



Stream Ecological Integrity Protocol Highlights

Monitoring Diatoms Leads to 21 New Species in Glacier NP

Summary

Vital Signs monitoring in Glacier National Park includes a detailed characterization of the diatoms (algae) found at each site. Diatoms are a key part of streams and can tell scientists and park resource managers far more about stream condition than their small size would suggest. The Rocky Mountain Network and our partners recently found over 20 likely new to science species of diatoms in the park. This exciting result is indicative of the relatively pristine state of the park's waters and the important role the park plays as a reservoir of biodiversity.



Phil Matson from the Flathead Biological Station measures discharge and Billy Schweiger from the ROMN collects diatoms on a small tributary to Bowman Lake in 2007 (photo: Lindsey Johnson, FLBS)

What Are Diatoms?

Diatoms are single-celled, photosynthetic algae with cell walls made of silica dioxide (the primary component of glass). They are the base of the food chain and the primary producers in most aquatic ecosystems. Diatoms produce more oxygen through their photosynthetic activities than all the rainforests of the world combined.

There are over 60,000 species of diatoms described world-wide. Individual communities of diatoms are often composed of tens to hundreds of species. In Lake Superior, for example, single small rocks have been found

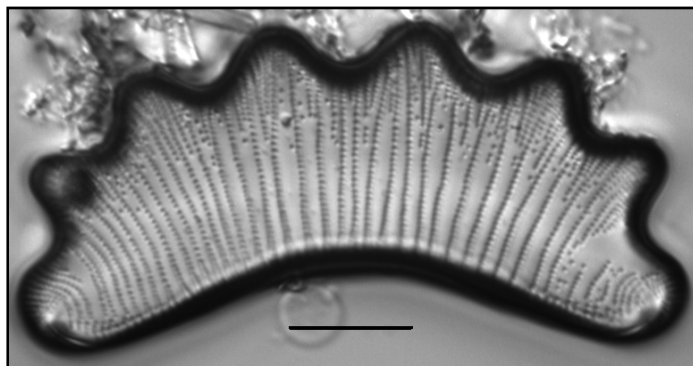


Image of a well known diatom (Eunotia diadema) found in northern Montana. The name "diadema" is from the Latin word meaning "crown". While not one of the new species we have found, this beautiful diatom may be a fitting 'diatom mascot' for the Crown of the Continent Ecosystem (photo and idea: Loren Bahls)

with over 400 different diatom species. As a group, diatoms are widely distributed. Species occur almost everywhere there is or has been water and across a wide range of environments. Some species of diatoms occur at the mouths of hot springs while other species are known to occur in sea-ice. There are species found in the most nutrient-dilute freshwaters and others that live at the outfalls of sewage treatment plants. The group occurs in systems over nearly 8 orders of magnitude of pH, with some species living in acid mine drainage and others living at about pH of 10 (where silica begins to dissolve!). And the group may be found across a wide salinity gradient, with some species found in inland hypersaline lakes, within the marine environment, estuaries and very dilute freshwaters.

What Do Diatoms Tell Us About Streams?

For over fifty years in the United States, diatoms have been applied to understanding the quality of freshwaters. While as a group diatoms are found across a wide spectrum of ecological conditions, individual species have more narrowly defined niches. Understanding the ecology of species and their individual tolerances and preferences allows us to better understand the conditions of aquatic ecosystems. This approach uses a wide range of diversity, species richness, and other community measures to

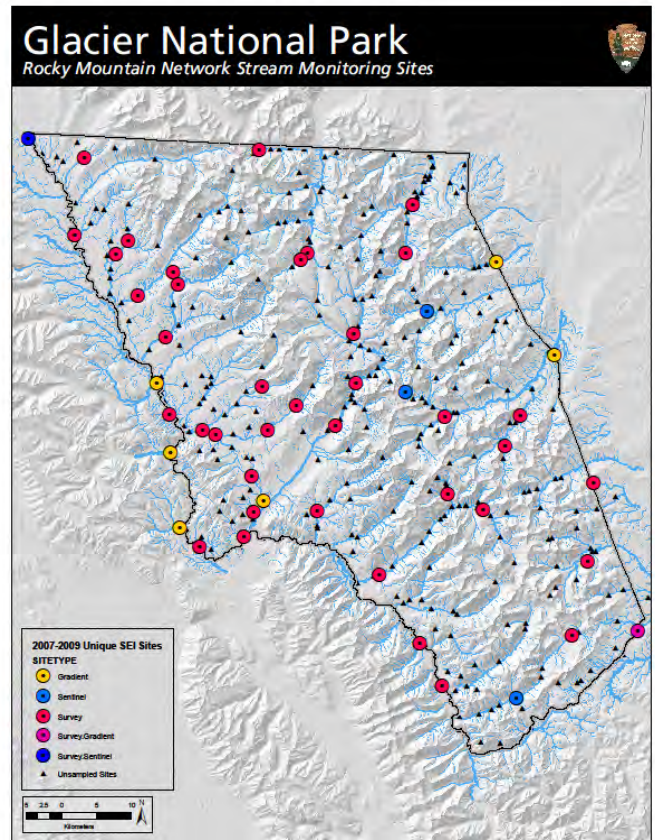
diagnose and understand water quality conditions. In addition, the numerous diatom species and large number of individuals—often numbering millions per square centimeter—lend statistical robustness to environmental analyses. These and other features make diatoms ideal biomonitors of aquatic systems.

Diatoms occupy the primary interface between the physical-chemical and the biological realms (i.e., converting carbon to sugars, taking up CO₂ and releasing O₂, cycling silica), and due to their short generation times, they react quickly to a wide range of changes in streams. Diatoms have been used to study changes in pH, temperature, salinity, nitrogen, phosphorus, and metals, whether those inputs have been from the atmosphere, terrestrial ecosystems or directly into aquatic systems. Because some diatoms are motile and others are not, the relative abundance of the two groups can be used to assess the impact of sediment on stream bottoms. Motile diatoms are capable of maintaining their position on loose sediments, where non-motile diatoms and other aquatic life may be smothered. Diatoms are also excellent indicators of past climates and climate change. Diatom communities are also indicators of land use patterns and point source pollutants. Finally, as fossils in lake sediments, diatoms are excellent indicators of past climatic regimes and offer a unique window into the current analysis of climate change.

Unlike some aquatic organisms that live months to years, diatoms divide 1 to several times a day, meaning that a single cell can turn into a billion cells in the course of a month. Thus, they react almost instantaneously to the environmental conditions they face. And like other biomonitors, diatoms face the environmental music 24/7. Intermittent testing of water quality provides only a snapshot of ecological time and conditions. Many studies have suggested that diatoms offer a more complete understanding of water quality than grab samples of water chemistry.

How Do We Study Diatoms in Streams?

As part of the ROMN SEI protocol, diatom samples from the surface of rocks, wood, and other substrates on the stream bottom are collected and then identified by experts. From 2007 to 2009, we sampled over 50 sites almost 100 times. Most of these sample sites were randomly located across the park, sending our crews to some crazy, way-back-there locations (but giving us the ability to make statistically valid statements).

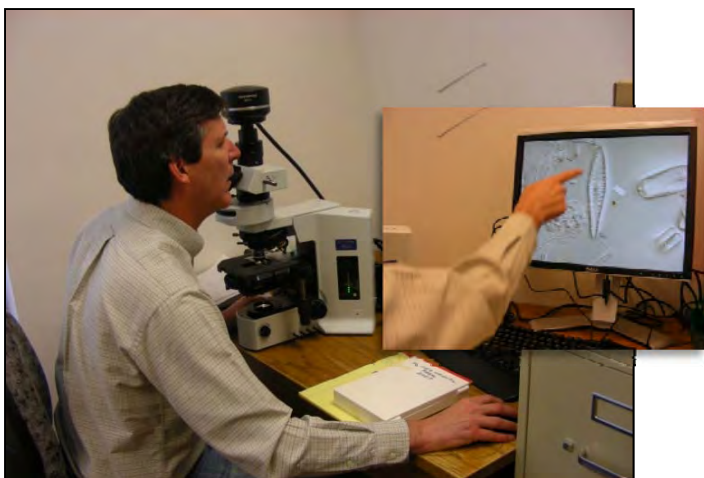


Vital Signs stream sample sites in Glacier National Park

Our diatom samples were analyzed by Dr. Loren Bahls and Dr. Pat Kocielek, two internationally recognized algae taxonomists and ecologists. Pat is perhaps the world's foremost expert on the genus *Gomphonema* – a group that characterizes much of the diatom flora of the park.



Diatom sample being taken from a stream rock. The small dark colored area in the center of the rock likely has several thousand individual diatom cells and several dozen different species (photo: Billy Schweiger, NPS)



Dr. Kocielek describes a new species of diatom as seen in the inset picture (photo: Billy Schweiger, NPS)

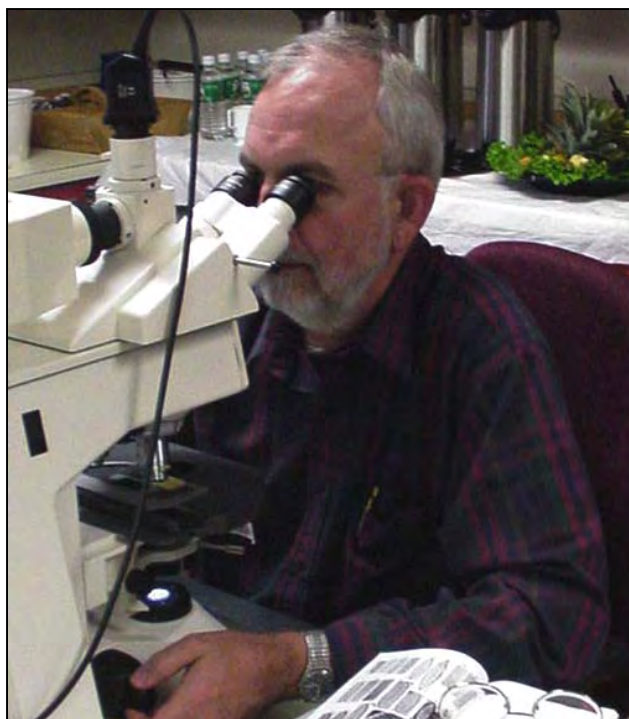
Pat has multiple publications on the algae of the western US and has added many identifications of new species to the field. Loren has worked in GLAC for years (his favorite place is Two Medicine, and he has worn down many of the trails there). He has several published papers on the algae of the region and, in his “retirement” is working on many more, including the final designation of many the new species found in our ROMN Vital Signs samples.

New to Science Species?

As of late 2010, we have documented 22 taxa that have never been described before. This is out of almost 500 total diatom species in our data set. The new species are distributed across 10 genera, with several in a single genus, *Gomphonema*. In fact, of all the *Gomphonema* species in our data set, almost 20% are new to science. Most of the new taxa were only found once at one site. However, they occurred across a broad diversity of stream types, elevations and macrohabitats. Ongoing work will better describe the community associations and key environmental drivers of these species.

We are working to confirm these as new species. This process requires specific steps and will take time. Therefore, while we expect these to be verified as new species, until then these must be considered provisional.

Many of these (superficially similar) new species are asymmetrical, with two lines or branches running down the center. These lines, termed a raphe system, allow the diatoms to move. Details of the hard cell wall of these species are also visible, including aligned perforations along the cell wall and a group of pores at one end through which mucilage is excreted. The mucilage develops into stalks that elevate the diatoms above the stream bed.



Dr. Bahls investigates Glacier diatom samples (photo: Loren Bahls)

New Species Name	Count
<i>Cymbella</i> sp. 398401	1
<i>Cymbella</i> sp. 409701	1
<i>Encyonema hamsherae</i> sp. nov. prov.	1
<i>Fragilariforma</i> sp. 1	1
<i>Fragilaria vaucheriae</i> morphotypes	129
<i>Gomphonema</i> cf. <i>minutum</i>	17
<i>Gomphonema</i> cf. <i>pumilum</i>	20
<i>Gomphonema</i> sp. 408603	3
<i>Gomphonema</i> sp. 408705	1
<i>Gomphonema</i> sp. 437501	1
<i>Gomphonema</i> sp. 408801	1
<i>Gomphonema</i> sp. 409801	1
<i>Gomphonema</i> aff. <i>longilineare</i>	48
<i>Navicula winona</i> sp. nov. prov.	3
<i>Navicula caroliniae</i> sp. nov. prov.	2
<i>Navicula weberi</i> sp. nov. prov.	1
<i>Navicula schweigeri</i> sp. nov. prov.	1
<i>Pinnularia</i> sp. 435902	1
<i>Pseudostaurosira caroliniae</i> sp. nov.	1
<i>Staurosira</i> sp. 409902	1
<i>Stauroneis gracilis</i> morphotype A	1
<i>Stauroneis gracilis</i> morphotype B	1

Other Key Diatom Results

Analyses of the 2007 – 2009 SEI Glacier National Park pilot data include several other important findings relative to diatoms. Preliminary work shows that over half of the



Rock snot bloom on McDonald Creek in Glacier, 2009 (photo: Donna Shorrock, NPS)

flowing water (about **68%**) in the park has an invasive diatom called *Didymosphenia geminata* or “rock snot”. Many of these occurrences are dramatic blooms that may be changing stream ecosystems. We have also found several unique taxa like *Distrionella incognita* or “glacial gold” that only occur in pristine glacial melt water, common (but decreasing) in the park. The interesting implications of these seemingly contradictory results are presented in greater detail in the ROMN SEI pilot report and a journal publication on rock snot.

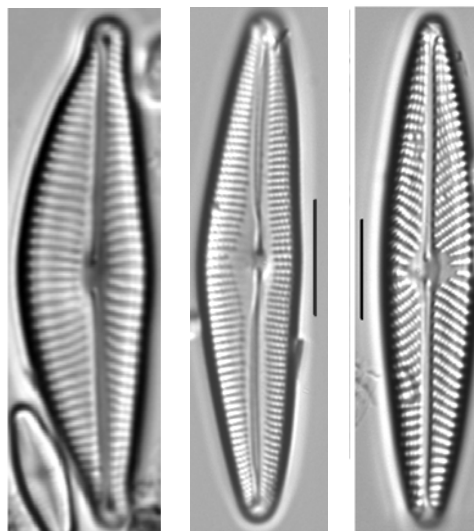
What Do These “New Species” Tell Us?

In some sense, it is not a total surprise that we are finding new species of diatoms in Glacier. Many Vital Signs stream sites are in locations that have never been sampled before (some may never even have been visited by people). While algae occur almost everywhere and are incredibly important for stream ecosystems they are not the typical megafauna like grizzlies that Glacier is so well known for. Much like insects in the tropics, all we needed to do was look! For example, in work by Dr. Bahls over the years in Glacier and Waterton, over 16% of the taxa found were new species. There are likely many more new species of diatoms in the park (and our continued monitoring may help them be “found”). However, this doesn’t really diminish the implications of these new species. Beyond just the ‘gee whiz’ aspect of discovering something never before recorded by modern science, most of these species are likely to be rare endemics, or species that occur only in a specific subset of streams in the world. Moreover, they also are likely highly responsive to climate change and indicative of the pristine condition characteristic of most of the parks streams. Therefore, they have great value as indicators of stream

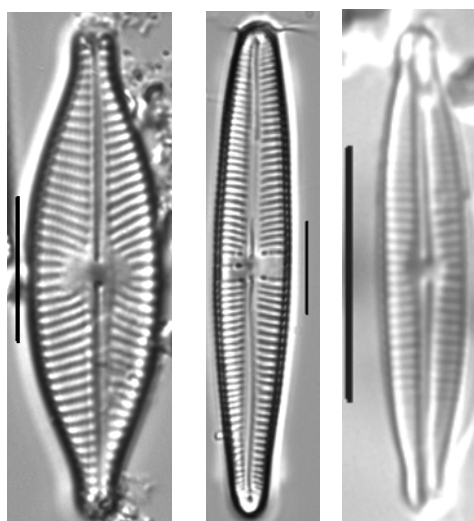
condition in the park. While much more study is needed, it is possible that given the small range of these species they may be at higher risk from climate change. Finally, they reveal one of the primary reasons for places like Glacier National Park. The park is truly a gold mine and stronghold of biological diversity that we should continue to protect and preserve for the benefit of science and the public at large.

Contacts

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 Dr. Pat Kociolek, University of Colorado, Boulder



Potential new to science diatoms (from left to right): *Encyonema hamsherae* sp. nov., *Cymbella* sp. 409701 and *Navicula schweigeri* (photos courtesy L. Bahls and P. Kociolek). Note, scales are different in the 3 images.



Potential new to science diatoms (from left to right): *Navicula* cf. *cryptocephala*, *Gomphonema* aff. *Longilineare*, and *Achnantheum* aff. *thienemannii* (photos courtesy L. Bahls and P. Kociolek). Note, scales are different in the 3 images.