Biomimicry…Nature Knows Best
Pathways to Healthier Water
By Bruce Kania, Frank Stewart & Mark Osterlund

The "What Is Pond Stratification?" article in the September/October edition of Pond Boss was outstanding! It did an excellent job explaining complex interactions between temperature, density, nutrients and oxygen that contribute to and are affected by stratification. This topic really does need to be clearly understood by all of us pondmeisters. Otherwise, it is really easy to get into serious trouble…as in dirty water and dead fish.

Wetlands represent a natural way to guard against dangerous stratification conditions by "processing" that which is dissolved into water. Wetlands are usually shallower bodies of water relatively uniform from top to bottom. The expansive surface area of a wetland allows for proportionately high diffusion of oxygen into the water as well as high levels of biosequestration of nutrients into biofilm. Wetlands are Nature's Laundromat…cleansing water by utilizing excess nutrients, exchanging healthy amounts of gasses via photosynthesis and respiration while providing much needed habitat for a wide range of wildlife. Shallow depth promotes aquatic plants, which represents another form of nutrient biosequestration to grow abundantly. Nutrients are plant fertilizer. Waste becomes food, rather than a water pollutant, via biofilm and wetland plants.

In addition, temperature throughout a wetland tends to be relatively uniform, which promotes stability of the biology of water. Stability leads to predictable consequences.

But, a problem with owning your very own wetlands is they can take up a lot of space. And, if you want a pond, well…wetlands are wetlands, after all.

Is there a way to perform the functions of a wetland in your pond?

Yes, there is.

For most of the last decade Floating Island International research scientists have been focused on experimentation and development of a floating wetland treatment technology. These systems provide a wetland effect, even in deeper water. The system is designed to biomimic Nature's wetland effect and offers an efficient way to move dissolved nutrients up the food chain without running out of vital dissolved oxygen for the creatures which need it.

These artificial floating islands turn nutrients into fish food in the form of highly palatable periphyton. Periphyton is that layer of sticky slime that occurs on almost everything under water. Technically, it is microbes and their residue, along with whatever sticks to the biofilm, which is mostly algae. Think meat and potatoes, the biofilm being the meat, algae providing the veggie. This combination, along with all kinds of other stuff that bonds to the biofilm is the base of the food chain in healthy freshwater environments.

Wetlands or floating islands, with their unique concentrated wetland effect, can be the impetus to an exceptionally healthy epilimnion layer that sets the stage for healthier and more productive water downstream.

Wetlands can also provide anoxic (without usable oxygen) and anaerobic (without oxygen) zones. (Think of that deep bog smell that happens as you tramp through an old,

active swamp.) These zones are important because some nutrients are best broken down under anoxic or anaerobic conditions.

Unique microbes functioning within these zones do this breakdown, and do it very well. In fact, some by-products of aerobic metabolism are best removed from a water system by anaerobic microbes. A classic example is the denitrification of ammonia. Fish give off ammonia through their gills as they breathe. It's a waste by-product of metabolism. Ammonia is broken down into nitrite aerobically (in the presence of oxygen); however nitrite is converted to nitrate and eventually nitrogen gas ideally in anaerobic environments. Water can easily eliminate nitrogen gas into the atmosphere, where it belongs.

The accompanying flow chart shows the various stages of breakdown. If the waterway does not offer aerobic, anoxic, and anaerobic nutrient breakdown, an accumulation of some form of nutrient can develop. Essentially, for a system to be healthy it has to do all of the above…aerobic, anoxic and anaerobic nutrient conversion. Otherwise, water ends up with nutrient loading.

Relating back to the article in the last issue of Pond Boss, stratified ponds, like wetlands, provide zones of aerobic, anoxic and anaerobic conditions. The difference is an issue of scale. While anoxic conditions are limited in a wetland, they can overwhelm a deep water body, suffocating most life-forms in that zone. Especially in the presence of heavy nutrient loads, aeration is required to expand the epilimnion (aerobic zone).

As pointed out in the stratification article, when aeration is stopped for whatever reason, an excessive anoxic or anaerobic condition can quickly develop...in other words, a potential opportunity for a fish kill, especially during those hottest three or four cloudy days each summer, or late winter in the north with ice and snow preventing natural aeration.

So, how do pondmeisters achieve a balance between nutrients coming into a waterway and the size of the various layers of water?

A 7 acre, 30 foot deep pond was filled with irrigation water (originating from the Yellowstone River) at the research center in Shepherd, Montana. During summer, water temperature at the bottom approached 54 degrees, while the top layer was a balmy 80. Earlier, local Fish and Game officials had recommended stocking with trout. But, because of the volume of nutrients and organic matter in the new pond, we were essentially void of oxygen in a form breathable by fish (anoxic) below a six foot depth. We developed a 24 foot deep hypolimnion (anoxic zone), which represented all of the cool water in the pond. In other words, had we stocked with trout they would have either cooked in the 80 degree top layer, or suffocated anywhere below that.

One note here…we have a situation fairly unique to our part of the world. Much of our irrigation water makes its way into the ponds via ground water. That means the water is used by farmers to irrigate crops. The water absorbs nutrients, especially nitrogen and phosphorus, percolates through the ground and makes its way under the soils and seeps into surrounding ponds…including ours. The irrigation water coming down the ditches from the river also have plenty of nutrients. So, we are dealing with nutrient rich water from the beginning.

Of course we want nutrients in our waterways to allow for maximum fish growth. That's not the problem. The problem is that we have no way to predict their volume or timing.

Here’s our bottom line. The pond in question is fairly deep and nutrient loading can be significant. For healthy, productive waters, top to bottom, this is not a great combination. Even with mechanical aeration/circulation, the stage is set for potential disaster. If aeration/circulation shuts down or breaks down, as the "Stratification" article points out, literally in a few hours oxygen depletion could happen.

Our plan is to circulate water through big volumes of surface area (the wetland effect) in the form of floating treatment wetlands. A 250 square foot floating island provides more than an acre's worth of wetland surface area.

While this sounds like a bit of a stretch, it isn’t.

The islands are made of a nonwoven matrix which provides more than 200 square feet of surface area for every one square foot of top surface. In essence, the inside of the island matrix works just like the surface of a wetland, without taking up such a wide area. Wind and solar aerators mounted on the islands provide localized aeration, supplemented by a series of bottom aerators in the pond. These linear aerators, using bubble tubing, provide roughly 3 cubic feet per foot per hour of fine air bubbles at any depth and are inexpensive. The units are designed by Canadianpond Products and have been used in ponds which actually deal with similar nutrient management issues.

In addition, we have the ability to pump water at three hundred gallons per minute from the deepest zone in the pond a half mile uphill and then use this nutrient rich water for irrigation. In other words, the research farm also operates as a biofilter. Instead of turning too many nutrients into too much fish food, this nutrient laden water becomes farm crops and pheasants. Vertical integration.

Figure 2 depicts another interesting phenomenon associated with the floating islands. When sufficiently thick, even with adjacent aeration, anoxic and anaerobic zones occur within the center of the islands. At the same time, on the outside perimeter of the island, aerobic conditions exist. This means that, just like a natural wetland, the islands can break down all the major nutrients and turn a significant fraction of them into fish food.

That’s significant, folks.

Pondmeisters interested in the study that measured this phenomenon are invited to request a PDF file on "Nutrient Uptake Efficacy of Floating Treatment Wetlands" from Floating Island International, 1-800-450-1088. This study also concurred with other research that measured microbial nutrient uptake, as in biofilm, doing over 80% of the total uptake, with plants handling most of the balance. Consider this as you look at the accompanying photos of floating islands in a wetland….all of that plant growth represents just 15 or 20% of the biologic activity, with the other 80% occurring under water in the form of biofilm production.

At Shepherd, unregulated nutrient loading into our test pond represents a very serious problem. It also presents an exciting challenge. We expect to identify just how much wetland effect is needed to ensure appropriate water quality health in a timely fashion. We are biting the bullet and are installing state of the art equipment for consistent measurement, even some “real time” measurement, of water quality parameters. Key measurements include pH, temperature, dissolved oxygen levels, Biological Oxygen Demand, nitrate, ammonia and phosphorus levels.

We are a research center and this is just the sort of project we enjoy!

It is extremely gratifying to know that folks like Bob Lusk and Bill Cody are tracking these same issues. With all of this energy, and more we have not mentioned, the future is really bright for healthy water and heavy fish!