The Water Line

Newsletter for the Lakes of Missouri Volunteer Program

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Fledgling Bald Eagles - The Lake of the Ozarks - Photo by Volunteer Rusty Bartels

LAKE STRATIFICATION LAKE TURNOVER - WHAT DOES THAT MEAN?

Have you ever dove into a lake during summer and felt cold water below the warm surface water? Have you ever heard someone talking about a lake "turning over" and wondered what they meant? The answers to these questions lie in understanding the lake phenomenon of thermal stratification and turnover.

I could go into a great deal of detail about the physics and chemistry of the water molecule but I would probably end up confusing all of us! So here is a brief lay

LOOK FOR YOUR QUESTIONNAIRES!!

The Lakes of Missouri Volunteer Program (LMVP) will be conducting a survey gathering information on basic demographics, lake use, perspectives on water quality and feedback concerning the program. The LMVP staff will present the results at the Seventh International Symposium on Society and Resource Management that will be held at the University of Missouri-Columbia in May 1998.

Your help is needed for our program to grow and improve. We sincerely appreciate the time you give to the LMVP, so please take a few more minutes to complete and return the surveys to us. Thank you again for your support!!

Inside this issue...

GREAT AMERICAN SECCHI DIP-IN

Along with the 1997 Great American Secchi Dip-In questionnaire, you should have received a report of results from 1995 and 1996. We would like to quickly review these results and explain what they mean about water quality in Missouri.

Some of the states with the deepest or best Secchis were Maine, Montana, Vermont, and New Hampshire. These New England states and the area of Montana that was sampled are areas where generally the soil is rocky with little or no farming. The lakes are naturally formed, not man-made reservoirs. States with consistently low Secchi's (Alabama, Iowa, Louisiana, Nebraska, Oklahoma, Ohio) are areas with deeper soils, more agriculture and more man-made reservoirs. Missouri had average readings of 3.95 ft. and 4.84 ft. in 1995 and 1996 respectively. These values are near the national median for each the year suggesting that Secchi transparency is fair in Missouri especially considering that our lakes are man-made reservoirs. We also have considerable agriculture in the northern part of the state.

If we look at trends of Secchi depth within Missouri, we find that the national trends are reflected. Secchi depths in southern Missouri (rocky, less farming) are deeper than northern Missouri (deeper nutrient rich soil with farming.)

CANADA GEESE BLESSING OR BANE???

"One swallow does not make a summer, but one skein of geese, cleaving the murk of a March thaw, is the spring" this quote from Aldo Leopold's classic A Sand County Almanac conveys the significance some people place on the spring and fall migrations of geese. The presence of a flock, flying in V-formation overhead is nature's way of declaring a change in the season. A Sand County Almanac was first published in 1949, since then an interesting thing has occurred in Missouri as well as in much of the country. Giant Canada goose (*Branta canadensis maxima)* populations have grown and many areas have resident populations. While this represents a conservation success story, it leaves many people wishing the geese would fly south for good!!

Geese can cause damage to lawns, golf courses and croplands while feeding. They also can be pushy and intimidating when they want a handout. But the biggest complaint is that geese aren't very concerned with where they defecate. Anyone who has used a boat ramp or dock on a lake with a resident goose population knows that the excessive goose waste can be quite disgusting. Besides being unpleasant, goose feces can lead to problems in your lake.

Studies have shown that geese are capable of depositing a large amount of fecal material in a day. Two studies found the number of droppings per goose were 28/day (Manny et al, 1975) to 92/day (Kear, 1963). These *(Continued on page 4 - Geese)*

(LAKE Continue on page 3)

(LAKE Continue from page 1) description of thermal stratification and turnover. Our lakes go through seasonal cycles. These cycles are greatly influenced by wind, rainstorms and changes in air temperature. We can divide these cycles into four phases: spring turnover, summer stratification, fall turnover and winter stratification. Each lake has its own particular characteristics and cycles will vary from lake to lake and year to year.

But to understand how this works, here is a quick chemistry/physics lesson on what makes water a relatively unique substance. Like most other substances, the <u>density of water changes as the temperature of water changes</u>. But an important concept to understand is that water's **maximum density (or when water is the heaviest) occurs at 4°C (39.2°F).** As it cools down below 4°C to become ice, it actually gets lighter or less dense, due to the way water forms ice crystals. It also becomes less dense or lighter as it warms up from 0° to 4° C.

During the winter, the coolest and lightest water (<4°C) is at the top of the lake while the warmest and densest water (4°C) is at the bottom of the lake. As the spring sun starts warming the upper layer of the lake, this water becomes heavier and sinks. This continues until the whole lake is 4°C from top to bottom. At this point the lake is mixing or "turning over" and the water is now homothermous. (See Figure 1) As the surface water continues to warm, springtime winds and rains help mix the surface water with the underlying water and the whole lake, from surface to bottom, gradually warms up.

In the late spring, surface waters begin to heat rapidly. This surface warming occurs at a more rapid pace than the heat can be distributed by mixing to the rest of the lake. As the surface water continues to heat up, it becomes lighter and less dense than the underlying waters. The surface water gets warmer and lighter to the point where there is virtually no mixing between the warm surface layer and the cooler layers below. The depth of the surface water layer will vary from lake to lake and year to year. Since the density of water corresponds to the temperature, a situation is created similar to oil and water. The lighter, warmer surface water does not mix with the cooler, heavier deeper water. This is the beginning of lake stratification into distinct temperature/density layers. Stratification is complete when the three main layers are formed. These layers are the epilimnion, the metalimnion and the hypolimnion. (See Important Terms for further definitions). By mid summer these layers are so well defined that mixing between layers is minimal. (Fig. 1)

During the cooler nights of fall, the temperature of the surface water begins to decrease. The surface water starts cooling and becoming heavier and more dense. Slowly circulation begins as the heavier water sinks causing an erosion of the layers. As the temperature of the surface water decreases, the depth at which it will mix increases, until the circulation of cooler, heavier water produces a homothermous condition and fall turnover is underway. (Figure 1) The winter stratification is similar to a reverse summer layering. Winter stratification layers are not as strong or defined as the summer layers. The water continues to cool to the magic water temperature of 4°C. As you remember, water is heaviest or at its maximum density at 4°C. As the water cools down, the 4°C water sinks to the bottom and the cooler water stays at the top. The lightest and coolest water - you guessed it, is ICE! The ice floats on the top, the temperature gradient goes down from 1° to 2° to 3° to 4° C at the bottom of the lake.(Figure 1)

This is a very simplified explanation of a complex system of stratification and turnover. There are many variations and conditions that affect this process. But the next time you dive in and hit the metalimnion of a lake, you might have a

Figure 1. Temperature profile of a hypothetical Missouri lake.

Mature Bald Eagle - The Lake of the Ozarks
Photo by Volunteer Rusty Bartels

(Continued from page 2 - Geese)
values represent data from two different species of geese, but the bottom line is that geese are prolific when it comes to defecating. All of this goose poop can negatively affect a lake in three ways. 1) Goose waste is organic and is decomposed by bacteria. Because decomposition uses up oxygen, goose droppings in a lake can reduce dissolved oxygen levels. 2) Goose manure contains nitrogen and phosphorus (See Table 1) which can act as fertilizer. 3) Goose feces also contain bacteria and other microbes. While no goose related illness have been documented in Missouri, it is reported that “geese are known to be carriers of *Salmonella, Chlamydia,*and the protozoan that causes swimmers itch” (Bland, 1996).

While a few geese on your lake may add to the ambiance, too many geese can be a problem. The first step in dealing with a nuisance goose population is to make sure that nobody is feeding them. Free handouts teach geese to associate humans with food. Once this association is made, no amount of harassment will successfully scare the geese from your lake. In response to increasing problems, many local ordinances have been passed that prohibit people from feeding geese. The Giant Canada goose is a federally protected species, so it is illegal to capture, injure, or kill them without the appropriate permit. If you feel that the goose population on your lake may be causing problems, contact the USDA Animal Damage Office at (573) 446-1862 for more information on ways of controlling the populations.

Table 1. Nutrient inputs from goose manure.

	Manny et al (1975)	Kear (1963)
Subspecies	Interior	Atlantic
Dropping frequency	28/day	92/day
Dry weight/dropping	1.17 grams	1.9 grams
Dry nitrogen/dropping	0.051 grams	0.042 grams
Dry phosphorus/dropping	0.016 grams	0.019 grams
Nitrogen/goose/year	521 grams (1.15 lbs.)	1410 grams (3.11 lbs.)
Phosphorus/goose/year	163 grams (0.36 lbs.)	638 grams (1.41 lbs.)

Bland, J.K. 1996. A gaggle of geese...or maybe a glut. LakeLine. 16:10-11, 45-47.

Kear, J. 1963. The agriculture importance of goose droppings. the 14th Annual Report of the Wildfowl Trust. p. 72-77.

Leopold, A. 1949 The geese return. A Sand County Almanac. p. 18.

Manny, B.A., R.G. Wetzel and W.C. Johnson. 1975. Annual contribution of carbon, nitrogen and phosphorus by migrant Canada geese to a hardwater lake. Verh. Internat. Verein. Limnol. 19:949-951.

Lake Profile
Prairie Lee Lake

Prairie Lee is located near Kansas City, in the Osage Plains physiographic region. The soil in this region is highly productive and nutrient rich with agricultural and urban land use. In past studies, the University of Missouri has found the lakes in this region have the highest amounts of nutrients, suspended solids, and chlorophyll in the state. Therefore it is not surprising Prairie Lee has been classified as eutrophic. The LMVP has been fortunate to have volunteer Frank Fitchner collecting data on Prairie Lee since 1992.

Prairie Lee has direct stream inflow from its watershed, which means storm events greatly influence the water quality of the lake. Runoff from heavy rain carries clays and silts with attached phosphorus into the lake. The response of algal chlorophyll to heavy runoff is difficult to predict in Prairie Lee. The input of silts and clays increases the phosphorus loading but can reduce the amount of algal production by increasing turbidity. This increase in turbidity limits the amount of light (which is necessary for algal growth) that penetrates into the water column. If the turbidity stays low enough, the increases in phosphorus can lead to an increase in algal chlorophyll.

The timing of the storm events also affects the amount of inorganic suspended solids (clays and silts) and nutrients entering the lake. When the soil has little vegetation such as early spring, fall, and during building construction, rain drops break the soil loose and make it available for transport via runoff into the lake. In late spring and summer, the rain drops hit the vegetation first and then the soil. The impact is lessened, and the soil stays intact.

Of the five years Prairie Lee has been in the volunteer program, 1993 and 1995 have been the wettest years. This is reflected in Figures #2- #4 where we see the increase in inorganic suspended solids and total phosphorus during these two years with a mixed response in chlorophyll.

Overall the data suggests that conditions in Prairie Lee are dependant on the timing and frequency of storm events and that no trend in annual water quality is apparent.

Figure 2 - Inorganic Suspended Solids

Figure 3 - Total Phosphorus

Figure 4 - Total Chlorophyll

IMPORTANT TERMS

1.Thermal Stratification - the layering of water masses caused by different densities in response to temperature; the condition of a body of water in which the successive horizontal layers have different temperatures, each layer more or less sharply differentiated from the adjacent ones.

2. Homothermous - having the same temperature throughout.

3. Density - the ratio of the weight of an object to its volume.When applied to water it is the number of water molecules per unit of volume

4. Epilimnion - the water mass at the surface extending down to the metalimnion; the epilimnion is warm, light (low density), wind-circulated and essentially homothermous.

5. Metalimnion - the transitional layer between the warm epilimnion and the cold hypolimnion of stratified bodies of water. An area where temperature changes rapidly with depth.

6. Hypolimnion - the region of a body of water that extends from the metalimnion to the bottom and is essentially isolated from major surface influences.

7. Turbidity - cloudy conditions caused by suspended solids in a liquid. In Missouri lakes, turbidity can be caused silt and clay material as well as algae.

Did You Know...

...that although 70 percent of the Earth's surface is water, 97 percent of that is in oceans and estuaries and not available for drinking or irrigating? And that much of the remaining 3 percent is trapped in glacial ice?

...that the volume of water on Earth stays the same, but the form — liquid, gas, or solid, — changes constantly?

...that per-capita daily water use in the United States is about 1,400 gallons (all uses, including irrigating, mining, and manufacturing, as well as domestic use)? Per-capita daily water use in other countries ranges from 5 gallons in Haiti to well over 3,000 gallons in Iraq, with a worldwide average of 475 gallons.

...that one American in six draws his or her drinking water from private wells and springs? And that many of these private water sources are not tested for water quality?

...that soil quality is a key determinant of water quality because soils regulate and partition water flow and buffer against human use and environmental changes?

...that the risks associated with water pollution can be measured both in terms of *hazard* (technical risks, such as getting cancer because of what's in the water) and in terms of *outrage* (public reaction to the presence of pollutants, usually synthetic chemical, without regard to hazard)?

...and the three out of four farmers have changed their farming practices to help reduce water pollution?

Information from the Natural Resources Conservation Service Bulletin on Water Quality