NEWSLETTER FOR THE LAKES OF MISSOURI VOLUNTEER PROGRAM

The Water Line

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The **BIGGER** picture- Bigger Watersheds

Often in The Water Line, we have discussed the impacts of nonpoint source pollution on our lakes. Once again, we'll address the impacts of nonpoint source pollution, but on the ocean. The big picture.

Almost all of Missouri's lakes are simply waypoints for water along its journey to the sea. Our dams simply delay the inevitable. Like your lake, the oceans have watersheds too. The northern Gulf of Mexico is fed water and nutrients by the Mississippi River via a watershed that covers 1.2 million square miles. That covers 40% of the United States, or 12 ½ % of all North America.

In this edition of The Water Line, we'll talk about a couple of problems facing the Gulf of Mexico. The issue of Gulf hypoxia (aka *the Dead Zone*) is a big one that you'll be hearing about in the news, if you haven't already. A news story passed through the office regarding the "black water" incident in Florida. Nonpoint source pollution isn't a local issue anymore.

Just as nonpoint source pollution affects the lakes of Missouri, it also affects the sea. We may not get to the beach very often, but our *runoff* arrives at the Gulf of Mexico every day. ▲

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Volunteers -

Mid-Season sample pick-ups are coming up for this year. Expect an email, post card or phone call with the details of when and where.

Please let us know if you need more bottles or filters.

Did you know ?

- During 1997 there were at least 4,153 individual beach closings or advisories.
- 69% of these closings or advisories were due to high bacteria levels.
- Pollution sources include polluted storm runoff, sewage spills, and sewage overflows.
- Coastal areas make up 17% of the contiguous U.S. land area, but is home to over 50% of the population.
- Harmful algal blooms have increased in frequency, intensity and severity in U.S. coastal areas over the last several decades.**
- Of the 275 groups of fish that are caught commercially, 22% have been assessed as being overexploited.

Facts are from U.S. EPA Office of Water with the exception of :
**National Office for Marine Biotoxins and Harmful Algal Blooms

Region VII, US Environmental Protection Agency, through the Missouri Department of Natural Resources, has provided partial funding for this project under Section 319 of the Clean Water Act. The Lakes of Missouri Volunteer Program is also supported by the University of Missouri

THE DEAD ZONE

HYPOXIA IN THE GULF

The Gulf of Mexico is dead. Well, part of it is anyway. The dead part was as big as New Jersey in 1999 and is as big as Massachusetts this year; over 8,000 square miles. It is a hypoxic region, also called a "dead zone", so-called because the lack of oxygen within its borders has rendered it nearly devoid of aquatic life. And it's all thanks to nutrient input from the Mississippi River basin. **That's us.**

> **According to the USGS, 56% of the nitrogen entering the Gulf of Mexico comes directly from agricultural runoff.**

Oceans are typically nitrogen limited. This means that algal growth (the base of aquatic food chains) is limited by the amount of nitrogen in the water. Add more nitrogen and you get increased algal growth. If you were to add phosphorus, you would expect little to no response by the algae. By contrast, most Missouri lakes are phosphorus limited, Thus, algal growth in our lakes responds to increases in phosphorus concentration.

Gulf hypoxia is caused by the settling out and subsequent decomposition of organic matter in the water. The density differences cause the water to stratify, with the nutrient-rich and warmer river water above the colder, salty seawater. The nutrients fuel algal growth in the top layer. Dead and dying algae sink through to the more dense, saltier layer at the bottom and decompose. The decomposition consumes oxygen, which can't be replaced in the deep layer, due to the stratification. In order for the stratification to be removed, a major storm event is required (e.g. tropical storm or hurricane). Then the water layers will mix, and the hypoxic zone will dissipate temporarily.

Much of the river's natural meanderings have been removed, leaving well engineered, navigable channels. Wetland draining and channelization have left river water with fewer opportunities to shed nutrients through plant uptake and bottom deposition.

The Mississippi River drains 40% of the US, or 12 ½ % of the continent of North America. On this very land lie 52% of the farms of the United States. These farms generate $98 billion in revenue each year.

Figuring out how to reduce nutrient inputs is a bit like balancing a budget. To communicate issues to a great number of people, environmental concerns must often be converted into monetary ones. Cost-benefit type analyses must be performed to determine the importance of the variables involved. Is the effect on the fisheries in the Gulf worth the overall cost of nutrient reduction in the Midwest?

Unfortunately, the benefits of a healthy ecosystem are difficult to quantify. How much would you pay each year to protect aquatic life hundreds of miles away? How much revenue will be lost if bottom-dwelling sponges die? What is the current market value of "clear water"? There is no correct answer, and yet these questions must be addressed.

It is quite likely that the Gulf of Mexico's $690 million fishery will suffer greatly if the input of nutrients, specifically nitrogen, is not reduced. Some have argued that Gulf fisheries have benefited from the "dead zone", as it has driven shellfish toward shore as they seek oxygen. This leads to "jubilee" events where harvesting is easier. Also, after fleeing the oxygen deprived waters, fish may congregate in high concentrations at the borders of the "dead zone". This can lead to better fishing…for a short while.

As migration paths and spawning habitats are overtaken by hypoxic water, animals (and the humans who depend on them) can suffer horribly. Hypoxia has led to the collapse of several fisheries worldwide. Commercial bottom fishing simply doesn't exist anymore in regions of the Black Sea, the Baltic Sea, Sweden, and Denmark, as their "dead zones" continue to grow.

Whatever course of action is chosen, recovery will be slow. Decomposition of organic matter in the sediments will continue to deplete oxygen, even after nutrient input to the Gulf is reduced. It could take years before results are seen from remediation efforts.

Tony Thorpe

Imagine that you are boating along the coast of Florida, enjoying the sun and looking forward to a little fishing when you realize something is wrong. You stop the boat, look around, and see that instead of being blue, *THE OCEAN IS BLACK*. If you were on the southwest coast of Florida earlier this year, you could have had this experience. This phenomenon has been called ...

Florida's Black Water

The Black Water started showing up sometime in mid-January. By the time it peaked in February, it covered a 700 square mile area. The water was described with terms such as 'snotty', 'nasty', and 'viscous'. If the appearance of the water wasn't enough to warrant concern, the fact that fishermen were not finding any fish in the Black Water was alarming. Floridians are familiar with many different water quality issues, but this was something no one had ever seen before.

While research has answered some questions, there is still a lot that is unknown about the mysterious Black Water. A diatom bloom was the cause of the dark coloration of the water, based on data and samples collected during March. Diatoms are a different type of algae than those that cause the Red Tide. In fact, research showed very few if any of the Red Tide causing algal species in the Black Water. This was important because one theory about the origin of the Black Water was that it may have been related to a Red Tide event that had been occurring off of the Florida coast since August 2001.

Along with few Red Tide algal species, fishermen and scientist were not finding many fish in the Black Water. Reports were that there wasn't a large fish kill, but instead fish seemed to avoid the water. Organisms that were not able to swim away from the bloom were not so lucky. Bottom dwelling sea sponges and soft coral where found either dead or dying in the Black Water. There were also reports that sea turtles that had eaten sea sponges were becoming ill with an unexplained pneumonia.

Even though the Black Water started to appear in January, real investigation into what it was and where it came from did not get underway until March. By this time, the bloom was in decline and the intensity of the Black Water was only 10% of what it had been in February. The delayed reaction to the phenomenon may have cost scientist a few answers, and left them to only be able to theorize about the causes of the Black Water.

Along with the Red Tide theory, others felt that nutrient inputs associated with December rains may have provided just the right conditions for the bloom. Those pointing to runoff as the catalyst can make a strong argument. Southern Florida experienced two and one half times the normal rainfall in December 2001. This could cause high loading of nutrients into the bay. Algal blooms are often associated with changes in the environment that create perfect conditions for algal growth.

The weather anomaly of December may have been significant enough to tip an environment that has been facing increased impacts over time. In the 1980's agricultural runoff was diverted from Lake Okeechobee into the Florida Bay. In 1981 there were 750 tons of nitrogen flowing into the bay, this increased to 2,500 tons in 1982. The load of nitrogen continued to increase and peaked in 1995, when almost 5,000 tons of nitrogen made its way into the bay. Over time, these impacts may have taken a toll on the bay's resiliency, leaving it out of balance and susceptible to an extreme event such as an algal bloom.

Will we see another episode of Black Water in the Florida Bay? Only time will tell. Time will also tell us what the long-term impacts of the bloom were. There are many water quality concerns associated with Florida, and this past winter another one was added to the list.

Dan Obrecht

OTHER WATER QUALITY CONCERNS IN FLORIDA

Red Tide – **Toxin producing algae that can, when in high concentrations, lead to fish kills, contaminate shellfish and create severe respiratory irritation in humans.**

Sea Grass – **Pollution may be killing off sea grass in the western Florida Bay. This leads to a loss of habitat as well as a loss of a natural filtration system that takes nutrients out of the system.**

Coral Bleaching – **The whitening of coral in response to a stress. The stress may be disease, increased shading, increased ultra-violet light, changes in salinity, changes in temperature, sedimentation or pollution.**

Cellulitis – **An infection that commercial fishermen have recently been dealing with. The infection spreads easily and can only be treated with stout antibiotics. Described as a "flesh-destroying" infection.**

We've been telling you that algae are at the base of all aquatic food webs and that all aquatic life is dependant upon their ability to photosynthesize. Well, we have been holding back.

In 1977, scientists discovered communities of organisms living 7,000 feet below the surface of the ocean in total darkness. These communities were centered around deep *hydrothermal vents* much like the geyser, Old Faithful. Mineral-rich water spews out of the vents at temperatures of up to 750^{o} Fahrenheit and is more acidic than vinegar. Thanks to the ambient pressure of about 3,300 pounds per square inch, the water doesn't boil. Definitely a tough place to live.

> **Toxic gasses, temperatures of up to 750^{o} Fahrenheit, more acidic than vinegar … and teeming with life. Who needs the sun when you've got all of this?**

The basis of life at hydrothermal vents is Archaea bacteria. We call them bacteria, but they are as genetically different from most other bacteria as you are from a head of lettuce. These Archaea convert hydrogen sulfide into energy via chemical reactions much like plants convert sunlight and carbon dioxide into energy. To exist in the extreme environment below the sea, you must either eat the Archaea (directly or indirectly) or use them to make food for you, like the 9 foot long tubeworms do.

Tubeworms that occupy the areas around the vents have a symbiotic relationship with the Archaea. The tubeworms rely on Archaea present inside their bodies to produce energy for them. The Archaea get exposed to high concentrations of hydrogen sulfide, thanks to the tubeworm's filtering apparatus.

This is all done without the sun, in total darkness. No plant energy is required down there. All that's needed is hydrogen sulfide and carbon dioxide. Oh, and a little oxygen. That comes from...well...photosynthesis. For that you need algae. I suppose we'll have to keep the sun around for a while longer.

Tony Thorpe

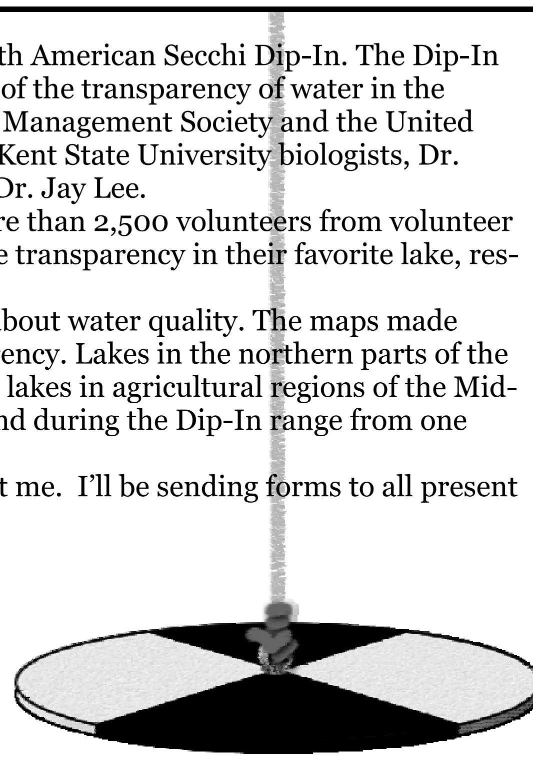
The summer of 2002 marks the ninth year of the Great North American Secchi Dip-In. The Dip-In is an international effort in which volunteers produce a "snapshot" of the transparency of water in the United States and Canada. Sponsored by the North American Lake Management Society and the United States Environmental Protection Agency, the Dip-In is directed by Kent State University biologists, Dr. Robert Carlson and Professor David Waller, and KSU geographer, Dr. Jay Lee.

During the period from **June 29 until July 14, 2002** more than 2,500 volunteers from volunteer monitoring programs in the United States and Canada will measure transparency in their favorite lake, reservoir, river, or estuary.

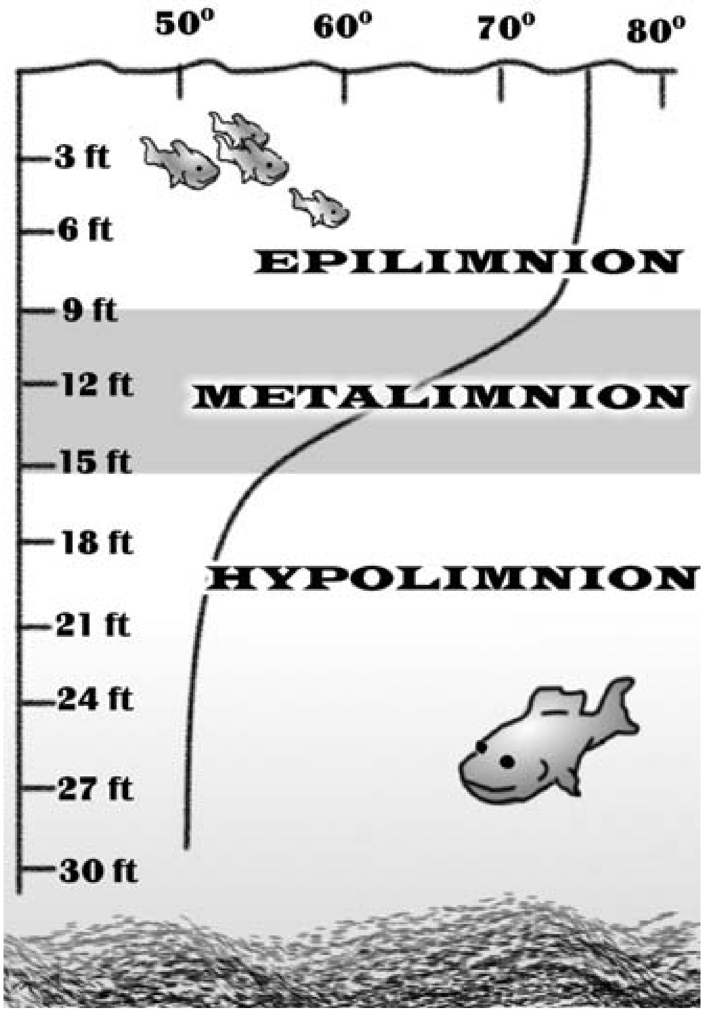
The previous Dip-In's have provided valuable information about water quality. The maps made each year have shown considerable regional differences in transparency. Lakes in the northern parts of the United States and in Canada typically have the clearest lakes, while lakes in agricultural regions of the Midwest have some of the smallest transparencies. Transparencies found during the Dip-In range from one inch to more than 65 feet.

For more information go to http://dipin.kent.edu or contact me. I'll be sending forms to all present volunteers as soon as I receive them, so check your mailboxes.

2002 Secchi Dip-In



THERMAL STRATIFICATION



Most people know of, or have heard of, "**turnover**". That's when the lake water mixes from the surface to the bottom. So what happens during the time when the lake isn't "turning over"? The lake is stratified, that's what.

A volume of water is heaviest at 4° Celsius (39.2° F). That is just above freezing. The same volume of water becomes lighter as it gets warmer. **So in a lake, warm lake water is at the top and the colder water is at the bottom** (except in winter—see below).

As the sun continues to heat the water at the top, the difference in temperature between the top and bottom water becomes greater. Eventually there are 2 distinct layers, the *epi*limnion at the top and the *hypo*limnion at the bottom. Between these 2 layers is a third, less distinct, transition layer called the *meta*limnion.

Because of the temperature difference (and thus density difference) between the epilimnion and hypolimnion, they don't typically mix together during the summer. It takes a major climactic event to accomplish this, though **the lake will mix in the autumn as the surface water cools**.

Often in the summer, the hypolimnion will become depleted of oxygen. The bacteria responsible for decomposition consume the oxygen and access to the atmosphere's oxygen is cut off by the stratification.

Then why does water freeze from the top down?

If water becomes more dense as it gets colder, then it *should* freeze from the bottom up, right? **Well, water is most dense at 4° Celsius** (or 39.2° F), which is warmer than freezing. So as water continues to cool from 4° C (39.2° F), it becomes less dense and rises back to the top, leaving the slightly *warmer* water below.

At the surface, the cooler water is exposed to freezing air temperatures and may eventually freeze. Once ice forms, the water beneath cannot be mixed by the wind.

When the ice melts in the spring, the entire water column will be at approximately 4° C for a brief time. The lake will mix thoroughly ("turn over") with just a bit of wind. A calm, warm day can heat the surface water and initiate the stratification process.

Stratification may also occur due to changes in salt content as well as temperature. Oceans, particularly in places where freshwater enters, may be stratified by salinity. The problems with Gulf Hypoxia may be attributed partially to the inability of the dense and salty bottom water to mix with the oxygen-rich, less salty water above.

Tony Thorpe