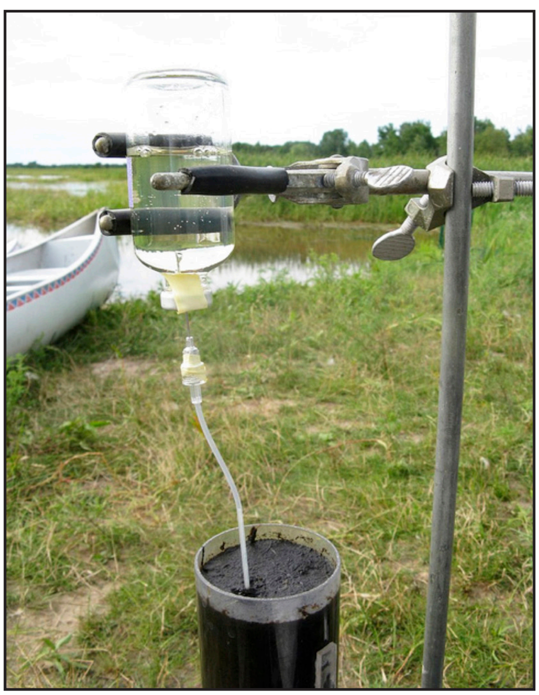
St. Croix Watershed Research Station
Highlights of 2013 - 2014

CSI : Isle Royale

Mark Edlund examines an algal bloom at Lake Richie; the same algae under the microscope

The victim, Lake Richie in the wilds of Isle Royale National Park, was found reeking of decayed algal mats in the summer of 2007, and it has suffered the same fate nearly every summer since then. And Lake Richie is not alone – other canoe-country wilderness lakes are likewise falling ill with excessive blooms of toxic blue-green algae, also called cyanobacteria. Analysis of microscopic algal remains in lake-sediment cores going back at least a century has confirmed that these algal blooms are unprecedented in these lakes and most evident during the last few decades. The culprit – silent, invisible, and wide-spread – could be a warming climate. Warmer lake water would not only extend the ice-free growing season and accelerate algal growth, but also fertilize the algae by releasing nutrients from lake sediments, creating a self-reinforcing internal cycle. To test the role of climate over the last 50 years, Research Station scientists are applying a computer model to simulate water temperatures in selected lakes (including Richie) in Voyageurs and Isle Royale national parks. If changes in lake-water temperature and ice-free season correlate with the algal changes documented in the lake-sediment cores, we will be one step closer to understanding the cause of these noxious algal blooms that are tainting our most beautiful wilderness lakes.



Sipping pore-waters from sediments where wild-rice roots – to be analyzed for sulfide and other chemical constituents

Wild Wild Rice

Minnesota's most iconic aquatic plant, wild rice (*Zizania palustris*), is at the center of a major scientific study with important implications for the state's mining industry. In 1973 Minnesota adopted a standard to protect wild rice from too much sulfate (anything above 10 parts per million [ppm]). Now four decades later that standard has come under renewed scrutiny as the state grapples with the sulfate-rich drainage of its iron-mining industry and that expected from the proposed sulfide-metal mining nearby. The state's water-quality managers, decision-makers, and key interest groups now want to know if the 10 ppm standard makes good sense. With funding from the Clean Water Land & Legacy Amendment and coordination by the Minnesota Pollution Control Agency, a team of scientists from the University of Minnesota (Duluth and Minneapolis campuses) and the St. Croix Research Station is probing wild-rice habitat throughout the state to understand what exactly about sulfate is bad for wild rice. Over the last three years they have been sampling hundreds of lakes where wild rice grows (or could grow) as well as cultivating wild rice in outdoor experimental enclosures. They are now zeroing in on the likely culprit, which is the sulfide that forms from sulfate in the anoxic sediments where wild rice takes root. The findings of this critical study, forthcoming in the next few months, are anxiously awaited by environmental groups, politicians, the mining industry – and of course, the scientists themselves.

Resurrection Ecology

Facilities Manager Todd Bentler pilots the boat on S. Center Lk. as he and Mark Edlund prepare to collect sediment cores for Daphnia *resurrection*

Station scientist Mark Edlund, in partnership with zooplankton ecologists from Oklahoma – Puni Jeyasingh from OSU and Larry Weider from OU – was recently awarded a National Science Foundation grant to examine the evolutionary response of zooplankton to changing nutrient levels in Minnesota lakes. The researchers are asking, "How have organisms in Minnesota lakes evolved and adapted to changing land use and water quality?" Zooplankton such as *Daphnia* produce special resting eggs surrounded by a tough coating called the ephippium which lie dormant in lake sediments awaiting the right conditions to hatch. Ephippial eggs that don't hatch get buried but remain viable for several centuries! It is this biological "seed bank" that researchers will study. Resting eggs in sediment cores from two Minnesota lakes will be hatched, and the ability of the offspring to use different levels of resources – carbon and phosphorus – will be tested. Hatchling genetics will also be sequenced to see if they have genes that allow them to succeed in high phosphorus environments like many nutrient-impacted Minnesota lakes. Finally, the scientists will force the ancient *Daphnia* hatchlings to evolve by growing them under changing culture conditions that replicate the history of nutrient pollution in many of our lakes.

Students STAR in Lake Research

Two university students participated in the 2013 STARS (Science Training and Research Skills) intern program at the Research Station. Natalie Hoidal, a sophomore at University of Minnesota-Morris, worked with staff scientists Mark Edlund and Joy Ramstack Hobbs to test whether shallow lakes in Minnesota had ever shifted from clear and plant-dominated to turbid and algae-dominated before Euro-american settlement. Natalie first took Edlund's annual diatom class at Iowa Lakeside Lab, then analyzed diatoms in cores from four shallow lakes that currently range from turbid to clear states. Her results show no evidence that shallow lakes "flipped" between clear and turbid states before settlement. Natalie traveled to Maine to present results of her research at the 2013 International Diatom Conference. Nick Hermann, a recent graduate of the University of St. Thomas, analyzed the geochemistry of lake sediments near Prior Lake, Minnesota, under the direction of Will Hobbs. He used both experimental and laboratory methods to quantify the amount of phosphorus being released from the sediments of two different lakes. Nick's work is part of a larger project to understand how lakes in the Prior Lake watershed have changed (or not) in response to land use and development. His results will be used to develop a nutrient reduction plan known as a TMDL (Total maximum daily load) for the Prior Lake system.

Natalie Hoidal samples water quality

BMPs DNT WRK

In 1992 then governor Arne Carlson declared that the Minnesota River should be "swimmable and fishable" in ten years. Twenty years later, with millions of dollars worth of soil conservation practices implemented, the river is still loaded with sediment. In fact, based on monitoring data and core records from Lake Pepin, there has been no significant decline in suspended sediment. Why? Maybe increased erosion of streambanks is overwhelming decreases in erosion from fields. Maybe it's the increase in total row-cropped acreage. Or maybe we simply have too few acres with soil conservation practices to make a measureable difference. In any case, we need to understand why sediment loads have not decreased if we are to make our management strategies more cost effective. Station scientists Shawn Schottler, Dan Engstrom and Jim Almendinger are teaming up to examine this question in their new Sediment and Riverine Lakes project funded by the Minnesota Pollution Control Agency. They will apply new radioisotopic fingerprinting techniques to sediment cores from riverine lakes to measure changes in field and non-field sediment inputs over time. Changes in the amount of sediment eroded from fields will be correlated to the amount of agricultural best management practices (BMPs) implemented in the watersheds to see how effective (or ineffective) these practices have been in reducing sediment pollution.