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The Ohio Water Table

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Brewing Biogas in the United States and China

By Karen Mancl, Ohio State University (reprint from New Security Beat)

Marmite, a popular food spread developed from yeast at the Burton on Trent brewery in west-central England, is a by-product of brewing beer. The sticky brown food paste adopted the marketing slogan "love it or hate it," hinting that its strong flavor is an acquired taste. For centuries, Burton on Trent brewed beer, but it has now gained another valuable brewing by-product in addition to Marmite—methane biogas. In 2008, the brewery built an anaerobic digester that converts the beer waste to methane, which is then burned to heat boilers to make beer.

More than twenty–five times more powerful than carbon dioxide, methane is an abundant greenhouse gas and thus has a significant impact on the world's climate. China is the world's largest emitter of methane. Methane is formed when organic matter, like food or beverage waste, is decomposed by microbes without oxygen through a natural process called anaerobic digestion. Methane biogas is natural gas and can be burned directly for heat or put through an engine to produce power.

China also has the largest beer market in the world, producing 4.6 billion liters per year, compared to the United States' brewing 2.9 billion liters. In China, the United States, and all around the world, breweries are seeking ways to decrease their environmental footprint while increasing production and profits. Every step in the beer–making process generates waste. For every 1,000 tons of beer, about 150 tons of solid waste are produced as spent grains and waste yeast. Brewing is also energy intensive. The energy needed to produce, package, and distribute 15 barrels of beer could provide a U.S. household with electricity for 1 month.

Source: New Security Beat

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Inside this issue:

President's Column

Eugene Braig, WMAO 2020-2021 President

Given the theme of this issue and current state of business in general, I think I'll open this column with a quote (quoting myself, of course) from the spring 2020 issue of The Ohio Water Table: "At present, my own work—teaching coursework, misc. meetings…even presenting for diverse groups—is entirely conducted from a stool in front of a laptop on a stereo stand in the hinterland between my mudroom, great room, and kitchen." In the current COVID climate, this still largely holds.

The current campus shutdown finds me exiled from my office and its phone. However, I'm still eager to offer my typical consultation services to pond owners and those who manage recreational fisheries. As such, in May, I implemented open "clinic" hours using Zoom. At a designated time each week, I open a Zoom meeting "space." Extension clients can log on to discuss their water management issues with me directly (ordinarily related to pond-/lake-management or fisheries). If more than one client is logged on, they are held in a virtual "waiting room" until I admit them one at a time, ensuring that each client is addressed privately, confidentially (just in case your pond-management issues are a confidential concern). If you're curious, you can find details on this page: https://senr.osu.edu/extensionoutreach/ponds-fisheries-aquatics/open-pond-clinic-zoom.

The experience has been interesting and largely successful. Initially, I was worried that I might be overwhelmed with more enquiries than I could handle in just two hours during any given week; that hasn't been the case. I'll typically have three or four per week, each typically taking approx. half an hour to talk through their issues and come to some kind of management recommendation. This is sometimes facilitated by e-mail correspondence in advance. Only once did nobody log on at all, occupying two hours of bandwidth time doing essentially nothing.

There have been some connection issues involving the limitations of whatever devices clients are using (or trying to use) to connect to the meeting space. Once, I was a victim of the Zoom equivalent to the "butt dial" where a client clicked the link to connect evidently without being aware of having done so. That particular event had me enjoying what I believe was a view of an automobile interior from the perspective of a smartphone looking out of a handbag on a passenger seat. Weird.

My work ordinarily involves a great deal of travel, in-state for consultations, to put on county-based workshops, and occasional programming at Ohio State's Stone Laboratory as well as abroad for misc. conferences, advisory meetings, etc. In addition to WMAO's annual conference, I had organizational roles in the American Fisheries Society (AFS), North American Lake

"….Cleveland (Ohio) was home to the first fish hatchery thanks to naturalist, plastic surgeon, sculptor, photographer, archeologist, civil-rights activist, and all-'round awesome dude, Theodatus Garlick [1805–1884]."

Management Society, and Upper Midwest Invasive Species conferences originally scheduled through summer and fall 2020. My own travel is restricted and every one of those events has been commuted to virtual/online.

Of these, the AFS was the most disappointing loss. This is a big conference, drawing an international audience of literally thousands of professionals. And the AFS had chosen Columbus, OH for its 150th anniversary celebration! The opportunity to present the state's strong history with fisheries management to a large international audience was exciting. (Not many know that Cleveland was home to the first fish hatchery thanks to naturalist, plastic surgeon, sculptor, photographer, archeologist, civil-rights activist, and all-'round awesome dude, Theodatus Garlick [1805–1884].) That opportunity is now delayed by several to a less meaningful date, but rightly so in the interest of human health, of humanity.

Of course, virtual attendance tends to be much easier on multiple fronts than in-person attendance, the latter involving expensive registrations, travel, lodging, meals abroad, etc. Virtual attendance is also more environmentally friendly. Virtual participation allows selective piecemeal involvement by personal/professional interest areas from anyplace at (ordinarily) substantially reduced registration fees. Still, I'd be lying if I claimed that I didn't miss the camaraderie of networking opportunities with my professional colleagues and friends. I'd be lying if I claimed that a computer screen was as successful in engaging my professional attention as a fellow human being at a podium and sharing real space with my person.

In any event, if you have questions about the planning process for any of these events, for WMAO's own annual (and, this year, virtual) conference, their miscellaneous successes and challenges as they come to unfold in time, or regarding my own open clinic hours, I'd be overjoyed to Zoom (or MS Teams, Discord, Google Meet, Skype for Business, etc.) them with you. Let me know as I can be of service. I thrive on it.

WMAO 49th Annual Conference

November 2 - 5, 2020

Sessions will be held remotely throughout the week

in coordination with our divisions, sponsors, and multiple partners.

Clean, Safe Water

CALL FOR ABSTRACTS

Deadline Extended to August 1st.

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Anaerobic digestion is a natural choice for breweries, as explained by Nick Matt of Matt Brewing Company in Utica, New York. While anaerobic digestion can be touchy, requiring the management of heat and pH for maximum methane yield, by the nature of their work, brewers already possess the skills to monitor and adjust the biological process.

Conservation as a Core Value

Brewers in both China and the United States face few special regulations or requirements for managing their waste, but wastewater treatment surcharge fees and hauling costs for disposal are high and increasing. Across the United States, breweries have found ways to convert their waste into a resource. Anaerobic digestion with methane capture reduces pollution, all the while cutting energy costs as a part of the core philosophy of environmental stewardship at breweries.

Magic Hat Brewery in Vermont, whose slogan is "saving the Earth, one beer at a time," is converting waste hops, barley, and yeast into methane via a $4 million digester. Processing in the digester has reduced the brewery's wastewater treatment bill by eliminating $600 per day in surcharges.

From its start in 1980, Sierra Nevada Brewing Company in Chico, California was a resource-conscious company. As a large craft brewer, recycling 99.5 percent of its materials, Sierra Nevada's efforts are supported by the PG & E Climate Smart program, which purchases greenhouse gas emission reductions. Their anaerobic digester captures 2,265 m3 of methane—the equivalent of 13 barrels of oil—each day to power their boilers.

These are just two examples of U.S. breweries harnessing the power of turning waste into resource. In other states, such as Wisconsin, business-government partnerships are taking advantage of this energy opportunity as well. Starting in

2008, Gunderson Lutheran Health System in La Crosse, Wisconsin started to develop renewable energy projects with the goals of being energy independent and reducing harmful emissions linked to disease. In a unique partnership, and with the support of a statewide energy efficiency prgram called Focus on Energy, they are working with City Brewing Company to convert brewery waste to biogas to electricity.

Anheuser-Busch is recovering biogas at 10 of its 12 U.S. breweries, making the company the largest operator of anaerobic digesters in the world. In 2008, their Merrimack Brewery in New Hampshire received the Governor's Award for Pollution Prevention. Biogas generated at their Fairfield, California plant supplies 15% of the brewery's energy needs.

Anaerobic digester in a Chinese brewery (Photo courtesy of Budweiser China)

China's Commitment to Methane Capture

In 1967, the first biogas digester was constructed at a Chinese distillery in Nanyang, Henan Province. The Tianguan alcohol plant now captures enough methane to provide fuel for more than 20,000 Nanyang households, 20 percent of the city's population. Alcohol and winery wastewater now account for over 55 percent of China's industrial biogas capture.

Back in 1979, the Chinese Ministry of Agriculture established the Biogas Institute (BIOMA) in Chengdu, Sichuan Province. For 40 years, the national government has supported research, training, demonstration, and technology development. In 2010, China's Ministry of Environmental Protection went on to issue Cleaner Production Guidelines for the brewing industry. These guidelines formed a framework to provide environmental and public health protection while facilitating economic development. Under the guidelines, Tsingtao Beer signed a low-carbon research agreement with the China National Institute of Standardization and China Quality Certification Center. The company invested 124 million RMB—about $17 million USD—to study energy savings and emission control.

Like in the United States, Budweiser APAC (a subsidiary of Anheuser-Busch–InBEV) in China has a sustainability program with a commitment to climate action. In an interview, Terry Yao, Director of Sustainability for AB–InBEV China, shared that in Budweiser China, 19 of their 29 Chinese breweries capture biogas to provide heat for the brewing process. Two of the breweries, an old one in Harbin and a new one in Jishui, have both won Green Manufacturing Awards. Budweiser China set a goal in 2018 for their breweries to abandon coal and convert the entire operation to renewable energy and natural gas by 2025.

While both the United States and China have government programs to support biogas capture in agriculture, that support does not extend to food and beverage processing. The brewery industry is on its own and must instead look at anaerobic digestion of their wastes as a part of their business plan. International companies like Anheuser-Busch that brew in both the United States and China have set corporate environmental sustainability goals. Smaller, U.S. craft breweries are the most innovative segment of the industry. Some of these small breweries are partnering with utility companies to capture biogas to reduce their power demand and even feed into the power grid.

The brewing industry serves as a role model for other food and beverage processors. Methane capture is one innovative way they can increase energy efficiency, recycle their waste products, and reduce greenhouse gases. Brewers capturing methane can be a win for breweries and for the environment.

Ohio Water Education Program (OWEP)

State Science Day Student Winners of 2020 WMAO Award

By Rick Weber, WMAO State Science Day Committee

The Ohio Academy of Science conducted the 2020 State Science Day this year as a virtual fair due to the outbreak of the Coronavirus (COVID-19). All judging was completed on-line the first week of June. The student participants uploaded videos of their presentation, pictures of their project board and their project report. The judging function was accomplished using a system that was already in place (STEM Wizard.) Nineteen students requested to be judged for the two WMAO awards: 14 were in the lower 7th - 9th grade category, and 5 were in the upper 10th - 12th grade category. The Peter G. Finke Water Management Award in each grade category includes a $250.00 check, a plaque, recognition in WMAO's "The Ohio Water Table" publication, and an invitation to the WMAO Annual Conference in November. Peter Soltys, Zach Smith and Rick Weber did the judging this year for WMAO.

The WMAO 2020 State Science Day awardee in the lower grade category is **Alice Lentz**, a 9th grade student at Put-in-Bay High School. Alice's project was entitled "The Effects of Salinity on GMO Arabidopsis." Alice formulated the idea for a project from her understanding of global warming. Living on South Bass Island, Alice was able to observe firsthand the effects of global warming on the water level of Lake Erie. She learned that global warming was causing elevated surface water levels around the world and unpresedented shoreline erosion. Alice realized that many plants and organisms will die from salt stress as the salinity increases in their habitat. She hypothesized that genetically modified plants could mitigate the increased salt stress on native plants along shorelines and in backwater areas. Her project involved three Arabidopis plant strains: one of which is a wild-type known as "Columbia" and two other genetically modified lab strains known as "abi5-1" and "sos1-1". Each of these three have different salt tolerance levels.

Arabidopsis thaliana is a small dicotyledonous species, a member of the Brassicaceae or more commonly known as the mustard family. Alice's experiment exposed each of the three strains of Arabidopsis to three different salt solutions. Each plant was watered with a solution labeled Ocean Salinity: 1.022 on a salinity meter (`35 practical salt units = 1.026). The next trial used a salt solution labeled Brackish Salinity: 1.012. The third trial used a solution of distilled water with no salt added, labeled Control. Each plant was watered using a 1ml pipette. Each solution had a dedicated pipette to eliminate cross-contamination. Plants were watered every other day and placed under a grow light.

At the end date of the experiment data were collected and grafted of the number of leaves grown and the length of the longest leaf on each plant. Conclusions were drawn on the success of the experiment based on the data. Alice concluded that by using the three different solutions with salinities simulating salt, brackish, and freshwater on the three inividual strains of Arabidopsis, there were observable differences in the salt stress tolerance of each plant. All three strains were able to grow using the freshwater solution. None of the strains were able to germinate using the water with a salinity of 3.5% or more. Only the Columbia and abi5-1 strains were able to grow in the brackish water. The abi5-1

strain plant grew one more leaf and had a leaf that reached 0.15 cm longer in length than the largest leaf of the Columbia plant using the brackish water to germinate and grow. The Columbia plant however, showed symptoms of salt-stress.

Alice supported her hypothesis. She demonstrated how valuable genetic modification can be to the survival of plants in our changing world. Alice demonstrated a thorough knowledge of her project and made effective use of the scientific method. Alice's science teacher at Put-in-Bay High School is Mrs. Missi Kowalski.

The WMAO 2020 State Science Day awardee in the upper grade category is **Emily Stevens**, a 10th grade student at New London High School. Emily's project was entitled "The Use of Wool to Control Sediment and Phosphorus Loss for an Ohio Soil." Emily, a farmer's daughter knows very well a persistent serious problem facing most farmers: topsoil and nutrient loss from soil erosion. Globally, it is estimated that 75 billion tons of soil erodes annually. Soil erosion can also contribute to phosphorus transport, which can lead to impaired water quality. Agricultural officials have been looking for best management practices to minimize soil loss and phosphorus runoff for years.

In Ohio, some of the best management practices available include reducing tillage, managing crop residue, maintaining grassed buffer zones, using cover crops, adjusting for row width/direction, and applying mulch to aid in preventing soil loss. Few are cheap and efficient. One such cheap and efficient way to prevent and minimize soil erosion is wool. Wool is a natural fiber, biodegradable, and even has some nutrients (nitrogen) that can enhance soil. In New Zealand, use of bio wool mats help with erosion control in landscaping and urban engineering. Emily's project objective was to evaluate if wool can be a tool used to prevent soil erosion in Ohio. Emily maintains a small sheep flock on her family farm.

The experiment was conducted using soil from her farm, a Bennington Silt Loam. Runoff trays with soil were packed with wool and placed under a programmable rainfall simulator. Three different wool types (medium, fine, and long) were used as variables. Surface runoff, sediment loss, and percolation filtrate were collected over a 30-minute time period with measurements taken at five-minute intervals. The volumes of all water were collected and quantified, as well as the total weight of sediment loss for each wool type. Total Phosphorous water quality analysis was performed on all sediment and water samples. Results of the study show that wool can reduce surface runoff as well as allow for greater water infiltration into soil under an intense rainfall event. All wool types in her study reduced cumulative sediment loss when compared to a control of bare soil. Soil erosion was reduced by upwards of 66% when wool was applied, with the medium wool type reducing soil erosion by >90%. Similarly, total P losses were reduced by upwards of 30% when wool was applied, with medium wool reducing phosphorus losses by almost 93%. It was apparent by her research that wool assisted to reduce the energy of the rainfall, thus causing less soil disturbance. In addition, soil erosion was minimized allowing more water to infiltrate into the soil. With more infiltration, there is less surface runoff to carry nutrients away. Nutrients remain in the soil and do not transport to bodies of water to impair the water quality. With additional research and product development, Emily believes that wool can be a viable erosion control measure. Wool could be a natural, affordable, and sustainable conservation practice that farmers could implement in the future.

Emily had an excellent understanding of the problem domain, having included nuanced environmental details in the experiment and making insightful quantitative and qualitative assessments of the outcome. Her report was well researched and the topic was locally relevant, proposing a creative solution to a persistent agricultural problem. Emily's science teacher at New London High School is Mr. David Kamm.

River Bugs and Stream Quality Monitoring

By Christine Szymanski, Ohio Scenic Rivers Program (Reprint from EECO newsletter)

If I were to ask you to tell me how healthy a river is, what factors would you consider? Would you suggest we look at the water chemistry to determine if it was polluted? What if I told you, "Pick up a rock."

When our Scenic River Program takes members of the public on an exploratory river journey during our Stream Quality Monitoring Workshops, the sentiment is often, "Wow! I had no idea so much life was in the river!" In 2019, over 12,000 Ohioans participated in our stream programs to learn how to quickly determine water quality by the types of macroinvertebrates that live in and among the rocks on the bottom of a stream.

What is a macroinvertebrate? If you break the word up into its parts, it becomes clearer. "Macro" means large—so something large enough to be seen with the naked eye. "Invertebrate" is an animal without a backbone. Examples of macroinvertebrates include snails, worms, crayfish, and the aquatic larval stage of terrestrial insects like mayflies and dragonflies.

To find the animals, we teach participants how to read the river to determine the best place to kick seine for macroinvertebrates. The main features we discuss are pools, runs, and riffles. The pools can be identified by the still surface of the water and they provide refuge for big fish from predators—but it's too deep to use our net, the 3' x 3 ' kick seine! The run comprises the long sections of fast moving water, but these are also too deep for sampling.

The sweet spot for kick seining occurs in the riffle—the shallowest but swiftest part of the stream. It is here that the water's surface breaks over rocks, creating the visual of white caps. This disturbance at the meeting of the water and air creates a mixing of oxygen into the stream. It is because of this phenomenon that we can find the more sensitive organisms living in this area. If we kick seine here, in the best habitat for sensitive animals, we can assess the stream's health based upon the assemblage of macroinvertebrates we find—or don't find.

A healthy stream will have several types of sensitive organisms like mayflies, stoneflies, caddisflies, and hellgrammites. But it will also have animals that are less sensitive, and even those that are tolerant of pollution. Ideally, we want to find many different types of animals which demonstrates a high level of biodiversity and a functioning food web. The fewer types of animals we find, the fewer possible links in the food chain can exist in that location. You see, the insects that we find among the rocks become food for other insects and fish, and then food for larger fish, which in turn become prey for kingfisher, herons, and eagles. Beyond that, if the insects survive their larval stage, they complete their metamorphosis and become winged adults. When they emerge from the stream, they become a vital food source

Central Ohio Scenic River Manager, Heather Doherty, checking under a river rock (source: ODNR)

for birds, bats, and spiders. So much other life hinges upon the survival of the small bugs living among the rocks at the bottom of a stream.

After participating in Workshops, citizens have the opportunity to become volunteers for the State and monitor a state scenic river site three times a year. Their observations act as the "canary in a coalmine." If they find sensitive organisms and a healthy biodiversity of other animals, we can assume that the stream is functioning well. On the other hand, if their sample turns up less organisms than usual, the Division will investigate further. Potential impacts to the stream can be mitigated because of the observations by community members—these citizen scientists.

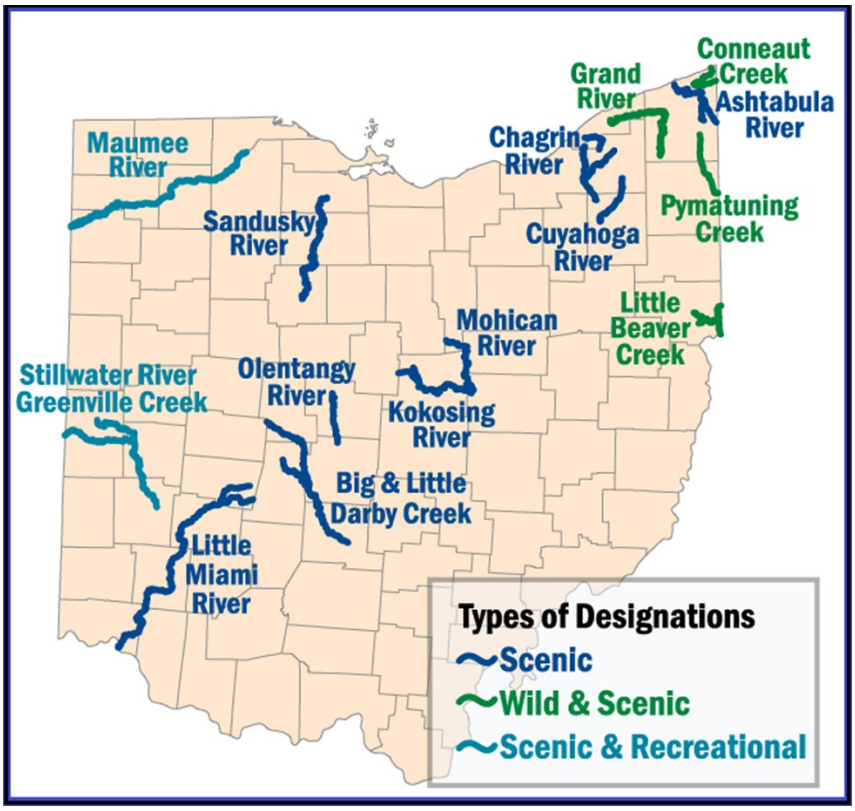
Central Ohio Stream Quality Monitoring Coordinator, Christine Szymanski, in a riffle (Source: ODNR)

If you are interested in attending a Workshop or would like more information on our program, please visit http://watercraft.ohiodnr.gov/scenicrivers . Some programming is delayed due to current Covid restrictions, but we will continue to update our online calendar as the situation progresses.

Participants identifying macroinvertebrates at a Workshop (source: ODNR)

As we wait for group programming to return, please check out the Ohio Scenic Rivers Children's Activity Book. Inside you'll discover more about the amazing animals that call the Scenic Rivers home.

ODNR intern, Sadie Lankenau, holding a hellgrammite larva (source: ODNR)



Over 800 miles of streams in Ohio are designated with protection under the Scenic River Law (Source: ODNR)

Water Management Association of Ohio
$1,000 Student Scholarship

Application Deadline has been extended
September 1, 2020

Eligibility Criteria

WATER MANAGEMENT ASSOCIATION OF OHIO

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Chagrin Falls, OH 44023

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The Water Management Association of Ohio (WMAO) is the one organization dedicated to all of Ohio's water resources.

VISION: To be recognized statewide as the go-to community for people who manage and safeguard Ohio's water resources.

MISSION: To support Ohio's water resource professionals with essential information, education, and networking opportunities

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