2015 volume 2

Aquatic Sciences Chronicle

UNIVERSITY OF WISCONSIN SEA GRANT INSTITUTE UNIVERSITY OF WISCONSIN WATER RESOURCES INSTITUTE

INSIDE:



Epic Project



Science Is Child's Play



Goby vs. Goby



VACCINE MAY PROTECT FISH FROM DEADLY COLUMNARIS DISEASE

Curbing Columnaris

t's insidious, it's unpredictable and it's one of the biggest threats faced by any freshwater aquaculture operation. *Flavobacterium columnare*, the bacteria behind the dreaded columnaris disease, can move with frightening quickness, leaving tanks of dead trout, perch and catfish in its wake.

But here's the good news: Professors Mark McBride and David Hunnicutt are discovering some of the bacterium's weapons, and, thanks to research funded in part by Wisconsin Sea Grant, they're several steps closer to developing a vaccine that could neutralize them.

McBride, a professor of microbiology and molecular biology at the University of Wisconsin-Milwaukee, spent years studying Flavobacterium, honing in on the basic biology that allows it to wreak havoc in aquaculture systems and in the wild.

Years of research revealed that Flavobacterium cells have a novel secretion system that transports proteins to the cell surface and beyond. Some of the secreted proteins are needed for the bacterium to attach to Students in David Hunnicutt's immunology class at St. Norbert College vaccinate zebrafish against *Flavobacterium columnare*.

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Aquatic Sciences Chronicle

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FEATURED SOCIAL MEDIA + WEB

New Releases

seagrant.wisc.edu/videos

Wondering how Wisconsin Sea Grant has been helping improve water quality and coastal resiliency in the Green Bay area? How about an update on the Eat Wisconsin Fish campaign? Maybe check out a lively preschool STEM story hour? Learn the latest in three new videos, focusing on Julia Noordyk, coastal storms outreach specialist; Kathy Kline, education outreach coordinator; and Anne Moser, senior special librarian for the Wisconsin Water Library. In the videos, produced by videography intern Jake Wears, Noordyk talks about the projects she's been involved with since joining Sea Grant, including coordinating a successful boat tour of Green Bay last summer that involved many elected officials. Kline, meanwhile, discusses the impact of the campaign to educate Wisconsin consumers on the benefits of buying and eating fish caught or farmed in Wisconsin. In her video, Moser explains what motivates her work — it's about the children. Find the videos in Wisconsin Sea Grant's video library by clicking **seagrant.wisc.edu/videos**.





avid Hart, a hydrogeologist with the Wisconsin Geological and Natural History Survey calls it "the perfect case study."

And in this case, that case study consists of an enormous field on the expansive headquarters of one of the largest health-care information system software companies in the United States.

It's here, on the ever-expanding corporate campus of EPIC systems in Wisconsin perform this well. Systems in Verona, Wis., that a group of researchers, supported "The ability to understand how the heat's being transferred by funding from the University of Wisconsin Water Resources into the ground, and how EPIC's operation of the system Institute, is testing aspects of a system of economically and environmentally friendly geothermal heat exchangers. EPIC is affects its efficiency, is very key," explained Hart. "The geology might work some places better than others. Hopefully, what using them to heat and cool its massive offices—and its 8,000+ we discover here will allow us to design better systems across plus employees-instead of burning natural gas or other fossil Wisconsin." fuels. The geothermal exchange system—which circulates Geothermal heat exchange systems have enjoyed an expowater in a completely enclosed system-takes advantage of nential growth in the United States in recent years, but not to the fact that the temperature several feet below the ground's the scale at which EPIC plans to harness them. By the time surface remains at or near 50 degrees throughout the year. The all is said and done, EPIC will have more than 6,100 vertical circulating water in the loop system is heated and/or cooled

an the in PIC ted via indirect contact of the underground circulation pipes with the near-constant-temperature earth, then pumped through plastic collector lines to high-efficiency mechanical heat pumps and chillers that air condition the occupied buildings.

The UW research team has measured the overall coefficient of the system's performance—i.e., the ratio of extracted or injected heat to the amount of energy used to operate the system—to be well above 3.0, but not all geothermal exchange systems in Wisconsin perform this well. wisconsin'swaterlibrary

Oh Those Great, Great, GREAT Lakes!

The Great Lakes are indeed pretty great. In turn, Wisconsin Water Library has a great collection of books about them. Pull up a title and explore from your own home, or check them out before you begin your travels!

BONNIE DAHL'S SUPERIOR WAY: THE CRUISING GUIDE TO LAKE SUPERIOR

By Bonnie Dahl. Duluth, Minn.: Lake Superior Port Cities, 2008. Bonnie Dahl is the acknowledged expert on navigating Lake Superior — whether in Bayfield or on the isolated north shore. A must for all vessels and water-based trip planning. Includes wilderness charts, harbor maps and complete GPS information.

GOING FULL CIRCLE: A 1,555-MILE WALK AROUND THE WORLD'S LARGEST LAKE

By Mike Link and Kate Crowley. Duluth, Minn.: Lake Superior Port Cities, 2012.

Husband-wife team Mike Link and Kate Crowley set off on a unique 1,555-mile, shore-hugging journey around the world's largest freshwater lake. As naturalists, travel writers and grandparents, they chronicle their life-altering experience on an epic five-month Lake Superior hike through Minnesota, Wisconsin, Michigan and Ontario.

GUIDE TO SEA KAYAKING IN LAKES SUPERIOR AND MICHIGAN: THE BEST DAY TRIPS AND TOURS

By Bill Newman, Sarah Ohmann and Don Dimond. Old Saybrook, Conn.: Globe Pequot Press, 1999. Sea caves, headlands, shores and cliffs are just a few of the exciting scenes available when touring our inland seas. This guidebook, written by three expert kayakers, features 49 expeditions for a range of skill levels. Maps and detailed route descriptions make planning your trip easy.

HAUNTED LAKES: GREAT LAKES GHOST STORIES, SUPERSTITIONS AND SEA SERPENTS

By Frederick Stonehouse. Duluth, Minn.: Lake Superior Port Cities, 1997. Stonehouse's book is a not-so-serious investigation of truly believed superstitions and stories that have become a part of the lore of the Great Lakes from the 1700s to today.

WISCONSIN LIGHTHOUSES: A

PHOTOGRAPHIC & HISTORICAL GUIDE By Ken Wardius and Barb Wardius. Madison, Wis.: Prairie Oak Press, 2000. If you enjoy visiting or learning more about Wisconsin's lighthouses, you will be interested in the photographs, descriptions, history and travel tips contained in this volume.

If you wish to see more books on this topic, visit our reading list at **go.wisc.edu/l62ewk**

Anyone in Wisconsin can borrow these books. Just email **askwater@aqua.wisc.edu**.

JENNIFER HAUXWELL What We Look For in a Project

"We're trying to encourage projects that bridge the gap between scientific results and actual use in society."

Wisconsin Sea Grant is in the midst of reviewing 49 full research proposals for the 2016-18 funding cycle. Writer Aaron Conklin sat down with Jennifer Hauxwell, assistant research director, to talk about the review process.

peoplenews

What kind of criteria do you and the panel use to sift and winnow through this sizable stack of proposals?

JH: The first key ingredient for a good project is that the science is of the highest quality. Ultimately, we're funding research projects and we never want to doubt the quality of the work that results from Sea Grant funding. Beyond that, what we really want to see is whether there's an effort to get that high-quality science into the hands of people who can use it, whether it's our public or key decision makers. Bridging that gap is really difficult. As we move forward, we're trying to encourage projects that bridge the gap between scientific results and actual use in society. There are all kinds of challenges that lead to that gap. To begin with, it's difficult to communicate science, to communicate technical information. Some scientists are really good at conveying technical information and may use techniques like telling stories and using analogies very well already, but for many researchers, this is really difficult. As we provide support to principal investigators doing research — we want to help them tell their stories. Linking up with our outreach and communications staff can really help researchers share their findings with a broader audience than may have been typical for them.

One other challenge in bridging the gap between science and informing decision makers is that often scientists and decision makers aren't necessarily in the same room together. Projects where we see collaborations between researchers, decision makers and stakeholders have a definite advantage. That to me is a sign that scientists are trying to bridge that gap. That's an area where if we focus, we'll result in what I'd call actionable science, science that will actually be used in society. Ideally, researchers are working with end-users before, during and after a project is underway.



What about the challenge of trying to achieve a balance between projects that focus on more traditional basic science and science that has a more immediate impact?

JH: We've always had a good element of basic research in our portfolio. Those are some of the building blocks of what the big picture looks like. And until you have that big picture, you can't really engage people in a conversation. As we build those pieces and get a picture to work from, let's bridge the gap. There are some key stories to tell here, too, about the value of basic research and some of the major breakthroughs that have occurred through basic research questions and projects.

One of the key pieces of your job is forging and maintaining relationships with our PI community, whether they're encouraged to submit a full proposal and eventually funded or not. That has to be a challenging role.

JH: Principal Investigators face steep challenges in finding funding for their research. Last year, the National Science Foundation, for example, funded only about one in five submitted proposals. This year, Wisconsin Sea Grant received 83 preproposals for what will likely result in only about a dozen funded projects. So, the competition is fierce. These funding ratios indicate that Wisconsin Sea Grant as the funding agency has the privilege of selecting the very best science on the highest priority issues. It also requires that we provide the most rigorous and fair process for the dozens

of investigators who take the time to put their best ideas forward for us to consider. Given the quality of the projects we receive, I think researchers know they can't get too down about not being encouraged or selected in a given cycle. They know to do the best they can, to learn from experience, to keep pushing forward and to look for that next good opportunity. A key aspect of my position is to make sure every proposal is considered fairly and that everything we decide to fund is justified. At the core of any review process is a fairness aspect that I'm very committed to. One other key aspect of my position is to support researchers at each stage of the process, even those researchers that may not be funded in a given year. For instance, as I am in the room as a technical panel vets projects, in addition to providing feedback to researchers on their project's strengths and weaknesses, if there are themes I can pull out for researchers on what makes a successful proposal, that's something I'm committed to doing as well.

Outreach is going to continue to be a major point of emphasis for successfully funded proposals. What does that outreach element look like?

JH: It very much depends on the project, and outreach can take on many different forms. It can be community workshops, it can be linking up with a local school, it might mean sitting down weekly or monthly for a year with policymakers to make sure a complex natural resources issue is informed by science, it may be a YouTube video that reaches thousands of Wisconsin citizens. Showing PIs examples and ideas of what outreach looks like is important—a lot of them may not really know what that is. I encourage all PIs to work with Sea Grant's outreach and communications staff to develop ideas. Working up front with end-users of the research is also a way toward effective outreach. I put a lot of emphasis on the concepts of relationships and conversations. Often science outreach is viewed as a one-way street-researchers informing end-users. But I think the only way to be effective is to think of it more as a relationship and dialogue. See our website go.wisc.edu/ab172s for more tools for researchers interested in pushing their boundaries in engaging stakeholders.

Ultimately, the point of our partnership between Wisconsin's research community and stakeholders is to have the option to select the best possible projects for the people of Wisconsin. We're funding work that's going to help shed light on some of the most difficult science questions that, if we had answers to, inform how we make decisions about how we use our natural and aquatic resources. That's the ultimate goal. —ARC

CAT FOR THE BIRDS

"It's for the birds" is a phrase often used to disparage something. But there's nothing to disparage about a new, 2.5-mile spine stretching into Green Bay, Lake Michigan. It's the beginning of a restored chain of barrier islands, known as the Cat Islands. The chain will be the result of 30-plus years of planning with involvement from four Sea Grant outreach specialists and in partnership with the U.S. Army Corps of Engineers, Wisconsin Department of Natural Resources, Port of Green Bay/Brown County and the U.S. Fish and Wildlife Service.

The islands were completely washed away-after years of erosion and large spring storms-in the 1970s, leaving the mainland's wetlands vulnerable to waves and bay-based storms, and compromising wildlife habitat.

Water Quality Specialist Julia Noordyk said, "This project is a great educational opportunity and the hope is that restoration of these islands will help re-establish upland and shore habitat, and the wetlands behind the island barrier, to the benefit of fish, water fowl and shorebirds."



In fact, last year, there were 30 types of shorebirds spotted, more than in any other place in the lower Green Bay. The endangered piping plover and threatened red knot were sighted 10 times and the Forster's tern successfully bred for the first time in 20 years. Now, the islands really are for the birds-and for clearer shipping channels and a protected mainland.

Noordyk is one of 12 members of a Cat Island Advisory Committee and will be instrumental to establishing a public access plan for the island with two primary goals. The first is protecting public safety. The islands are being restored, in part, using clean dredged materials (it will be 2.5 million cubic yards in all) taken from the bay's outer shipping channel. Dredged material is very unstable, like quicksand, she said, so caution is the watchword.

The second goal is to ensure a successful wildlife restoration effort. "Many of the species we're hoping come back are endangered or threatened, therefore, limiting disturbance will be critical to the effort," Noordyk said.

Off and Blogging

Wisconsin Sea Grant's three 2015 Knauss Marine Policy fellows-that'd be Caroline Mosley, Catherine Simons and Kristina Surfus-have been in Washington, D.C. for about six months now. They've acclimated to their new and exciting situations, and, better yet, they've blogged about them. Surf on over to our Great Lakes Takes blog to hear how Mosely's adapting to the fastpaced, acronym-heavy life as a comms specialist in NOAA's Office of Atmospheric Research office, or how Simons is handling her stint with the Navy's Task Force Climate Change. Surfus, meanwhile,

has set up shop in the office of Wisconsin Sen. Tammy Baldwin and has some unique perspectives to share. All three will be submitting missives every couple of months. Find them at uwiscseagrant.tumblr.com. —ARC

New Photo Display Travels to Wisconsin **Communities**

Public libraries and venues across Wisconsin are signing up to host a new traveling photo display on Wisconsin Water, developed by Wisconsin Sea Grant and the Water Resources institute (WRI). The display engages Wisconsin residents with the role of water in Wisconsin and its deep connection to the economy, the environment and residents' health. Display visitors will learn about water through the lens of Sea Grant and WRI research, education and outreach projects that study and promote the sustainable use of Wisconsin's water. In addition to the photo display, the Wisconsin Water Library's K-12 STEM curriculum kits and aquatic invasive species "Attack Packs" will be promoted for local teachers to borrow through the hosting venue.

"I am proud of the diverse projects around Wisconsin improving the health and sustainability of our water," said James Hurley, director of Sea Grant and WRI. "This

display is a great opportunity for residents to learn about the role of water in their lives and to think about how they can be good stewards of an important shared resource."

The display has made landfall in Cross Plains, River Falls and Marinette, Wis., and made an

appearance at the annual Nelson Institute Earth Day Conference in Madison. Look out for the display in a community near you!

If you know of a public venue in your community that would be excited to host the traveling display, please email katy.thostenson@ aqua.wisc.edu. —KT

This Summer, Get Down to the Water!

Wisconsin has 820 miles of coastline along the Great Lakes abundant with natural wonders and welcoming communities. With this resource in mind, Wisconsin Sea Grant developed the Wisconsin Coastal Guide (wisconsincoastalguide.org), an interactive website for residents and tourists to discover where they can pull off the highway to experience Wisconsin's coast.

David Hart, assistant director for extension at Wisconsin Sea Grant, said the idea for the Wisconsin Coastal Guide developed after he took a circle tour trip around Lake Huron with his father. They left the main highways to explore small towns, and along the way his father shared knowledge from previous visits to the coast and their trip became a "deep travel" experience. The concept of deep travel, coined by writer Tony Hiss, describes the unique, heightened feeling of awareness we experience when we travel.

The Wisconsin Coastal Guide uses geospatial and Web technologies to gather information from disparate sources and display it in a userfriendly Google Maps interface. On the website, users select different map layers to explore beaches, bike routes, boat access points, lighthouses, marinas, parks, rustic roads, shipwrecks, state natural Wildlife Sanctuary areas and nature centers. Otherlayers tell place-based stories and historical vignettes Eastman Ave about the people who live on the Basten St coasts. To heighten the experience, Sea Grant staff captured more than 300

panoramic photos at publicly accessible sites along the coast, giving potential travelers a taste of the scenic views that await them.

A number of coastal towns have already embraced the project, and Hart plans to add new layers to deepen the site experience for coastal travelers. Ready to travel yet? This summer, tap into the Wisconsin Coastal Guide and get down to the water. ---KT

Bay Beach



Anne Moser, senior special librarian with the Wisconsin Water Library, wants kids to jump around with frogs. Not literally, although a little jumping in the classroom or library might be all right. Moser has created a free educational STEM kit called "Jump around with frogs!" It's one of several she will be producing over the coming months in an effort to encourage literacy and science learning for children ages three to 10.

STEM @

STEN

The STEM kits are a natural outgrowth of the popularity of Moser's story-time activities for libraries and classrooms across Wisconsin. Moser is spread too thin to meet the demand, so she developed activities that other librarians and teachers can do themselves. "They'll be able to open up the kit and use it out of the box. The kit is an easy way to add science into an educational curriculum or library," Moser said.

The 14-by-16-inch pouch kit includes a guide, books about frogs, songs and a craft that involves creating a frog out of a paper bag, "which gives children a chance to take the story home with them," Moser said. The information meets earlychildhood state science standards. Other kits are on the way. Moser is creating STEM kits on the topics of buoyancy and winter.

Five frog kits are available for free loan and shipping through Wisconsin Libraries' Delivery Network. Fill out the book request form found here: go.wisc.edu/gmp2a6. The call number to use on the form for the kit is 281681.



Goby vs. Goby

Gobies Compete With Each Other When Crowded, Sparing Native Fishes



Former Sea Grant Ph.D. student Matt Kornis is shown with electroshocking equipment among the enclosures where round obies were kept in the Little Suamico River in Wisconsin. Kornis and Prof. Jake Vander Zanden attribute the gobies' natural aggressiveness toward each other for their findings.

IT SEEMS COUNTER-INTUITIVE, but Wisconsin Sea Grant researchers have found that an invasive fish, the round goby, may have greater impacts on native fish populations when there are fewer of them. The reason? The round goby (Neogobius melanostomus) is so pugnacious and aggressive toward its own kind that when numbers are high, they compete among themselves to a greater extent than against native fishes.

University of Wisconsin-Madison Professor Jake Vander Zanden and former Ph.D. student Matthew Kornis (see facing page) and their team published their findings last year in the journal Oecologia. They stocked 18 enclosures in Little Suamico River, a tributary of Lake Michigan in northeastern Wisconsin, with gobies and three species of native fishes (creek chubs, white suckers and Johnny darters).

The enclosures contained the same amounts and types of natural food. The only difference was the number of gobies: from "no goby" to "low goby" (2.7 fish per square meter) to "high goby" (10.7 fish per square meter). The fish lived in enclosures made from PVC pipe and plastic mesh for 52 days and were weighed at the beginning and end of the experiment.

The lowest growth rates in the native fishes were in the low-goby enclosures, with Johnny darters and white suckers faring worst. Native fish growth

in the high-goby enclosures was no different than in the enclosures without gobies.

"Gobies are super-territorial and they beat up on other gobies in these experimental settings," explained Vander Zanden. "We believe that because they're spending their time competing with other gobies, their impact on other species is reduced at high densities."

Vander Zanden and his team were surprised by this result "because there's an implicit assumption that presence corresponds with impacts, and that if you increase an invasive's abundance, its impact would increase."

Kornis explained "Although this type of finding isn't entirely new, it has not been shown for an invasive species before in terms of its effect on native species." He said that in addition to competing for food, gobies, which can spawn up to six times per season, are also intense rivals for mates.

Although the finding is specific to round gobies, Vander Zanden said it addresses broader issues in invasion science. "Don't always assume that just because something is more abundant that it's going to have more impact. Understanding how species have different impacts on different ecosystems is helpful in determining where to put our increasingly limited resources so that we get the most bang for the buck," Vander Zanden said.

This experiment was part of a larger project that looked at the presence and impacts of round gobies in Great Lakes streams. Several years ago, Vander Zanden's students found gobies in streams that drain into Lake Michigan.

"We were just shocked that this species that lives in huge lakes was moving into these tiny little streams because they're such a different habitat," Vander Zanden said. "Even in their native range in the Black and Caspian seas in Europe, they only live in large rivers and lakes."

He set Kornis on the case, who confirmed that the gobies were living and expanding their range upstream every year by a third to a half of a mile.

FORMER SEA GRANT STUDENT W WORKS WITH MILLIONS OF FISH

Matt Kornis's mother likes to tell the story of how they would walk in the neighborhood when Matt was two and he would pick up a stick to "fish" for leaves in puddles. Later, in college, his love for the help of an automated process that can handle water, fish and the outdoors won out over his interest in molecular biology, leading to his current job have inserted tiny coded wire tags into the snouts with the U.S. Fish and Wildlife Service (USFWS) in of 16 million Chinook salmon and 28.5 million Green Bay, Wis.

degree in biology at Lawrence University in Wisconsin when he applied for several internships in molecular biology or fisheries. As fate would have it, he received a fisheries internship with University of Wisconsin-Milwaukee's John Janssen to look at alewife diets and habitat selection in Lake Michigan.

"I loved being outside every day during the summer, looking at different fish, analyzing data and using it to answer questions," Kornis said. And his fisheries career

began. Kornis pursued both his master's and Ph.D. in limnology and marine science at UW-Madison with the help of Wisconsin Sea Grant funding. He worked with Professor Jake Vander Zanden at the Center for Limnology on projects that explored the expansion of the invasive round goby into streams that enter Lake Michigan.

This led to a post-doctoral fellowship with the tion on two important Great Lakes fisheries. Smithsonian Environmental Research Center in Marvland, Kornis looked at how land use in the Chesapeake Bay watershed combined with shoreline alteration to impact fish and shellfish. A major finding of his work was that wetland loss and shoreline hardening (construction with cement, rock or other hard materials) have negative effects on the abundance of many species. Kornis also explored how phragmities, an invasive wetland plant, affects nearshore fish communities.

UNIVERSITY OF WISCONSIN

"For a fish that normally has a small home range—like the size of a person's living room—this is a very rapid range expansion," Kornis said. He suspects the pressure of living in the higher stream temperatures and finding food, which is relatively less abundant in streams, may be the causes of their spread. "Unlike many native species, round gobies are built to feed on zebra mussels and quagga mussels, which are plentiful in the Great Lakes but usually absent in streams. Gobies in streams must compete with every other fish for the same food," Kornis said. He used this information to develop a simulation model that predicts the gobies' range expansion in streams. —MEZ

After three years at the center, Kornis, a native of Glendale, Wis., moved back to Wisconsin to work for the Great Lakes Mass Marking Program. With more than 8,000 fish per hour, USFWS biologists lake trout stocked into lakes Michigan and Huron Kornis was working on his undergraduate since 2010. The tags, which look like small pieces



of mechanical pencil lead, rest in the cartilage of the fish's snout and contain numerical codes that denote what hatchery the fish are from and where they were stocked. The fish's adipose fin (the lake trout and Chinook small fleshy fin located behind the dorsal fin on the top of each fish) is clipped as a visual marker that the fish is tagged.

The tags are retrieved later by fisheries managers, sport anglers, commercial fishermen and "head hunters"-USFWS tag recovery

technicians who haunt fishing tournaments and fish cleaning stations to assess fish caught by anglers willing to participate in the program.

Each tag is painstakingly extracted from the fish's snout by hand and read under a microscope for its code. Nearly 50,000 tags have been recovered since the program's inception, providing informa-

"Chinook salmon and lake trout fisheries contribute to a 7-billion-dollar-per-year industry," said Kornis. "The importance of these fisheries to the Great Lakes region can't be understated, and we're processing information to help enhance our understanding of that fishery."

The boy who used to fish in puddles has come a long way. —MEZ

A love of fishing as a child led Matt Kornis to his current job assessing the effectiveness of stocking salmon in the Great Lakes

Curbing Columnaris



continued from page 1

Researchers McBride and Hunnicutt have found that proteins secreted by the Flavobacterium columnaris bacteria appear to be the cause of disease rather than the bacteria themselves. Above: A zebrafish in the lab exhibits lesions indicative of columnaris disease

and move over surfaces. McBride and Hunnicutt suspected that these secreted proteins might allow the bacteria to cause disease in fish. This gave them a clear strategy to attack the bacterium.

"When we disrupted the secretion system, we expected that the cells would lose motility and attachment," explained McBride. "But more importantly, we were also looking to see if they would lose their virulence."

Early tests on zebrafish and perch suggest that that their hunch was correct—the mutant bacteria failed to cause disease. This suggests that proteins secreted by this system are needed to cause disease.

The researchers set out to find those proteins. They bathed fish in a solution containing proteins secreted from the wild bacteria and the fish died rapidly, even with no bacteria present.

"What we found is that the proteins may be toxic all by themselves, without the bacteria present," Hunnicutt said.

This helps the researchers determine how the bacterium causes disease, and strategies to stop it. One approach is to use their mutant bacteria that don't cause disease as vaccine strains.

Recently, Hunnicutt, a professor at St. Norbert College in De Pere, Wis., gave students in his immunology class a chance to test-drive the latest version of a nascent columnaris vaccine. Students inoculated more than 100 zebrafish with the harmless strain and have been monitoring them for signs of resistance to infection with the deadly strain.

Hunnicutt said he didn't expect protective results from the first batch of fish, but a second inoculation, given in April, will tell whether the vaccine strategy is working. The incorporation of research with a real-world application into the classroom setting has been exciting for his students.

"When you can bring in ongoing research, it gets the students motivated," Hunnicutt said. "We've been using it as a way to talk about comparative immunology between fish and mammals."

FOCUS ON YELLOW PERCH

Here in Wisconsin, McBride and Hunnicutt have focused primarily on perch because it's the staple of the legendary Wisconsin fish fry. Wild perch populations have plummeted, but commercial aquaculture operations in the upper Midwest have risen to meet the demand for this popular fish. Several of these facilities have been plagued by-you guessed it-columnaris disease. However, the significance of the research conducted by McBride, Hunnicutt and their students extends beyond the Midwest. For example, they are collaborating with a team at the USDA labs in Auburn, Ala., to develop vaccines that might protect catfish, a common aquaculture fish in the southern U.S., and also rainbow trout.

It is still an open question whether the phase one vaccine will provide strong resistance to wild-type F. columnare in diverse aquaculture fish.

"The genetic tools that we developed allow us to determine which proteins are important in the disease process," said McBride. "Even if our first vaccine strains are not optimal, we have a rational path to follow to generate new and improved strains that are likely to function as better vaccines."

McBride said he gives special credit to visiting scientist Nan Li from China, where columnaris disease also devastates the aquaculture industry. Li played a large part in developing the genetic tools to unravel the bacterium's basic biology.

"If we can accomplish this, we may be able to limit the problems caused by Flavobacterium columnare in many aquaculture systems," said Hunnicutt. "It's always gratifying for those of us in the lab when something is useful in the field."-ARC



continued from page 3

geothermal exchange wells that have been installed that may be caused by the heat exchange loops. to depths ranging between 300 and 500 feet below The EPIC site contains a mix of dolomite, shale ground surface. The WRI-supported piece is more and sandstone, each of which might react to temfocused. James Tinjum, a UW-Madison professor of perature changes differently. Preliminary research engineering, and Christopher Choi, a UW-Madison findings have indicated that the local ground temprofessor of biological heat and mass transfer, and perature is not raised above about 63.5 degrees, a Hart, have teamed up with EPIC staff to evaluate benign temperature with respect to groundwater



the effectiveness of the heat transfer and, as a secondary goal, determine how the heat exchange process affects ground strata and groundwater.

To measure temperatures, the research team has drilled five groundwater wells to gauge the heat exchange, taking readings with fiber-optic cables, a process Hart refers to as "sticking a long thermometer into the ground."

In addition, the team is measuring temperature profiles at various distances from the heat exchange loops. Those profiles will allow the researchers to calculate temperatures across the entire site and determine how well heat is transferred in the different rocks beneath the site. The key to understanding why EPIC's system operates so efficiently, said Tinjum, is to measure the properties of the varying ground strata and groundwater with respect to geothermal exchange efficiency and vice-versa.

The team is also collecting groundwater samples to measure any change in water chemistry

WRI researchers are working with EPIC Systems to evaluate th effectiveness of a new and huge, geothermal heat exchange system and how that system affects ground strata and aroundwate

geochemistry. Furthermore, the research team has predicted, through modeling efforts, that the ground temperature should return to a background temperature in the mid 50s within about 20 meters of the geothermal field.

Because the key to operating an efficient geothermal exchange system over the long term is to balance the heat exchange annually, EPIC also proactively uses the geothermal exchange system to preheat domestic water, aid in humidity control within its buildings and melt snow, thereby reducing the need for ice melt chemicals.

"It's really the scale that comprises the unique opportunity here," said Tinjum. "This is the largest geothermal exchange system in North America. Instead of burning natural gas, we're looking to optimize the mechanical geothermal performance of this system. The results of this project could become the basis for future design of geothermal systems statewide." -ARC



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CALENDAR OF EVENTS

AUG. 5, 2015 Sea Grant and Water Resources at the State Fair West Allis, Wis.

wistatefair.com/wp

AUG. 19 AND 22, 2015

Association of Nature Center Administrators Gainesville, Ga. natctr.org/meetings/annual-summit

AUG. 16-20, 2016

144th Annual Meeting of the American Fisheries Society Portland, Ore. *2015.fisheries.org*

SEPT. 29-OCT. 1, 2015

11th Annual Great Lakes Restoration Conference Chicago *conference.healthylakes.org*

NOV. 16-19, 2015

2015 AWRA Annual Water Resources Conference Denver awra.org/meetings/Denver2015/

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