contamination to the samples. Network quality assurance criteria stipulate that analytical results for water sample duplicates should be within 10% of each other for all parameters except nutrients and chl-*a*, which should be within 30% of each other (Ledder and Elias 2008). In addition, the contract laboratories conducted their own QA/QC work, including blanks, duplicates, and spikes, and generated QA/QC reports that accompanied water sample results.

Results and Discussion

Data relative to flow, general water quality results, and comparisons of 2009 and 2010 data with past results collected by NPS and/or other agencies are presented below. For MISS, data from previously established long-term Network sites are compared with data from long-term sites in similar river stretches or Navigation Pools established by the Metropolitan Council Environmental Services (MCES) within MISS boundaries. Data are also compared with federal and/or state water quality standards, where applicable, for MISS and SACN. Appendix A contains a summary of all data collected at MISS in 2010. Appendix B contains a summary of all data collected at SACN in 2009. Appendix C contains a summary of data collected at select sites at SACN from 2007-2010 in April, July, and November. All data from 2009 and 2010 and past years are posted in EPA's STORET database and can be accessed at http://www.epa.gov/storet/dw_home.html.

Mississippi National River and Recreation Area

Impairments

Within MISS, sections of the Mississippi River are on the 303(d) List of Impaired Waters for Minnesota due to water quality standard exceedances for water clarity, fecal coliform bacteria, mercury, polychlorinated biphenyl (PCB), and perflourooctane sulfonate (PFOS) (MPCA 2008, Magdalene et al. 2008a, NPS 1995). Additional impairments for excess sediment and nutrients are described below and likely will be enacted in the near future. Mercury, PCBs and PFOS are currently being monitored in bald eagle and fish tissue by GLKN staff under a separate protocol, and in river water by other regulatory agencies. Fecal coliform bacteria are monitored by several other agencies within park boundaries. However, nutrient and water clarity monitoring is being conducted by GLKN staff as a component of the Large Rivers Water Quality Monitoring Protocol (Magdalene et al 2008).

Flow

Three streamflow gages currently operate on the mainstem of the Mississippi River within MISS park boundaries: near Anoka, Minnesota (UM 864); at St. Anthony Falls, Minnesota (UM 853) and at Lock & Dam #2 (UM 815) (Figure 1). The site near Anoka (site # 05288500) is operated by the US Geological Survey, while the other two sites are controlled by the US Army Corps of Engineers (COE). Flows at water quality monitoring sites UM 868 and 862 are best represented by the streamflow gage near Anoka, while flows at sites UM 852 and 822 are approximated by the streamflow gages at UM 853 and 815, respectively. Flow at water quality monitoring site UM 880 is best represented by subtracting flow values from the Crow and Rum Rivers (site #'s 05280000 and 05286000, respectively), from those of the streamflow gage near Anoka.

Comparisons of long-term (1932-2009) mean monthly flow conditions at the Anoka site with mean monthly flows in years when water quality was monitored by Network staff show that in 2006 and 2008 flow was near the long-term average in early spring, peaked well above the long-term average in May, and dropped well below average during the summer and fall periods (Figure 3).

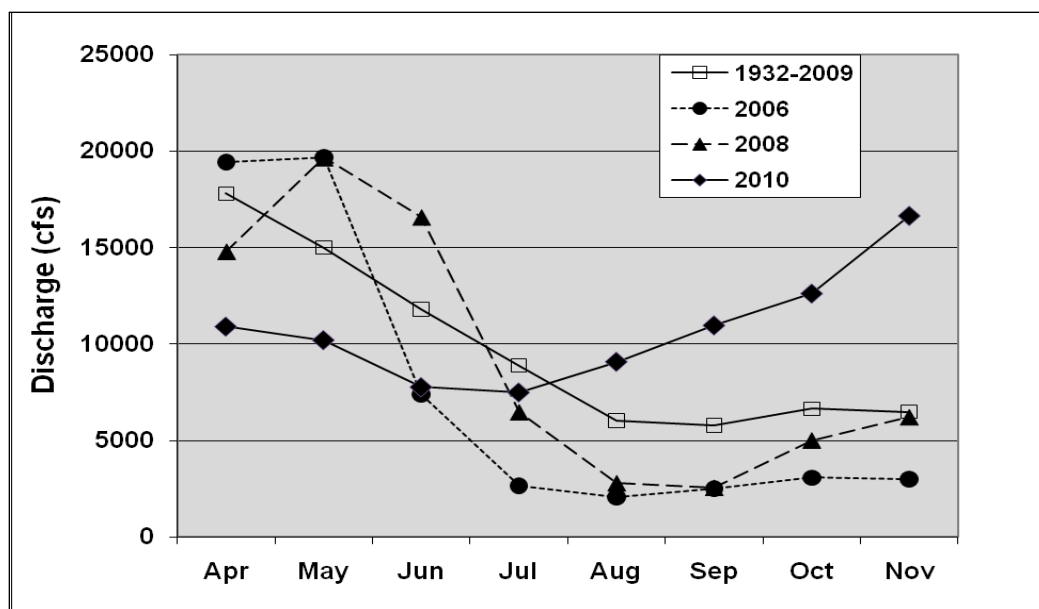


Figure 3. Historic and recent mean monthly Mississippi River discharge at Anoka, MN during the 2006, 2008, and 2010 water quality monitoring seasons and during the period of flow record. cfs = cubic feet per second. Flow data from 2010 should be considered provisional.

In 2006, flow remained well below average through the end of the monitoring season, but in 2008 had recovered to average conditions by November. In 2010, flow was below average in the spring and early summer but from mid-summer on was well above average, especially in the fall. Although not shown, this pattern for these years was also present at the two downstream COE streamflow gaging sites.

Water Quality

General Observations

At MISS ionic strength and buffering capacity are high, with average specific conductance ranging from 351 to 644 uS/cm, and average alkalinity ranging between 163 and 202 mg/L (Appendix A). Total suspended solids concentrations were generally highest in spring but were also high at certain times in the summer and fall when sampling occurred during or shortly after major storms. Water clarity was generally lowest in the spring and greatest in fall. Total phosphorus concentrations were high in early spring, with additional peaks in mid-summer and fall that coincided with major storm events. For any given month of sampling, TP levels increased going downstream, with a large increase at site UM 822, which is downstream of the confluence with the Minnesota River (Figure 4.) Chlorophyll-*a* was high in the spring, and decreased throughout the monitoring season, except for a very high concentration at UM 822 in August (Fig 5). Seasonal patterns for total nitrogen and nitrogen species ($\text{NO}_3 + \text{NO}_2\text{-N}$ and $\text{NH}_4\text{-N}$) are more complex, and are influenced by tributaries and site-specific channel morphology.

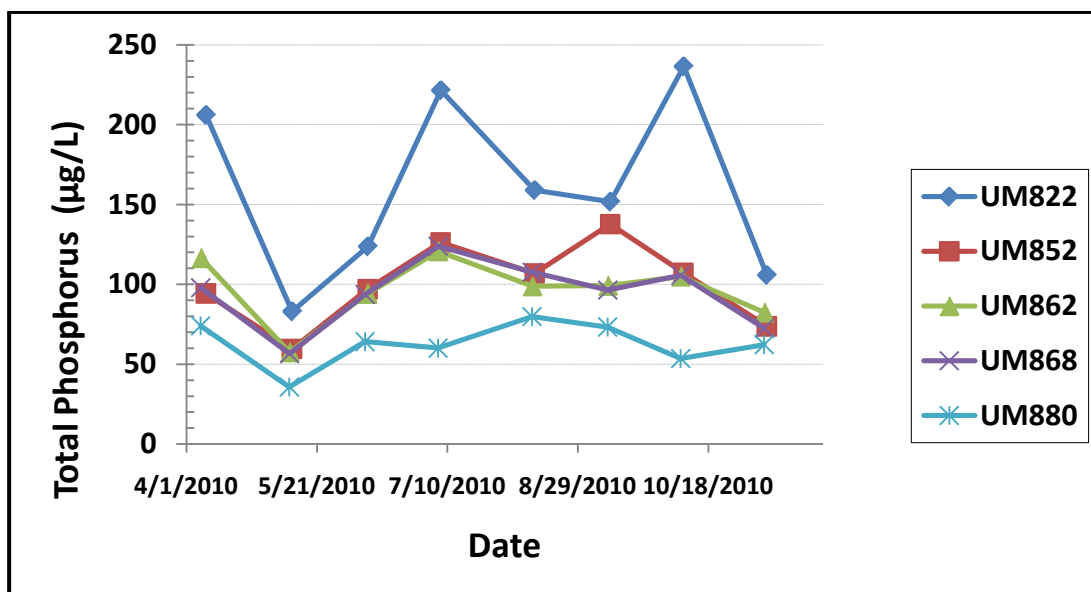


Figure 4. Total phosphorus concentration at Mississippi National River and Recreation Area water quality monitoring sites in 2010.

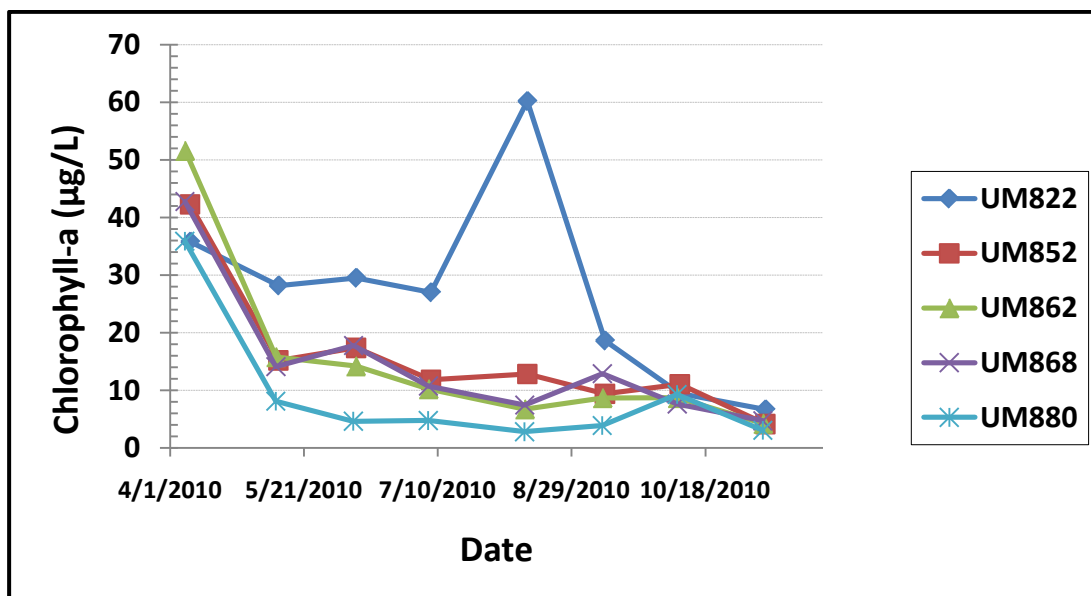


Figure 5. Chlorophyll-a concentration at Mississippi National River and Recreation Area water quality monitoring sites in 2010.

Water quality at site UM822 differs substantially from that at the four upstream sites (Table 4). Concentrations of nutrients, ions, and total suspended solids were typically much higher at UM822, while T-tube measurements were consistently lower. UM822 is the only Network monitoring site located below the confluence with the Minnesota River, a tributary with high nutrient concentrations (Minnesota River Basin Data Center 2001), and 303(d)-listed for high

turbidity and low dissolved oxygen (MPCA 2008). The Minnesota River contributes an additional 50% to the flow of the Mississippi River at the two rivers' confluence (Moody and Battaglin 1995).

Designated Uses, Water Quality Standards, and Data Comparisons

The State of Minnesota designated beneficial uses for all surface waters in the state (MPCA: <http://www.revisor.leg.state.mn.us/arule/7050/>) as follows:

- Class 1 - protected for drinking
- Class 2 - protected for aquatic life and recreation
- Class 3 - protected for industrial uses
- Class 4 - protected for agricultural uses
- Class 5 - protected for aesthetics and navigation
- Class 6 - other uses
- Class 7 - limited resource value waters

Use classes 1, 2, 3, and 4 have subclasses. Of these, the Class 2 subclasses are most pertinent to natural resource considerations:

- 2A: Cold-water fisheries, trout waters, also protected as a source of drinking water
- 2Bd: Cool-and warm-water fisheries, also protected as a source of drinking water
- 2B: Cool-and warm-water fisheries (not protected for drinking water)
- 2C: Indigenous fish and associated aquatic community (not protected for drinking water)
- 2D: Wetlands (not protected for drinking water).

The sections of the Mississippi River where our sampling sites are located have multiple designations, as do all surface waters. Sites UM880, UM868, and UM862 are designated Class 1C, 2Bd, and 3B waters, protected for drinking water uses due to the municipal water intakes for the cities of Minneapolis and St. Paul, which are located at UM862. Sites UM852 and UM822 are designated Class 2B, 3B, 4A, 4B, 5, and 6 waters. The State of Minnesota has also established water quality standards for some water quality parameters to ensure that the designated uses for state waters are met (MnRule 7050.0220). Site-specific designated uses and water quality standards designed to protect those uses are shown in Table 5.

Table 4. Mean values of measured parameters at Mississippi National River and Recreational Area, April to November, 2010 (standard deviation in parentheses). Near-surface values (0.3 - 1.2 m) are used for pH, SC25, DO, and Temperature. See Table 2 for sampling frequency for each variable.

Variable	UM880	UM868	UM862	UM852	UM822
Chl-a (ug/L)	9.1 (11.1)	14.8 (12.1)	16.2 (16.1)	15.5 (11.5)	26.9 (16.8)
TP (µg/L)	62.9 (13.9)	94.3 (21.0)	96.8 (20.0)	100.3 (25.6)	160.9 (56.1)
TN (µg/L)	1208 (152.2)	1709 (371.5)	1737 (390)	1648 (344.2)	4263 (1357)
NO ₃ +NO ₂ -N (µg/L)	414.8 (82.1)	788.7 (320.3)	807.7 (348.3)	714.3 (296)	3278 (1312)
NH ₄ -N (µg/L)	13.0 (14.1) ^{*,5}	8.9 (13.4) ^{*,6}	8.9 (11.8) ^{*,6}	12.0 (12.9) ^{*,5}	25.96 (30.1) ^{*,3}
TSS (mg/L)	7.3 (1.8)	11.9 (3.1)	11.5 (2.8)	13.1 (2.4)	37.9 (15.7)
DOC (mg/L)	10.8 (1.3)	10.9 (1.1)	11 (1)	10.9 (1.1)	8.9 (0.3)
Alkalinity (mg/L)	163 (15.6)	183 (16)	195 (21.1)	181.3 (13.7)	208.2 (28.8)
Cl ⁻ (mg/L)	12.5 (0.3)	16.5 (0.2)	17.4 (1.2)	19.1 (1.5)	19.6 (2.3)
SO ₄ ⁻² (mg/L)	12.4 (1.8)	27.7 (2.5)	30.7 (2.1)	28.4 (3.4)	110.7 (15.3)
Ca ⁺² (mg/L)	45.9 (4.4)	55.1 (7.7)	56 (3.6)	55.3 (4.6)	79.6 (8.9)
Mg ⁺² (mg/L)	16.2 (2.0)	21.0 (3.4)	21.7 (1.9)	21.0 (2.9)	31.3 (3.7)
K ⁺ (mg/L)	2.3 (0.3)	3.0 (0.5)	3.2 (0.6)	3.1 (0.3)	4.62 (0.6)
Na ⁺ (mg/L)	7.7 (1.6)	8.1 (1.4)	8.3 (1.3)	9.5 (1.8)	12.3 (1.4)
SiO ₂ (mg/L)	9.2 (1.6)	12.3 (3.2)	12.7 (3.5)	11.4 (3.7)	18.3 (2.9)
T-Tube (cm)	89.2 (22.8) ^{*,1}	64.9 (10.6)	59.2 (12.2)	58.6 (10.3)	31.3 (7.8)
pH (std. units)	8.2 (0.2)	8.3 (0.2)	8.3 (0.2)	8.3 (0.2)	8.2 (0.2)
SC25 (µS/cm)	353 (33.7)	413.1 (46.7)	415.6 (44.9)	415.5 (42.4)	640 (61.5)
DO (mg/L)	9.1 (1.9)	9.0 (2.0)	10.3 (1.5)	10.7 (1.6)	9.3 (1.8)
Temperature (°C)	16.3 (7.1)	17.0 (7.2)	17.2 (7.3)	16.1 (6.9)	16.5 (7.2)

(*,ⁿ) = censored data used to calculate mean; n=number of censored values.

Table 5. Minnesota state water quality standards (MnRule 7050.0220) for monitored variables, based on designated use classifications (MnRule 7050.0200) that apply to Mississippi National River and Recreation Area water quality monitoring sites. All limits are maximum values, except dissolved oxygen (DO), which is a minimum allowable value, and pH, which is an allowable range of values.

Water Quality Parameter	Designated Water Use Classifications	
	1C, 2Bd, 3B (sites 880, 868, 862)	2B, 3B, 4A, 4B, 5, 6 (sites 852, 822)
Temperature (°F)	within 5 °F of natural	within 5 °F of natural
pH (SU)	6.5-9.0	6.5-8.5
Dissolved oxygen (mg/L)	5 daily min	5 daily min ¹
Nitrate+nitrite nitrogen (mg/L-N) - Federal drinking water standard	10	N/A
Nitrate+nitrite nitrogen (mg/L-N) – <i>draft</i> acute/chronic toxicity standard for MN ²	41/4.9	41/4.9
Ammonia, unionized (ug/L-N)	40	40
Chloride (mg/L) ³	860/230	860/230

¹The standard is not less than 5 mg/l as a daily average from 4/1 through 11/30, and not less than 4 mg/l at other times.

²Draft criteria (Monson and Preimesberger 2010). Draft acute value (41 mg/L, maximum standard) is for a one-day duration, and the draft chronic value (4.9 mg/L) is for a four-day duration.

³Acute value (860 mg/L) maximum standard is for a 1-hour duration, and chronic value (230 mg/L) is for a 4-day duration.

All pH values measured at site UM852 in April 2010 exceeded the upper limit of 8.50, with values ranging from 8.71 to 8.81, and a mean value of 8.77. No additional exceedances of pH standards occurred at UM852 during the rest of the sampling season or at any of the other sites in 2010. In April, pH values across all sites ranged from 8.28 to 8.81. These higher than expected pH values likely resulted from lower spring flows resulting in very high algal production and chl-*a* concentrations (Figure 3) that decrease the amount of carbon dioxide in the water through photosynthesis, which has an overall effect of increasing pH.

The Minnesota State Legislature in 2010 approved funding for the MPCA to develop aquatic life standards for nitrogen and nitrate. Draft acute and chronic standards for nitrate are shown in Table 5. At site UM822 the draft chronic standard of 4.9 mg/L NO₃+NO₂-N was exceeded (5.8 mg/L) on July 7, 2010. However, the chronic standard is based on exceedances of the standard over a four-day period, and the Network's sampling frequency for large rivers (once per month per site during ice-free months, every other year) is not adequate to assess violation of the chronic NO₃+NO₂-N standard. The acute and chronic standards for NO₃+NO₂-N were not exceeded at any other MISS sites during the sampling season.

The Minnesota Pollution Control Agency (MPCA) has developed draft eutrophication criteria for rivers in 2010 (Heiskary et al. 2010), with distinct eutrophication criteria applied across different regions of the state (Markus 2010) (Table 6). All sites within MISS fall within the Central River

Nutrient Region. In order to assess for impairment and subsequent 303(d) listing, at least six water quality samples are collected in the summer (June through September) for a minimum of two summers. These data are combined with all available data for the most recent 10-year assessment period. Means are calculated and compared to the criteria. For a river reach to be listed as impaired it must exceed the causative variable (TP) and one or more of the response variables (sestonic chlorophyll, 5-day biochemical oxygen demand (BOD5), DO flux and/or pH) (Heiskary et al. 2010).

Table 6. Draft river nutrient criteria by River Nutrient Region for Minnesota.

Region	Nutrient	Response Variables		
	<i>TP (ug/L)</i>	<i>Chl-a (ug/L)</i>	<i>DO flux (mg/L)</i>	<i>BOD5 (mg/L)</i>
North	55	<10	<4.0	<1.5
Central	100	<20	<4.5	<2.0
South	150	<40	<5.0	<3.5

The State of Minnesota is also in the process of replacing its stream turbidity standards with another measure of water clarity, total suspended solids, which, unlike turbidity, is a concentration-based standard more appropriate to development of Total Maximum Daily Load (TMDL) plans (Heiskary and Parson 2010). As with the draft eutrophication criteria, river regions were used to assign TSS criteria of 15, 30, and 65 mg/L for the North, Central, and South regions, respectively.

In 2010, site specific eutrophication standards were proposed for Mississippi River Pools 1 through 8 (Heiskary and Wasley 2010). Site-specific TSS standards were also proposed for the Mississippi River from Lock and Dam 1 to Lock and Dam 4 (MPCA 2010). Regional and site-specific eutrophication and TSS standards as they apply to Network water quality monitoring sites at MISS are shown in Table 7.

Metropolitan Council Environmental Services (MCES) has been conducting water quality monitoring in and near MISS for several decades. The locations of Network water quality monitoring sites at MISS are primarily designed to cover spatial and temporal monitoring gaps within the more comprehensive MCES monitoring effort inside the park (MCES 2009, Magdalene et al. 2008a). In an effort to provide perspective and context to NPS Network monitoring efforts, data results as they apply to regional and site-specific draft eutrophication and water clarity standards are shown in Figures 6, 7, and 8. For comparison purposes, MCES water quality data results are also shown in the figures.

Mean TP levels for GLKN monitoring sites were below the draft TP standards (100 ug/L) above Lock and Dam #1 and above the draft TP standard (100 ug/L) for Pool 1. The opposite is true for MCES sites in these two spatial categories, although mean TP for the MCES site in Pool 1

Table 7. Minnesota water clarity and eutrophication standards for rivers applicable at Mississippi National River and Recreation Area water quality monitoring sites^{1,2}.

Site	TSS (mg/L)	TP (ug/L)	Chl-a (ug/L)
UM 880	30 ³	100 ⁵	20 ⁵
UM 868	30 ³	100 ⁵	20 ⁵
UM 862	30 ³	100 ⁵	20 ⁵
UM 852	30 ³	100 ⁶	35 ⁶
UM 822	32 ⁴	not available ⁷	35 ⁶

¹In general, the criteria presented here are based on samples collected during the summer (June – September), with assessment for impairment based on exceedances of mean summer values for half or more of all summers in a 10-year period over a range of flow conditions. The draft TSS criteria for sites UM880, 868, 862, and 852 are based on concentrations not being exceeded more than 10% of the time over a 10-year period using an April through September assessment window.

²Draft criteria for diurnal DO flux and BOD are also provided in Heiskary et al. (2010) but are not shown since these parameters are not monitored by GLKN staff.

³Based on draft TSS criteria for Minnesota rivers (Heiskary and Parson 2010, Markus, 2010).

⁴Based on recently approved TSS TMDL for the Mississippi River from Lock and Dam 1 to Lock and Dam 4 (MPCA 2010).

⁵Based on draft nutrient criteria for rivers in Minnesota (Heiskary et al. 2010, Heiskary and Parson 2010).

⁶Based on draft eutrophication criteria for pools 1-8 (Heiskary and Wasley 2010).

⁷Not available since a strong relationship between TP and Chl-a could not be established in Pool 2 (Heiskary and Wasley 2010).

(MCES-847.7) fell just below the draft TP standard. Mean TP concentrations for both GLKN and MCES sites in Pool 2 were much higher than upstream sites, which is not surprising since the Pool 2 sites are located below the confluence of the Minnesota River, a major contributor of phosphorus to the Mississippi River (Heiskary et al. 2010). The long-term summer mean TP concentration for the Minnesota River from 1993 to 2009 is 258 ug/L. The higher mean chl-*a* values in Pool 2 can be partially attributed to high chl-*a* levels in the Minnesota River, which from 1993 to 2009 had a mean chl-*a* value of 61 ug/L (Heiskary and Wasley 2010). There currently is no proposed TP standard for sites in Pool 2 due to an inconsistent relationship between TP and chl-*a* (Heiskary and Wasley 2010).

Despite the relatively low number of samples (n=4) for NPS sites in Pools 1 and 2, mean TP levels are comparable to mean TP at MCES sites in those Pools. Mean TP at NPS sites above Pool 1 (i.e., St. Anthony Falls) was considerably lower than at the MCES site. Land use in the vicinity of MISS is heavily urbanized and suburbanized with major tributaries flowing from areas with intense agricultural use. As such, nonpoint source runoff from these land uses is currently contributing to the water quality impairments identified. The Rum and Crow Rivers drain largely agricultural areas, and since NPS site UM880 is located above the confluence of these tributaries, the fact that its mean TP is lower than MCES site 871.6—which is downstream of these tributaries—is to be expected.

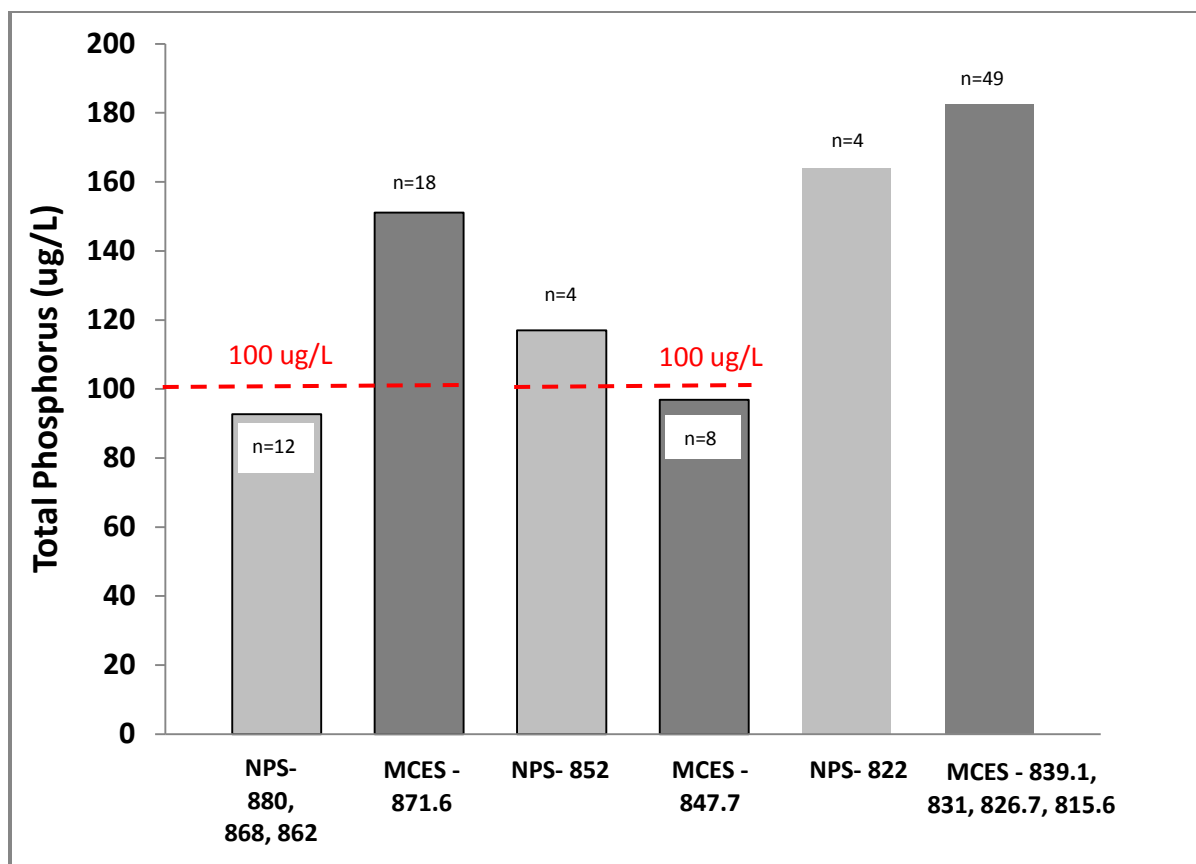


Figure 6. Mean total phosphorus concentrations, June through September 2010, for National Park Service (NPS) and Metropolitan Council Environmental Services (MCES) water quality monitoring sites above Lock and Dam #1 (NPS-880,868,862; MCES-871.6), Pool 1 (NPS-852; MCES-847.7), and Pool 2 (NPS-822, MCES-939.1,831,826.7,815.6). Dashed red line indicates site-specific or draft regional TP standard, when applicable. n = number of samples.

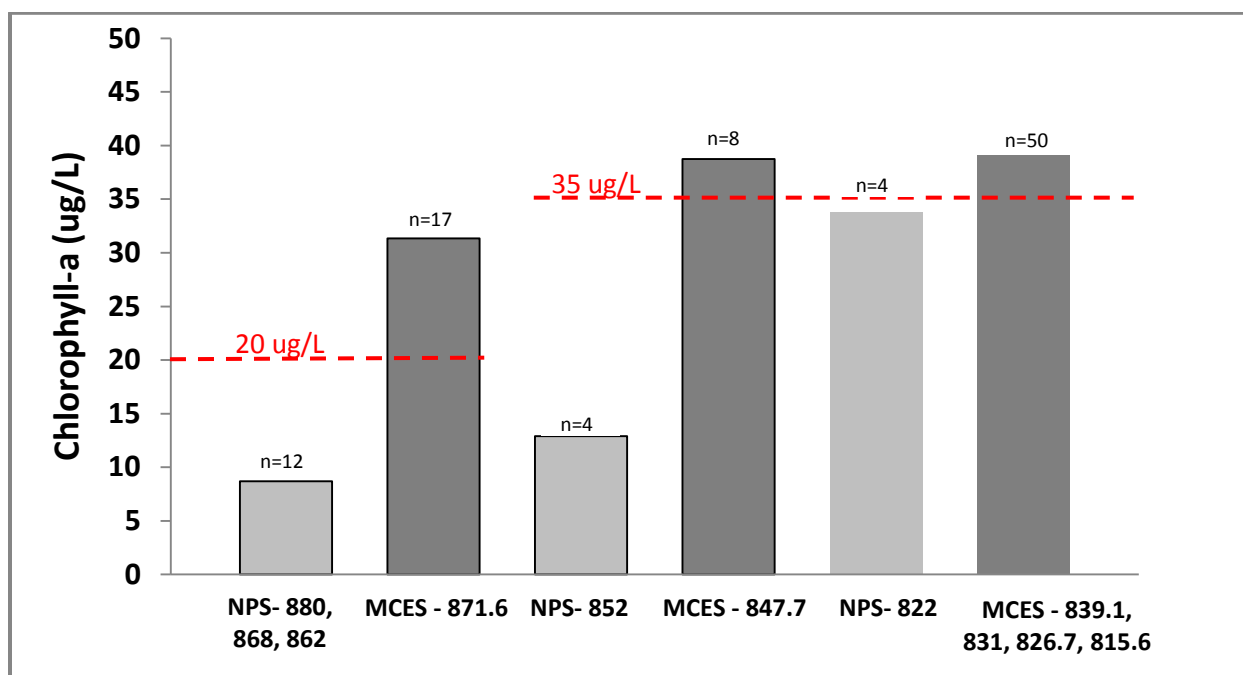


Figure 7. Mean chlorophyll-a concentrations, June through September 2010, for National Park Service (NPS) and Metropolitan Council Environmental Services (MCES) water quality monitoring sites above Lock and Dam #1 (NPS-880,868,862; MCES-871.6), 1 (NPS-852; MCES-847.7), and Pool 2 (NPS-822, MCES-939.1,831,826.7,815.6). Dashed red line indicates site-specific or draft regional chl-a standard. n = number of samples

Mean chl-*a* concentrations for GLKN monitoring sites were below the draft chl-*a* standards above Lock and Dam #1 (20 ug/L) and for Pool 1 (35 ug/L) (Figure 7). Mean chl-*a* for MCES sites in these two spatial categories exceeded the draft chl-*a* standards. Mean chl-*a* concentrations for GLKN and MCES sites in Pool 2 were slightly below and above the draft chl-*a* standard, respectively, and like TP levels, were much higher than sites upstream of Pool 2. The higher mean chl-*a* values in Pool 2 can be partially attributed to high chl-*a* levels in the Minnesota River, which from 1993 to 2009 had a mean of 61 ug/L (Heiskary and Wasley 2010).

Despite the relatively low number of samples (n=4) for NPS site UM 822, in Pool 2, mean chl-*a* is comparable to that of mean chl-*a* at MCES sites (n=49) in that pool. Mean chl-*a* at NPS sites in and above Pool 1 was considerably lower than that found at MCES sites. The discrepancy in mean chl-*a* between NPS and MCES sites may be due to the low number of samples at NPS sites, timing of sampling between agencies, differences in field or lab methodology, or actual differences based on local differences among the sites.

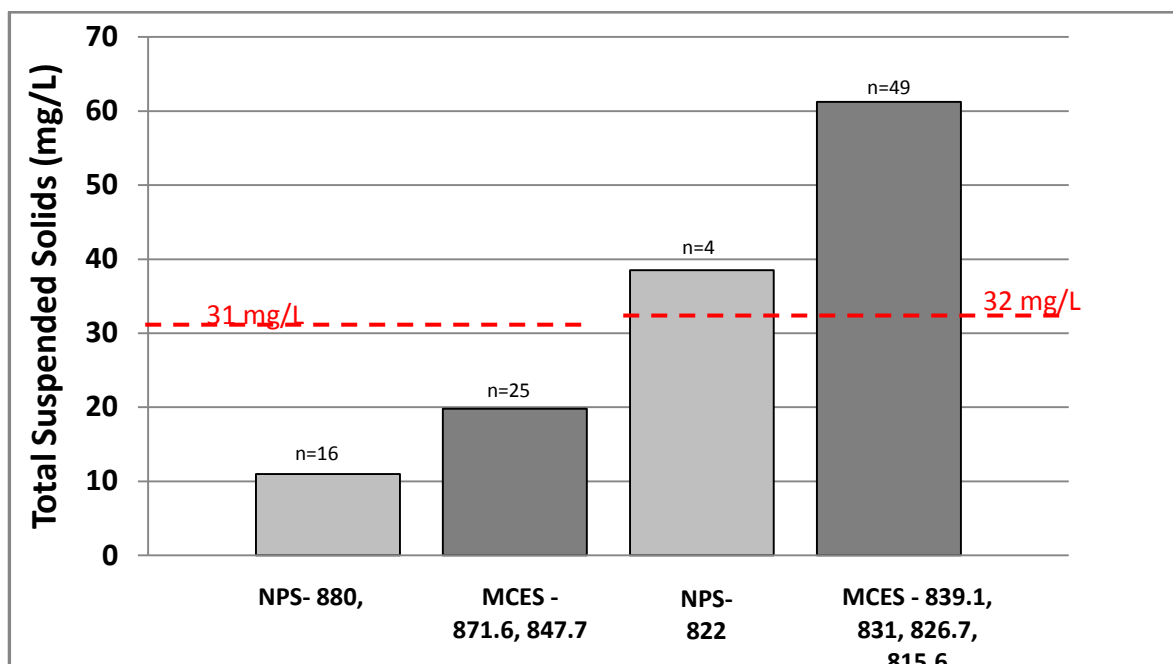


Figure 8. Mean total suspended solids concentrations, June through September 2010, for National Park Service (NPS) and Metropolitan Council Environmental Services (MCES) water quality monitoring sites above (NPS-880,868,862,852; MCES-871.6,847.7) and below (NPS-822; MCES-839.1,831,826.7,815.6) Lock and Dam #1. Dashed red line indicates site-specific or draft regional TSS standard. n = number of samples.

Mean summer TSS at sites above Lock and Dam #1 was much lower than that measured in Pool 2 below Lock and Dam #1 (Figure 8). In addition, mean summer TSS for NPS and MCES sites above Lock and Dam #1 were below the draft regional standard of 31 mg/L. Mean summer TSS for NPS and MCES sites below Lock and Dam #1 were above 32 mg/L, the standard set in a draft TSS TMDL for the South Metro Mississippi River currently under review by the U.S. Environmental Protection Agency (MPCA 2010).

The majority of sediment that contributes to high TSS in the Mississippi River in Pool 2 originates in the Minnesota River Basin, which on average contributes 74 percent of the TSS load to the South Metro Mississippi River (MPCA 2010). Land use in the Minnesota River Basin is dominated by agriculture, which has led to increased sediment load in the Minnesota river and its tributaries through increased erosion of soil resulting from altered hydrology (e.g., drain tiling) and surface runoff (MPCA 2010). TSS values are also positively correlated with flow and since flow in the Mississippi and Minnesota Rivers was very high in June through September, 2010, the high mean TSS concentration for MCES sites in Pool 2 is not unexpected. As with TP and chl-*a*, the discrepancy in mean TSS between NPS and MCES sites may be due to the low number of samples at NPS sites, timing of sampling between agencies, differences in field or lab methodology, or they may represent actual differences based on local differences among the sites.

St. Croix National Scenic Riverway

Impairments

The entire section of the St. Croix River within Minnesota is on the state's 303(d) list for mercury, and the St. Croix River below St. Croix Falls is on Wisconsin's 303(d) list for PCBs (Magdalene et al 2008). In 2008, both states placed Lake St. Croix on their respective 303(d) lists for excess nutrients (phosphorus), and the lake is now the subject of an interstate TMDL for excess nutrient is in progress. Mercury and PCBs are currently being monitored in bald eagle and fish tissue by GLKN staff under a separate protocol, and in river water by other regulatory agencies. However, nutrient monitoring is being conducted by GLKN staff as a component of the Large Rivers Water Quality Monitoring Protocol (Magdalene et al 2008).

Flow

Six USGS streamflow gages currently operate within or near SACN park boundaries (Table 8). The streamflow gages on the Namekagon at Leonards, WI and the St. Croix River (Norway Point) near Grantsburg, WI are no longer active due to lack of funding, although river stage information is still collected at those sites. In addition, in 2011 St. Croix River flow will be collected at Stillwater Minnesota by MCES and USGS staff, which will also use water elevation data collected by the COE to develop a discharge rating curve for the river as it enters Lake St. Croix.

Table 8. Active U.S. Geological Survey (USGS) streamflow gage sites at St. Croix National Scenic Riverway.

Site #	Period of Record	Location
05331833	1996-2010	Namekagon River near Leonards, WI
05332500	1927-present	Namekagon River near Trego, WI
05333500	1914-present	St. Croix River at Danbury, WI
05336000	2008-2010	St. Croix River near Grantsburg, WI
05340500	1902-present	St. Croix River at St. Croix Falls, WI
05341500	1914-1970, 1986-present	Apple River near Somerset, WI
05342000	1916-present	Kinnickinnic River near River Falls, WI
05344490	2008-present	St. Croix River at Prescott, WI

In general, flow observed at the USGS gage in St. Croix Falls, WI is representative of flow throughout SACN in any given year. When comparing average monthly flows at St. Croix Falls from April through November from 2009 and 2010 with the long-term (1902-2008) average monthly flow, flow in 2009 was lower than average from early spring to late summer, and near average for the rest of the year (Figure 9). In 2010 flows were very low in the spring, near average in early summer, but significantly higher than average from mid-summer until early winter.

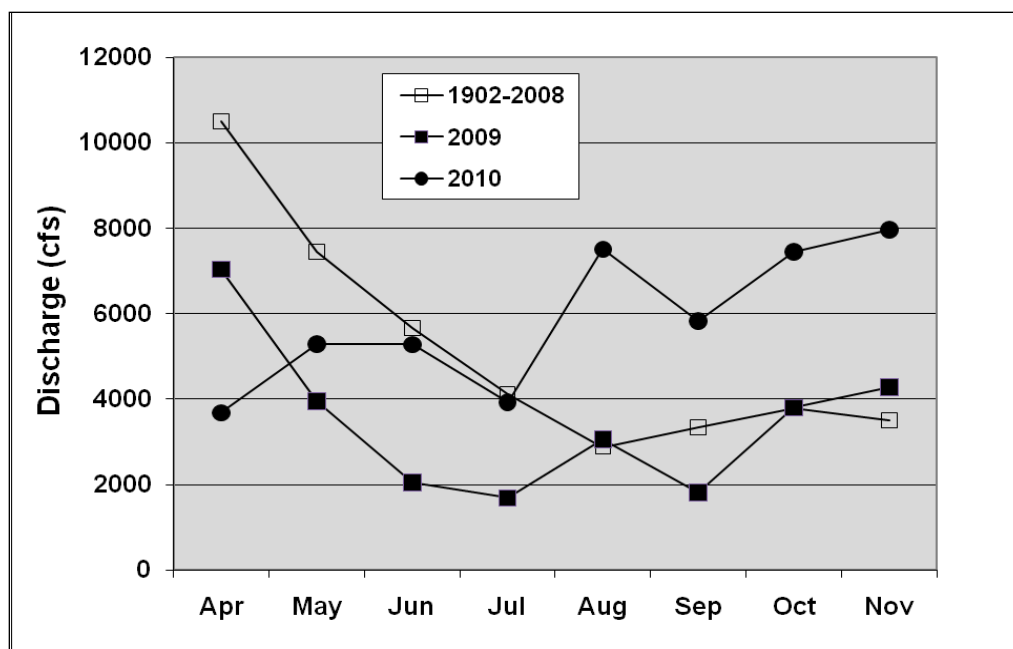


Figure 9. Historic (1902-2008) and more recent (2009-2010) mean monthly St. Croix River discharge at St. Croix Falls, Wisconsin. cfs = cubic feet per second. Data from 2010 should be considered provisional.

Water Quality

General Observations

The thirteen water quality monitoring sites at SACN can be broken down into two general categories based mainly on hydrology and channel morphology:

- Lake and Riverine Impoundment sites** – These sites are generally >3 m deep, have little to no evidence of flow through visual observation, and have the potential to thermally stratify. Sites that exhibit these conditions are the three stations on Lake St. Croix (SACN07, SACN09, and SACN11), and the two impoundments above the dams at St. Croix Falls (St. Croix River) and North Hudson (Lake Mallalieu on the Willow River) (SACN05 and SACN08, respectively). All of these sites will be referred to as ‘lake sites’.
- River sites** – These sites are generally <3 m deep, have obviously flowing water, and are well-mixed. Sites that exhibit these conditions are the two stations on the Namekagon River (SACNb and SACN01), three stations on the St. Croix River north of St. Croix Falls (SACNa, SACN02, and SACN04), and the remaining stations on the Snake, Apple, and Kinnickinnic Rivers (SACN03, SACN06, and SACN10, respectively). These sites will be referred to as ‘river sites’.

Range and average values of field and laboratory variables measured in 2009 at all thirteen sites are shown in Table 9; all data are shown in Appendix B. All data for sites sampled in April, July, and October 2010 are shown in Appendix C. The next few paragraphs are devoted to a discussion of noteworthy results from 2009 across all sites and over the complete sampling season. Seasonal (temporal) and geographic (spatial) trends and comparisons to water quality standards will be addressed later in this document.

Alkalinity, Specific Conductivity, and Cations/Anions

Alkalinity is a term that refers to the buffering capacity of a solution. The buffering capacity is essentially the ability of the solution (water) to resist changes in pH through additions of acids or bases. Mean alkalinity values at the river sites ranged from a low of 28 mg/L at the CCC Bridge in the upper St. Croix River (SACNa) to 190 mg/L at the Kinnickinnic River (SACN10). Mean alkalinity values at the lake sites ranged from a low of 39 mg/L at Lake St. Croix near Hudson, WI (SACN09) to 174 mg/L at Lake Mallalieu (SACN08-Lake Mallalieu). Alkalinity values at both river and lake sites indicate that waters at SACN are reasonably well-buffered, especially in the lower portion of the basin, except for relatively low alkalinity water in the Upper St. Croix River above the confluence with the Namekagon River.

Table 9. Range and mean values of field and laboratory variables measured at St. Croix National Scenic Riverway, 2009. N = number of samples. Field measurements are transparency tube, Secchi depth, pH, specific conductance (SC25), dissolved oxygen (DO), and temperature. Near-surface ($\leq 1.2\text{m}$) values were used for pH, specific conductance, DO, and temperature. ND = not detected. Dash (-) = not measured or calculated.

Variable	N	SACNa		SACNb		SACN01		SACN02		SACN03	
		range	mean	range	mean	range	mean	range	mean	range	mean
Temperature ($^{\circ}\text{C}$)	8	3.2-22.5	14.1	3.3-20.4	10.8	3.8-21.2	12.5	4.0-22.0	14.8	4.6-23.8	16.0
DO (mg/L)	8	8.2-12.8	9.9	9.4-12.2	10.7	8.2-11.9	9.6	7.4-11.5	8.9	7.5-11.5	10.1
pH (std. units)	8	7.1-8.1	7.7	7.5-8.7	7.8	7.6-8.1	7.9	7.2-7.9	7.7	7.0-8.7	8.1
SC25 ($\mu\text{S}/\text{cm}$)	8	73.0-117.0	100.5	139.5-177.1	156.1	154.7-190.3	176.1	99.8-168.1	144.3	101.5-224.6	185.9
TSS (mg/L)	8	ND-3.0	1.3	ND-6	2.3	2-6	4	2-5	3.8	3-6	4.5
Trans. Tube (cm)	8	>120	>120	115.8 - >120	>120	118.0 - >120	>120	96.6 - >120	>120	99.4 - >120	>120
Secchi Depth (m)	8	-	-	-	-	-	-	-	-	-	-
TP ($\mu\text{g}/\text{L}$)	8	15.7-22.6	19.6	14.4-26.6	17.3	17.7-28.0	22.3	22.2-40.0	29.0	45.2-79.4	60.0
Chl-a ($\mu\text{g}/\text{L}$)	8	ND-1.4	0.5	0.3-2.0	1.0	0.6-2.1	1.4	2.3-5.3	3.1	2.4-12.5	5.0
TN ($\mu\text{g}/\text{L}$)	8	323.3-693.6	461.1	144.5-389.2	261.6	196.9-454.4	321.7	342.0-695.4	496.2	861.3-1192.0	981.6
$\text{NO}_3+\text{NO}_2\text{-N}$ ($\mu\text{g}/\text{L}$)	8	ND-31.1	9.9	4.2-107.1	49.5	30.1-183.4	93.6	3-92.4	38.5	23.5-168.1	114.5
$\text{NH}_4\text{-N}$ ($\mu\text{g}/\text{L}$)	8	ND-9.4	-	ND-5.5	-	ND-2	-	ND-2	-	ND-41.7	-
DOC (mg/L)	3	6.0-11.0	9.3	3.9-4.8	4.4	3.1-4.8	3.9	5.6-9.6	8.2	13.0-13.2	13.1
Alkalinity (mg/L)	3	28.0-50.0	42.7	62-76	70.0	67.0-84.0	76.3	35.0-75.0	58.3	36.0-97.0	75.3
Cl^- (mg/L)	3	2.1-2.9	2.5	2.8-3.4	3.1	4.4-5.0	4.7	3.1-3.8	3.5	6.2-17.5	10.5
SO_4^{-2} (mg/L)	3	3.5-5.2	4.4	5.0-6.4	5.7	4.7-5.8	5.2	3.8-4.9	4.2	3.8-4.1	3.9
Ca^+ (mg/L)	3	8.9-16.0	13.3	20.2-23.4	21.2	20.1-26.9	24.1	12.7-23.3	18.7	11.2-28.2	22.3
Mg^{+2} (mg/L)	3	2.9-4.8	4.0	5.6-6.7	6.2	5.8-8.05	7.1	4.1-6.7	5.8	4.3-11.1	8.6
K^+ (mg/L)	3	0.3-0.6	0.5	0.4-0.8	0.6	0.5-0.8	0.7	0.5-0.8	0.7	1.4-2.9	2.1
Na^{+2} (mg/L)	3	1.8-2.7	2.3	2.5-3.1	2.8	2.9-4.0	3.6	1.9-3.4	2.9	2.3-6.0	4.4
SiO_2 (mg/L)	3	7.0-13.0	9.1	12-14	13	12-14	12.7	8.5-10.0	9.1	4.2-6.6	5.4

Table 9. Range and mean values of field and laboratory variables measured at St. Croix National Scenic Riverway, 2009. N = number of samples. Field measurements are transparency tube, Secchi depth, pH, specific conductance (SC25), dissolved oxygen (DO), and temperature. Near-surface (<1.2m) values were used for pH, specific conductance, DO, and temperature. ND = not detected. Dash (-) = not measured or calculated (continued).

Variable	N	SACN04		SACN05		SACN06		SACN07		SACN08	
		range	mean	range	mean	range	mean	range	mean	range	mean
Temperature (°C)	8	4.6-24.2	15.0	4.8-25.1	15.7	6.6-21.5	14.3	5.6-26.0	17.2	6.5-23.0	15.3
DO (mg/L)	8	7.9-11.6	9.3	8.3-11.2	9.7	8.5-12.5	10.3	7.3-11.4	10.1	11.1-20.2	15.2
pH (std. units)	8	7.4-8.3	7.9	7.4-8.6	8.0	7.8-8.4	8.2	7.3-8.8	8.1	8.2-9.1	8.7
SC25 (µS/cm)	8	101.4-195.0	157.6	110.8-199.8	169.3	262.5-311.9	287.6	121.9-231.7	193.0	300.3-402.2	346.5
TSS (mg/L)	8	2-8	4.4	2-4	3.1	1-4	2.4	2-7	3.4	4-26	10.1
Trans. Tube (cm)	8	85.1 - >120	-	85.2 - >120	115.3	99.5 - >120	>120	75.0 - >120	102.4	44.4-105.0	69.8
Secchi Depth (m)	8	-	-	1.4-2.1	1.7	-	-	1.0-2.5	1.6	0.7-1.9	1.2
TP (µg/L)	8	25.2-49.5	34.5	26.1-43.0	33.6	34.7-62.0	45.1	34.3-50.8	41.8	36.8-91.7	70.6
Chl-a (ug/L)	8	1.9-7.4	3.5	2.3-9.4	5.8	2.7-9.6	5.5	0.9-35.3	12.0	6.9-50.6	28.1
TN (µg/L)	8	420.2-830.3	588.6	463.4-867.4	643.6	1020-1380	1197	633.6-1267	861.8	1573-3362	2367
NO ₃ +NO ₂ -N (µg/L)	8	21.8-123.3	56.6	2.3-168.1	101.4	571.8-985.2	793.3	2.4-299.1	149.5	496.7-3106	1596
NH ₄ -N (µg/L)	8	ND-11.4	-	ND-6.8	-	ND-5.5	-	ND-130.1	-	ND-42.3	-
DOC (mg/L)	3	6.8-11.8	9.5	6.4-11.9	9.3	3.8-4.4	4.1	5.4-8.8	7.1	2.5-4	3.3
Alkalinity (mg/L)	3	37-83	66.0	42-90	71.7	115-137	125.7	44-103	80	145-174	156
Cl ⁻ (mg/L)	3	4.1-5.5	4.9	4.1-6.0	5.2	8.4-9.7	9.2	5.4-7.4	6.7	14.5-15.4	14.9
SO ₄ ⁻² (mg/L)	3	3.7-5.0	4.4	4.2-5.7	4.9	4.7-6.5	5.7	4.2-5.9	5.1	9.7-12.3	10.8
Ca ⁺ (mg/L)	3	12.4-24.8	19.6	13.5-26.9	21.2	32.9-39.3	35.4	13.8-29.0	23.9	35.2-43.8	39.3
Mg ⁺² (mg/L)	3	4.5-8.4	6.9	4.6-9.0	7.3	12.6-17.6	15.1	5.1-11.5	9.2	19-24.8	22.8
K ⁺ (mg/L)	3	0.7-1.5	1.1	0.8-1.6	1.2	1.0-1.8	1.4	0.9-2.0	1.4	1.2-3.2	1.9
Na ⁺² (mg/L)	3	2.2-4.4	3.6	2.2-4.7	3.8	4.1-5.3	4.8	2.6-5.4	4.4	4.8-6.4	5.6
SiO ₂ (mg/L)	3	7.0-7.8	7.5	6.6-8.5	7.6	6.9-15.0	11.3	7.7-8.3	8.1	8.7-13	11.2

Table 9. Range and mean values of field and laboratory variables measured at St. Croix National Scenic Riverway, 2009. N = number of samples. Field measurements are transparency tube, Secchi depth, pH, specific conductance (SC25), dissolved oxygen (DO), and temperature. Near-surface (<1.2m) values were used for pH, specific conductance, DO, and temperature. ND = not detected. Dash (-) = not measured or calculated (continued).

Variable	N	SACN09		SACN10		SACN11	
		range	mean	range	mean	range	mean
Temperature (°C)	8	4.5-24.7	16.3	5.4-16.6	11.6	3.3-23.6	16.1
DO (mg/L)	8	7.0-11.5	9.5	9.3-13.3	10.8	5.1-11.5	9.3
pH (std. units)	8	7.4-8.7	8.0	7.6-8.1	7.9	7.1-8.6	7.9
SC25 (µS/cm)	8	117.3-244.2	201.2	478.2-504.3	493.6	106.7-249.9	203.8
TSS (mg/L)	8	2-7	3.4	1-7	4.4	ND-4	2.4
Trans. Tube (cm)	8	81.0 - >120	105.4	>120	>120	78.6 - >120	-
Secchi Depth (m)	8	1.2-1.9	1.5	-	-	1.2-3.6	2.1
TP (µg/L)	8	28.8-50.0	39.0	12.0-162.5	56.1	18.8-75.3	40.4
Chl-a (ug/L)	8	3.4-23.1	8.9	0.7-5.2	2.8	0.3-16.9	6.8
TN (µg/L)	8	585.0-985.8	852.3	5017-5843	5355	718.7-1060	932.8
NO ₃ +NO ₂ -N (µg/L)	8	58.4-337.0	221	4511-5371	4907	178-488.7	340.9
NH ₄ -N (µg/L)	8	ND-120.9	-	ND-5.5	-	ND-126.5	-
DOC (mg/L)	3	6.8-11.6	8.6	1.7-3.7	2.8	8.0-11.8	9.4
Alkalinity (mg/L)	3	39-106	83.1	107-190	160.7	42-100	80
Cl ⁻ (mg/L)	3	5.4-8.6	7.3	21.5-22.6	22.1	4.9-8.7	7.1
SO ₄ ⁻² (mg/L)	3	4.4-6.1	5.5	16.5-25.4	19.9	4.3-6.6	5.8
Ca ⁺² (mg/L)	3	13.2-29.7	23.0	55.8-59.7	57.6	11.7-28.7	22.6
Mg ⁺² (mg/L)	3	5.1-12.0	9.2	26.6-28.2	27.6	4.5-11.3	9.0
K ⁺ (mg/L)	3	1.0-2.1	1.4	1.1-2.4	1.7	1.0-2.1	1.4
Na ⁺ (mg/L)	3	2.5-5.5	4.3	8.0-9.0	8.6	2.1-5.1	4.1
SiO ₂ (mg/L)	3	7.6-8.6	8.0	7.3-14.0	10.0	6.7-8.2	7.3

Specific conductance is a measure of the ability of sample water to conduct electricity. Waters with higher concentrations of ions will have higher values of specific conductance. Listed in order of importance, CO_3^{-2} , SO_4^{-2} , Cl^- (anions) and Ca^{+2} , Mg^{+2} , Na^+ , K^+ (cations) are the major contributors to specific conductivity in the St. Croix River basin. A marked difference in mean specific conductance values was observed for samples from the Apple, Willow (Lake Mallalieu), and Kinnickinnic Rivers (288 $\mu\text{S}/\text{cm}$, 347 $\mu\text{S}/\text{cm}$, and 494 $\mu\text{S}/\text{cm}$, respectively) compared to the other water quality monitoring sites, which were all less than 205 $\mu\text{S}/\text{cm}$. Because conductivity is related to the concentration of ions, it is not surprising that concentrations of measured anions (SO_4^{-2} , Cl^-) and cations (Ca^{+2} , Mg^{+2} , Na^+ , K^+) were correlated to values of specific conductance (Table 3). Much of the calcium (Ca^{+2}) and sulfate (SO_4^{-2}) was most likely weathered from the underlying clay-rich, calcareous glacial deposits and sedimentary rocks, especially in the Apple, Willow, and Kinnickinnic watersheds (Juckem 2007). Concentrations of the remaining anions and cations are derived through weathering of the surrounding rocks and soils, and from anthropogenic inputs including fertilizers and runoff from urban and industrial areas (Stark et al. 2000).

Nitrate+Nitrite-Nitrogen

The Apple (SACN06), Willow (SACN08-Lake Mallalieu), and Kinnickinnic (SACN10) Rivers had very high concentrations of $\text{NO}_3+\text{NO}_2\text{-N}$, with mean values ranging from 793 $\mu\text{g}/\text{L}$ at SACN06 to 4907 $\mu\text{g}/\text{L}$ at SACN10 (Table 9 and Appendix B). In comparison, site SACN11 in Pool 4 of Lake St. Croix, which integrates water quality for the complete St. Croix Basin, had a mean $\text{NO}_3+\text{NO}_2\text{-N}$ value of 341 $\mu\text{g}/\text{L}$. The watersheds associated with these tributaries are dominated by agriculture and increasing development. In addition, soils generally are coarse textured and highly permeable, which makes groundwater more susceptible to $\text{NO}_3+\text{NO}_2\text{-N}$ loading via fertilizer application (Juckem 2007). This is especially evident in the Kinnickinnic River, which not only has highly permeable soils but is underlain by carbonate bedrock, making this watershed more susceptible to groundwater contamination (Juckem 2007).

Chlorophyll-a

Chlorophyll pigment (chlorophyll-*a*) concentrations can be used to estimate algal biomass, and serve as a basis for evaluation of overall productivity. Chlorophyll-*a* concentration in samples from all 13 monitoring sites over the 2009 monitoring season varied widely, with generally lower values at river sites vs. lake sites, and higher chl-*a* in the summer compared with spring and fall across all sites. Mean chl-*a* for three river sites and three lake sites is shown in Figure 10. Mean chl-*a* was low over the whole monitoring season for the river sites, likely due to the low residence time of water at those sites. In comparison, with the exception of the June round of sampling, mean chl-*a* increased throughout the summer and early fall at the lake sites, falling back to low levels in October and November.

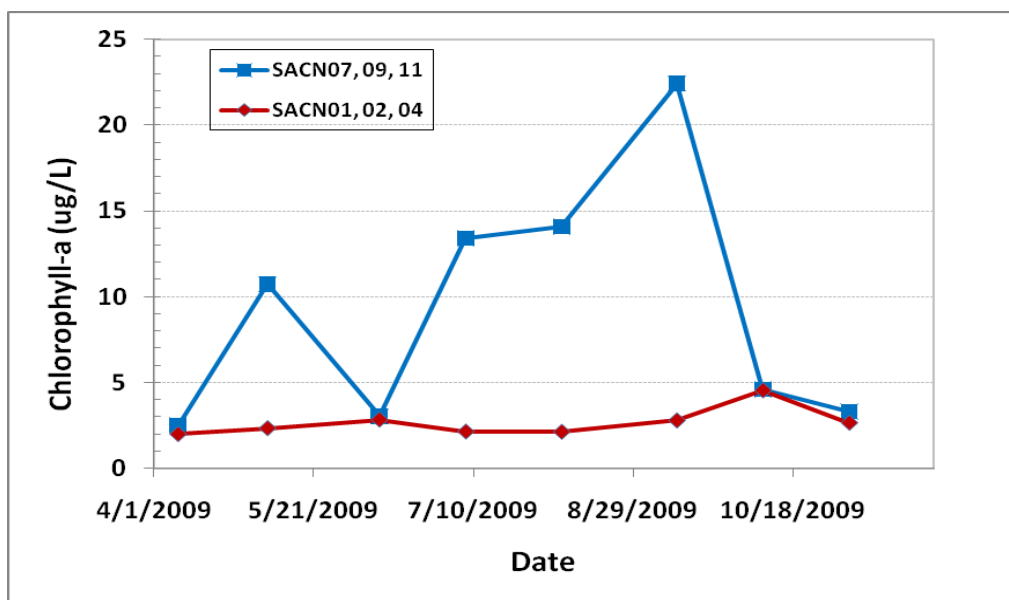


Figure 10. Mean chlorophyll-a concentration at St. Croix National Scenic Riverway for National Park Service water quality monitoring sites SACN01, 02, 04, and SACN07, 09, 11 in 2009.

Dissolved Organic Carbon

Dissolved organic carbon (DOC) for the river sites ranged from a low of 2.8 mg/L at the Kinnickinnic River (SACN10) to a high of 13.1 mg/L at the Snake River (SACN03) (Table 9). Sources of DOC for vegetated streams and rivers are both allochthonous and autochthonous (Hauer and Lamberti 2006). DOC for the lake sites ranged from a low of 3.3 mg/L at Lake Mallalieu (SACN08) to a high of 9.4 mg/L at Lake St. Croix at Prescott, WI (SACN11). DOC values >3 mg/L are high enough to attenuate light and thus reduce photosynthesis (Schindler and Gunn 2004), which is of greater relevance at the lake sites where an abundance of nutrients has the potential to fuel excessive algal growth.

Temporal Variability – Comparison of Seasons

Temperature and Dissolved Oxygen

Profiles of temperature and dissolved oxygen concentration show all eight river sites were well mixed throughout the open-water season. However, at the lakes sites, the upper and lower stations on Lake St. Croix (SACN07, 11) and the station on Lake Mallalieu (SACN08) became stratified with respect to temperature and dissolved oxygen by mid-summer. Water temperature and dissolved oxygen were the most stratified during the August sampling event (Figure 11), with near-bottom dissolved oxygen levels at 1.62, 0.17, and 2.61 mg/L, respectively.

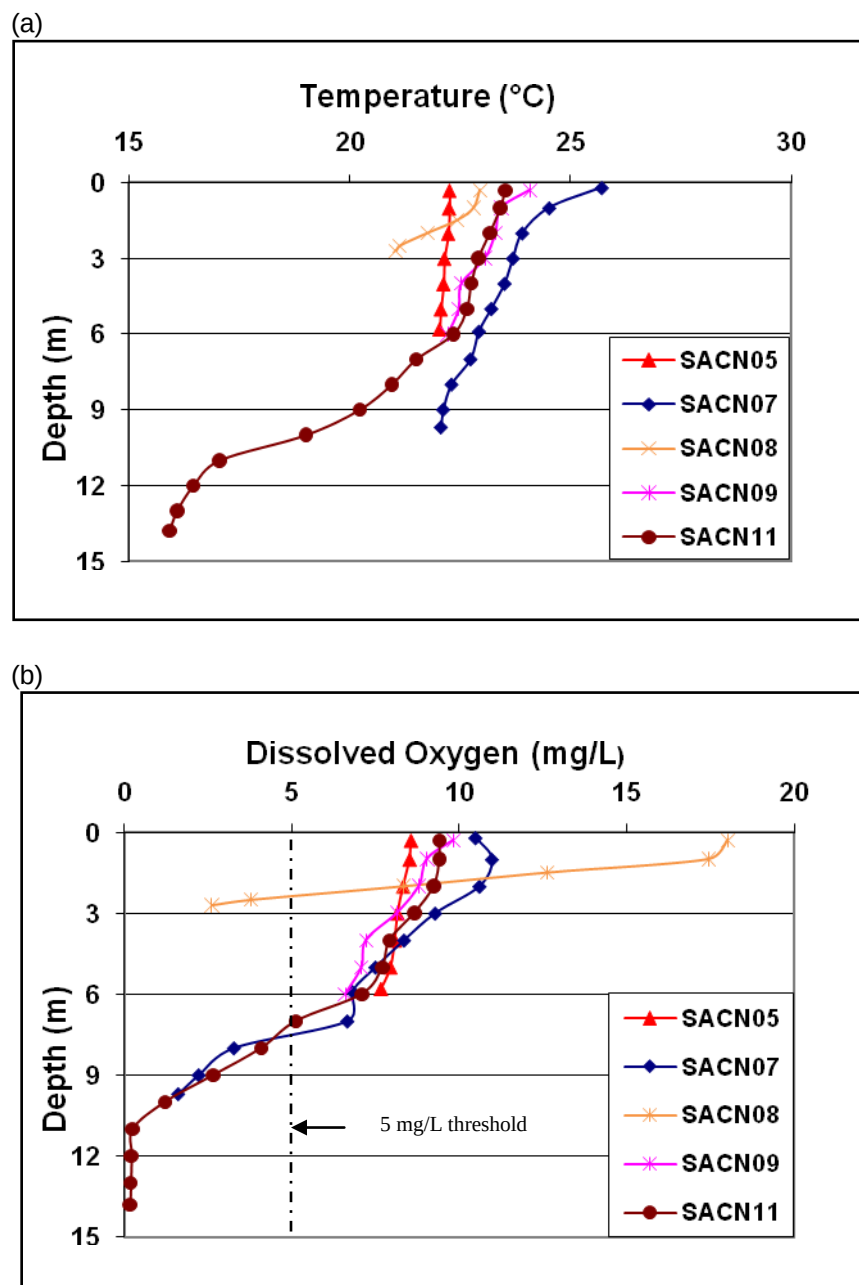


Figure 11. Temperature (a) and dissolved oxygen (b) values at St. Croix National Scenic Riverway for 'lake-like' National Park Service water quality monitoring sites in August, 2009.

Dissolved oxygen levels <5 mg/L as a daily minimum are considered below the standard for Class 2B waters (Minnesota water quality standards), and may be detrimental to aquatic life. Stratified waters with low (<5 mg/L) oxygen levels were also found at several sites in Lake St. Croix during August sampling in 2005 and 2006 by volunteers working with NPS staff (Brenda Moraska Lafrancois, personal communication), and by volunteers working for MCES since 2007 (Kent Johnson, personal communication). The potential for stratification at lake sites is increased during years of high air temperatures and low flow. Moreover, multiple lines of evidence point

towards a situation where the four pools within Lake St. Croix exhibit stratification with respect to temperature and dissolved oxygen during early summer to late fall, with cold anaerobic water in the lower half of the water column and warmer free-flowing aerobic water flowing over the top of the pools, until the pools turnover in September and October.

Anaerobic conditions in the lower water column of stratified waters typically lead to a significant decrease in pH, increased specific conductivity, and the release of soluble phosphorus from the sediment. Both near-surface and bottom TP samples were collected at lake sites in July in 2009 and 2010 that exhibited stratification (Table 10). Sites SACN05, SACN08, and SACN09 were not stratified with respect to dissolved oxygen in either year in July and near bottom TP samples were not collected. In 2007, both sites in Lake St. Croix had much higher concentrations of TP near the bottom compared to near the surface (VanderMeulen and Elias 2007). However, in 2009 and 2010, near surface and near bottom TP concentrations for both sites were similar, except for samples collected at SACN07 in 2009.

Table 10. Near-surface (0-2 m) and bottom total phosphorus (TP) values in July 2009 for select sites at St. Croix National Scenic Riverway. Bottom TP samples collected ≤ 1 m from sediment-water interface.

Site	Year	Depth (m)	TP ($\mu\text{g/L}$)
SACN07	2009	0-2	35.0
		9.1	99.8
	2010	0-2	69.0
		10	66.9
SACN11	2009	0-2	75.3
		13.0	74.6
	2010	0-2	49.1
		14.7	55.9

Nutrients

A large portion of the annual nutrient and sediment loading to the St. Croix River occurs during snowmelt runoff and storm events (Lenz et al. 2001, Robertson and Lenz 2002), and during leaf senescence in the fall (nutrients). Therefore, for the 2009 monitoring season at SACN, the hydrological characteristics shown earlier (i.e., early spring snowmelt followed by lower than normal flows until mid-summer, and approximately average flows until early winter) should be reflected in concomitant increases and decreases in nutrient concentrations. Site SACN11, which integrates all upstream conditions in the river, is used to illustrate this point (Figure 12). At this site, TN (including $\text{NO}_3+\text{NO}_2\text{-N}$ and $\text{NH}_4\text{-N}$, not shown in figure) concentrations were high in the spring, declined throughout the summer, spiked in the fall, and declined in early winter. The increase in the fall coincided with inputs of organic material from the landscape during leaf senescence. Total phosphorus showed a similar pattern, except for a large increase in July that coincided with a large storm event.

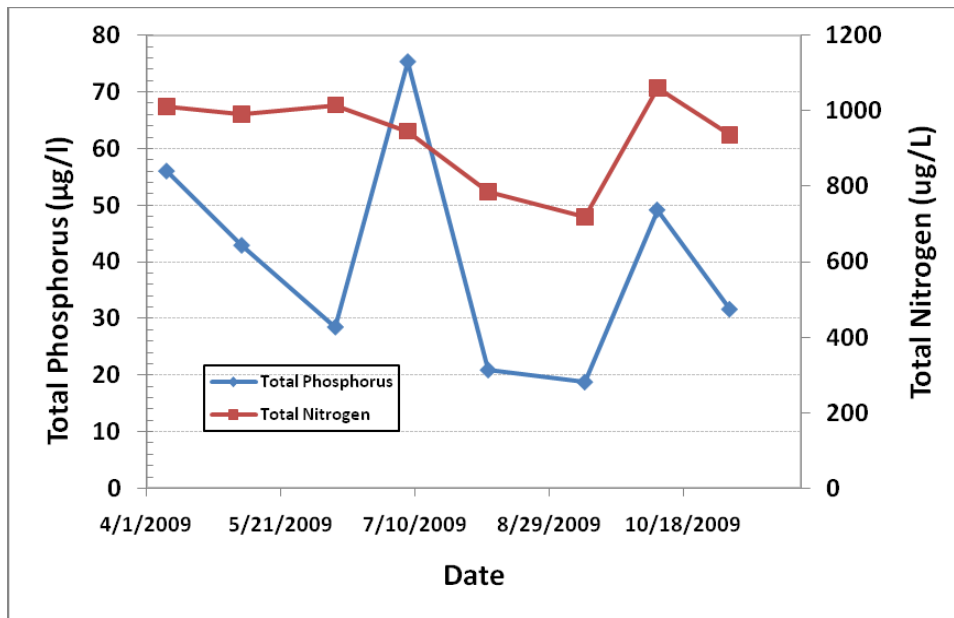


Figure 12. Mean total phosphorus and total nitrogen concentrations at St. Croix National Scenic Riverway at water quality monitoring site SACN11 in 2009.

Total Suspended Solids

Total suspended solids, along with transparency tube and Secchi disc measurements, are used by GLKN to assess water clarity across all sites at SACN. Total suspended solids in a water sample consist of organic and inorganic particles large enough to be suspended in the water column. Organic particles are usually associated with suspended algae or detritus while inorganic particles result from erosion of soils. Figure 13 shows mean TSS for two groups of sites at SACN in 2009: free flowing river sites (SACN01, 02 and 04), and Lake St. Croix Sites (SACN07, 09, and 11). Mean TSS at the river sites was high in the spring, slowly declined through the summer, spiked in the fall, and began to decline in November. Mean TSS at the lake sites was low in the spring, increased steadily through the summer, peaked in early fall, and declined in October and November. It is likely that TSS in the river sites is mainly a reflection of suspended inorganic particles and to a lesser extent diatomaceous algae, with higher levels in the spring and fall when flows are higher and diatoms are more abundant. In contrast, TSS at the lake sites likely is dominated by the overall productivity of the lake, which increases throughout the summer and peaks in early fall (Fig 8). In addition, declines in sediment-dominated TSS at the river sites over the summer may be leading to increased algal-dominated TSS at the lakes over the summer, since sediment can inhibit algae growth by blocking sunlight.

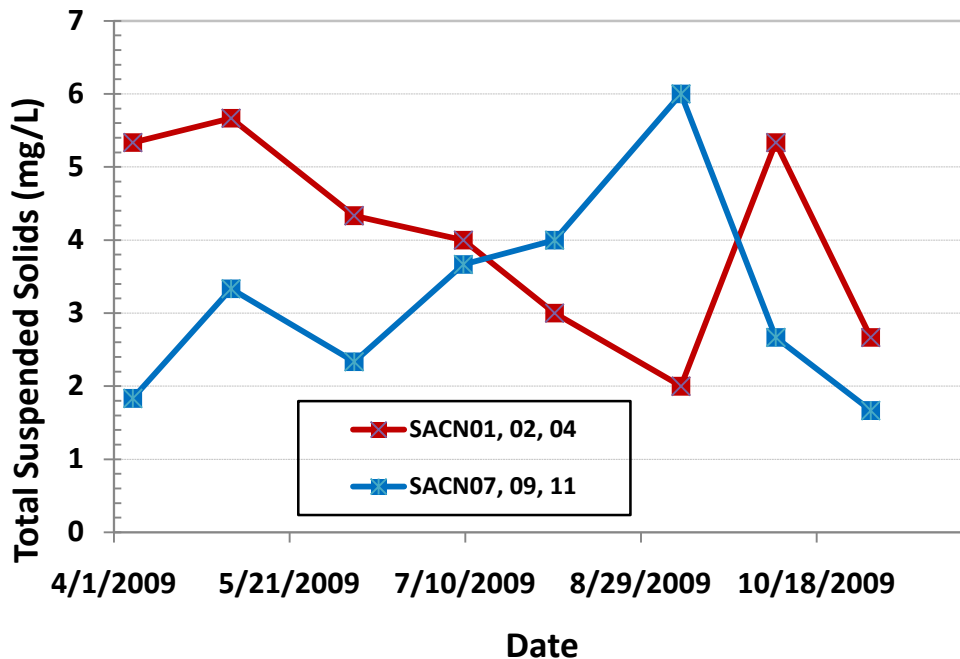


Figure 13. Mean total suspended solids at St. Croix National Scenic Riverway at water quality monitoring sites SACN01, 02, 04, and 07, 09, 11 in 2009.

pH

The pH of natural waters is defined as the logarithm of the reciprocal of the concentration of free hydrogen ions. As pH decreases below 7.00 waters become progressively more acidic; as pH increases above 7.00 waters become more basic. Because organisms can only tolerate a pre-defined range of pH values, the mean and range of pH values at a given site often determine which organisms can exist there. At SACN in 2009, mean monthly near-surface pH values were generally lower in early spring, reached a maximum in mid-summer, and decreased in the fall (Figure 12). The increase in pH in the summer is most likely due to increased water temperatures (less dissolved CO₂) and less dissolved organic carbon (i.e., lower concentration of organic acids), as well as conditions of higher primary productivity.

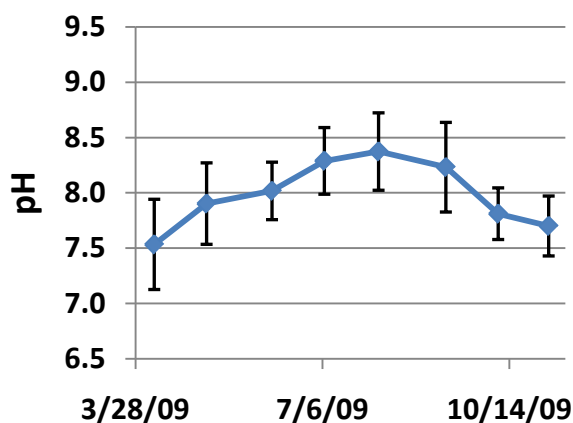


Figure 14. Mean monthly near-surface (depth ≤ 1.2 m) pH across all water quality monitoring sites at St. Croix National Scenic Riverway in 2009. Error bars are ± 1 standard deviation.

Long-Term Data

Off-year sampling in 2008 and 2010 at select sites allowed for comparison of data over a four-year period (2007-2010, Appendix C). The availability and amount of funding available dictated how many sites were sampled and how frequently sites were monitored during off-year sampling. Appendix C shows mean values for water quality parameters collected at six sites in April, July, and November from 2007 to 2010, the period of record for which there is a complete dataset. Continuation of off-year sampling will allow for more timely analysis of the inherent variability and potential trends at these sites. In addition, since these sites were randomly-selected as part of the initial site selection process at SACN (Magdalene et al 2008), statistically-defendable inferences of trends (or lack thereof) across SACN are appropriate.

Spatial Variability – Comparison of Sites

Although comparisons of water quality parameters have been made within two broad categories (river and lake sites), in terms of spatial variability it is most useful to compare water quality monitoring sites on the mainstem of the St. Croix River, upstream to downstream. Mean water quality values for select parameters are shown in Table 11, starting with the site farthest upstream (SACN01) on the mainstem of the Namekagon River and ending at the last mainstem site (SACN11) just upstream from the river's terminus at the Mississippi River.

Temperature, specific conductivity, Secchi Depth, TP, TN, alkalinity, cations, and anions typically increased from upstream to downstream. Silica decreased from upstream to downstream. There were no clear patterns among these six sites for DO, pH, TSS, and DOC. However, through examination of only those sites on Lake St. Croix (SACN07, 09, and 11) concentrations of DO, TSS, chl-*a*, and DOC generally decreased from upstream to downstream. From a hydrologic and channel morphology perspective, Lake St. Croix is fundamentally different from the other three upstream river-like sites. Historically, TSS and TP have been consistently higher at the site near the head of the lake (SACN07), due to allochthonous sources of TSS and TP from upstream sources (Kent Johnson, personal communication). TP (and potentially silica) decreases as it is taken up by algae, which then settle out in the slow-moving waters. TSS and silica also decrease as suspended particles settle out (Triplett et al. 2008). TSS,

TP, and silica concentrations may also be decreasing as mixing occurs in progressively deeper waters, which causes overall concentrations to be diluted.

Table 11. Mean values of select water quality variables from sites on the mainstem of the St. Croix National Scenic Riverway, 2009. Water quality monitoring sites are listed upstream to downstream, left to right. Sites SACN01, 02, and 04 are river sites, and sites SACN07, 09, and 11 are lake sites. Near-surface ($\leq 1.2\text{m}$) values were used for pH, specific conductance, DO, and temperature. Dash (-) = not measured or calculated.

Variable	N	SACN01	SACN02	SACN04	SACN07	SACN09	SACN11
Temperature ($^{\circ}\text{C}$)	8	12.5	14.8	15.0	17.2	16.3	16.1
DO (mg/L)	8	9.6	8.9	9.3	10.1	9.5	9.3
pH (std. units)	8	7.9	7.7	7.9	8.1	8.0	7.9
SC25 ($\mu\text{S}/\text{cm}$)	8	176.1	144.3	157.6	193.0	201.2	203.8
TSS (mg/L)	8	4	3.8	4.4	3.4	3.4	2.4
Trans. Tube (cm)	8	>120	>120	-	102.4	105.4	-
Secchi Depth (m)	8	-	-	-	1.6	1.5	2.1
TP ($\mu\text{g}/\text{L}$)	8	22.3	29.0	34.5	41.8	39.0	40.4
Chl-a ($\mu\text{g}/\text{L}$)	8	1.4	3.1	3.5	12.0	8.9	6.8
TN ($\mu\text{g}/\text{L}$)	8	321.7	496.2	588.6	861.8	852.3	932.8
$\text{NO}_3+\text{NO}_2\text{-N}$ ($\mu\text{g}/\text{L}$)	8	93.6	38.5	56.6	149.5	221	340.9
$\text{NH}_4\text{-N}$ ($\mu\text{g}/\text{L}$)	8	-	-	-	-	-	-
DOC (mg/L)	3	3.9	8.2	9.5	7.1	8.6	9.4
Alkalinity (mg/L)	3	76.3	58.3	66.0	80	83	80
Cl^- (mg/L)	3	4.7	3.5	4.9	6.7	7.3	7.1
SO_4^{-2} (mg/L)	3	5.2	4.2	4.4	5.1	5.5	5.8
Ca^{+2} (mg/L)	3	24.1	18.7	19.6	23.9	23.0	22.6
Mg^{+2} (mg/L)	3	7.1	5.8	6.9	9.2	9.2	9.0
K^+ (mg/L)	3	0.7	0.7	1.1	1.4	1.4	1.4
Na^+ (mg/L)	3	3.6	2.9	3.6	4.4	4.3	4.1
SiO_2 (mg/L)	3	12.7	9.1	7.5	8.1	8.0	7.3

Designated Uses and Water Quality Standards

The State of Minnesota lists the entire St. Croix River as an Outstanding Resource Water. The State of Wisconsin has listed the St. Croix River as an Outstanding Resource Water, except between the St. Croix Falls city limits to one mile below the STH 243 Bridge at Osceola, where it is listed as an Exceptional Resource Water (a category of lesser protection). Wisconsin also lists the Namekagon River as an Outstanding Resource Water.

The St. Croix River and its tributaries are governed by state-specific water quality criteria. Whether the water quality standards of Minnesota, Wisconsin, or both apply depends on the location of the water quality monitoring site. A summary of state-specific water quality standards was compiled by Ledder (2005) for the Network during development of the Network's Monitoring Plan (Route and Elias 2007). In the following sections water quality monitoring

results from SACN in 2007 are compared with federal standards and the criteria listed in Ledder's (2005) state-specific summary.

Minnesota

As with the Mississippi River (discussed earlier), the State of Minnesota has assigned designated use classes for the portion of the St. Croix River that form the border between Minnesota and Wisconsin, and on Minnesota tributaries flowing into the St. Croix River. For the St. Croix River, waters north of Taylors Falls, Minnesota, are designated Class 1B, 2Bd, 3B, 3C, 4A, 4B, 5, and 6, while waters south of Taylors Falls are designated Class 1C, 2Bd, 3B, 3C, 4A, 4B, 5, and 6. Water quality monitoring site SACN03 near the mouth of the Snake River is designated Class 2B, 3B, 4A, 4B, 5, and 6.

The State of Minnesota has established criteria for some water quality parameters based on the designated uses (MnRule 7050.0220). Criteria that apply to sampling sites within SACN are shown in Table 12. Note that Minnesota state water quality standards are not applicable for sites SACNa, b, 01, 06, 08, and 10. At site SACN03 (Snake River), mean pH for August was 8.67,

Table 12. Minnesota state water quality standards (MnRule 7050.0220) for monitored variables, based on designated use classifications (MnRule 7050.0200) that apply to St. Croix National Scenic Riverway water quality monitoring sites. All limits are maximum values, except dissolved oxygen (DO), which is a minimum allowable value, and pH, which is an allowable range of values. The most conservative values are used when differences occur among use classifications.

Water Quality Parameter	Designated Water Use Classifications
	1B & C, 2Bd, 3B, 3C, 4A, 4B, 5, 6 (sites 2, 3 ¹ , 4, 5, 7, 9, 11)
Temperature (°F)	± 5 of natural
pH (standard units)	6.50-8.50
Dissolved oxygen (mg/L)	5 daily min
Specific conductance (µS/cm)	1000
Nitrate+nitrite nitrogen (mg/L-N) - Federal drinking water standard	10
Nitrate+nitrite nitrogen (mg/L-N) – draft acute/chronic toxicity standard for MN ²	41/4.9
Ammonia, unionized (ug/L-N)	40
Chloride (mg/L) ³	860/230
Sulfate (mg/L)	10, for wild rice
Sodium (% total cations)	60%

¹Site 3 has designated water use classifications 2B, 3B, 4A, 4B, 5, and 6.

²Draft criteria (Monson and Preimesberger 2010). Draft acute value (maximum standard) is for a 1-day duration, and the draft chronic value is for a 4-day duration.

³Acute value (860 mg/L) maximum standard is for a 1-hour duration, and chronic value (230 mg/L) is for a 4-day duration.

exceeding the standard of 8.50. In July and August of 2007 mean pH at SACN03 was 8.66 and 8.62, respectively, also exceeding the standard (VanderMeulen and Elias 2008). At sites SACN 07 and 11 on Lake St. Croix, dissolved oxygen concentrations were less than 5 mg/L below the thermocline in July, August (Figure 9), and September. All other standards listed in Table 12 were met during the 2009 sampling season.

Wisconsin

The State of Wisconsin categorizes all waters of the state according to the following designated uses (NR 102.04):

- Fish and Other Aquatic Life Uses – Cold water communities, warm water sport fish communities, warm water forage communities, limited forage fish communities, limited aquatic life (marginal surface water).
- Recreational Use – A sanitary survey and/or evaluation to assure protection from fecal contamination is the chief criterion determining suitability for recreational use.
- Public Health and Welfare – All surface waters shall meet the human threshold and human cancer criteria specified in NR 105.08 and NR 105.09, respectively.
- Wildlife Use – All surface waters shall be classified for wildlife uses and meet the wildlife criteria specified in NR 105.07.

In accordance with Wisconsin's NR102 Uses and Designated Standards, "the St. Croix River has high scenic and aesthetic value and is used for recreation, fishing, hydropower, commercial shipping, stock and wildlife water supply, and waste assimilation. Its water shall meet the standards and requirements for recreational use and fish and aquatic life. ...standards for public water supply shall be met downstream of the north line of Polk County."

The three parameters that apply to the suite of water quality characteristics monitored by the Network are dissolved oxygen, pH, and phosphorus. NR 102.04(4) states that "dissolved oxygen may not be lowered to less than 5 mg/L at any time. Dissolved oxygen in classified trout streams...may not be artificially lowered to less than 6.0 mg/L, nor 7.0 mg/L during spawning. ...pH shall be maintained between 6.0 to 9.0 with no change greater than 0.5 units outside estimated natural seasonal maximum and minimum." NR 102.06 was enacted in December 2010 and identifies water quality criteria for total phosphorus for surface waters, including but not limited to streams, rivers, reservoirs, and lakes. Wisconsin total phosphorus standards applicable to monitoring sites at SACN are shown in Table 13.

Wisconsin standards for dissolved oxygen were met at all applicable monitoring sites, except for two stations on Lake St. Croix that had low dissolved oxygen levels in the lower water column during summer stratification (discussed earlier). Wisconsin standards for pH were exceeded at the Willow River (Lake Mallilieu, SACN08) in August 2009, with a mean pH of 9.09 near the surface (≤ 1.0 m). Mean TP concentrations at sites SACNa, b, 01, 02, 04, 05, 06, and 10 in 2009 did not exceed Wisconsin TP standards put in place in 2010.

Lake St. Croix (SACN07, 09, 11) and the Willow River (Lake Mallilieu, SACN08) will be subject to site-specific TP standards shown in Table 13. These standards were derived through

development of TMDL Plans currently under review (MPCA and WDNR 2010, WDNR 2011). Mean summer (June-September) TP for SACN08 in 2009 was 82.0 ug/L, exceeding the draft standard of 45 ug/L. Mean summer TP for Lake St. Croix (SACN07, 09, 11) was 37.9 ug/L, which is less than the draft standard of 40 ug/L.

Table 13. Wisconsin (total phosphorus [TP] only) and Minnesota eutrophication and water clarity standards for rivers and lakes applicable at St. Croix National Scenic Riverway water quality monitoring sites^{1,2}. Dash (-) = not applicable.

Site	Wisconsin	Minnesota			
	TP (ug/L)	TP (ug/L)	Chl-a (ug/L)	Secchi Disc (m)	TSS (mg/L)
SACNa	75 ³	-	-	-	-
SACNb	75 ³	-	-	-	-
SACN01	75 ³	-	-	-	-
SACN02	100 ³	55 ⁶	10 ⁶	-	15 ⁷
SACN03	-	100 ⁶	20 ⁶	-	30 ⁷
SACN04	100 ³	55 ⁶	10 ⁶	-	15 ⁷
SACN05	100 ³	55 ⁶	10 ⁶	-	15 ⁷
SACN06	100 ³	-	-	-	-
SACN07	40 ²	40 ⁴	14 ⁵	1.4 ⁵	-
SACN08	45 ¹	-	-	-	-
SACN09	40 ⁴	40 ⁴	14 ⁵	1.4 ⁵	-
SACN10	75 ³	-	-	-	-
SACN11	40 ⁴	40 ⁴	14 ⁵	1.4 ⁵	-

¹Based on the Draft Willow River TMDL (WDNR 2011).

²Draft Minnesota criteria for diurnal DO flux and BOD are also provided in Heiskary et al. (2010) but are not shown since these parameters are not monitored by GLKN staff.

³Based on WDNR phosphorus standards published December 2010 (WDNR 2010).

⁴Based on the Draft Lake St. Croix TMDL (2010).

⁵Based on Deep Lake Eutrophication Standards (NCHF) for MN (Minnesota Rule 7050.0222 Subp. 4. Class 2B Waters.

⁶Based on draft nutrient criteria for rivers in Minnesota (Heiskary et al. 2010, Heiskary and Parson 2010).

⁷Based on draft TSS criteria for Minnesota rivers (Heiskary and Parson 2010, Markus 2010).

Lake St. Croix is also subject to chl-*a* and Secchi disc criteria as per Minnesota Rules Chapter 7050. In 2009, mean summer chl-*a* and Secchi disc values at Lake St. Croix were 13.2 ug/L and 1.9 m, respectively, within reference criteria.

As stated earlier, in 2010 the MPCA developed draft eutrophication and TSS standards for rivers. SACN sites 02, 04, and 05 fall within Minnesota's North River Nutrient Region, with its associated draft values for TP, chl-*a*, and TSS. SACN site 03 at the Snake River falls within the Central River Nutrient Region, with higher standards for eutrophication and TSS (Table 13). The draft eutrophication and TSS standards were not exceeded at applicable SACN sites in 2009.

Federal

The USEPA (EPA) has recommended reference criteria for nutrients for two broad categories of water resources: rivers and streams, and lakes and reservoirs. EPA criteria are stringent, as they

are based on the 25th percentile of all data (USEPA 2000a, 2000b, 2000c, 2000d, 2001). Table 14 shows EPA-recommended water quality reference criteria applicable to GLKN monitoring sites at MISS and SACN. Reference nutrient criteria for all sites at MISS were exceeded throughout the sampling season in 2010.

At SACN, sites in the upper reaches of the park (SACNa, b, 01, and 02) generally were at or just above nutrient reference conditions, whereas mainstem and tributary sites farther downstream (SACN03, 04, 06, and 10) exceeded nutrient reference conditions throughout the sampling season. As discussed earlier, mean NO₃+NO₂-N concentration in the Kinnickinnic River was much higher (4.9 mg/L) than the recommended reference criterion (1.97 mg/L). However, mean TP concentration (56.1 µg/L) was below the recommended reference criterion (118.13 µg/L). Nutrient and water clarity reference criteria were also exceeded on most occasions for the lake sites at SACN, and as discussed earlier, Lake St. Croix has been listed as impaired for excessive nutrients (phosphorus) by Minnesota and Wisconsin.

Table 14. U.S. Environmental Protection Agency recommended nutrient and water clarity reference criteria for water quality monitoring sites at St. Croix National Scenic Riverway and Mississippi National River and Recreation Area (USEPA 2000a, 2000b, 2000c, 2000d, 2001).

Water Resource	Ecoregion/ subcoregion	SACN Sites	MISS Sites	TN (mg/L)	NO ₃ +NO ₂ -N (mg/L)	TP (µg/L)	Secchi disc (m)
Rivers & Streams	VI/47	10	-	3.26	1.965	118.13	-
	VII/51	06	all	0.71	0.13	28.75	-
	VIII/50	a, b, 01, 02, 03, 04	-	0.44	0.03	12	-
Lakes & Reservoirs	VII/51	07, 08, 09, 11	-	0.81	0.008	20	3.2
	VIII/50	05	-	0.40	0.003	9.69	4.2

Quality Assurance and Quality Control

Network quality assurance criteria stipulate that analytical results for water sample duplicates should be within 10% of each other for all parameters except nutrients and chl-*a*, which should be within 30% of each other (Ledder and Elias 2008). Most of our duplicates fell within the acceptable criteria. Those that did not meet quality assurance criteria were usually very close to laboratory detection or reporting limits. In such cases, actual small differences can result in large relative mean differences (e.g., the actual difference between 1 and 2 mg/L is small, but the relative mean difference is 67%). Values that did not meet our quality assurance criteria were flagged as such in the National Park Service database NPSTORET (Table 15). Duplicate values are not included with this report, but are available through the Environmental Protection Agency's STORET database, including those that do not meet our quality assurance criteria.

Table 15. List of water quality samples from St. Croix National Scenic Riverway and Mississippi National River and Recreation Area in 2009 and 2010 not meeting Network quality assurance criteria.

Park	Site	Sample Date	Parameter	Relative Percent (%) Difference
SACN	02	7/9/10	Silicate	14.1
SACN	04	10/9/09	Silicate	44.4
SACN	04	10/5/10	Chlorophyll-a	127.8
SACN	09	4/7/10	Alkalinity	51.9
MISS	UM822	7/7/10	Alkalinity	16.0
MISS	UM862	8/11/10	Chlorophyll-a	43.2

Comments and Recommendations

Mississippi National River and Recreation Area

All sampling took place as scheduled at MISS in 2010, and represents the third full season of sampling at MISS since the GLKN Large Rivers Protocol was implemented in 2006. All data results from 2006, 2008, and 2010 are available to the public through the EPA's STORET database. A summary of water quality data results from MISS for 2010 is also shown in Appendix A.

Several important developments have occurred recently that are consequential for water quality monitoring at MISS. These developments can be broken down into two categories: Statewide and Site-Specific. The next two paragraphs outline developments within these broad categories.

Statewide

One such development is the publication by the State of Minnesota draft river nutrient criteria (Heiskary et al. 2010) that uses long-term historical water quality data to propose regional river nutrient criteria. The Mississippi River within MISS boundaries is assigned to the Central River Nutrient Region, based on analysis of long-term water quality data collected statewide. Minnesota has also developed regionally-based draft standards for total suspended solids (Markus 2010) based on the same river nutrient regions used to develop river nutrient criteria. The regional TSS standards are more amenable to load based studies and likely will replace turbidity standards, which have been shown to be unreliable and not always protective of aquatic life.

Site-specific

The MPCA recently developed draft site-specific eutrophication criteria applicable to stretches of the Mississippi River within MISS boundaries, which expanded upon the earlier effort to develop site specific eutrophication criteria for Lake Pepin (Heiskary and Wasley 2010). These site specific criteria are designed to protect aquatic life in the river within the designated reaches as well as downstream sites. In addition, the EPA recently began review of a TMDL for TSS in the South Metro Mississippi River that is applicable to navigation Pool 2 within MISS boundaries. This TMDL is a companion project to the site-specific eutrophication criteria outlined above and replaces the statewide turbidity standards from Lock and Dam 1 to Lock and Dam 4 on the Mississippi River.

Water quality results from 2010 as they applied to the regional and site-specific criteria are shown above. The site-specific draft criterion of 100 ug/L for mean summer TP for Pool 1 was exceeded at NPS site UM 852, and the site-specific criterion of 32 mg/L for mean summer TSS was exceeded at NPS site UM 822 in Pool 2. Both regional and site-specific criteria were exceeded at MCES sites within MISS boundaries. Future monitoring at MISS by GLKN staff will allow for additional comparisons with State water quality criteria and will be valuable in assessing future impairments or improvements. The Network expects to continue to monitor water quality in MISS, with the next full season of water quality monitoring scheduled to take place in 2012.

St. Croix National Scenic Riverway

All sampling took place as scheduled at SACN in 2009, with additional monitoring at six sites in 2010 in what normally would have been an off-year. Monitoring in 2009 represents the second full season of sampling at SACN since the GLKN Large Rivers Protocol was implemented in 2006, with the third full season of monitoring scheduled for 2011. All data results since monitoring was initiated in 2007 are available to the public through the EPA's STORET database. A summary of water quality data results from SACN for 2009 is shown in Appendix B. A comparison of water quality data results from SACN for 2007 through 2010 is shown in Appendix C.

As with MISS, several important developments have occurred recently that are consequential for water quality monitoring at SACN. These developments are broken down into two categories: Statewide and Site-Specific. The next two paragraphs outline developments within these categories.

Statewide

Minnesota

The State of Minnesota draft river nutrient criteria (Heiskary et al. 2010) uses long-term historical water quality data to propose regional river nutrient criteria. The St. Croix River upstream of Stillwater, MN along the Minnesota-Wisconsin border is assigned to the Northern River Nutrient Region, based on analysis of long-term water quality data collected statewide. Minnesota has also developed regionally-based draft standards for total suspended solids (Markus 2010) based on the same river nutrient regions used to develop river nutrient criteria. Monitoring sites at which these draft standards apply are shown in Table 13.

Wisconsin

In December 2010, the State of Wisconsin enacted NR 102.06, which sets standards for total phosphorus in surface waters of the state (lakes, rivers, streams). As shown earlier (Table 13), these standards are applicable to many of the Network's water quality monitoring sites at SACN, and will be used by the State to assess for impairment (or lack thereof) for total phosphorus in the future.

Site-specific

The draft Lake St. Croix TMDL is a joint effort between the states of Minnesota and Wisconsin that sets limits for annual loading of total phosphorus to the lake. The plan is currently under review by the EPA, and if approved, will meet TP standards for both states and water quality goals of the St. Croix Water Resources Basin Team. A draft TMDL for the Willow River is also being reviewed by the State of Wisconsin, and once approved and implemented should improve water quality in the Willow River, including Lake Mallalieu.

Water quality results from 2009 as they applied to the regional and site-specific criteria are discussed in this report. Mean summer (June-September) TP for the Willow River (Lake Mallalieu, SACN08) in 2009 was 82.0 ug/L, exceeding the draft standard of 45 ug/L. Mean summer TP for Lake St. Croix (SACN07, 09, 11) was 37.9 ug/L, which is less than the draft standard of 40 ug/L. Future monitoring at SACN by GLKN staff will allow for additional comparisons with State and site-specific water quality criteria and be valuable in assessing future

impairments or improvements. The Network expects to continue to monitor water quality in SACN, with the next full season of water quality monitoring scheduled to take place in 2011.

Literature Cited

- Elias, J. E., and J. L. Sieracki. 2007. Report on 2006 water quality sampling at Mississippi National River and Recreation Area. Great Lakes Inventory and Monitoring Network Annual Report GLKN/2007/07. National Park Service, Ashland, Wisconsin, USA.
- Hauer, F. R., and G. A. Lamberti. 2006. *Methods in Stream Ecology*, 2nd edition. Academic Press, San Diego, California, USA.
- Heiskary, S., R. W. Bouchard Jr., and H. Markus. 2010. *Draft* – Minnesota nutrient criteria for rivers. Minnesota Pollution Control Agency, St. Paul, Minnesota, USA.
- Heiskary, S. and K. Parson. 2010. Regionalization of Minnesota's rivers for application of river nutrient criteria. Minnesota Pollution Control Agency, St. Paul, Minnesota, USA.
- Heiskary, S. and D. Wasley. 2010. *Draft* - Mississippi river pools 1 through 8: Developing river, pool, and Lake Pepin eutrophication criteria. Minnesota Pollution Control Agency, St. Paul, Minnesota, USA.
- Helsel, D. R. 1990. Less than obvious: Statistical treatment of data below detection limit. *Environmental Science and Technology* 24:1766-1774.
- Helsel, D. R., and T. A. Cohn. 1988. Estimation of descriptive statistics for multiply censored water quality data. *Water Resources Research* 24:1997-2004.
- Juckem, P. F. 2007. Hydrogeologic characteristics of the St. Croix River basin, Minnesota and Wisconsin: Implications for the susceptibility of ground water to potential contamination. U.S. Geological Survey Scientific Investigations Report 2007-5112. U.S. Geological Survey, Reston, Virginia, USA.
- Ledder, T. 2005. Water quality standards information for the Great Lakes Inventory and Monitoring Network. National Park Service Great Lakes Inventory and Monitoring Network Report GLKN/2005/12. National Park Service, Ashland, Wisconsin, USA.
- Ledder T., and J. Elias. 2008. Standard operating procedure #12: Quality assurance/quality control. *In* S. Magdalene, D. R. Engstrom, and J. Elias. 2008. Large rivers water quality monitoring protocol, Version 1.0. NPS/GLKN/NRR—2008/060. National Park Service, Fort Collins, Colorado, USA.
- Magdalene S., D. R. Engstrom, and J. Elias. 2008a. Large rivers water quality monitoring protocol, Version 1.0. NPS/GLKN/NRR—2008/060. National Park Service, Fort Collins, Colorado, USA.
- Magdalene, S., D. R. Engstrom, and J. Elias. 2008b. Standard operating procedure #7: Processing water samples and analytical laboratory requirements. *In* S. Magdalene, D. R.

- Engstrom, and J. Elias. 2008. Large rivers water quality monitoring protocol, Version 1.0. NPS/GLKN/NRR - 2008/060. National Park Service, Fort Collins, Colorado, USA.
- Markus, D. 2010. Aquatic life water quality standards draft technical support document for total suspended solids (turbidity). Minnesota Pollution Control Agency, St. Paul, Minnesota, USA.
- Metropolitan Council Environmental Services (MCES). 2009. Environmental Information System Management database. Online. (<http://es.metc.state.mn.us/eims-dev/index.asp>). Accessed 10 February 2009.
- Minnesota River Basin Data Center. 2001. State of the Minnesota River. Executive summary: Surface water quality monitoring. Online. (http://mrbdc.mnsu.edu/mnbasin/fact_sheets/stateofriver_2001.html). Accessed 23 February 2007.
- Monson, P., and A. Preimesberger. 2010. *Draft – Aquatic life water quality standards technical support document for nitrate*. Minnesota Pollution Control Agency, St. Paul, Minnesota, USA.
- Moody, J. A., and W. A. Battaglin. 1995. Setting: Chemical character of the Mississippi River. In R. H. Meade, editor. *Contaminants in the Mississippi River, 1987-92*. U.S. Geological Survey Circular 1133. Online. (<http://pubs.usgs.gov/circ/circ1133/>).
- MPCA (Minnesota Pollution Control Agency) and WDNR (Wisconsin Department of Natural Resources). 2010. *Draft Total Maximum Daily Load for Lake St. Croix*. Online. (<http://www.pca.state.mn.us/index.php/view-document.html?gid=15338>). Accessed 10 December 2010.
- MPCA (Minnesota Pollution Control Agency). 2010. *Draft South Metro Mississippi River Total Suspended Solids TMDL*. Online (<http://www.pca.state.mn.us/index.php/view-document.html?gid=10530>). Accessed 15 December 2010.
- MPCA (Minnesota Pollution Control Agency). Minnesota rules chapter 7050: Waters of the state. Online. (<http://www.revisor.leg.state.mn.us/arule/7050/>). Accessed 23 February 2007.
- MPCA (Minnesota Pollution Control Agency). 2008. 2008 Final TMDL list of impaired waters. Online. (<http://www.pca.state.mn.us/water/tmdl/index.html>).
- MPCA (Minnesota Pollution Control Agency). 2004. Minnesota's water quality monitoring strategy 2004-2014. Online. (<http://www.pca.state.mn.us/publications/reports/p-gen1-10.pdf>).
- NPS (National Park Service). 1995. Baseline water quality data inventory and analysis: Mississippi National River and Recreation Area. Technical Report NPS/NRWRD/NRTR-95/61. National Park Service, Water Resources Division, Fort Collins, Colorado, USA.

- Ramstack, J. M., M. B. Edlund, D. R. Engstrom, B. M. Lafrancois, and J. E. Elias. 2008. Diatom monitoring protocol, Version 1.0. NPS/GLKN/NRR—2008/068. National Park Service, Fort Collins, Colorado, USA.
- Robertson, D. M. and B. N. Lenz. 2002. Response of the St. Croix River pools, Wisconsin and Minnesota, to various phosphorus-loading scenarios. Water Resources Investigations Report 02-4181. U.S. Geological Survey, Middleton, Wisconsin, USA.
- Route, B., and J. Elias (editors). 2007. Long-term ecological monitoring plan: Great Lakes Inventory and Monitoring Network. Natural Resource Report NPS/GLKN/NRR-2007/001. National Park Service, Fort Collins, Colorado, USA.
- USEPA (U.S. Environmental Protection Agency). 2000a. Ambient water quality criteria recommendations: Information supporting the development of state and tribal nutrient criteria for rivers and streams in nutrient ecoregion VII. EPA-822-B-00-018. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Health and Ecological Criteria Division, Washington, D.C., USA.
- USEPA (U.S. Environmental Protection Agency). 2000b. Ambient water quality criteria recommendations: Information supporting the development of state and tribal nutrient criteria for rivers and streams in nutrient ecoregion VI. EPA-822-B-00-017. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Health and Ecological Criteria Division, Washington, D.C., USA.
- USEPA (U.S. Environmental Protection Agency). 2000c. Ambient Water Quality Criteria Recommendations: Information supporting the development of state and tribal nutrient criteria for lakes and reservoirs in nutrient ecoregion VII. EPA-822-B-00-009. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Health and Ecological Criteria Division, Washington, D.C., USA.
- USEPA (U.S. Environmental Protection Agency). 2000d. Ambient Water Quality Criteria Recommendations: Information supporting the development of state and tribal nutrient criteria for lakes and reservoirs in nutrient ecoregion VIII. EPA-822-B-00-010. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Health and Ecological Criteria Division, Washington, D.C., USA.
- USEPA (U.S. Environmental Protection Agency). 2001. Ambient Water Quality Criteria Recommendations: Information supporting the development of state and tribal nutrient criteria for rivers and streams in nutrient ecoregion VIII. EPA-822-B-01-015. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Health and Ecological Criteria Division, Washington, D.C., USA.
- VanderMeulen, D., and J. E. Elias. 2008. Water quality sampling at St. Croix National Scenic Riverway, 2007. Great Lakes Inventory and Monitoring Network Annual Monitoring Report GLKN/2008/03. National Park Service, Ashland, Wisconsin, USA.

VanderMeulen, D. 2009. Monitoring water quality of large rivers, 2008. Annual summary report. National Park Service, Great Lakes Inventory and Monitoring Network Report GLKN/2009/03. National Park Service, Ashland, Wisconsin, USA.

WDNR (Wisconsin Department of Natural Resources). 2004. Lakes partnership website. (<http://www.dnr.state.wi.us/org/water/fhp/lakes/selfhelp/equipment.htm>).

WDNR (Wisconsin Department of Natural Resources). 2010. Chapter NR 102, Water Quality Standards for Wisconsin Surface Waters. Online (<http://legis.wisconsin.gov/rsb/code/nr/nr102.pdf>). Accessed 22 December 2010.

WDNR (Wisconsin Department of Natural Resources). 2011. *Draft* Phosphorus Total Maximum Daily Load: Willow River and Lake Mallalieu, St. Croix and Polk Counties, Wisconsin. WDNR *Draft* Report. Madison, WI.

Appendix A. Descriptive statistics for monitoring sites in the Mississippi National River and Recreation Area, Minnesota, as entered in NPStoret.

Appendix A. Descriptive statistics for monitoring sites in the Mississippi National River and Recreation Area, Minnesota, as entered in NPStoret.



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Station

Station ID: MISS_UM822		Station Name: Mississippi River next to Spring Lake												
Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/8/2010 - 10/8/2010	3	0	3	176	217	202	---	22.61	---	---	---	---
Ammonium_SCRS	µg/l	4/8/2010 - 11/9/2010	8	3	8	2	88.42	25.96	---	30.14	---	---	---	---
Calcium	mg/l	4/8/2010 - 10/8/2010	3	0	3	72.2	89.5	79.6	---	8.917	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/8/2010 - 11/9/2010	8	0	8	6.67	60.19	26.93	---	16.81	---	---	---	---
Chloride	mg/l	4/8/2010 - 10/8/2010	3	0	3	17.3	21.8	19.63	---	2.255	---	---	---	---
DO%_HL_MS5.0	%	4/8/2010 - 11/9/2010	33	0	33	71.4	129.2	92.87	95.9	15.76	71.9	78.1	98.9	119.7
DO_HL_MS5.0	mg/l	4/8/2010 - 11/9/2010	33	0	33	6.19	11.81	8.769	8.8	1.834	6.224	7.05	10.12	11.76
DOC	mg/l	4/8/2010 - 10/8/2010	3	0	3	8.6	9.2	8.933	---	0.3055	---	---	---	---
EC25_HL_MS5.0	µS/cm	4/8/2010 - 11/9/2010	33	0	33	534.8	743.7	644.1	635.8	62.11	536.5	604.8	696	743.2
Magnesium	mg/l	4/8/2010 - 10/8/2010	3	0	3	28.4	35.5	31.27	---	3.742	---	---	---	---
Nitrate+Nitrite_SCRS	µg/l	4/8/2010 - 11/9/2010	8	0	8	1308	5842	3278	---	1312	---	---	---	---
pH_HL_MS5.0	None	4/8/2010 - 11/9/2010	33	0	33	7.82	8.4	8.168	8.24	0.1997	7.854	8.01	8.345	8.38
converted pH	None					7.82	8.4	8.119	8.237	0.0037	7.854	8.009	5.096	5.105
H+ computed from pH	µeq/l					0.004	0.0151	0.0076	0.0058	0.0037	0.0042	0.0045	0.0098	0.014
Potassium	mg/l	4/8/2010 - 10/8/2010	3	0	3	4.06	5.3	4.62	---	0.6286	---	---	---	---
Silicate	mg/l	4/8/2010 - 10/8/2010	3	0	3	15	20	18.33	---	2.887	---	---	---	---
Sodium	mg/l	4/8/2010 - 10/8/2010	3	0	3	11.4	13.9	12.27	---	1.415	---	---	---	---
Sulfate	mg/l	4/8/2010 - 10/8/2010	3	0	3	93.1	121	110.7	---	15.32	---	---	---	---
Temp_HL_MS5.0	°C	4/8/2010 - 11/9/2010	33	0	33	6.46	27.9	17.53	18.03	7.067	6.474	11.22	25.66	27.75
Total Nitrogen_SCRS	µg/l	4/8/2010 - 11/9/2010	8	0	8	2221	7015	4263	---	1357	---	---	---	---
Total Phosphorus_SCRS	µg/l	4/8/2010 - 11/9/2010	8	0	8	83.02	236.4	160.9	---	56.05	---	---	---	---
Total Suspended Solids	mg/l	4/8/2010 - 11/9/2010	8	0	8	22	62	37.88	---	15.68	---	---	---	---
Transparency Tube	cm	4/8/2010 - 11/9/2010	8	0	8	22.15	43.65	31.33	---	7.802	---	---	---	---

Station ID: MISS_UM852		Station Name: Mississippi River near East River Flats Park in Minneapolis												
Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/8/2010 - 10/8/2010	3	0	3	172	197	181.3	---	13.65	---	---	---	---
Ammonium_SCRS	µg/l	4/8/2010 - 11/9/2010	8	5	8	2	39.01	11.96	---	12.9	---	---	---	---
Calcium	mg/l	4/8/2010 - 10/8/2010	3	0	3	50.1	58.9	55.27	---	4.596	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/8/2010 - 11/9/2010	8	0	8	4.16	42.28	15.52	---	11.51	---	---	---	---
Chloride	mg/l	4/8/2010 - 10/8/2010	3	0	3	18	20.8	19.13	---	1.474	---	---	---	---
DO%_HL_MS5.0	%	4/8/2010 - 11/9/2010	46	0	46	107.4	114.9	112	112.6	2.118	107.8	110.8	113.5	114.4

Appendix A. Descriptive statistics for monitoring sites in the Mississippi National River and Recreation Area, Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Station

Station ID: MISS_UM852		Station Name: Mississippi River near East River Flats Park in Minneapolis												
Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
DO_HL_MS5.0	mg/l	4/8/2010 - 11/9/2010	46	0	46	8.44	13.46	10.91	10.68	1.622	8.51	9.695	12.34	13.41
DOC	mg/l	4/8/2010 - 10/8/2010	3	0	3	9.7	12	10.9	---	1.153	---	---	---	---
EC25_HL_MS5.0	µS/cm	4/8/2010 - 11/9/2010	46	0	46	329.4	468.4	413.9	415	43.49	331.6	391	442.2	467.4
Magnesium	mg/l	4/8/2010 - 10/8/2010	3	0	3	17.8	23	21.03	---	2.822	---	---	---	---
Nitrate+Nitrite_SCRS	µg/l	4/8/2010 - 11/9/2010	8	0	8	229.5	1104	714.3	---	296	---	---	---	---
pH_HL_MS5.0	None	4/8/2010 - 11/9/2010	46	0	46	7.81	8.81	8.307	8.31	0.2513	7.877	8.24	8.38	8.763
converted pH	None					7.81	8.81	8.237	8.31	0.0036	7.876	8.237	5.084	5.104
H+ computed from pH	µeq/l					0.0015	0.0155	0.0058	0.0049	0.0036	0.0017	0.0042	0.0058	0.0133
Potassium	mg/l	4/8/2010 - 10/8/2010	3	0	3	2.75	3.4	3.083	---	0.3253	---	---	---	---
Silicate	mg/l	4/8/2010 - 10/8/2010	3	0	3	7.1	14	11.37	---	3.729	---	---	---	---
Sodium	mg/l	4/8/2010 - 10/8/2010	3	0	3	7.7	11.3	9.513	---	1.8	---	---	---	---
Sulfate	mg/l	4/8/2010 - 10/8/2010	3	0	3	25.1	31.8	28.4	---	3.351	---	---	---	---
Temp_HL_MS5.0	°C	4/8/2010 - 11/9/2010	46	0	46	5.87	27.52	16.2	14.44	7.192	5.87	10.7	20.95	27.49
Total Nitrogen_SCRS	µg/l	4/8/2010 - 11/9/2010	8	0	8	1026	2118	1648	---	344.2	---	---	---	---
Total Phosphorus_SCRS	µg/l	4/8/2010 - 11/9/2010	8	0	8	59.59	137.7	100.3	---	25.57	---	---	---	---
Total Suspended Solids	mg/l	4/8/2010 - 11/9/2010	8	0	8	10	17	13.12	---	2.357	---	---	---	---
Transparency Tube	cm	4/8/2010 - 11/9/2010	8	0	8	44.9	71.8	58.56	---	10.26	---	---	---	---

Station ID: MISS_UM862		Station Name: Mississippi River near St. Paul Water Works Pumping Station												
Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO3	4/6/2010 - 10/7/2010	3	0	3	173	215	195	---	21.07	---	---	---	---
Ammonium_SCRS	µg/l	4/6/2010 - 11/8/2010	8	6	8	2	37	8.927	---	11.81	---	---	---	---
Calcium	mg/l	4/6/2010 - 10/7/2010	3	0	3	52.6	59.8	56	---	3.617	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	4.25	51.58	15.03	---	15.24	---	---	---	---
Chloride	mg/l	4/6/2010 - 10/7/2010	3	0	3	16.6	18.8	17.4	---	1.217	---	---	---	---
DO%_HL_MS5.0	%	4/6/2010 - 11/8/2010	31	0	31	101.8	115.1	107.5	108.2	4.609	102	102.4	111.7	114.7
DO_HL_MS5.0	mg/l	4/6/2010 - 11/8/2010	31	0	31	8.31	12.42	10.28	10.21	1.561	8.388	8.51	12.03	12.39
DOC	mg/l	4/6/2010 - 10/7/2010	3	0	3	10	12	11	---	1	---	---	---	---
EC25_HL_MS5.0	µS/cm	4/6/2010 - 11/8/2010	31	0	31	272.3	467.3	409.8	426.2	51.09	330.5	373.7	453.2	465.2
Magnesium	mg/l	4/6/2010 - 10/7/2010	3	0	3	19.6	23.3	21.67	---	1.888	---	---	---	---
Nitrate+Nitrite_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	245.1	1211	807.7	---	348.3	---	---	---	---

Appendix A. Descriptive statistics for monitoring sites in the Mississippi National River and Recreation Area, Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Station

Station ID: MISS_UM862		Station Name: Mississippi River near St. Paul Water Works Pumping Station												
Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
pH_HL_MS5.0	None	4/6/2010 - 11/8/2010	31	0	31	8.07	8.62	8.32	8.39	0.1661	8.1	8.12	8.43	8.508
converted pH	None					8.07	8.62	8.292	8.387	0.002	8.102	8.119	5.09	5.091
H+ computed from pH	µeq/l					0.0024	0.0085	0.0051	0.0041	0.002	0.0031	0.0037	0.0076	0.0079
Potassium	mg/l	4/6/2010 - 10/7/2010	3	0	3	2.52	3.5	3.173	---	0.5658	---	---	---	---
Silicate	mg/l	4/6/2010 - 10/7/2010	3	0	3	9.1	16	12.7	---	3.46	---	---	---	---
Sodium	mg/l	4/6/2010 - 10/7/2010	3	0	3	6.8	9.21	8.3	---	1.309	---	---	---	---
Sulfate	mg/l	4/6/2010 - 10/7/2010	3	0	3	28.4	32.5	30.7	---	2.095	---	---	---	---
Temp_HL_MS5.0	°C	4/6/2010 - 11/8/2010	31	0	31	5.69	27.8	16.94	14.27	7.529	5.692	11.58	26.53	27.76
Total Nitrogen_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	1057	2185	1737	---	390	---	---	---	---
Total Phosphorus_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	57.54	120.8	96.78	---	19.98	---	---	---	---
Total Suspended Solids	mg/l	4/6/2010 - 11/8/2010	8	0	8	9	18	11.5	---	2.777	---	---	---	---
Transparency Tube	cm	4/6/2010 - 11/8/2010	8	0	8	40.1	74.3	59.23	---	12.17	---	---	---	---

Station ID: MISS_UM868		Station Name: Mississippi River upstream of the Coon Rapids Dam												
Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/6/2010 - 10/7/2010	3	0	3	167	199	183	---	16	---	---	---	---
Ammonium_SCRS	µg/l	4/6/2010 - 11/8/2010	8	6	8	2	41.09	8.901	---	13.39	---	---	---	---
Calcium	mg/l	4/6/2010 - 10/7/2010	3	0	3	47.2	62.6	55.13	---	7.711	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	4.71	42.78	14.77	---	12.07	---	---	---	---
Chloride	mg/l	4/6/2010 - 10/7/2010	3	0	3	16.3	16.7	16.5	---	0.2	---	---	---	---
DO%_HL_MS5.0	%	4/6/2010 - 11/8/2010	31	0	31	79.7	106.7	92.48	94.1	8.218	80.72	82	97.7	105.2
DO_HL_MS5.0	mg/l	4/6/2010 - 11/8/2010	31	0	31	6.22	11.85	8.852	8.69	1.951	6.292	6.43	10.24	11.82
DOC	mg/l	4/6/2010 - 10/7/2010	3	0	3	9.8	12	10.93	---	1.102	---	---	---	---
EC25_HL_MS5.0	µS/cm	4/6/2010 - 11/8/2010	31	0	31	320.9	478.1	414.3	428.6	46.47	322.6	378.4	446	475.2
Magnesium	mg/l	4/6/2010 - 10/7/2010	3	0	3	17.3	23.8	21.03	---	3.356	---	---	---	---
Nitrate+Nitrite_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	273.2	1202	788.7	---	320.3	---	---	---	---
pH_HL_MS5.0	None	4/6/2010 - 11/8/2010	31	0	31	7.86	8.53	8.26	8.29	0.1701	8.03	8.09	8.35	8.466
converted pH	None					7.86	8.53	8.229	8.292	0.0026	8.032	8.092	5.092	5.095
H+ computed from pH	µeq/l					0.003	0.0138	0.0059	0.0051	0.0026	0.0034	0.0045	0.0081	0.0093
Potassium	mg/l	4/6/2010 - 10/7/2010	3	0	3	2.53	3.4	3.043	---	0.4557	---	---	---	---
Silicate	mg/l	4/6/2010 - 10/7/2010	3	0	3	8.8	15	12.27	---	3.164	---	---	---	---
Sodium	mg/l	4/6/2010 - 10/7/2010	3	0	3	6.5	8.96	8.133	---	1.415	---	---	---	---

Appendix A. Descriptive statistics for monitoring sites in the Mississippi National River and Recreation Area, Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Station

Station ID: MISS_UM868

Station Name: Mississippi River upstream of the Coon Rapids Dam

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Sulfate	mg/l	4/6/2010 - 10/7/2010	3	0	3	24.9	29.7	27.7	---	2.498	---	---	---	---
Temp_HL_MS5.0	°C	4/6/2010 - 11/8/2010	31	0	31	5.51	26.95	17.34	18.07	7.117	5.512	13.16	25.75	26.86
Total Nitrogen_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	1033	2226	1709	---	371.5	---	---	---	---
Total Phosphorus_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	56.65	123.8	94.28	---	21.02	---	---	---	---
Total Suspended Solids	mg/l	4/6/2010 - 11/8/2010	8	0	8	8	17	11.88	---	3.091	---	---	---	---
Transparency Tube	cm	4/6/2010 - 11/8/2010	8	0	8	48.5	75.7	64.93	---	10.63	---	---	---	---

Station ID: MISS_UM880

Station Name: Mississippi River just above the Crow River Confluence

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/6/2010 - 10/7/2010	3	0	3	145	172	163	---	15.59	---	---	---	---
Ammonium_SCRS	µg/l	4/6/2010 - 11/8/2010	8	5	8	2	38.6	12.95	---	14.14	---	---	---	---
Calcium	mg/l	4/6/2010 - 10/7/2010	3	0	3	41.4	50.2	45.9	---	4.403	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	2.82	35.88	9.066	---	11.08	---	---	---	---
Chloride	mg/l	4/6/2010 - 10/7/2010	3	0	3	12.2	12.8	12.53	---	0.3055	---	---	---	---
DO%_HL_MS5.0	%	4/6/2010 - 11/8/2010	32	0	32	81.8	102.7	91.94	94.75	7.045	81.9	84.38	97.8	102.4
DO_HL_MS5.0	mg/l	4/6/2010 - 11/8/2010	32	0	32	6.42	12.04	8.963	9.43	1.969	6.433	6.698	10.72	11.98
DOC	mg/l	4/6/2010 - 10/7/2010	3	0	3	9.5	12	10.83	---	1.258	---	---	---	---
EC25_HL_MS5.0	µS/cm	4/6/2010 - 11/8/2010	32	0	32	272.1	383.4	351.1	363.8	34.7	278.9	344.4	375.2	383.2
Magnesium	mg/l	4/6/2010 - 10/7/2010	3	0	3	13.9	17.6	16.17	---	1.986	---	---	---	---
Nitrate+Nitrite_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	297.6	526.7	414.8	---	82.11	---	---	---	---
pH_HL_MS5.0	None	4/6/2010 - 11/8/2010	32	0	32	7.86	8.42	8.171	8.19	0.1581	7.876	8.088	8.278	8.374
converted pH	None					7.86	8.42	8.143	8.187	0.0029	7.876	8.086	5.092	5.104
H+ computed from pH	µeq/l					0.0038	0.0138	0.0072	0.0065	0.0029	0.0042	0.0053	0.0082	0.0133
Potassium	mg/l	4/6/2010 - 10/7/2010	3	0	3	1.94	2.5	2.28	---	0.2987	---	---	---	---
Silicate	mg/l	4/6/2010 - 10/7/2010	3	0	3	8.2	11	9.2	---	1.562	---	---	---	---
Sodium	mg/l	4/6/2010 - 10/7/2010	3	0	3	5.9	8.8	7.72	---	1.585	---	---	---	---
Sulfate	mg/l	4/6/2010 - 10/7/2010	3	0	3	10.4	14	12.4	---	1.833	---	---	---	---
Temp_HL_MS5.0	°C	4/6/2010 - 11/8/2010	32	0	32	5.14	26.18	16.5	14.6	7.195	5.14	11.64	24.99	26.16
Total Nitrogen_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	1008	1442	1208	---	152.2	---	---	---	---
Total Phosphorus_SCRS	µg/l	4/6/2010 - 11/8/2010	8	0	8	35.76	79.83	62.85	---	13.89	---	---	---	---
Total Suspended Solids	mg/l	4/6/2010 - 11/8/2010	8	0	8	5	10	7.25	---	1.832	---	---	---	---

Appendix A. Descriptive statistics for monitoring sites in the Mississippi National River and Recreation Area, Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Station

Station ID: MISS_UM880		Station Name: Mississippi River just above the Crow River Confluence												
Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Transparency Tube	cm	4/6/2010 - 11/8/2010	8	1	8	64.3	132	89.21	---	22.77	---	---	---	---

Reported Local Characteristics				
Local Name	STORET Name	Medium	Subject Taxon	Bio Part
Alkalinity	Alkalinity, Total (total hydroxide+carbonate+bicarbonate)	Water		
Ammonium_SCRS	Nitrogen, Ammonium (NH4) as N	Water		
Calcium	Calcium	Water		
chl_a(fluor)_SCRS	Chlorophyll a, free of pheophytin	Water		
Chloride	Chloride	Water		
DO%_HL_MS5.0	Dissolved oxygen saturation	Water		
DO_HL_MS5.0	Dissolved oxygen (DO)	Water		
DOC	Carbon, organic	Water		
EC25_HL_MS5.0	Specific conductance	Water		
Magnesium	Magnesium	Water		
Nitrate+Nitrite_SCRS	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	Water		
pH_HL_MS5.0	pH	Water		
Potassium	Potassium	Water		
Silicate	Silicate	Water		
Sodium	Sodium	Water		
Sulfate	Sulfur, sulfate (SO4) as SO4	Water		
Temp_HL_MS5.0	Temperature, water	Water		
Total Nitrogen_SCRS	Nitrogen	Water		
Total Phosphorus_SCRS	Phosphorus	Water		
Total Suspended Solids	Solids, Total Suspended (TSS)	Water		
Transparency Tube	Transparency, tube with disk	Water		

Results filtered for:

Organization = MISS: Mississippi National River and Recreation Area

Station = MISS_UM822: Mississippi River next to Spring Lake

MISS_UM852: Mississippi River near East River Flats Park in Minneapolis

MISS_UM862: Mississippi River near St. Paul Water Works Pumping Station

MISS_UM868: Mississippi River upstream of the Coon Rapids Dam

Appendix A. Descriptive statistics for monitoring sites in the Mississippi National River and Recreation Area, Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Station

MISS_UM880: Mississippi River just above the Crow River Confluence

Activities with Characteristic = Alkalinity

or Ammonium_SCRS
or Calcium
or chl_a(fluor)_SCRS
or Chloride
or Chloride_Filtered
or DO%_HL_MS5.0
or DO_HL_MS5.0
or DOC
or EC25_HL_MS5.0
or Magnesium
or Nitrate+Nitrite_SCRS
or pH_HL_MS5.0
or Potassium
or Silicate
or Sodium
or Sulfate
or Sulfate_Filtered
or Temp_HL_MS5.0
or Total Nitrogen_SCRS
or Total Phosphorus_SCRS
or Total Suspended Solids
or Transparency Tube

Only display results that meet characteristic criteria

Include Only Samples Not Checked as QC

Date (>=3/1/2010 and <=12/30/2010)

Censored Data Substitutions: *Non-detect=0.5 * DetectionLimit, *Present >QL=1.1 * UpperQuantificationLimit, *Present <QL=0.5 * LowerQuantificationLimit

Missing Statistic Codes:

--- Computation requires 9 observations

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret.

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret.



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_01

Station Name: Namekagon River at North Road Just West of Earl, WI

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/6/2009 - 10/6/2009	3	0	3	67	84	76.33	---	8.622	---	---	---	---
Calcium	mg/l	4/6/2009 - 10/6/2009	3	0	3	20.1	26.9	24.13	---	3.573	---	---	---	---
Chl_a	ppb	4/6/2009 - 11/2/2009	8	0	8	0.56	2.12	1.371	---	0.5869	---	---	---	---
Chloride_Filtered	mg/l	4/6/2009 - 10/6/2009	3	0	3	4.4	5	4.7	---	0.3	---	---	---	---
DO Concentration	mg/l	4/6/2009 - 11/2/2009	16	0	16	8.22	11.93	9.609	9.475	1.179	8.234	8.485	10.38	11.91
DO Saturation	%	4/6/2009 - 11/2/2009	16	0	16	83	102.9	91.02	90.3	5.495	83	87.82	92.52	102.8
DOC	mg/l	4/6/2009 - 10/6/2009	3	0	3	3.1	4.8	3.933	---	0.8505	---	---	---	---
Magnesium	mg/l	4/6/2009 - 10/6/2009	3	0	3	5.8	8.05	7.127	---	1.178	---	---	---	---
Nitrates_Nitrites	µg/l	4/6/2009 - 11/2/2009	8	0	8	30.12	183.4	93.64	---	50.67	---	---	---	---
Nitrogen	µg/l	4/6/2009 - 11/2/2009	8	0	8	196.9	454.4	321.7	---	87.27	---	---	---	---
pH	None	4/6/2009 - 11/2/2009	16	0	16	7.63	8.11	7.854	7.835	0.1623	7.644	7.715	8.028	8.089
converted pH	None					7.63	8.11	7.827	7.836	0.0053	7.644	7.714	5.113	5.117
H+ computed from pH	µeq/l					0.0078	0.0234	0.0149	0.0146	0.0053	0.0082	0.0095	0.0193	0.0227
Phosphorus	µg/l	4/6/2009 - 11/2/2009	8	0	8	17.72	27.96	22.31	---	3.007	---	---	---	---
Potassium	mg/l	4/6/2009 - 10/6/2009	3	0	3	0.47	0.82	0.6667	---	0.179	---	---	---	---
Silicate	mg/l	4/6/2009 - 10/6/2009	3	0	3	12	14	12.67	---	1.155	---	---	---	---
Sodium	mg/l	4/6/2009 - 10/6/2009	3	0	3	2.93	4	3.643	---	0.6178	---	---	---	---
Specific Conductivity	µS/cm	4/6/2009 - 11/2/2009	16	0	16	154.7	190.3	176.1	180	13.54	154.8	162.4	189.2	190.2
Sulfate_Filtered	mg/l	4/6/2009 - 10/6/2009	3	0	3	4.74	5.75	5.18	---	0.5174	---	---	---	---
Temperature	°C	4/6/2009 - 11/2/2009	16	0	16	3.84	21.21	12.47	11.38	6.03	3.84	6.91	18.76	21.2
Total Ammonia Nitrogen	µg/l	4/6/2009 - 11/2/2009	8	8	8	1.5	2	1.938	---	0.1768	---	---	---	---
Total Suspended Solids	mg/l	4/6/2009 - 11/2/2009	8	0	8	2	6	4	---	1.512	---	---	---	---
Transparency Tube	cm	4/6/2009 - 11/2/2009	8	7	8	118	132	130.2	---	4.95	---	---	---	---
Water Level	m	4/6/2009 - 11/2/2009	8	0	8	-5.298	-4.99	-5.192875	---	0.106	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_02

Station Name: St. Croix River Just Upstream from Norway Point Boat Landing

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/9/2009 - 10/9/2009	3	0	3	35	75	58.33	---	20.82	---	---	---	---
Calcium	mg/l	4/9/2009 - 10/9/2009	3	0	3	12.7	23.3	18.67	---	5.424	---	---	---	---
Chl_a	ppb	4/9/2009 - 11/5/2009	8	0	8	2.29	5.32	3.108	---	1.033	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_02

Station Name: St. Croix River Just Upstream from Norway Point Boat Landing

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Chloride_Filtered	mg/l	4/9/2009 - 10/9/2009	3	0	3	3.1	3.8	3.5	---	0.3606	---	---	---	---
DO Concentration	mg/l	4/9/2009 - 11/5/2009	23	0	23	7.4	11.51	9.067	8.52	1.521	7.424	7.6	10.78	11.49
DO Saturation	%	4/9/2009 - 11/5/2009	23	0	23	85.9	89.7	88.18	88	1.283	86.08	87.2	89.4	89.62
DOC	mg/l	4/9/2009 - 10/9/2009	3	0	3	5.6	9.6	8.233	---	2.281	---	---	---	---
Magnesium	mg/l	4/9/2009 - 10/9/2009	3	0	3	4.1	6.7	5.813	---	1.484	---	---	---	---
Nitrates_Nitrites	µg/l	4/9/2009 - 11/5/2009	8	0	8	3	92.4	38.51	---	30.1	---	---	---	---
Nitrogen	µg/l	4/9/2009 - 11/5/2009	8	0	8	342	695.4	496.2	---	129.7	---	---	---	---
pH	None	4/9/2009 - 11/5/2009	23	0	23	7.22	7.94	7.665	7.73	0.2325	7.266	7.48	7.87	7.926
converted pH	None					7.22	7.94	7.602	7.73	0.0148	7.264	7.48	5.126	5.139
H+ computed from pH	µeq/l					0.0115	0.0603	0.025	0.0186	0.0148	0.0119	0.0135	0.0331	0.0545
Phosphorus	µg/l	4/9/2009 - 11/5/2009	8	0	8	22.2	37.99	28.97	---	5.128	---	---	---	---
Potassium	mg/l	4/9/2009 - 10/9/2009	3	0	3	0.5	0.83	0.6767	---	0.1662	---	---	---	---
Silicate	mg/l	4/9/2009 - 10/9/2009	3	0	3	8.5	10	9.1	---	0.7937	---	---	---	---
Sodium	mg/l	4/9/2009 - 10/9/2009	3	0	3	1.92	3.4	2.873	---	0.8271	---	---	---	---
Specific Conductivity	µS/cm	4/9/2009 - 11/5/2009	23	0	23	99.8	168.1	141.9	148.3	24.48	100.2	120.6	166.5	167.9
Sulfate_Filtered	mg/l	4/9/2009 - 10/9/2009	3	0	3	3.83	4.89	4.227	---	0.5781	---	---	---	---
Temperature	°C	4/9/2009 - 11/5/2009	23	0	23	4.04	21.97	14.03	15.8	6.911	4.05	5.6	20.99	21.96
Total Ammonia Nitrogen	µg/l	4/9/2009 - 11/5/2009	8	8	8	1.5	2	1.938	---	0.1768	---	---	---	---
Total Suspended Solids	mg/l	4/9/2009 - 11/5/2009	8	0	8	2	5	3.75	---	1.282	---	---	---	---
Transparency Tube	cm	4/9/2009 - 11/5/2009	8	6	8	96.55	132	125.5	---	13.07	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_03

Station Name: Snake River Approx. 1/2 Mile Upstream of the St. Croix River

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO3	4/6/2009 - 10/6/2009	3	0	3	36	97	75.33	---	34.12	---	---	---	---
Calcium	mg/l	4/6/2009 - 10/6/2009	3	0	3	11.2	28.2	22.33	---	9.646	---	---	---	---
Chl_a	ppb	4/6/2009 - 11/2/2009	8	0	8	2.44	12.52	5.038	---	3.818	---	---	---	---
Chloride_Filtered	mg/l	4/6/2009 - 10/6/2009	3	0	3	6.2	17.5	10.47	---	6.137	---	---	---	---
DO Concentration	mg/l	4/6/2009 - 11/2/2009	16	0	16	7.45	11.54	10.1	10.24	1.186	7.45	9.705	10.75	11.53
DO Saturation	%	4/6/2009 - 11/2/2009	16	0	16	86.3	124.1	103.3	100.4	12.7	87.28	95.82	111.1	124
DOC	mg/l	4/6/2009 - 10/6/2009	3	0	3	13	13.2	13.07	---	0.1155	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_03

Station Name: Snake River Approx. 1/2 Mile Upstream of the St. Croix River

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Magnesium	mg/l	4/6/2009 - 10/6/2009	3	0	3	4.34	11.1	8.647	---	3.742	---	---	---	---
Nitrates_Nitrites	µg/l	4/6/2009 - 11/2/2009	8	0	8	23.52	168.1	114.5	---	45.3	---	---	---	---
Nitrogen	µg/l	4/6/2009 - 11/2/2009	8	0	8	861.3	1192	981.6	---	123.3	---	---	---	---
pH	None	4/6/2009 - 11/2/2009	16	0	16	6.98	8.68	8.109	8.085	0.4257	7.547	7.912	8.338	8.673
converted pH	None					6.98	8.68	7.851	8.086	0.0246	7.369	7.914	5.102	5.133
H+ computed from pH	µeq/l					0.0021	0.1047	0.0141	0.0082	0.0246	0.0021	0.0046	0.0122	0.0428
Phosphorus	µg/l	4/6/2009 - 11/2/2009	8	0	8	45.18	79.4	59.99	---	12.5	---	---	---	---
Potassium	mg/l	4/6/2009 - 10/6/2009	3	0	3	1.41	2.92	2.077	---	0.7703	---	---	---	---
Silicate	mg/l	4/6/2009 - 10/6/2009	3	0	3	4.2	6.6	5.4	---	1.2	---	---	---	---
Sodium	mg/l	4/6/2009 - 10/6/2009	3	0	3	2.25	6	4.383	---	1.928	---	---	---	---
Specific Conductivity	µS/cm	4/6/2009 - 11/2/2009	16	0	16	101.5	224.6	185.9	198.1	39.74	120.9	159.6	217.8	224.5
Sulfate_Filtered	mg/l	4/6/2009 - 10/6/2009	3	0	3	3.79	4.09	3.947	---	0.1504	---	---	---	---
Temperature	°C	4/6/2009 - 11/2/2009	16	0	16	4.6	23.8	15.95	14.04	6.739	5.937	12.13	21.91	23.8
Total Ammonia Nitrogen	µg/l	4/6/2009 - 11/2/2009	8	6	8	2	41.7	10.21	---	15.64	---	---	---	---
Total Suspended Solids	mg/l	4/6/2009 - 11/2/2009	8	0	8	3	6	4.5	---	1.069	---	---	---	---
Transparency Tube	cm	4/6/2009 - 11/2/2009	8	6	8	99.35	132	125	---	13.24	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_04

Station Name: St. Croix River About 1 Mile Above Nevers Dam Boat Landing

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/9/2009 - 10/9/2009	3	0	3	37	83	66	---	25.24	---	---	---	---
Calcium	mg/l	4/9/2009 - 10/9/2009	3	0	3	12.4	24.8	19.63	---	6.453	---	---	---	---
Chl_a	ppb	4/9/2009 - 11/5/2009	8	0	8	1.9	7.42	3.529	---	1.722	---	---	---	---
Chloride_Filtered	mg/l	4/9/2009 - 10/9/2009	3	0	3	4.1	5.5	4.933	---	0.7371	---	---	---	---
DO Concentration	mg/l	4/9/2009 - 11/5/2009	21	0	21	7.89	11.62	9.53	8.69	1.422	7.912	8.145	10.7	11.61
DO Saturation	%	4/9/2009 - 11/5/2009	21	0	21	86.1	96.9	92.3	92.9	3.107	86.2	91.05	94.25	96.42
DOC	mg/l	4/9/2009 - 10/9/2009	3	0	3	6.8	11.8	9.533	---	2.532	---	---	---	---
Magnesium	mg/l	4/9/2009 - 10/9/2009	3	0	3	4.51	8.43	6.9	---	2.097	---	---	---	---
Nitrates_Nitrites	µg/l	4/9/2009 - 11/5/2009	8	0	8	21.79	123.3	56.63	---	37.79	---	---	---	---
Nitrogen	µg/l	4/9/2009 - 11/5/2009	8	0	8	420.2	830.3	588.6	---	158.5	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_04

Station Name: St. Croix River About 1 Mile Above Nevers Dam Boat Landing

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
pH	None	4/9/2009 - 11/5/2009	21	0	21	7.36	8.25	7.83	7.87	0.3169	7.404	7.46	8.145	8.228
converted pH	None					7.36	8.25	7.724	7.87	0.0133	7.403	7.46	5.127	5.131
H+ computed from pH	µeq/l					0.0056	0.0437	0.0189	0.0135	0.0133	0.0059	0.0072	0.0347	0.0395
Phosphorus	µg/l	4/9/2009 - 11/5/2009	8	0	8	25.19	49.45	34.48	---	9.052	---	---	---	---
Potassium	mg/l	4/9/2009 - 10/9/2009	3	0	3	0.71	1.52	1.103	---	0.4055	---	---	---	---
Silicate	mg/l	4/9/2009 - 10/9/2009	3	0	3	7	7.8	7.467	---	0.4163	---	---	---	---
Sodium	mg/l	4/9/2009 - 10/9/2009	3	0	3	2.24	4.4	3.647	---	1.219	---	---	---	---
Specific Conductivity	µS/cm	4/9/2009 - 11/5/2009	21	0	21	100.8	195	152.1	167.8	34.28	101.4	121.7	185.4	193.2
Sulfate_Filtered	mg/l	4/9/2009 - 10/9/2009	3	0	3	3.71	4.99	4.387	---	0.6431	---	---	---	---
Temperature	°C	4/9/2009 - 11/5/2009	21	0	21	4.64	24.15	13.88	16.84	7.225	4.64	6.17	21.08	23.81
Total Ammonia Nitrogen	µg/l	4/9/2009 - 11/5/2009	8	7	8	2	11.4	3.175	---	3.323	---	---	---	---
Total Suspended Solids	mg/l	4/9/2009 - 11/5/2009	8	0	8	2	8	4.375	---	1.996	---	---	---	---
Transparency Tube	cm	4/9/2009 - 11/5/2009	8	5	8	85.05	132	120.2	---	17.81	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_05

Station Name: St. Croix River Just Upstream from the St. Croix Falls Dam

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO3	4/9/2009 - 10/9/2009	3	0	3	42	90	71.67	---	25.93	---	---	---	---
Calcium	mg/l	4/9/2009 - 10/9/2009	3	0	3	13.5	26.9	21.17	---	6.906	---	---	---	---
Chl_a	ppb	4/9/2009 - 11/5/2009	8	0	8	2.34	9.4	5.759	---	2.394	---	---	---	---
Chloride_Filtered	mg/l	4/9/2009 - 10/9/2009	3	0	3	4.1	6	5.2	---	0.9849	---	---	---	---
DO Concentration	mg/l	4/9/2009 - 11/5/2009	53	0	53	7.07	11.22	9.364	9.47	1.234	7.914	8.245	10.52	11.13
DO Saturation	%	4/9/2009 - 11/5/2009	53	0	53	82	123.1	94.7	93	9.843	85.4	87.25	98.7	109
DOC	mg/l	4/9/2009 - 10/9/2009	3	0	3	6.4	11.9	9.267	---	2.757	---	---	---	---
Magnesium	mg/l	4/9/2009 - 10/9/2009	3	0	3	4.59	9.02	7.257	---	2.349	---	---	---	---
Nitrates_Nitrites	µg/l	4/9/2009 - 11/5/2009	8	0	8	2.28	168.1	101.4	---	60.15	---	---	---	---
Nitrogen	µg/l	4/9/2009 - 11/5/2009	8	0	8	463.4	867.4	643.6	---	147.2	---	---	---	---
pH	None	4/9/2009 - 11/5/2009	53	0	53	7.42	8.58	7.953	7.92	0.3586	7.48	7.565	8.22	8.476
converted pH	None					7.42	8.58	7.818	7.921	0.0115	7.48	7.562	5.121	5.126
H+ computed from pH	µeq/l					0.0026	0.038	0.0152	0.012	0.0115	0.0033	0.006	0.0274	0.0331
Phosphorus	µg/l	4/9/2009 - 11/5/2009	8	0	8	26.08	43	33.6	---	7.497	---	---	---	---

Wednesday, April 27, 2011

Percentiles Calculated Using NIST Method

Page 4 of 14

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_05

Station Name: St. Croix River Just Upstream from the St. Croix Falls Dam

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Potassium	mg/l	4/9/2009 - 10/9/2009	3	0	3	0.77	1.59	1.18	---	0.41	---	---	---	---
Silicate	mg/l	4/9/2009 - 10/9/2009	3	0	3	6.6	8.5	7.567	---	0.9504	---	---	---	---
Sodium	mg/l	4/9/2009 - 10/9/2009	3	0	3	2.24	4.7	3.847	---	1.392	---	---	---	---
Specific Conductivity	µS/cm	4/9/2009 - 11/5/2009	53	0	53	110.8	201.8	170.4	193.3	33.75	111.5	136.1	198.6	200
Sulfate_Filtered	mg/l	4/9/2009 - 10/9/2009	3	0	3	4.16	5.7	4.907	---	0.7711	---	---	---	---
Temperature	°C	4/9/2009 - 11/5/2009	53	0	53	4.74	25.08	15.59	16.38	7.257	4.814	8.02	22.24	24.14
Total Ammonia Nitrogen	µg/l	4/9/2009 - 11/5/2009	8	7	8	2	6.8	2.6	---	1.697	---	---	---	---
Total Suspended Solids	mg/l	4/9/2009 - 11/5/2009	8	0	8	2	4	3.125	---	0.6409	---	---	---	---
Transparency Tube	cm	4/9/2009 - 11/5/2009	8	3	8	85.2	132	115.3	---	16.7	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_06

Station Name: Apple River Approx. 1/2 Mile Upstream of the St. Croix River

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO3	4/7/2009 - 10/7/2009	3	0	3	115	137	125.7	---	11.02	---	---	---	---
Calcium	mg/l	4/7/2009 - 10/7/2009	3	0	3	32.9	39.3	35.4	---	3.422	---	---	---	---
Chl_a	ppb	4/7/2009 - 11/3/2009	8	0	8	2.68	9.55	5.552	---	3.172	---	---	---	---
Chloride_Filtered	mg/l	4/7/2009 - 10/7/2009	3	0	3	8.4	9.7	9.2	---	0.7	---	---	---	---
DO Concentration	mg/l	4/7/2009 - 11/3/2009	16	0	16	8.5	12.52	10.28	10.4	1.415	8.507	8.84	11.66	12.49
DO Saturation	%	4/7/2009 - 11/3/2009	16	0	16	94	105.3	100.2	99.75	3.307	94.14	98.7	103.2	105.1
DOC	mg/l	4/7/2009 - 10/7/2009	3	0	3	3.8	4.4	4.1	---	0.3	---	---	---	---
Magnesium	mg/l	4/7/2009 - 10/7/2009	3	0	3	12.6	17.6	15.1	---	2.5	---	---	---	---
Nitrates_Nitrites	µg/l	4/7/2009 - 11/3/2009	8	0	8	571.8	985.2	793.3	---	147	---	---	---	---
Nitrogen	µg/l	4/7/2009 - 11/3/2009	8	0	8	1020	1380	1197	---	125.2	---	---	---	---
pH	None	4/7/2009 - 11/3/2009	16	0	16	7.76	8.38	8.173	8.2	0.1926	7.788	8.06	8.34	8.366
converted pH	None					7.76	8.38	8.131	8.201	0.004	7.788	8.06	5.094	5.109
H+ computed from pH	µeq/l					0.0042	0.0174	0.0074	0.0063	0.004	0.0043	0.0046	0.0087	0.0163
Phosphorus	µg/l	4/7/2009 - 11/3/2009	8	0	8	34.73	62.04	45.09	---	8.909	---	---	---	---
Potassium	mg/l	4/7/2009 - 10/7/2009	3	0	3	0.96	1.81	1.353	---	0.4285	---	---	---	---
Silicate	mg/l	4/7/2009 - 10/7/2009	3	0	3	6.9	15	11.3	---	4.095	---	---	---	---
Sodium	mg/l	4/7/2009 - 10/7/2009	3	0	3	4.13	5.3	4.843	---	0.6258	---	---	---	---
Specific Conductivity	µS/cm	4/7/2009 - 11/3/2009	16	0	16	262.5	311.9	287.6	287.9	17.5	262.6	271.7	304.3	311.9

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_06

Station Name: Apple River Approx. 1/2 Mile Upstream of the St. Croix River

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Sulfate_Filtered	mg/l	4/7/2009 - 10/7/2009	3	0	3	4.7	6.5	5.707	---	0.9188	---	---	---	---
Temperature	°C	4/7/2009 - 11/3/2009	16	0	16	6.6	21.46	14.25	14.33	5.867	6.6	7.592	20.73	21.46
Total Ammonia Nitrogen	µg/l	4/7/2009 - 11/3/2009	8	8	8	1.5	5.5	2.375	---	1.275	---	---	---	---
Total Suspended Solids	mg/l	4/7/2009 - 11/3/2009	8	0	8	1	4	2.375	---	1.061	---	---	---	---
Transparency Tube	cm	4/7/2009 - 11/3/2009	8	7	8	99.95	132	128	---	11.33	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_07

Station Name: Pool #1 of Lake St. Croix near Bayport, MN

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/8/2009 - 10/8/2009	3	0	3	44	103	80	---	31.58	---	---	---	---
Bottom Phosphorus	µg/l	7/7/2009 - 7/7/2009	1	0	1	99.77	99.77	99.77	---	---	---	---	---	---
Calcium	mg/l	4/8/2009 - 10/8/2009	3	0	3	13.8	29	23.87	---	8.719	---	---	---	---
Chl_a	ppb	4/8/2009 - 11/4/2009	8	0	8	0.86	35.33	12	---	11.05	---	---	---	---
Chloride_Filtered	mg/l	4/8/2009 - 10/8/2009	3	0	3	5.4	7.4	6.7	---	1.127	---	---	---	---
DO Concentration	mg/l	4/8/2009 - 11/4/2009	91	0	91	0.27	11.42	8.432	9.47	2.965	3.442	7.02	10.69	11.26
DO Saturation	%	4/8/2009 - 11/4/2009	91	0	91	3	133.6	83.49	88.7	28.44	39.96	78.5	93.5	119.9
DOC	mg/l	4/8/2009 - 10/8/2009	3	0	3	5.4	8.8	7.1	---	1.7	---	---	---	---
Magnesium	mg/l	4/8/2009 - 10/8/2009	3	0	3	5.06	11.5	9.22	---	3.608	---	---	---	---
Nitrates_Nitrites	µg/l	4/8/2009 - 11/4/2009	8	0	8	2.42	299.1	149.5	---	113	---	---	---	---
Nitrogen	µg/l	4/8/2009 - 11/4/2009	8	0	8	633.6	1267	861.8	---	202.2	---	---	---	---
pH	None	4/8/2009 - 11/4/2009	91	0	91	7.09	8.77	7.804	7.74	0.4127	7.352	7.57	8.02	8.534
converted pH	None					7.09	8.77	7.652	7.74	0.0172	7.352	7.57	5.121	5.134
H+ computed from pH	µeq/l					0.0017	0.0813	0.0223	0.0182	0.0172	0.0029	0.0095	0.0269	0.0445
Phosphorus	µg/l	4/8/2009 - 11/4/2009	8	0	8	34.28	50.77	41.8	---	6.206	---	---	---	---
Potassium	mg/l	4/8/2009 - 10/8/2009	3	0	3	0.93	2.02	1.383	---	0.5677	---	---	---	---
Silicate	mg/l	4/8/2009 - 10/8/2009	3	0	3	7.7	8.3	8.1	---	0.3464	---	---	---	---
Sodium	mg/l	4/8/2009 - 10/8/2009	3	0	3	2.63	5.4	4.41	---	1.545	---	---	---	---
Specific Conductivity	µS/cm	4/8/2009 - 11/4/2009	91	0	91	120.6	244.3	191.2	211.2	39.77	121.6	157.4	226.9	231.8
Sulfate_Filtered	mg/l	4/8/2009 - 10/8/2009	3	0	3	4.16	5.93	5.057	---	0.8852	---	---	---	---
Temperature	°C	4/8/2009 - 11/4/2009	91	0	91	4.85	26.01	15.42	15.42	6.847	5.522	7.37	22.08	23.9

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_07

Station Name: Pool #1 of Lake St. Croix near Bayport, MN

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Total Ammonia Nitrogen	µg/l	4/8/2009 - 11/4/2009	8	6	8	2	130.1	19.93	---	44.69	---	---	---	---
Total Phosphorus VANDORN_SCRS	µg/l	7/7/2009 - 7/7/2009	1	0	1	99.77	99.77	99.77	---	---	---	---	---	---
Total Suspended Solids	mg/l	4/8/2009 - 11/4/2009	8	0	8	2	7	3.75	---	1.669	---	---	---	---
Transparency Tube	cm	4/8/2009 - 11/4/2009	8	2	8	74.95	132	102.4	---	21.76	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_08

Station Name: Lake Mallalieu (Willow River) Just East of Pub. Boat Launch

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO3	4/7/2009 - 10/7/2009	3	0	3	145	174	156	---	15.72	---	---	---	---
Calcium	mg/l	4/7/2009 - 10/7/2009	3	0	3	35.2	43.8	39.33	---	4.31	---	---	---	---
Chl_a	ppb	4/7/2009 - 11/3/2009	8	0	8	6.85	50.63	28.09	---	15.72	---	---	---	---
Chloride_Filtered	mg/l	4/7/2009 - 10/7/2009	3	0	3	14.5	15.4	14.9	---	0.4583	---	---	---	---
DO Concentration	mg/l	4/7/2009 - 11/3/2009	40	0	40	2.61	20.19	12.64	11.45	4.477	6.934	10.65	16.88	18.89
DO Saturation	%	4/7/2009 - 11/3/2009	40	0	40	29.9	230.6	129.6	112.2	54.37	70.97	95.12	184.7	213.5
DOC	mg/l	4/7/2009 - 10/7/2009	3	0	3	2.5	4	3.333	---	0.7638	---	---	---	---
Magnesium	mg/l	4/7/2009 - 10/7/2009	3	0	3	19	24.8	22.8	---	3.292	---	---	---	---
Nitrates_Nitrites	µg/l	4/7/2009 - 11/3/2009	8	0	8	496.7	3106	1596	---	917	---	---	---	---
Nitrogen	µg/l	4/7/2009 - 11/3/2009	8	0	8	1573	3362	2367	---	637.7	---	---	---	---
pH	None	4/7/2009 - 11/3/2009	40	0	40	7.67	9.11	8.462	8.465	0.3746	7.944	8.212	8.81	8.957
converted pH	None					7.67	9.11	8.301	8.469	0.0047	7.943	8.215	5.085	5.1
H+ computed from pH	µeq/l					0.0008	0.0214	0.005	0.0034	0.0047	0.0011	0.0016	0.0061	0.0114
Phosphorus	µg/l	4/7/2009 - 11/3/2009	8	0	8	36.76	91.7	70.56	---	19.42	---	---	---	---
Potassium	mg/l	4/7/2009 - 10/7/2009	3	0	3	1.19	3.24	1.953	---	1.121	---	---	---	---
Silicate	mg/l	4/7/2009 - 10/7/2009	3	0	3	8.7	13	11.23	---	2.25	---	---	---	---
Sodium	mg/l	4/7/2009 - 10/7/2009	3	0	3	4.83	6.4	5.643	---	0.7865	---	---	---	---
Specific Conductivity	µS/cm	4/7/2009 - 11/3/2009	40	0	40	300.3	402.4	355.3	353.4	29.06	307.9	338.4	383.3	400.7
Sulfate_Filtered	mg/l	4/7/2009 - 10/7/2009	3	0	3	9.65	12.3	10.75	---	1.381	---	---	---	---
Temperature	°C	4/7/2009 - 11/3/2009	40	0	40	6.34	22.95	15.53	15.66	6.105	6.573	10.22	21.18	22.48
Total Ammonia Nitrogen	µg/l	4/7/2009 - 11/3/2009	8	5	8	2	42.3	11.91	---	15.88	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_08

Station Name: Lake Mallalieu (Willow River) Just East of Pub. Boat Launch

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Total Suspended Solids	mg/l	4/7/2009 - 11/3/2009	8	0	8	4	26	10.12	---	7.12	---	---	---	---
Transparency Tube	cm	4/7/2009 - 11/3/2009	8	0	8	44.35	105	69.84	---	22.71	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_09

Station Name: Pool #2 on Lake St. Croix Downstream of I94 Bridge in Hudson

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO3	4/7/2009 - 10/7/2009	3	0	3	39	106	83	---	38.12	---	---	---	---
Calcium	mg/l	4/7/2009 - 10/7/2009	3	0	3	13.2	29.7	22.97	---	8.658	---	---	---	---
Chl_a	ppb	4/7/2009 - 11/3/2009	8	0	8	3.38	23.07	8.946	---	6.627	---	---	---	---
Chloride_Filtered	mg/l	4/7/2009 - 10/7/2009	3	0	3	5.4	8.6	7.267	---	1.665	---	---	---	---
DO Concentration	mg/l	4/7/2009 - 11/3/2009	72	0	72	6.09	11.52	8.994	9.415	1.762	6.537	7.082	10.42	11.44
DO Saturation	%	4/7/2009 - 11/3/2009	72	0	72	65.2	121.1	89.52	87.75	14.16	71.3	77.25	101.6	108.5
DOC	mg/l	4/7/2009 - 10/7/2009	3	0	3	6.8	11.6	8.567	---	2.639	---	---	---	---
Magnesium	mg/l	4/7/2009 - 10/7/2009	3	0	3	5.08	12	9.227	---	3.659	---	---	---	---
Nitrates_Nitrites	µg/l	4/7/2009 - 11/3/2009	8	0	8	58.44	337	221	---	95.36	---	---	---	---
Nitrogen	µg/l	4/7/2009 - 11/3/2009	8	0	8	585	985.8	852.3	---	122	---	---	---	---
pH	None	4/7/2009 - 11/3/2009	72	0	72	7.35	8.66	7.934	7.915	0.3203	7.443	7.76	8.06	8.447
converted pH	None					7.35	8.66	7.827	7.914	0.0106	7.442	7.759	5.11	5.128
H+ computed from pH	µeq/l					0.0022	0.0447	0.0149	0.0122	0.0106	0.0036	0.0087	0.0174	0.0361
Phosphorus	µg/l	4/7/2009 - 11/3/2009	8	0	8	28.82	50	39.01	---	6.661	---	---	---	---
Potassium	mg/l	4/7/2009 - 10/7/2009	3	0	3	1	2.13	1.397	---	0.6358	---	---	---	---
Silicate	mg/l	4/7/2009 - 10/7/2009	3	0	3	7.6	8.6	8	---	0.5292	---	---	---	---
Sodium	mg/l	4/7/2009 - 10/7/2009	3	0	3	2.49	5.5	4.263	---	1.575	---	---	---	---
Specific Conductivity	µS/cm	4/7/2009 - 11/3/2009	72	0	72	116.9	247.5	196.9	202.3	39.69	117.4	167.4	233.2	241
Sulfate_Filtered	mg/l	4/7/2009 - 10/7/2009	3	0	3	4.43	6.05	5.503	---	0.9296	---	---	---	---
Temperature	°C	4/7/2009 - 11/3/2009	72	0	72	4.27	24.65	15.3	15.52	6.351	4.448	13.75	21.8	22.92
Total Ammonia Nitrogen	µg/l	4/7/2009 - 11/3/2009	8	5	8	2	120.9	32.24	---	46.65	---	---	---	---
Total Suspended Solids	mg/l	4/7/2009 - 11/3/2009	8	0	8	2	7	3.375	---	1.685	---	---	---	---
Transparency Tube	cm	4/7/2009 - 11/3/2009	8	1	8	80.75	132	105.4	---	16.21	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_10

Station Name: Kinnickinnic River at County Highway F Bridge

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/8/2009 - 10/8/2009	3	0	3	107	190	160.7	---	46.54	---	---	---	---
Calcium	mg/l	4/8/2009 - 10/8/2009	3	0	3	55.8	59.7	57.57	---	1.976	---	---	---	---
Chl_a	ppb	4/8/2009 - 11/4/2009	8	0	8	0.74	5.22	2.792	---	1.747	---	---	---	---
Chloride_Filtered	mg/l	4/8/2009 - 10/8/2009	3	0	3	21.5	22.6	22.1	---	0.5568	---	---	---	---
DO Concentration	mg/l	4/8/2009 - 11/4/2009	16	0	16	9.26	13.29	10.83	10.57	1.154	9.295	10.2	11.47	13.27
DO Saturation	%	4/8/2009 - 11/4/2009	16	0	16	94.9	109.9	100.6	98.65	5.61	94.97	95.48	106.2	109.6
DOC	mg/l	4/8/2009 - 10/8/2009	3	0	3	1.7	3.7	2.767	---	1.007	---	---	---	---
Magnesium	mg/l	4/8/2009 - 10/8/2009	3	0	3	26.6	28.2	27.57	---	0.8505	---	---	---	---
Nitrates_Nitrites	µg/l	4/8/2009 - 11/4/2009	8	0	8	4511	5371	4907	---	277.3	---	---	---	---
Nitrogen	µg/l	4/8/2009 - 11/4/2009	8	0	8	5017	5843	5355	---	257.5	---	---	---	---
pH	None	4/8/2009 - 11/4/2009	16	0	16	7.58	8.13	7.916	7.975	0.182	7.58	7.782	8.065	8.116
converted pH	None					7.58	8.13	7.876	7.975	0.0063	7.58	7.78	5.109	5.12
H+ computed from pH	µeq/l					0.0074	0.0263	0.0133	0.0106	0.0063	0.0077	0.0086	0.0166	0.0263
Phosphorus	µg/l	4/8/2009 - 11/4/2009	8	0	8	12	162.5	56.06	---	49.55	---	---	---	---
Potassium	mg/l	4/8/2009 - 10/8/2009	3	0	3	1.14	2.43	1.66	---	0.6804	---	---	---	---
Silicate	mg/l	4/8/2009 - 10/8/2009	3	0	3	7.3	14	10	---	3.534	---	---	---	---
Sodium	mg/l	4/8/2009 - 10/8/2009	3	0	3	8.04	9	8.58	---	0.4911	---	---	---	---
Specific Conductivity	µS/cm	4/8/2009 - 11/4/2009	16	0	16	478.2	504.3	493.6	494.8	8.279	478.2	487.7	500.4	504.3
Sulfate_Filtered	mg/l	4/8/2009 - 10/8/2009	3	0	3	16.5	25.4	19.9	---	4.807	---	---	---	---
Temperature	°C	4/8/2009 - 11/4/2009	16	0	16	5.44	16.55	11.63	12.55	4.169	5.447	6.868	15.58	16.54
Total Ammonia Nitrogen	µg/l	4/8/2009 - 11/4/2009	8	8	8	1.5	5.5	2.812	---	1.668	---	---	---	---
Total Suspended Solids	mg/l	4/8/2009 - 11/4/2009	8	0	8	1	7	4.375	---	2.134	---	---	---	---
Transparency Tube	cm	4/8/2009 - 11/4/2009	8	8	8	132	132	132	---	0	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_11

Station Name: Pool #4 on Lake St. Croix near Prescott, WI

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/8/2009 - 10/8/2009	3	0	3	42	100	80	---	32.92	---	---	---	---
Bottom Phosphorus	µg/l	7/7/2009 - 7/7/2009	1	0	1	74.58	74.58	74.58	---	---	---	---	---	---
Calcium	mg/l	4/8/2009 - 10/8/2009	3	0	3	11.7	28.7	22.63	---	9.488	---	---	---	---
Chl_a	ppb	4/8/2009 - 11/4/2009	8	0	8	0.31	16.92	6.811	---	5.999	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_11

Station Name: Pool #4 on Lake St. Croix near Prescott, WI

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Chloride_Filtered	mg/l	4/8/2009 - 10/8/2009	3	0	3	4.9	8.7	7.133	---	1.986	---	---	---	---
DO Concentration	mg/l	4/8/2009 - 11/4/2009	123	0	123	0.17	11.53	7.314	7.76	3.31	1.55	5.06	9.93	11.23
DO Saturation	%	4/8/2009 - 11/4/2009	123	0	123	1.8	120.2	70.67	82.9	29.88	16.56	53	86.3	102.2
DOC	mg/l	4/8/2009 - 10/8/2009	3	0	3	8	11.8	9.367	---	2.113	---	---	---	---
Magnesium	mg/l	4/8/2009 - 10/8/2009	3	0	3	4.48	11.3	8.96	---	3.881	---	---	---	---
Nitrates_Nitrites	µg/l	4/8/2009 - 11/4/2009	8	0	8	178	488.7	340.9	---	91.88	---	---	---	---
Nitrogen	µg/l	4/8/2009 - 11/4/2009	8	0	8	718.7	1060	932.8	---	119.7	---	---	---	---
pH	None	4/8/2009 - 11/4/2009	123	0	123	7.11	8.64	7.67	7.69	0.3962	7.18	7.37	7.81	8.412
converted pH	None					7.11	8.64	7.529	7.69	0.0212	7.18	7.37	5.133	5.144
H+ computed from pH	µeq/l					0.0023	0.0776	0.0296	0.0204	0.0212	0.0039	0.0155	0.0427	0.0661
Phosphorus	µg/l	4/8/2009 - 11/4/2009	8	0	8	18.75	75.31	40.38	---	19.32	---	---	---	---
Potassium	mg/l	4/8/2009 - 10/8/2009	3	0	3	0.97	2.13	1.437	---	0.6123	---	---	---	---
Silicate	mg/l	4/8/2009 - 10/8/2009	3	0	3	6.7	8.2	7.267	---	0.8145	---	---	---	---
Sodium	mg/l	4/8/2009 - 10/8/2009	3	0	3	2.11	5.1	4.103	---	1.726	---	---	---	---
Specific Conductivity	µS/cm	4/8/2009 - 11/4/2009	123	0	123	106.4	285.4	200.5	226.7	46.67	107.2	156.2	228.5	241.4
Sulfate_Filtered	mg/l	4/8/2009 - 10/8/2009	3	0	3	4.25	6.64	5.76	---	1.314	---	---	---	---
Temperature	°C	4/8/2009 - 11/4/2009	123	0	123	3.24	23.6	14.56	16.43	6.293	3.26	8.52	19	22.49
Total Ammonia Nitrogen	µg/l	4/8/2009 - 11/4/2009	8	5	8	2	126.5	38.7	---	53.04	---	---	---	---
Total Phosphorus VANDORN_SCRS	µg/l	7/7/2009 - 7/7/2009	1	0	1	74.58	74.58	74.58	---	---	---	---	---	---
Total Suspended Solids	mg/l	4/8/2009 - 11/4/2009	8	1	8	0.5	4	2.438	---	1.4	---	---	---	---
Transparency Tube	cm	4/8/2009 - 11/4/2009	8	6	8	78.6	132	123.4	---	18.88	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_A

Station Name: Upper St. Croix River at CCC Bridge

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO3	4/6/2009 - 10/6/2009	3	0	3	28	50	42.67	---	12.7	---	---	---	---
Calcium	mg/l	4/6/2009 - 10/6/2009	3	0	3	8.86	16	13.32	---	3.889	---	---	---	---
Chl_a	ppb	4/6/2009 - 11/2/2009	8	0	8	0.02	1.38	0.5088	---	0.4601	---	---	---	---
Chloride_Filtered	mg/l	4/6/2009 - 10/6/2009	3	0	3	2.1	2.9	2.467	---	0.4041	---	---	---	---
DO Concentration	mg/l	4/6/2009 - 11/2/2009	15	0	15	8.23	12.78	9.914	10.06	1.405	8.23	8.51	10.67	12.24

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_A

Station Name: Upper St. Croix River at CCC Bridge

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
DO Saturation	%	4/6/2009 - 11/2/2009	15	0	15	84.2	103.4	95.65	97.1	4.867	86.66	93	98.2	102.4
DOC	mg/l	4/6/2009 - 10/6/2009	3	0	3	6	11	9.267	---	2.831	---	---	---	---
Magnesium	mg/l	4/6/2009 - 10/6/2009	3	0	3	2.88	4.75	4.007	---	0.9922	---	---	---	---
Nitrates_Nitrites	µg/l	4/6/2009 - 11/2/2009	8	1	8	1	31.1	9.868	---	9.75	---	---	---	---
Nitrogen	µg/l	4/6/2009 - 11/2/2009	8	0	8	323.3	693.6	461.1	---	132.5	---	---	---	---
pH	None	4/6/2009 - 11/2/2009	15	0	15	7.11	8.09	7.739	7.84	0.2984	7.182	7.58	8.03	8.078
converted pH	None					7.11	8.09	7.631	7.839	0.0199	7.178	7.58	5.12	5.144
H+ computed from pH	µeq/l					0.0081	0.0776	0.0234	0.0145	0.0199	0.0084	0.0093	0.0263	0.0664
Phosphorus	µg/l	4/6/2009 - 11/2/2009	8	0	8	15.71	22.61	19.59	---	2.6	---	---	---	---
Potassium	mg/l	4/6/2009 - 10/6/2009	3	0	3	0.3	0.58	0.4667	---	0.1474	---	---	---	---
Silicate	mg/l	4/6/2009 - 10/6/2009	3	0	3	7	13	9.1	---	3.381	---	---	---	---
Sodium	mg/l	4/6/2009 - 10/6/2009	3	0	3	1.8	2.7	2.333	---	0.4726	---	---	---	---
Specific Conductivity	µS/cm	4/6/2009 - 11/2/2009	15	0	15	73	117	100.5	107.6	16.72	73.18	82.9	114.9	116.9
Sulfate_Filtered	mg/l	4/6/2009 - 10/6/2009	3	0	3	3.53	5.19	4.4	---	0.8329	---	---	---	---
Temperature	°C	4/6/2009 - 11/2/2009	15	0	15	3.21	22.47	14.08	12.75	6.945	3.216	10.07	21.76	22.45
Total Ammonia Nitrogen	µg/l	4/6/2009 - 11/2/2009	8	7	8	2	9.4	3.362	---	2.73	---	---	---	---
Total Suspended Solids	mg/l	4/6/2009 - 11/2/2009	8	1	8	0.5	3	1.312	---	0.799	---	---	---	---
Transparency Tube	cm	4/6/2009 - 11/2/2009	8	8	8	132	132	132	---	0	---	---	---	---
Water Level	m	4/6/2009 - 11/2/2009	8	0	8	-3.63	-3.334	-3.496125	---	0.1146	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_B

Station Name: Namekagon River at Phipps Landing

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/6/2009 - 10/6/2009	3	0	3	62	76	70	---	7.211	---	---	---	---
Calcium	mg/l	4/6/2009 - 10/6/2009	3	0	3	20.2	23.4	21.87	---	1.604	---	---	---	---
Chl_a	ppb	4/6/2009 - 11/2/2009	8	0	8	0.34	2.03	1.045	---	0.5512	---	---	---	---
Chloride_Filtered	mg/l	4/6/2009 - 10/6/2009	3	0	3	2.8	3.4	3.1	---	0.3	---	---	---	---
DO Concentration	mg/l	4/6/2009 - 11/2/2009	16	0	16	9.42	12.23	10.67	10.48	1.046	9.441	9.618	11.77	12.22
DO Saturation	%	4/6/2009 - 11/2/2009	16	0	16	90.3	130.7	98.26	94.05	12.9	90.37	90.82	97.95	130.3
DOC	mg/l	4/6/2009 - 10/6/2009	3	0	3	3.9	4.8	4.433	---	0.4726	---	---	---	---
Magnesium	mg/l	4/6/2009 - 10/6/2009	3	0	3	5.57	6.71	6.167	---	0.5719	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_B

Station Name: Namekagon River at Phipps Landing

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Nitrates_Nitrites	µg/l	4/6/2009 - 11/2/2009	8	0	8	4.18	107.1	49.54	---	43.64	---	---	---	---
Nitrogen	µg/l	4/6/2009 - 11/2/2009	8	0	8	144.5	389.2	261.6	---	92.35	---	---	---	---
pH	None	4/6/2009 - 11/2/2009	16	0	16	7.49	8.74	7.839	7.74	0.3806	7.497	7.572	7.945	8.726
converted pH	None					7.49	8.74	7.735	7.74	0.0095	7.498	7.57	5.121	5.125
H+ computed from pH	µeq/l					0.0018	0.0324	0.0184	0.0182	0.0095	0.0019	0.0114	0.0269	0.0318
Phosphorus	µg/l	4/6/2009 - 11/2/2009	8	0	8	14.41	26.62	17.25	---	3.958	---	---	---	---
Potassium	mg/l	4/6/2009 - 10/6/2009	3	0	3	0.4	0.76	0.6133	---	0.189	---	---	---	---
Silicate	mg/l	4/6/2009 - 10/6/2009	3	0	3	12	14	13	---	1	---	---	---	---
Sodium	mg/l	4/6/2009 - 10/6/2009	3	0	3	2.51	3.1	2.837	---	0.3001	---	---	---	---
Specific Conductivity	µS/cm	4/6/2009 - 11/2/2009	16	0	16	139.5	177.1	156.1	155.9	13.89	139.5	141.9	168.9	176.7
Sulfate_Filtered	mg/l	4/6/2009 - 10/6/2009	3	0	3	5.04	6.43	5.673	---	0.7032	---	---	---	---
Temperature	°C	4/6/2009 - 11/2/2009	16	0	16	3.25	20.37	10.75	9.47	5.423	3.264	6.078	14.97	20.36
Total Ammonia Nitrogen	µg/l	4/6/2009 - 11/2/2009	8	8	8	2	5.5	2.562	---	1.237	---	---	---	---
Total Suspended Solids	mg/l	4/6/2009 - 11/2/2009	8	1	8	0.5	6	2.312	---	1.907	---	---	---	---
Transparency Tube	cm	4/6/2009 - 11/2/2009	8	7	8	115.8	132	130	---	5.71	---	---	---	---

Reported Local Characteristics				
Local Name	STORET Name	Medium	Subject Taxon	Bio Part
Alkalinity	Alkalinity, Total (total hydroxide+carbonate+bicarbonate)	Water		
Calcium	Calcium	Water		
Chloride_Filtered	Chloride	Water		
DOC	Carbon, organic	Water		
Magnesium	Magnesium	Water		
Potassium	Potassium	Water		
Silicate	Silicate	Water		
Sodium	Sodium	Water		
Sulfate_Filtered	Sulfur, sulfate (SO4) as SO4	Water		
Total Phosphorus VANDORN_SCRS	Phosphorus	Water		
Total Suspended Solids	Solids, Total Suspended (TSS)	Water		
Transparency Tube	Transparency, tube with disk	Water		

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Water Level	Water level in relation to reference point	Air
-------------	--	-----

Results filtered for:

Organization = SACN: St. Croix National Scenic Riverway

Station = Include All Station Visit Results

Activities with Characteristic = Alkalinity

or Bottom Phosphorus*

or Calcium

or Chl_a*

or Chloride

or Chloride_Filtered

or DO Concentration*

or DO Saturation*

or DOC

or Magnesium

or Nitrates_Nitrites*

or Nitrogen*

or pH*

or Phosphorus*

or Potassium

or Silicate

or Sodium

or Specific Conductivity*

or Sulfate

or Sulfate_Filtered

or Temperature*

or Total Ammonia Nitrogen*

or Total Phosphorus VANDORN_SCRS

or Total Suspended Solids

or Transparency Tube

or Water Level

Only display results that meet characteristic criteria

* Indicates Analytical Group Within Organization

** Indicates Analytical Group Across Organizations

Include Only Samples Not Checked as QC

Date (>=4/1/2009 and <=11/30/2009)

Censored Data Substitutions: *Non-detect=0.5* DetectionLimit, *Present >QL=1.1 * UpperQuantificationLimit, *Present <QL=0.5 * LowerQuantificationLimit

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Missing Statistic Codes:
--- Computation requires 9 observations
... Computation requires more than 1 observation

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_01

Station Name: Namekagon River at North Road Just West of Earl, WI

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/5/2010 - 10/5/2010	3	0	3	71	83	78.33	---	6.429	---	---	---	---
Calcium	mg/l	4/5/2010 - 10/5/2010	3	0	3	21.3	24.5	22.8	---	1.609	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/5/2010 - 10/5/2010	3	0	3	1.226	2.692	1.806	---	0.7794	---	---	---	---
Chloride	mg/l	4/5/2010 - 10/5/2010	3	0	3	4.5	5.2	4.867	---	0.3512	---	---	---	---
DO Concentration	mg/l	4/5/2010 - 10/5/2010	6	0	6	7.64	10.01	8.842	---	1.052	---	---	---	---
DO Saturation	%	4/5/2010 - 10/5/2010	6	0	6	82.5	93.3	87.9	---	4.786	---	---	---	---
DOC	mg/l	4/5/2010 - 10/5/2010	3	0	3	5.1	9.4	6.6	---	2.427	---	---	---	---
Magnesium	mg/l	4/5/2010 - 10/5/2010	3	0	3	6.31	7.39	6.677	---	0.6178	---	---	---	---
Nitrates_Nitrites	µg/l	4/5/2010 - 10/5/2010	3	0	3	50.49	160.5	119.1	---	59.82	---	---	---	---
Nitrogen	µg/l	4/5/2010 - 10/5/2010	3	0	3	464	605.2	519.1	---	75.49	---	---	---	---
pH	None	4/5/2010 - 10/5/2010	6	0	6	7.39	7.93	7.747	---	0.2143	---	---	---	---
converted pH	None					7.39	7.93	7.699	---	0.0114	---	---	---	---
H+ computed from pH	µeq/l					0.0117	0.0407	0.02	---	0.0114	---	---	---	---
Phosphorus	µg/l	4/5/2010 - 10/5/2010	3	0	3	25.58	44.4	33.95	---	9.581	---	---	---	---
Potassium	mg/l	4/5/2010 - 10/5/2010	3	0	3	0.54	1	0.7467	---	0.2335	---	---	---	---
Silicate	mg/l	4/5/2010 - 10/5/2010	3	0	3	13	18	15	---	2.646	---	---	---	---
Sodium	mg/l	4/5/2010 - 10/5/2010	3	0	3	2.9	3.66	3.38	---	0.4176	---	---	---	---
Specific Conductivity	µS/cm	4/5/2010 - 10/5/2010	6	0	6	154.4	181.4	169	---	12.13	---	---	---	---
Sulfate	mg/l	4/5/2010 - 10/5/2010	3	0	3	4.14	5.19	4.687	---	0.5263	---	---	---	---
Temperature	°C	4/5/2010 - 10/5/2010	6	0	6	8.58	23.47	14.16	---	7.249	---	---	---	---
Total Ammonia Nitrogen	µg/l	4/5/2010 - 10/5/2010	3	2	3	2	21.24	9.579	---	10.25	---	---	---	---
Total Suspended Solids	mg/l	4/5/2010 - 10/5/2010	3	0	3	3	8	5	---	2.646	---	---	---	---
Transparency Tube	cm	4/5/2010 - 10/5/2010	3	1	3	106	132	117.8	---	13.17	---	---	---	---
Water Level	m	4/5/2010 - 10/5/2010	3	0	3	-5.43	-4.939	-5.216333	---	0.2516	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_02

Station Name: St. Croix River Just Upstream from Norway Point Boat Landing

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/5/2010 - 10/5/2010	3	0	3	50	66	59	---	8.185	---	---	---	---
Calcium	mg/l	4/5/2010 - 10/5/2010	3	0	3	13.8	17.6	16.17	---	2.065	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/5/2010 - 10/5/2010	3	0	3	4.2	4.42	4.29	---	0.1153	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_02

Station Name: St. Croix River Just Upstream from Norway Point Boat Landing

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Chloride	mg/l	4/5/2010 - 10/5/2010	3	0	3	2.9	3.2	3.1	---	0.1732	---	---	---	---
DO Concentration	mg/l	4/5/2010 - 10/5/2010	10	0	10	6.64	9.53	8.36	8.78	1.224	6.641	6.65	9.492	9.527
DO Saturation	%	4/5/2010 - 10/5/2010	10	0	10	82.2	89.5	85.21	84.9	3.042	82.21	82.3	89.2	89.47
DOC	mg/l	4/5/2010 - 10/5/2010	3	0	3	9.8	18	13.6	---	4.133	---	---	---	---
Magnesium	mg/l	4/5/2010 - 10/5/2010	3	0	3	4.37	5.55	5.15	---	0.6756	---	---	---	---
Nitrates_Nitrites	µg/l	4/5/2010 - 10/5/2010	3	0	3	40.58	69.97	53.08	---	15.18	---	---	---	---
Nitrogen	µg/l	4/5/2010 - 10/5/2010	3	0	3	528.5	950.8	755.2	---	212.8	---	---	---	---
pH	None	4/5/2010 - 10/5/2010	10	0	10	7.43	7.84	7.625	7.57	0.1447	7.44	7.53	7.808	7.839
converted pH	None					7.43	7.84	7.606	7.57	0.0075	7.439	7.53	5.123	5.128
H+ computed from pH	µeq/l					0.0145	0.0372	0.0248	0.0269	0.0075	0.0145	0.0156	0.0295	0.0364
Phosphorus	µg/l	4/5/2010 - 10/5/2010	3	0	3	38.1	51.32	42.57	---	7.581	---	---	---	---
Potassium	mg/l	4/5/2010 - 10/5/2010	3	0	3	0.5	0.9	0.6433	---	0.2228	---	---	---	---
Silicate	mg/l	4/5/2010 - 10/5/2010	3	0	3	9.9	10	9.967	---	0.0577	---	---	---	---
Sodium	mg/l	4/5/2010 - 10/5/2010	3	0	3	1.7	2.79	2.323	---	0.5616	---	---	---	---
Specific Conductivity	µS/cm	4/5/2010 - 10/5/2010	10	0	10	111.9	126.2	120.9	123.6	5.875	112	112.8	125.4	126.1
Sulfate	mg/l	4/5/2010 - 10/5/2010	3	0	3	3	4	3.35	---	0.5635	---	---	---	---
Temperature	°C	4/5/2010 - 10/5/2010	10	0	10	11.2	26.3	15.86	11.53	7.2	11.2	11.21	26.29	26.3
Total Ammonia Nitrogen	µg/l	4/5/2010 - 10/5/2010	3	2	3	2	44.68	16.23	---	24.64	---	---	---	---
Total Suspended Solids	mg/l	4/5/2010 - 10/5/2010	3	0	3	5	7	5.667	---	1.155	---	---	---	---
Transparency Tube	cm	4/5/2010 - 10/5/2010	3	0	3	48.3	108.7	78.12	---	30.21	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_04

Station Name: St. Croix River About 1 Mile Above Nevers Dam Boat Landing

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/5/2010 - 10/5/2010	3	0	3	63	78	69	---	7.937	---	---	---	---
Calcium	mg/l	4/5/2010 - 10/5/2010	3	0	3	14.1	20.3	17.5	---	3.143	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/5/2010 - 10/5/2010	3	0	3	1.07	5.98	3.48	---	2.456	---	---	---	---
Chloride	mg/l	4/5/2010 - 10/5/2010	3	0	3	3.9	4.2	4.1	---	0.1732	---	---	---	---
DO Concentration	mg/l	4/5/2010 - 10/5/2010	7	0	7	6.88	9.64	8.774	---	1.293	---	---	---	---
DO Saturation	%	4/5/2010 - 10/5/2010	7	0	7	90.1	92.7	90.97	---	1.153	---	---	---	---
DOC	mg/l	4/5/2010 - 10/5/2010	3	0	3	11	18	14.67	---	3.512	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_04

Station Name: St. Croix River About 1 Mile Above Nevers Dam Boat Landing

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Magnesium	mg/l	4/5/2010 - 10/5/2010	3	0	3	5.17	7	6.13	---	0.9183	---	---	---	---
Nitrates_Nitrites	µg/l	4/5/2010 - 10/5/2010	3	0	3	86.23	144.1	106.8	---	32.33	---	---	---	---
Nitrogen	µg/l	4/5/2010 - 10/5/2010	3	0	3	693.5	1012	869.2	---	161.8	---	---	---	---
pH	None	4/5/2010 - 10/5/2010	7	0	7	7.58	7.81	7.693	---	0.0941	---	---	---	---
converted pH	None					7.58	7.81	7.684	---	0.0045	---	---	---	---
H+ computed from pH	µeq/l					0.0155	0.0263	0.0207	---	0.0045	---	---	---	---
Phosphorus	µg/l	4/5/2010 - 10/5/2010	3	0	3	48.28	67.84	57.04	---	9.937	---	---	---	---
Potassium	mg/l	4/5/2010 - 10/5/2010	3	0	3	0.88	1.2	1.027	---	0.1617	---	---	---	---
Silicate	mg/l	4/5/2010 - 10/5/2010	3	0	3	9.8	10	9.933	---	0.1155	---	---	---	---
Sodium	mg/l	4/5/2010 - 10/5/2010	3	0	3	2.1	3.27	2.83	---	0.6366	---	---	---	---
Specific Conductivity	µS/cm	4/5/2010 - 10/5/2010	7	0	7	126.3	150	137.9	---	9.563	---	---	---	---
Sulfate	mg/l	4/5/2010 - 10/5/2010	3	0	3	2.7	3.68	3.26	---	0.5048	---	---	---	---
Temperature	°C	4/5/2010 - 10/5/2010	7	0	7	12.41	27.8	16.85	---	7.475	---	---	---	---
Total Ammonia Nitrogen	µg/l	4/5/2010 - 10/5/2010	3	2	3	2	124.7	42.9	---	70.83	---	---	---	---
Total Suspended Solids	mg/l	4/5/2010 - 10/5/2010	3	0	3	5	9	6.667	---	2.082	---	---	---	---
Transparency Tube	cm	4/5/2010 - 10/5/2010	3	0	3	65	114.7	84.53	---	26.5	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_07

Station Name: Pool #1 of Lake St. Croix near Bayport, MN

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO ₃	4/7/2010 - 10/6/2010	3	0	3	70	118	86	---	27.71	---	---	---	---
Bottom Phosphorus	µg/l	7/8/2010 - 7/8/2010	1	0	1	66.9	66.9	66.9	---	---	---	---	---	---
Calcium	mg/l	4/7/2010 - 10/6/2010	3	0	3	18.3	24.9	21.07	---	3.427	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/7/2010 - 10/6/2010	3	0	3	6.3	15.88	10.28	---	4.99	---	---	---	---
Chloride	mg/l	4/7/2010 - 10/6/2010	3	0	3	5.2	5.9	5.5	---	0.3606	---	---	---	---
DO Concentration	mg/l	4/7/2010 - 10/6/2010	38	0	38	3.93	9.57	7.917	8.265	1.619	5.092	7.315	9.38	9.491
DO Saturation	%	4/7/2010 - 10/6/2010	38	0	38	47.3	96.7	80.8	83.7	10.71	63.43	76.82	88.2	89.53
DOC	mg/l	4/7/2010 - 10/6/2010	3	0	3	10	17	14.33	---	3.786	---	---	---	---
Magnesium	mg/l	4/7/2010 - 10/6/2010	3	0	3	6.6	8.94	7.54	---	1.236	---	---	---	---
Nitrates_Nitrites	µg/l	4/7/2010 - 10/6/2010	3	0	3	117.9	244.4	191.4	---	65.7	---	---	---	---
Nitrogen	µg/l	4/7/2010 - 10/6/2010	3	0	3	774.8	1199	1024	---	221.6	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_07

Station Name: Pool #1 of Lake St. Croix near Bayport, MN

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
pH	None	4/7/2010 - 10/6/2010	38	0	38	7.28	7.79	7.506	7.505	0.1093	7.359	7.438	7.58	7.612
converted pH	None					7.28	7.79	7.493	7.504	0.0077	7.359	7.438	5.129	5.133
H+ computed from pH	µeq/l					0.0162	0.0525	0.0321	0.0313	0.0077	0.0245	0.0263	0.0365	0.0438
Phosphorus	µg/l	4/7/2010 - 10/6/2010	3	0	3	46.28	69.02	56.22	---	11.64	---	---	---	---
Potassium	mg/l	4/7/2010 - 10/6/2010	3	0	3	1.13	1.5	1.277	---	0.1966	---	---	---	---
Silicate	mg/l	4/7/2010 - 10/6/2010	3	0	3	8.3	11	10.1	---	1.559	---	---	---	---
Sodium	mg/l	4/7/2010 - 10/6/2010	3	0	3	2.7	3.8	3.38	---	0.5943	---	---	---	---
Specific Conductivity	µS/cm	4/7/2010 - 10/6/2010	38	0	38	141.3	192.3	165.3	160.2	13.64	155.1	157	174	189.3
Sulfate	mg/l	4/7/2010 - 10/6/2010	3	0	3	3.5	4.93	4.187	---	0.7167	---	---	---	---
Temperature	°C	4/7/2010 - 10/6/2010	38	0	38	8.35	27.11	16.31	13.65	6.3	10.66	11.38	24.29	26.29
Total Ammonia Nitrogen	µg/l	4/7/2010 - 10/6/2010	3	1	3	5.5	17.37	12.13	---	6.056	---	---	---	---
Total Phosphorus VANDORN_SCRS	µg/l	7/8/2010 - 7/8/2010	1	0	1	66.9	66.9	66.9	---	---	---	---	---	---
Total Suspended Solids	mg/l	4/7/2010 - 10/6/2010	3	0	3	3	5	3.667	---	1.155	---	---	---	---
Transparency Tube	cm	4/7/2010 - 10/6/2010	3	0	3	50.4	96.75	74.73	---	23.26	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_09

Station Name: Pool #2 on Lake St. Croix Downstream of I94 Bridge in Hudson

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO3	4/7/2010 - 10/6/2010	3	0	3	60	108	82.67	---	24.11	---	---	---	---
Calcium	mg/l	4/7/2010 - 10/6/2010	3	0	3	16.7	24.1	20.83	---	3.775	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/7/2010 - 10/6/2010	3	0	3	4.06	17.03	9.877	---	6.588	---	---	---	---
Chloride	mg/l	4/7/2010 - 10/6/2010	3	0	3	5.4	6	5.767	---	0.3215	---	---	---	---
DO Concentration	mg/l	4/7/2010 - 10/6/2010	33	0	33	3.98	10.54	8.14	7.46	2.087	5.236	6.695	10.36	10.5
DO Saturation	%	4/7/2010 - 10/6/2010	33	0	33	46.8	113	80.52	76.3	14.02	63.38	72.85	90.75	95.86
DOC	mg/l	4/7/2010 - 10/6/2010	3	0	3	10	16	13.33	---	3.055	---	---	---	---
Magnesium	mg/l	4/7/2010 - 10/6/2010	3	0	3	6.54	9.03	7.833	---	1.248	---	---	---	---
Nitrates_Nitrites	µg/l	4/7/2010 - 10/6/2010	3	0	3	91.54	396.6	274	---	161.1	---	---	---	---
Nitrogen	µg/l	4/7/2010 - 10/6/2010	3	0	3	929.3	1241	1137	---	179.5	---	---	---	---

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_09

Station Name: Pool #2 on Lake St. Croix Downstream of I94 Bridge in Hudson

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
pH	None	4/7/2010 - 10/6/2010	33	0	33	7.31	8.25	7.526	7.52	0.2047	7.31	7.42	7.575	7.632
converted pH	None					7.31	8.25	7.491	7.52	0.0108	7.31	7.42	5.13	5.136
H+ computed from pH	µeq/l					0.0056	0.049	0.0323	0.0302	0.0108	0.0233	0.0266	0.038	0.049
Phosphorus	µg/l	4/7/2010 - 10/6/2010	3	0	3	50.33	71.09	61.61	---	10.5	---	---	---	---
Potassium	mg/l	4/7/2010 - 10/6/2010	3	0	3	1.13	1.7	1.377	---	0.2926	---	---	---	---
Silicate	mg/l	4/7/2010 - 10/6/2010	3	0	3	8.4	11	10.13	---	1.501	---	---	---	---
Sodium	mg/l	4/7/2010 - 10/6/2010	3	0	3	2.5	3.82	3.343	---	0.7324	---	---	---	---
Specific Conductivity	µS/cm	4/7/2010 - 10/6/2010	33	0	33	132.4	182.8	160.5	160.8	16.77	132.8	152.2	174.1	178.4
Sulfate	mg/l	4/7/2010 - 10/6/2010	3	0	3	3.79	4.85	4.24	---	0.5478	---	---	---	---
Temperature	°C	4/7/2010 - 10/6/2010	33	0	33	6.52	27.09	15.18	14.3	6.929	6.652	9.645	23.61	24.63
Total Ammonia Nitrogen	µg/l	4/7/2010 - 10/6/2010	3	1	3	5.5	20.93	14.19	---	7.895	---	---	---	---
Total Suspended Solids	mg/l	4/7/2010 - 10/6/2010	3	0	3	2	6	4	---	2	---	---	---	---
Transparency Tube	cm	4/7/2010 - 10/6/2010	3	0	3	51.5	112.2	82.25	---	30.36	---	---	---	---

Organization: St. Croix National Scenic Riverway

Station ID: SACN_11

Station Name: Pool #4 on Lake St. Croix near Prescott, WI

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Alkalinity	mg/l CaCO3	4/7/2010 - 10/6/2010	3	0	3	60	97	84.33	---	21.08	---	---	---	---
Bottom Phosphorus	µg/l	7/8/2010 - 7/8/2010	1	0	1	55.94	55.94	55.94	---	---	---	---	---	---
Calcium	mg/l	4/7/2010 - 10/6/2010	3	0	3	16.1	25.2	21.37	---	4.716	---	---	---	---
chl_a(fluor)_SCRS	µg/l	4/7/2010 - 10/6/2010	3	0	3	1.52	15.2	6.537	---	7.534	---	---	---	---
Chloride	mg/l	4/7/2010 - 10/6/2010	3	0	3	5.6	6.8	6.033	---	0.6658	---	---	---	---
DO Concentration	mg/l	4/7/2010 - 10/6/2010	46	0	46	4.89	10.76	8.092	6.8	2.097	5.912	6.325	10.54	10.68
DO Saturation	%	4/7/2010 - 10/6/2010	46	0	46	58	123.6	78.63	74.35	14.25	63.2	68.22	87.02	88.26
DOC	mg/l	4/7/2010 - 10/6/2010	3	0	3	10	15	13	---	2.646	---	---	---	---
Magnesium	mg/l	4/7/2010 - 10/6/2010	3	0	3	6.1	9.41	8.087	---	1.752	---	---	---	---
Nitrates_Nitrites	µg/l	4/7/2010 - 10/6/2010	3	0	3	290	658.3	496.8	---	188.3	---	---	---	---
Nitrogen	µg/l	4/7/2010 - 10/6/2010	3	0	3	1198	1414	1290	---	111.3	---	---	---	---
pH	None	4/7/2010 - 10/6/2010	46	0	46	7.08	8.42	7.439	7.485	0.2925	7.154	7.18	7.52	7.632
converted pH	None					7.08	8.42	7.367	7.485	0.0212	7.154	7.18	5.144	5.145
H+ computed from pH	µeq/l					0.0038	0.0832	0.043	0.0327	0.0212	0.0234	0.0302	0.0661	0.0702

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Organization: St. Croix National Scenic Riverway

Station ID: SACN_11

Station Name: Pool #4 on Lake St. Croix near Prescott, WI

Local Name	Units	Period of Record	Count	Cens.	Incl.	Min.	Max.	Mean	Median	Std Dev	10th per.	25th per.	75th per.	90th per.
Phosphorus	µg/l	4/7/2010 - 10/6/2010	3	0	3	49.05	61.75	56.49	---	6.625	---	---	---	---
Potassium	mg/l	4/7/2010 - 10/6/2010	3	0	3	1.2	1.6	1.467	---	0.2309	---	---	---	---
Silicate	mg/l	4/7/2010 - 10/6/2010	3	0	3	10	13	11	---	1.732	---	---	---	---
Sodium	mg/l	4/7/2010 - 10/6/2010	3	0	3	2.2	4.28	3.457	---	1.106	---	---	---	---
Specific Conductivity	µS/cm	4/7/2010 - 10/6/2010	46	0	46	141.5	204.6	175.5	182.4	27.28	141.7	142	202.9	204
Sulfate	mg/l	4/7/2010 - 10/6/2010	3	0	3	4.2	4.97	4.54	---	0.3928	---	---	---	---
Temperature	°C	4/7/2010 - 10/6/2010	46	0	46	5.81	27.35	14.35	15.92	7.456	5.83	5.86	17.81	24.82
Total Ammonia Nitrogen	µg/l	4/7/2010 - 10/6/2010	3	2	3	2	43.89	17.13	---	23.24	---	---	---	---
Total Phosphorus VANDORN_SCRS	µg/l	7/8/2010 - 7/8/2010	1	0	1	55.94	55.94	55.94	---	---	---	---	---	---
Total Suspended Solids	mg/l	4/7/2010 - 10/6/2010	3	0	3	2	4	2.667	---	1.155	---	---	---	---
Transparency Tube	cm	4/7/2010 - 10/6/2010	3	1	3	69	132	100.6	---	31.5	---	---	---	---

Reported Local Characteristics				
Local Name	STORET Name	Medium	Subject Taxon	Bio Part
Alkalinity	Alkalinity, Total (total hydroxide+carbonate+bicarbonate)	Water		
Calcium	Calcium	Water		
chl_a(fluor)_SCRS	Chlorophyll a, free of pheophytin	Water		
Chloride	Chloride	Water		
DOC	Carbon, organic	Water		
Magnesium	Magnesium	Water		
Potassium	Potassium	Water		
Silicate	Silicate	Water		
Sodium	Sodium	Water		
Sulfate	Sulfur, sulfate (SO4) as SO4	Water		
Total Phosphorus VANDORN_SCRS	Phosphorus	Water		
Total Suspended Solids	Solids, Total Suspended (TSS)	Water		
Transparency Tube	Transparency, tube with disk	Water		
Water Level	Water level in relation to reference point	Air		

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

Results filtered for:

Organization = SACN: St. Croix National Scenic Riverway

Station = Include All Station Visit Results

Activities with Characteristic = Alkalinity

or Bottom Phosphorus*

or Calcium

or chl_a(fluor)_SCRS

or Chl_a*

or Chloride

or Chloride_Filtered

or DO Concentration*

or DO Saturation*

or DOC

or Magnesium

or Nitrates_Nitrites*

or Nitrogen*

or pH*

or Phosphorus*

or Potassium

or Silicate

or Sodium

or Specific Conductivity*

or Sulfate

or Sulfate_Filtered

or Temperature*

or Total Ammonia Nitrogen*

or Total Phosphorus VANDORN_SCRS

or Total Suspended Solids

or Transparency Tube

or Water Level

Only display results that meet characteristic criteria

* Indicates Analytical Group Within Organization

** Indicates Analytical Group Across Organizations

Include Only Samples Not Checked as QC

Date (>=4/1/2010 and <=11/30/2010)

Censored Data Substitutions: *Non-detect=0.5* DetectionLimit, *Present >QL=1.1 * UpperQuantificationLimit, *Present <QL=0.5 * LowerQuantificationLimit

Missing Statistic Codes:

Appendix B. Descriptive statistics for monitoring sites in the St. Croix National Scenic Riverway, Wisconsin/Minnesota, as entered in NPStoret (continued).



NPSTORET Descriptive Statistics - Period of Record



Filtered Results, Grouped by Organization, Station

- Computation requires 9 observations
- ... Computation requires more than 1 observation

Appendix C. Mean values (N=3) of field and laboratory variables measured at six mainstem sites on the St. Croix River in April, July, and October for 2007-2010

Appendix C. Mean values (N=3) of field and laboratory variables measured at six mainstem sites on the St. Croix River in April, July, and October for 2007-2010. Near-surface values were used for pH, specific conductance, DO, and temperature. Dash (-) = not measured, calculated, or available. * = includes censored data. ** = Mean values are not shown due to a high number of censored values.

Variable	SACN01				SACN02				SACN04			
	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
Temperature (°C)	14.0	11.1	11.5	14.2	13.2	11.4	12.1	15.9	13.5	12.2	11.5	16.9
DO (mg/L)	8.9	10.9	10.3	8.8	9.3	9.5	9.5	8.4	8.5	10.2	10.0	8.8
pH (std. units)	7.4	7.7	7.8	7.7	7.4	7.3	7.6	7.6	7.4	7.5	7.8	7.7
SC25 (µS/cm)	148.7	157.3	174	169	120.3	114.6	138.7	120.9	132.0	128.1	151.6	137.9
TSS (mg/L)	8.3	8.0	5.0	5.0	7.7	10.0	4.3	5.7	11.7	13.3	5.3	6.7
T-Tube (cm)	**	**	**	117.8*	97.08*	77.6	**	78.12	83.7	63.8	108.6*	84.5
Secchi (m)	-	-	-	-	-	-	-	-	-	-	-	-
TP (µg/L)	37.7	25.3	23.4	34.0	44.7	38.0	31.1	42.6	70.0	51.3	39.1	57.0
Chl a (ug/L)	-	4.4	1.4	1.8	-	4.2	3.3	4.3	-	4.2	3.9	3.5
TN (µg/L)	682	458.3	328.6	519.1	860	693.7	518.5	755.2	1027	832.3	608.2	869.2
NO ₃ +NO ₂ -N (µg/L)	148.0	166.3	115.3	119.1	157.3	146.3	52.2	53.1	169.0	190.3	75.7	106.8
NH ₄ -N (µg/L)	20.7	26.7	**	**	44.3	32.3	**	**	59.3	42.3	**	**
DOC (mg/L)	9.9	5.2	3.9	6.6	11.8	10.9	8.2	13.6	12.5	12.1	9.5	14.7
Alkalinity (mg/L)	64.3	70.3	76.3	78.3	53.7	51.0	58.3	59.0	54.3	55.0	66.0	69.0
Cl ⁻ (mg/L)	4.1	4.7	4.7	4.9	3.3	3.4	3.5	3.1	4.8	4.4	4.9	4.1
SO ₄ ⁻² (mg/L)	5.2	4.8	5.2	4.7	5.5	4.3	4.2	3.4	6.4	4.4	4.4	3.3
Ca ⁺² (mg/L)	19.6	20.8	24.1	22.8	15.0	15.4	18.7	16.2	16.8	16.4	19.6	17.5
Mg ⁺² (mg/L)	6.0	6.4	7.1	6.7	5.2	5.3	5.8	5.15	6.0	5.9	6.9	6.1
K ⁺ (mg/L)	0.9	0.8	0.7	0.7	1.1	0.8	0.7	0.6	1.8	1.2	1.1	1.0
Na ⁺² (mg/L)	3.2	3.5	3.6	3.38	2.7	2.8	2.9	2.3	3.5	3.2	3.6	2.8
SiO ₂ (mg/L)	10.5	10.3	12.7	15.0	7.6	8.7	9.1	10.0	7.6	8.3	7.5	9.9

Appendix C. Mean values (N=3) of field and laboratory variables measured at six mainstem sites on the St. Croix River in April, July, and October for 2007-2010. Near-surface values were used for pH, specific conductance, DO, and temperature. Dash (-) = not measured, calculated, or available. * = includes censored data. ** = Mean values are not shown due to a high number of censored values (continued).

Variable	SACN07				SACN09				SACN11			
	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
Temperature (°C)	14.3	14.7	15.0	17.9	14.8	14.5	14.8	17.5	15.5	15.1	14.5	16.4
DO (mg/L)	9.6	9.4	10.4	8.6	9.7	8.5	9.4	8.9	9.3	8.0	8.9	9.1
pH (std. units)	7.6	7.6	7.9	7.6	7.7	7.6	7.9	7.8	7.9	7.6	7.7	7.7
SC25 (µS/cm)	176.9	171.9	194	168.5	185.8	179.4	198	170.9	206	194.1	190.7	175.4
TSS (mg/L)	4.7	3.0	3.3	3.7	5.3	3.3	2.3	4.0	4.0	2.3	1.8	2.7
T-Tube (cm)	74.3	65.9*	104.9*	74.7	-	99.8*	108.4*	82.3	-	**	**	100.6*
Secchi (m)	1.0	1.5	1.7	1.3	1.2	1.7	1.6	-	-	2.0	1.7	-
TP (µg/L)	58.0	45.0	38.8	56.2	51.0	51.7	42.7	61.6	55.0	75.3	60.2	56.5
Chl a (ug/L)	-	6.4	8.5	10.3	-	5.7	5.8	9.9	-	4.2	6.2	6.5
TN (µg/L)	1039	941	755.6	1024	1016	1067	876.2	1137	1093	1107	1005.2	1290
NO ₃ +NO ₂ -N (µg/L)	277.0	284.3	233.4	191.4	277.3	436.7	258.4	274.0	456.7	571.7	358.2	496.8
NH ₄ -N (µg/L)	93.0	110.0	**	12.1*	58.0	111.0	55.3*	14.2*	66.7	66.6	67.6*	**
DOC (mg/L)	10.7	10.9	7.1	14.3	9.4	10.2	8.6	13.3	7.7	10.9	9.4	13.0
Alkalinity (mg/L)	72.0	74.0	80.0	86.0	79.7	77.3	83.0	82.7	88.1	82.7	80.0	84.3
Cl ⁻ (mg/L)	6.6	6.5	6.7	5.5	7.0	7.3	7.3	5.8	7.0	7.5	7.1	6.0
SO ₄ ⁻² (mg/L)	6.1	5.2	5.1	4.2	6.3	5.4	5.5	4.2	6.4	5.8	5.8	4.5
Ca ⁺² (mg/L)	21.0	20.9	23.9	21.1	22.3	22.4	23.0	20.8	24.12	23.3	22.6	21.4
Mg ⁺² (mg/L)	7.9	8.0	9.2	7.5	8.7	8.7	9.3	7.8	9.9	8.7	9.0	8.1
K ⁺ (mg/L)	3.8	1.4	1.4	1.3	1.8	1.5	1.4	1.4	1.8	1.4	1.4	1.5
Na ⁺² (mg/L)	4.2	4.2	4.4	3.4	4.3	4.3	4.3	3.3	4.7	4.3	4.1	3.5
SiO ₂ (mg/L)	8.7	7.9	8.1	10.1	8.2	7.6	8.0	10.1	7.5	8.1	7.3	11.0

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 920/107605, May 2011

National Park Service
U.S. Department of the Interior



Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov