HPC Talk 12/6/18
Holland's Wicked Problem

Jay True

Intro

Holland has a wicked problem. No, it's not the new marijuana law. It started with Dr Van Raalte and his Reformers. We need to solve it.

Before you get offended or titillated, I should clarify that this problem is wicked in technical and social terms, not moral ones.

Holland's problem is Lake Macatawa, nee Black Lake. Ever since an Allegan judge sold the Dutch refugees on a bunch of swamp land, water quality in Lake Macatawa has been declining. First, let's go way back.

History

About 15,000 years ago, the Canadian glaciers began their retreat in the face of non-anthropogenic global warming, aka the end of the ice age. Over the next 10,000 years or so, they formed what is now Michigan, leaving river beds and glacial moraines; those piles of junk that they had been carrying around. Early on, Black Lake was the outlet of the Grand River, coming right down Chicago Drive. The Grand River relocated to the current route north of Allendale to Grand Haven. The moraines formed the perimeter of a small watershed that exited through the drowned river mouth that the Grand River left.

About 4000 years ago, the watershed of Black Lake, began forming from the soil left behind by glaciers and the rich black muck of the old Grand River bed. The rim near Lake Michigan was predominantly eroded sand driven by wind and waves into the dunes and subsoil around Black Lake.

By the time of the well-documented Dutch arrival, the entire watershed was dominated by forests, swamps, marshes, and bogs. When they arrived, about 15% of the area was wetlands. The native people apparently called it the

equivalent of "Black Lake", but it was dark for a different reason than today. Most of the dark color and bottom probably came from the tannins released by decaying leaves. The various "wetlands" served as important filters for sediment.

The immigrants thought it was their sacred duty, and critical to their survival to clear trees and redeem the swamp land. They found it tough going. Malaria was rampant, transportation was difficult, and they were unfamiliar with felling trees, since their ancestors had pretty much denuded the Netherlands. One story is that they started by chopping around the base of each tree, with unpredictable results as to where it would fall. After some injuries and damage to previously erected structures, they learned from local loggers how to aim their tree falls. Over the next several decades, thousands of acres, and perhaps a million trees were cleared.

At the same time, the settlers were working on another project that they were better suited for; dewatering. They channelized the swamps, marshes, and bogs, straightened waterways, and even built a few dikes.

Along the way, they rid themselves of a few pests; mosquitoes, snakes, and native Americans, the Ottawa Indians who fled north.

By the late 1850's, they seriously wanted a navigable channel to Holland. They succeeded in re-directing the exit of the lake from its original shallow path through Holland State Park to its current alignment. Their efforts were not particularly successful, only lasting a season before the hand-dug channel silted in. With the aid of Army Engineers starting in 1867, permanent shoring was installed, and annual dredging was implemented, which continues to this day.

By the beginning of the 20th century, they had achieved clear dominion of the area. They were also using the river and lake as a toilet, counting on the flushing action of rainfall to take it to the big lake. Unfortunately, Black Lake had been created by the Grand River, draining a 6000 square mile watershed and by then it was fed by only 175 square miles of watershed runoff. It takes an average of 77 days for the water in Lake Mac to turn over.

Things were deteriorating. Black Lake was no longer clear and black; it was becoming more brown-green-ish and opaque. All the clearing, channelizing and straightening mainly succeeded in speeding up the water, increasing its sediment carrying ability. In addition, human waste was going into the lake from Zeeland, Holland, and septic systems. Last, but not least, industrial wastes came from sawmills, tanneries, shoe factories, a power plant, a pickle plant, gravel yards, furnace works, ship builders, furniture makers, a paint factory, food processors, and even a scrap metal yard.

By the 1930's, degradation was evident. In the interests of differentiating their lake from the other Black Lakes in Michigan and perhaps to divert attention from its condition, the community leaders came up with renaming it Lake Macatawa.

Post WW II, when we were making America great the first time, things were booming in Holland. But there were signs of distress; fishing was declining and there were more algae blooms and some e-coli contamination incidents. Holland got its new sewer treatment plant in 1962. In 1971, Lake Macatawa had the dubious distinction of making a national list of "Problem Lakes in the US".

Across the country, there were signs that freshwater resources were being polluted beyond their capacity to recover. Flaming rivers, dead lakes, and health concerns led to the passing of the Clean Water Act of 1972. Standards were set, and the EPA began studies of many water bodies, including Lake Mac.

So, what does this mean to us?

It took us less than 125 years to severely damage an ecosystem that had been stable for several thousand years. Despite 45 years of supposed repentance since then, little headway has been made. Repairing the damage won't be easy, cheap, or fast. This is a sign of a "wicked" problem. Before we explore what has been done and what we need to do, we should understand how this pollution is measured and the watershed works.

To scientists, lakes come in three main flavors; oligotrophic, mesotrophic, and eutrophic. They are always moving very, very slowly from oligo- (few

nutrients)-with few plants and lots of dissolved oxygen, toward meso-(moderate) with more plants, to eu-(excess nutrients) with poor clarity and limited dissolved oxygen. When the Dutch arrived, Lake Mac was mesotrophic, at worst. Today, about 25% of Michigan's inland lakes are oligotrophic, 52% are mesotrophic, and 23% are eutrophic. Lake Mac is extremely hypereutrophic, usually 5 to 10 times more polluted than a merely eutrophic lake. We have dramatically accelerated the natural aging of the lake.

The primary criteria for classifying lakes are total phosphorous, chlorophyll-a, and Secchi transparency. The three variables are linked causally: Excess phosphorus, especially soluble phosphorus, encourages algae, which raises chlorophyll-a, and reduces transparency. In a eutrophic lake, phosphorus is > 20 ug/L, chlorophyll-a is > 6ug/L, and Secchi transparency is less than 7.5 ft. In fall of 1972, per the 1975 EPA report, the levels in Lake Mac for phosphorus were 175 to 212, chlorophyll-a were 22 to 60, and Secchi transparency was 9" to 3'. As the algae feeds on the phosphorus, it chokes off light for deeper water plants. Eventually the orgy ends, the algae dies from lack of light, and bacteria take dissolved oxygen from the water to decompose it. Fish have neither air nor food. They die.

Lake Mac has a perfect storm of pollution; water runs off farms and hard surfaces rapidly on a short trip to the lake, carrying both soluble phosphorus and phosphorus attached to sediment. All it takes is a warming lake for a major fish kill like the spring of 2007.

Before you get too depressed, with few exceptions, Lake Mac has lesser levels of pollution like arsenic, mercury, DDT, Lead, PCB's, etc. The various industrial wastes have largely been sequestered in the sediments or gone to Lake Michigan and been diluted. Hope College continues to study these and other pollutants in Lake Mac. For example, they have recently documented dangerous levels of copper, lead and cadmium in fish caught at marinas on Lake Mac. Still, the Kalamazoo, Grand, and Muskegon Rivers all have bigger problems than we do on this score.

The frustrating search for a fix

In the early years after the Clean Water Act of 1972, most efforts were expended on the low-hanging fruit, not only in Lake Mac, but around the country. Point source pollution is generally easier to measure, regulate, and improve. Here in the Lake Macatawa watershed, the industrial sources either closed or implemented control measures and both sewer plants upgraded their processes. In 1997, when average phosphorus was down to 125 ug/L, the point sources of phosphorus were down to less than 10% of that total load. In 1997, the MDEQ set a new goal of 50 ug/L by 2009. Unfortunately, 1997 was an atypical year.

Macatawa Area Coordinating Council (MACC) was tasked with reaching the goal, but the strategy was vague, and funding was unclear. To make things worse, the point loads were expected to rise by about 67% so the reduction in non-point loads would need to be 72%. Sediment was expected to also drop as a result of unspecified Best Management Practices (BMP's). By mid-2010, levels of phosphorus had been higher most of the years since 1997. This is another factor that makes this a wicked problem; measurements taken at a single point in time do not guarantee a trend. It was acknowledged in a new agreement between MACC and now the MDNR

that the targeted reductions had not been reached and that a more expansive (and probably expensive) plan would be submitted. The wicked problem was resisting a solution.

Enter Project Clarity (which I may refer to as "PC")

Origins

With the new agreement, it was evident that major campaign was needed. In 2012, our current Secretary of Education, Betsy DeVos was paddle boarding during an algae bloom and saw up close how polluted Lake Mac was. That led to the DeVos's and Jim & Donna Brooks funding a study of the problem and potential solutions. As I understand it, there was bad news and good news; the lake has big problems, but the small size of the watershed means they can perhaps be solved. They set out to raise the $12,000,000 suggested budget for

a 10-year effort including 5 years of active improvements to wetlands, phosphorus interception, two-stage ditches, and urban runoff.

Funding

Over $11,000,000 has been raised. In round numbers, this is where the funds have come from:

$5,000,000 – Individuals (580 separate donors)

$5,000,000 – Businesses

$2,000,000 – Government (some still in pledges)

Spending

Of that, more than $8,000,000 has been spent, leaving less than $4,000,000, including $3,000,000 earmarked for an endowment to monitor, maintain, and manage.

The Major Players

The Executive Committee is led by the major donors and other representatives of the community and government.

MACC/Macatawa Watershed Project serves as the conduit for, and solicitor of grants, as well as doing extensive reporting and ag outreach.

Outdoor Discovery Center (ODC)/Macatawa Greenway Project is a 501(c)3 non-profit that owns property and contracts for the various improvement projects using most of the PC funds.

Annis Water Resources Institute (GVSU) does ongoing research and takes timely measurements of the watershed.

Hope College does a broad range of research projects and gives students opportunities to get hands on experience in field work.

Niswander Environmental provides design and implementation of engineering solutions like 2 stage ditches and constructing the new wetlands.

Progressive AE provided initial advice on active removal techniques. More on that later.

Findings

The simple answer is to blame it on the farmers because much of the sediment and phosphorus comes off their fields. The more nuanced answer is that residents, streets, and commercial development also contribute significantly to the problem. If water flows slower, more settles out. It also gives the phosphorus a chance to sequester in the weeds. Dealing with sediment is obvious, but phosphorus is a pesky problem. It is an important nutrient to encourage healthy plant growth and is found in all plants. So, a leaf that falls in or travels to the lake releases phosphorus as it decays. Urban and suburban development contributes with increased run-off, higher peak flows, and introduces several other contaminants.

First Steps

The team of MACC, ODC, and the Executive Committee knew that maximizing the return on investment was the key. They identified nine areas of the watershed with decreasing impact on the lake. They have wisely concentrated their efforts on the highest ones.

Farmland & Farmers

PC does not want to alienate the farmers by blaming them. They work through an Ag Coordinating committee to encourage cooperation and innovation. They have pursued grants and used project funds to help farmers afford improvements like two stage ditches, gypsum, and no-till practices with cover crops. In terms of lost area, two-stage ditches take about 2 acres per mile. Gypsum and cover crops cost perhaps $50-$100/acre/year. MACC's Ag Technician has leveraged his contacts with the agronomists in the ag retail arena whom farmers trust. The agronomists deliver the message instead of the always-dubious "I'm from the Government and I'm here to help." This also helps the retailers sell more gypsum and cover crops since PC rebates reduce the cost for the farmers. He has clearly focused on the highest priority areas in the watershed even though some of them are in Overisel Township, not a MACC participant. His best moments are when the farmers share their success stories and when their neighboring farmers wonder why other guy is harvesting sooner or his crops look healthier. Looking at the long-term, if

farmers keep losing 7,000 tons of sediment each year, they eventually must be replaced by more, expensive fertilizers. Another promising strategy is using technology to precision apply fertilizers in only the needed amounts to different parts of each field, saving the farmer money and reducing run-off of excess nutrients.

Wetlands

Since settlement of the area, 87% of the wetlands found in an 1832 survey are gone. In an important first step for PC, Dick Haworth donated a 72-acre parcel along the river of which 42 acres were restored into a wetland, slowing the water down and allowing the nutrients to settle out. A similar, 15-acre, wetland was constructed along I-196 in cooperation with MDOT. Their effectiveness is not yet proven since changes like this can take several years to be confirmed. Even wetlands constructed earlier, like Paw Paw and Stu Visser, have shown ambiguous results in phosphorus removal.

Urban/Suburban Development

The impact of urbanization on the ecosystem is undeniable but even harder to quantify and mitigate; another wicked part of the problem. There are many ways we have contributed to the runoff of phosphorus and other pollutants. We have also built about 15 miles of steel seawalls around Lake Mac. These seawalls frequently extend 10 feet or more out into the lake from the original high-water mark. I concluded that by how much they protrude past the few natural shore areas and by comparing property corners to the seawall locations. So, the buffering effect of sandy beaches and grasses is gone from 90% of the shoreline, plus the lost wetlands behind them that were the last defense against sediment. Roofed areas, driveways, streets, even patios reduce the ability of the ground to absorb water which increases and accelerates runoff. Even boating on the lake, with wakes reflecting off seawalls, increase churning and turbidity in the lake like an agitator washing machine. And, we paid our drain commissioners and public works departments to speed the water away for many years. Fortunately, MACC is encouraging local jurisdictions to adopt low impact development policies, new ways of

dealing with storm water like rain gardens, bioswales, permeable pavements, and retention.

Progress So Far

There are some encouraging trends in both the farmers' acceptance of BMP's and some of the other markers that the project tracks. Most landscape maintenance companies on the lakeshore have committed to avoiding fertilizers containing phosphorus. There has been a major push for awareness and education through both MACC & ODC. During steady state conditions, we are meeting the goals. Wickedly, every major storm or rapid snowmelt sends the phosphorus and sediment through the roof. Project Clarity has run through much of its budget and a clear trend is hard to discern. Large year-to-year variances make it hard to be sure we are making progress. Even if the constructed wetlands do show promise, more are needed. It will be difficult and expensive to find good sites to replicate them. With much of PC's funds spent, we are faced with a conundrum; double down or wait and see. At best, I see the PC efforts achieving "less murky", rather than clarity. We are coming up on the next milestone in 2020. Even if we meet it, Lake Mac will still be very eutrophic (50 ug/L) instead of extremely hypereutrophic.

So, why should we care?

It's like mowing your lawn. Do you really want to have the ugliest lake in the state? From an economic perspective, a cleaner Lake Mac will attract more people and business, both to live and recreate. Even if you don't want more neighbors, will you do it for the fish? For Lake Michigan, our water supply?

What's Next?

There is little doubt that Lake Mac is healthier than it would have been without PC and the many complementary efforts going with it. But, what will it take to really heal Lake Mac? Wickedly, it's hard to know. Project clarity has already extended its timeline to 5 more years of implementation and 10 more years of monitoring. One of the most perverse things with environmental problems is that it takes many years to find out if what you did works. If we sit back for a

while and see what happens, tons of phosphorus laden sediment will journey to Lake Michigan. Unfortunately, it is likely that the best we can expect with what has been done is some incremental improvement, on an average year. So, let's talk options.

Worst case scenario

We can try to undo all the harm that has been done. First, we evict about 125,000 people. Then we spend $50,000-$200,000 per acre to return the land to a state where nature can start restoring itself. We close the channel. Then, we wait 100 years to see what happens. The price tag would be at least a billion dollars and could be ten billion dollars. Now, that's a wicked solution to a wicked problem.

Other solutions

The key is reducing the supply of nutrients. In this case, phosphorus. Of course, we also want to reduce the sediment and other contaminants.

One exotic idea was considered to intercept the water in the river before it reaches Lake Macatawa and treating like sewage, using alum to flocculate the phosphorus and sediment. The wicked part is that the base flows already meet the target standards, although they could be cleaner. It is the high flows during spring thaw and post-rains that can be up to 10 times the volume with much higher levels of phosphorus and sediment. Progressive AE estimated 5 years ago that such a plant would cost $7-8,000,000. And, where we put it? Windmill Island?

Starting at the upstream end, expanding implementation of the agricultural BMP's (grassed waterways, 2 stage ditches, cover crops and gypsum) will be an important step. Many of these practices can become self-sustaining over the long haul. The goal of eliminating surface application of phosphorus (particularly in the form of manure) should be considered. The soluble phosphorus in drain tile lines may be reduced with iron slag filters once you find the outlets. A test of this technology is slated for next year. Somehow, these measures must be implemented without bankrupting the farmers.

Subsidies far in excess of current grants and PC's funds will probably be required.

Beyond the farms, creeks need to be restored and two stage ditches need to be extended, monitored, and improved to reduce both phosphorus and sediment. This means the county drain commissioners will need to be on board, take more land, and have bigger budgets. Plus, the water needs to be slowed down with in-stream engineering. Again, over the long haul, slower water means less erosion and ditch dredging, reducing maintenance costs.

If the man-made wetlands work, substantial expansions will depend on finding appropriately located land and willing or enticed owners. Fully replacing the lost wetlands is monumentally difficult, involving about 13,000 acres. We need to figure out where is best and how much is enough.

Suburban residents can do their part by avoiding phosphorus fertilizers, slowing runoff, and not introducing other pollutants, like from bottom paint. MACC has developed some great materials for residents.

Some pollution and accelerated water flows are from urban development concentrated near the lower river and lake. The best fixes for this fall in the categories of low impact development, green infrastructure, and stormwater retention. Continued verification of industrial pollution is needed too. Fortunately, all these measures are well understood and proven technologies. Unfortunately, they will take broad buy-in and lots of money.

Improving the lake ecosystem itself is particularly pesky. Perhaps storm drain outlets at the lake can be baffled or filtered. Reducing the impact of 15 miles of seawalls is going to be difficult. Again, the technology is well known. At a minimum, buttressing seawalls with riprap is a first step. Removing them is better but problematic due to loss of cherished outdoor areas, undermining structures, and the impact on neighbors who don't participate.

So, that is our wicked problem. Now for some speculation and hope.

Funding the solution

I have given this some thought from the perspective of equity and practicality. I don't think we can count on the federal or state government for much help, just critiques. How to pay for it locally can be debated. You probably can't directly charge the tourists, boaters, or fishermen enough to make a dent in the problem. I doubt the farmers are willing or able to carry the whole burden. Waterfront property owners certainly have contributed in a small way and stand to benefit from better water quality, but would resist paying for a problem they have played a small part in. (these are OPM solutions). Increasing sales tax or the flat rate income tax would be regressive, burdening those least able to afford it. It is possible that higher development standards and property taxes on those in the watershed are an equitable way to share the load. The farmers, businesses, and waterfront owners would rightfully pay a larger share due to their property values. Everyone will derive some social and economic benefit from a cleaner lake. I admit it's not perfect but a starting place. It is like that with wicked problems.

A reason for hope

In the course of my research, I interviewed a number of people on the front lines of the PC effort. They were all young, caring, bright, well informed, thoughtful, and realistic yet optimistic. Given the right tools, I think we can make big progress in their lifetimes, if not ours.

I hope I've made myself perfectly clear.

If not, I'll be glad to take your questions.