EVALUATION OF THE BAD RIVER WETLANDS, RIVERS, AND STREAMS 2011

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September 2012

PUB SS-1096 2012

Introduction

This report summarizes the diatom community of wetlands, rivers, and streams (hereafter referred to as wetlands and streams) on the Bad River Indian Reservation that were sampled in 2011. The evaluation was performed using the alga in the group diatoms. Diatoms are a type of algae that possess siliceous cell walls and are usually abundant, diverse, and well preserved in sediments. They are especially useful because they are ecologically diverse and their ecological optima and tolerances can be quantified. Diatoms are strongly affected by the chemical composition of their surroundings. Certain taxa are usually found under nutrient poor conditions while others are more common under elevated nutrient levels.

Methods

Samples were received from the Bad River Natural Resources Department. Wetland samples consisted of the top 0.5 cm of sediment collected from the 12 wetlands in 2011 on the Bad River Indian Reservation (Figure 1). This material should contain an integrated sample of the diatoms that have recently accumulated in these wetlands. The rivers and streams samples were collected from 8 sites.

For all of the samples, a small amount of material was placed in a labeled test tube and 1N nitric acid was added. The samples were boiled for at least 1 hour. The sample digestion was finished by adding a small amount of 30% H_2O_2. After the sample has digested, the sample is washed 4 times with deionized water.

After the final washing deionized water is added. Number 1 coverslips, which have been stored in 70% EtOH are placed on a drying table and the diatom/sediment mixture is added to the coverslips. The table is marked into a numbered grid and the identity of each coverslip is recorded in a logbook. After the sample has dried, the coverslip is fixed to a microscope slide with Naphrax. The identity of each sample is etched onto the slide with a diamond tipped scribe. Paper labels are also affixed to the slides. For each sample at least 500 valves are enumerated. Sample counts were recorded in a computer counting program

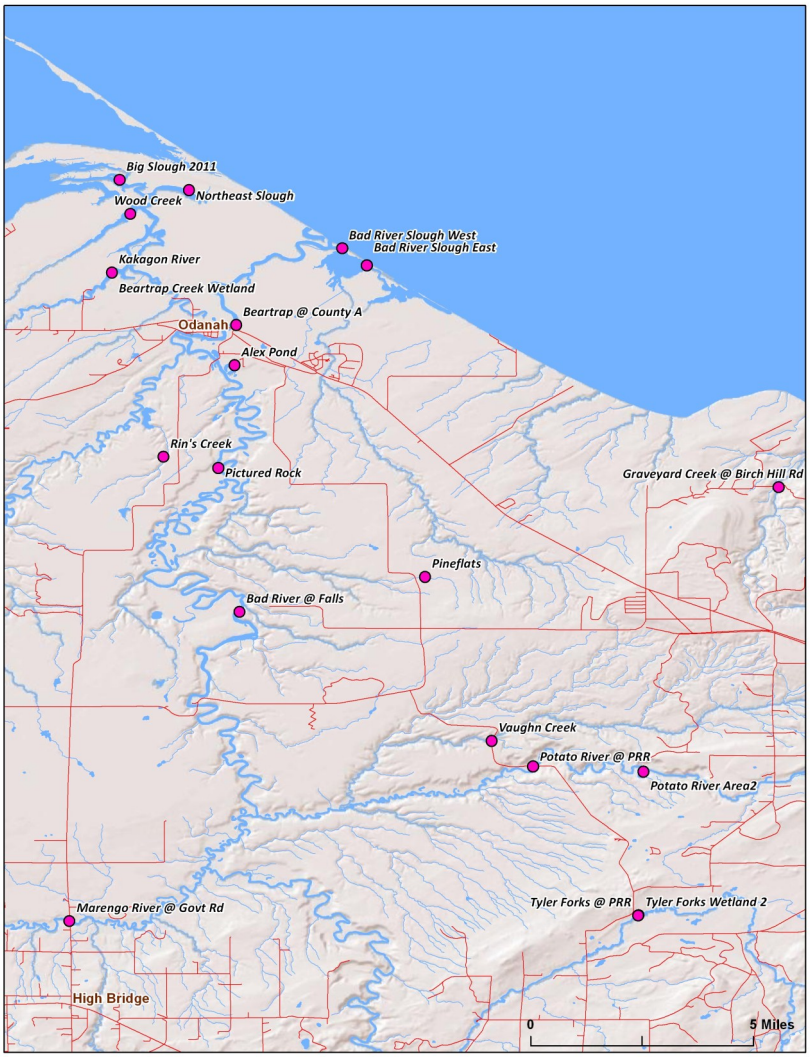

Figure 1. 2011 wetland and stream sites on the Bad River Indian Reservation.

and this information was transferred to an Excel spreadsheet. Internationally recognized taxonomic keys were utilized for identification. These keys include Patrick & Reimer (1966, 1975), Camburn et al. (1984-86), Krammer & Lange-Bertalot (1986, 1988, 1991a,b), Krammer (1997a, b), and Krammer (2000) Camburn and Charles (2000), Lange-Bertalot (2001), Siver et al. (2005), and Lange-Bertalot (2011). All samples are archived at the DNR Science Operations Center in Madison, WI.

Results

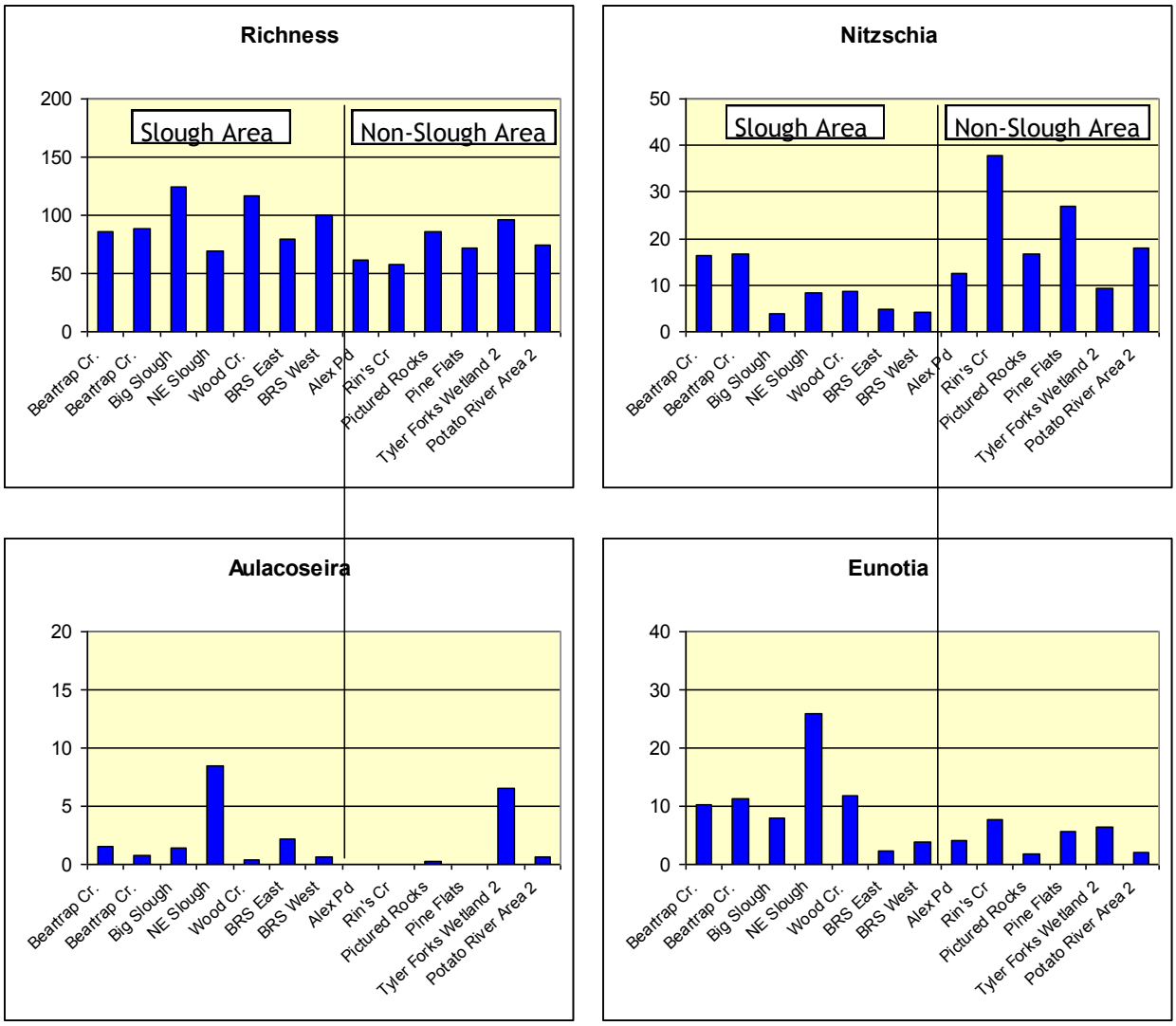

Figure 2. Summary indices from the 2011 sites. Sites are grouped into sites in the Kakagon Slough area and non-slough sites.

Wetland Sites

Most of the sites had a relatively high number of species. The highest taxa richness was found at the Big Slough site with the Wood Creek site having only slightly lower number of taxa. The richness was over 100 taxa which is a large number of taxa and represents a diverse community (Figure 2). In the past the Bad River Slough-West site has had high taxa richness and this is true in 2011. The sites with the lowest richness were Alex Pond and Rin's Creek sites.

The highest amount of *Nitzschia*, which generally indicates higher nutrient levels (van Dam et al. 1994), occurred at the Rin's Creek site. The Pine Flats site, also had higher amounts of this diatom group. In 2006, the Beartrap Creek site had the greatest *Nitzschia* abundance. The abundance in 2011 was similar as in 2006 but the first two sites, which were not sampled in 2006, had more *Nitzschia*.

The abundance of the genera *Aulacoseira* was much lower than in 2006. This may reflect a change in the type of sites that had been sampled in the past. This genera is most common in lacustrine type environments and these were not sampled in 2011 (Figure 2) . The three sites that were sampled in 2006 and 2011 had similar amounts of *Aulacoseira* in both years.

The trophic ranking of van Dam et al. (1994) was used to develop a Diatom Trophic Index (DTI) for these wetland samples. This index has a range from 1 to 6 with the lower value indicating oligotrophic conditions. Figure 3 shows the ranking of each site. The sites with the lowest ranking were Rin's Creek and Pine Flats with values of 2.13 and 2.15 respectively. These sites would be classified as oligo-mesotrophic. Most of the sites would also be classified in this category. The sites that had higher nutrients which placed them in the mesotrophic category were Bad River Slough-West, Alex Pond, Pictured Rocks, and Bad River Slough-East. Bad River Slough-West had the highest value at 3.13.

Most of the sites sampled in 2011 had not been sampled previously. The exceptions were Bad River Slough-West, Wood Creek, Beartrap Creek, and Pine Flats. The first two sites have been sampled every year (2002, 2003, 2004, 2005, 2006, 2011) while Beartrap Creek has been sampled 4 times and Pine Flats 2 times. Sites Bad River Slough-West and Wood Creek show little change through the years with the first site always being in the mesotrophic range while the second site is close to the oligo-mesotrophic to mesotrophic line (Figure 4). Beartrap Creek was sampled less frequently and this site shows a general improving trend in trophic status. Pine Flats was only sampled twice and its condition was somewhat worse in 2011 compared with 2004.

In summary, the water quality of the wetlands continues to be better than average. All of the sites are classified as oligo-mesotrophic or mesotrophic. All of the sites had relatively high taxa richness which is further indication of their good water quality. The sites with the

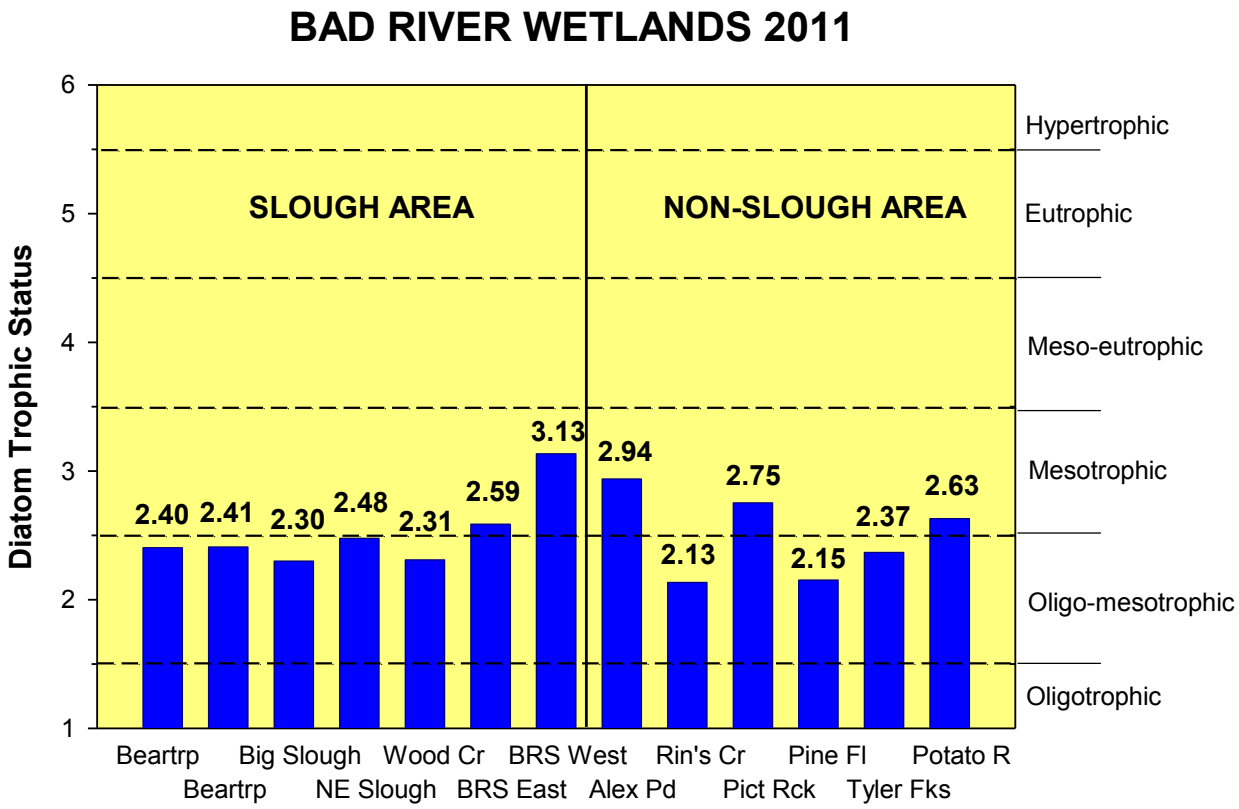

Figure 3. Diatom Trophic Index for the 12 wetland sites in 2011. Lower numbers indicate better water quality.

best trophic status were Rin's Creek and Pine Flats while the worst were Bad River Slough-West and Alex Pond. The two sites that have been sampled every year that samples were collected do not show any trend over time. The Beartrap Creek site has been sampled 4 times and may be getting better. Pine Flats was worse in 2001 compared with 2004 but it continues to have some of the best water quality.

River and Stream Sites

The water quality of the streams was assessed with 3 diatom metrics. The Diatom Nutrient Index (DNI) assigns tolerance values to individual taxa. The values ranged from 1 to 6 with 1 being the lowest nutrients (oligotrophic) to 6 being hypereutrophic. Nutrient values for Wisconsin diatoms were generated largely from Van Dam et al. (1994) but values were also assigned based upon experience with the diatom community in Wisconsin. If no autecological data was known, the taxa were not assigned a value and were not included in the DNI calculation. Because the index is based upon relative abundance, rare species will have little ef-

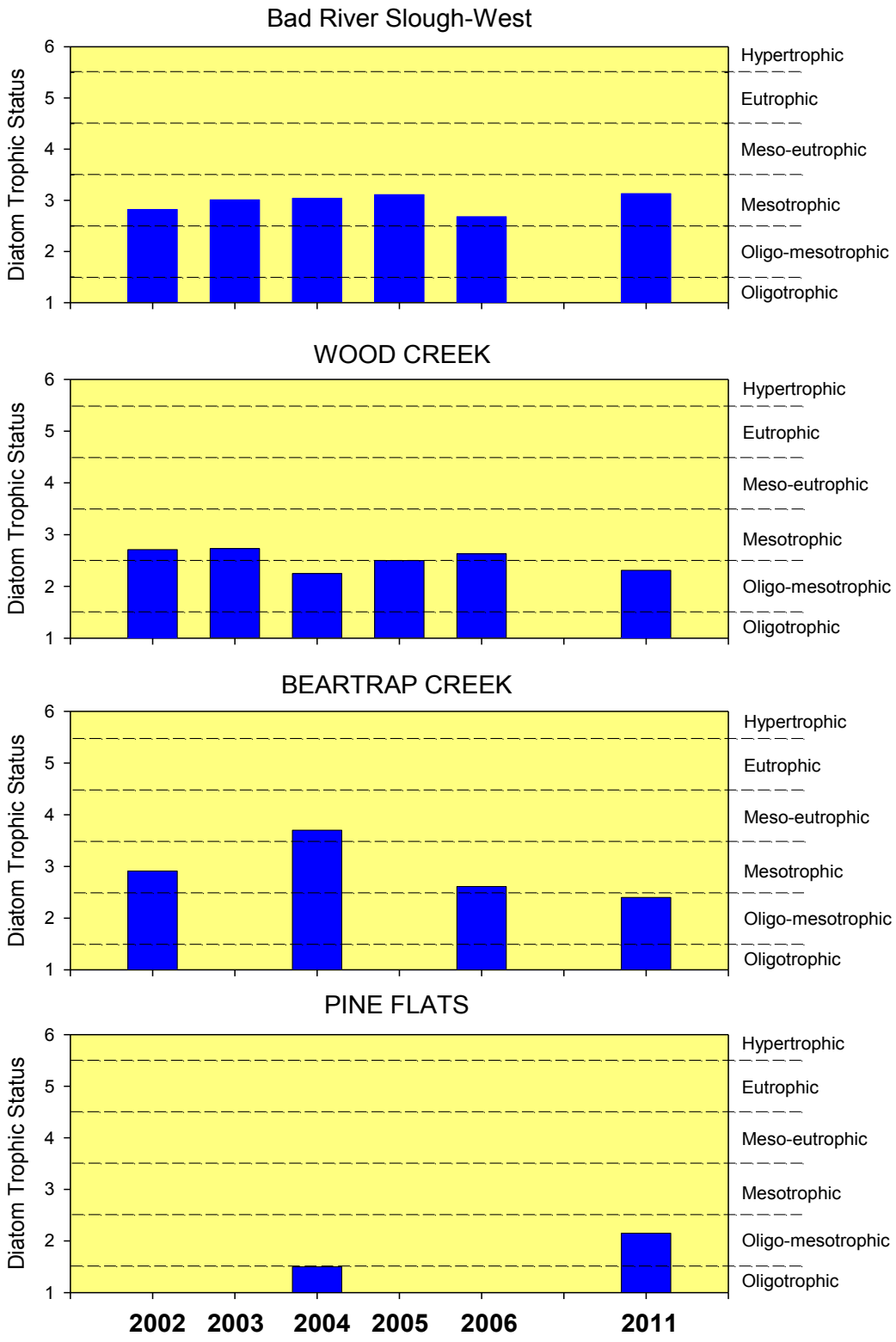

Figure 4. Diatom Trophic Index of 4 sites that have been sampled in multiple years. Lower numbers indicate better water quality. the two sites with the most complete record do not appear to be changing.

fect on the final index value. The index value for each of the diatom taxa is presented in Robertson et al. (2006). The formula used to calculate DNI is:

$$DNI = \frac{\sum n_i x t_i}{N}$$

where n_i = number of individuals in species i

t_i = nutrient value of species I

N = total number of individuals

The scale for this index ranges from 1 to 6 with lower values indicating lower nutrient concentrations.

The second metric is the Diatom Siltation Index (DSI). This index is the sum of all *Navicula* (including *Adlafia, Cavinula Chamaepinnularia, Craticula, Diadesmis, Fallacia, Fistulifera, Geissleria, Hippodonta, Kobarasiea, Luticola, Mayamaia, Placoneis*, and *Sellaphora*), *Nitzschia* (including *Psammodictyon* and *Tryblionella*), and *Surirella* taxa. This metric reflects the degree of siltation at a reach (Bahls 1993) because all of these taxa have good motility. The scale for the index is 0-100 with lower values indicating less silt and thus better water quality.

To assess stream biological integrity a multi-metric index called the Diatom Biotic Index (DBI) was created. The DBI was created using both diatom indices, DNI and DSI. For scoring the DBI, each metric is standardized to the 95th percentile of 38 reference streams in the Northern Lakes and Forest Ecoregion as part of a study reported in Robertson et al. (2006). The scale of the DBI is 0 to 100 with lower values indicating better biotic integrity. The DBI is intrinsically designed to be sensitive to nutrient enrichment and the impacts of sedimentation.

Results

The Diatom Nutrient Index for the stream sites is shown in Figure 5. All of the sites are classified as either mesotrophic or meso-eutrophic. The site with the lowest nutrients was Tyler Forks at PRR while the highest DNI was the duplicate sample from this same site. It is not clear why there is such a difference. Since we do not know what habitats were sampled,

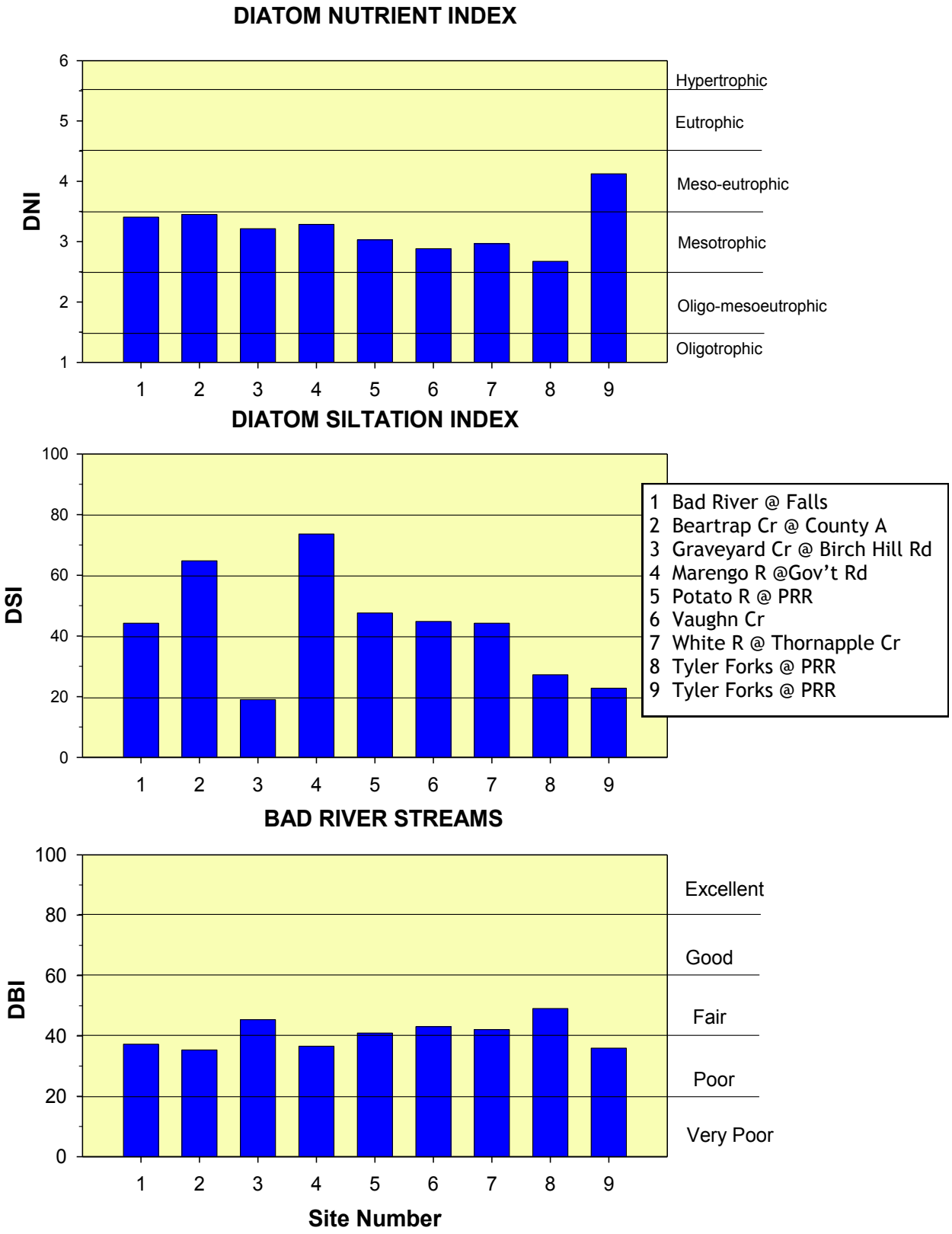

Figure 5. The nutrient levels in the streams are good but the high sediment loads depress the DBI.

perhaps different habitats were sampled for each sample. The diatom community in Tyler Forks duplicates was fairly similar but in the first sample, taxa that indicate low nutrients were more abundant while in the duplicate sample taxa that indicate higher nutrients were more common.

The Diatom Siltation Index (DSI) for the stream sites was generally high (Figure 5). This index is an indication of the amount of sediment in streams. Since the Bad River Reservation is in a high clay region of the state, it is not surprising that many of these streams have elevated DSI values. The streams with the lowest sediment are Graveyard at Birch Hill Road and both Tyler Forks samples. The sites with the most sediment are Marengo River at Government Road and Beartrap Creek at County A.

The Diatom Biotic Index (DBI) is a multimetric index that assesses the streams biotic integrity. This index integrates the stressors nutrients and sediment and thus provides an overall index of the streams' integrity. The DBI for all of the stream sites ranges was in the poor or lower fair range (Figure 5). The sites with the best DBI were Tyler Forks at PRR and Graveyard Creek at Birch Hill Road. The reason for the low DBI values is the relatively high sediment load in the streams.

A study of 240 wadable streams throughout Wisconsin was recently completed (Robertson et al. 2006). Among the streams sampled were 56 streams in the Northern Lakes and Forests (NLF) ecoregion. This is the same ecoregion that the Bad River streams are located. Figure 6 compares the diatom metrics calculated for this study with the 56 streams in the NLF ecoregion. The Diatom Nutrient Index in the Bad River sites was somewhat better compared with the values found in the NLF streams (median value for Bad River sites 3.2 and for NLF 3.7) (Figure 6). However, the Diatom Sediment Index in the Bad River sites was much worse (higher) than found in the NLF sites. The median value for the NLF sites was 12.5 while it was 44.2 for the Bad River sites. Again this reflects the high sediment load found in the part of the state where the Bad River streams are located. The Diatom Biotic Index in the NLF had a median of 48.5 while it was 41.0 for the Bad River sites (Figure 6).

One of the purposes of the statewide wadable stream study (Robertson et al. 2006) was to determine the phosphorus and nitrogen values at which the biotic integrity of streams is ad-

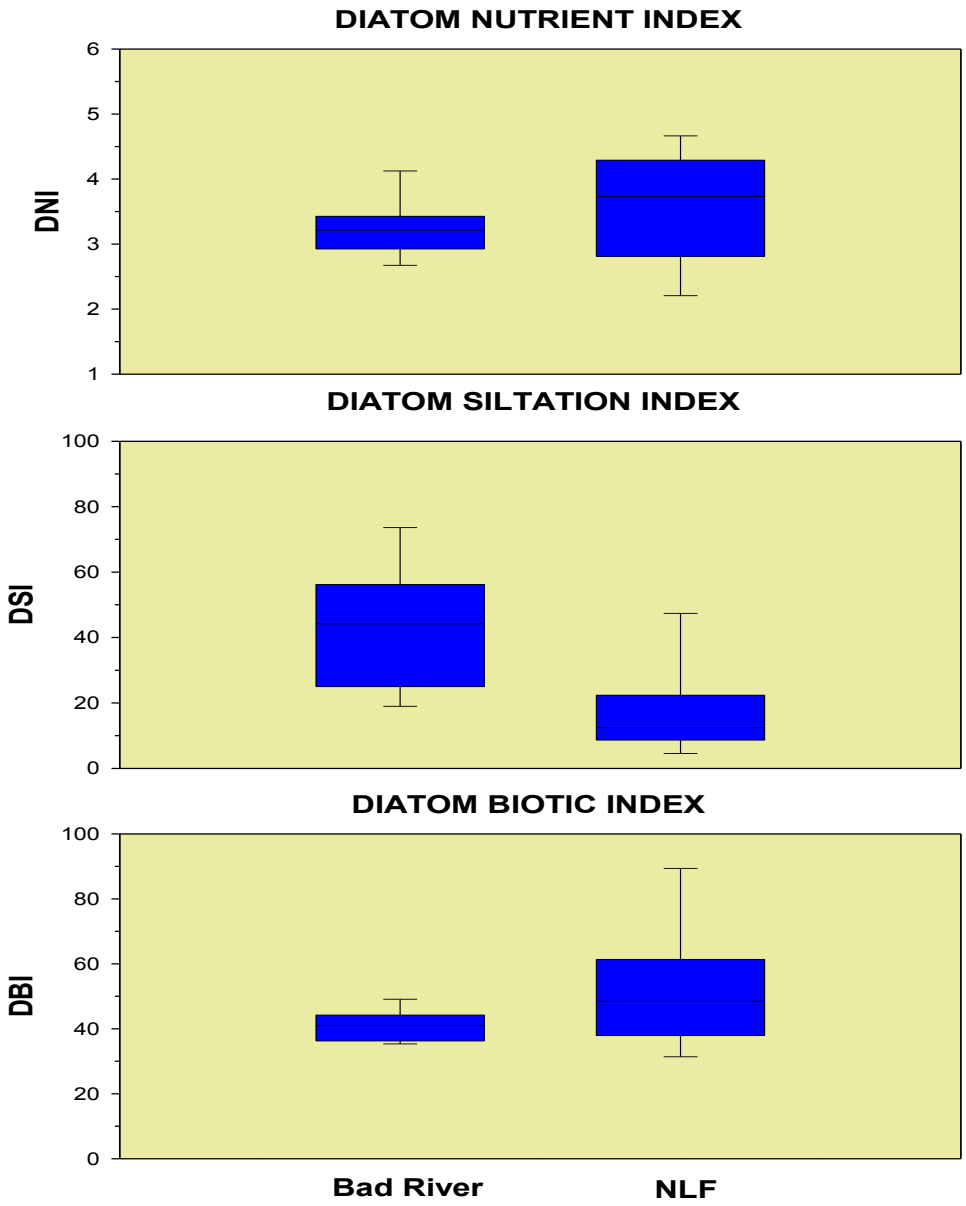

Figure 6. Comparison of diatom metrics of the Bad River streams with other sites in the Northern Lake and Forests Ecoregion. These box plots reflect the 25th, 75th, and median values for the sites. The DSI values for the Bad River sites are worse than the other sites in the region and this results in lower DBI scores.

versely affected. The value for phosphorus was 0.04-0.06 mg L^{-1} and 0.6 mg L^{-1} for nitrogen. This study also determined at what metric values the streams begin to become impaired. The values are DNI 4.1, DSI 22.5, and DBI 38.0. The Bad River sites are below the standard for the Diatom Nutrient Index but above it (impaired) for the Diatom Siltation Index and the Diatom Biotic Index.

With the exception of the Tyler Forks site, all of these sites were sampled in 2006. All the sites had lower nutrients in 2011 compared with 2006 while many also had lower sediment loads in 2011. Both Potato River at PRR and Vaughn Creek had substantially higher sediment values in 2011. With the exception of Potato River at PRR, the diatom biotic index was better in 2011 indicating that these streams are in better condition in 2011 compared with 2006.

Table 1. A comparison of metrics for the streams in 2006 and 2011. The streams are generally better in 2011 compared with 2006. Tyler Forks at PRR was the only stream not sampled in 2006.

	DNI		DSI		DBI	
	2006	2011	2006	2011	2006	2011
Bad River @ Falls	3.59	3.41	56.5	44.2	34.5	37.3
Beartrap @ County A	3.89	3.45	73.3	64.8	31.4	35.4
Graveyard @Birch Hill Rd	4.38	3.21	28.5	19.0	32.6	45.4
Marengo @ Govt Rd	4.09	3.29	78.0	73.6	29.8	36.6
Potato @ PRR	3.11	3.03	20.0	47.6	46.0	41.0
Vaughn @ PRR	3.80	2.88	36.0	44.8	34.9	43.1
White R @ Thornapple Cr	4.38	2.97	63.0	44.2	28.6	42.1

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