AN AQUACULTURE TECHNICAL BRIEF

Aquaculture Science Education at Freedom High School

A Chronicle of Wisconsin's Flagship Program

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What is aquaculture? Why teach it?

Aquaculture is the production of aquatic life (plant and animal) in a partially controlled environment for the purposes of human food and recreation, while providing economic and environmental gains to our society.

As educators at Freedom High School in rural Wisconsin, a community known for its dairy production, Paul Larson and Kevin Champeau saw family farms consolidating and leaving the dairy industry at an alarming rate. Over their 30+ years of teaching, they saw their students from dairy farm families fall from 50% to 10% of the student body.

Paul and Kevin found that aquaculture not only presented a viable new path for agriculture production in Wisconsin, but it also has the added benefit of providing excellent hands-on and theoretical learning opportunities for high school students in STEM (science, technology, engineering, math) disciplines. It also provides numerous applications of important cross-curricular topics.

Outside of the classroom, awareness of the enormous economic, health and ecological benefits of aquaculture is of growing importance. Modern aquaculture production has grown worldwide due to the expansion of scientific and engineering breakthroughs, and to the increased market demands associated with population growth, high economic values of aquatic foods, ecological issues and overfishing. The practice of sustainable aquaculture solves many serious food security issues that humanity faces today.

Will aquaculture engage students?

Paul began infusing aquaculture topics into his established agriculture sciences course in 1989. From 1989-1994, all students were exposed to aquaculture content through agriculture sciences courses. In 1995, Paul and Kevin launched a dedicated course, *Introduction to Aquaculture*, and responding to student demand in 1996, they launched *Advanced Aquaculture* and several lab courses. Were students engaged? The numbers speak for themselves (Fig. 1).

Figure 1. Student engagement in dedicated aquaculture curriculum at Freedom High School.

Testimonials

"As a high school student involved in agriculture and FFA (Future Farmers of America), aquaculture was not on my radar. So I'm not going to lie, I took aquaculture as a last resort. I'm certainly glad that I did. In college, we were given an uncommon topic to teach, it was aquaculture. I was one of only three students in the class that had any experience at all with the topic, and my knowledge was the broadest. I excelled in that course.

Now, four years after graduating from Freedom High School, I'm right here in the very school where it all began for me, running a five-tank recirculating system with three species of fish, and sharing knowledge with current high school students. I am so glad I had the opportunity to explore aquaculture science when I did."

– Dani Heenen, Freedom High School Alum '19, UW-River Falls Alum '23,
Student Agriculture Science Teacher

Figure 2. Freedom High School students gathering data in their lab.

"The aquaculture program at Freedom High School was pivotal in my education. While most classes focused on understanding a single subject, the aquaculture program taught me to think at a systems level and how interconnected subjects like chemistry and biology really are. I recall a chemistry unit that I would not have done well on if not for my involvement in the aquaculture program. While the chemistry class taught concepts and facts, the aquaculture program showed me why these concepts actually mattered and how to apply them to our goal of keeping fish alive and growing! The systems level thinking I learned from Kevin Champeau's program helped to set me up for educational and career success, and was a pivotal reason I pursued a career in agriculture."

– Karolyn Terpstra, Freedom High School Alum '99

"Larson and Champeau are at the cutting edge of agriculture education."

– Bill Glauber, reporter, Milwaukee Journal Sentinel

"The Agriculture Program at Freedom High School has grown into one of the best this country has to offer. The students ... will carry the success they have gleaned well in the future."

– David Moscinski Ed.S., former superintendent, Freedom Area School District

"I have witnessed firsthand the tremendous educational value provided by our teachers and the great learning students have gained by being involved with aquaculture. [It is] a life experience and real-world application that will serve them well into adulthood as they connect in our ever changing, global society."

– Dr. Jill Mussett, administrator, Freedom Area School District

"Learning to be accurate, consistent, and reliable, while providing the requirements of feeding, raising, and marketing the fish, will provide quality skills required for any business [and which] so many employers are desperately seeking in today's youth. I strongly recommend adding aquaculture to your school!"

– Kurt Erickson, principal, Freedom High School

"The school now has the unique situation of students volunteering to go back to school during the summer. [They] are learning about microbiology, water recirculation system technology, feeding strategies, water quality monitoring and analysis, and fish disease and medication... learning agri-business firsthand."

– Fred Binkowski, senior scientist, UW-Milwaukee and Freedom High School program advisor and partner

Our story

By Paul Larson

The beginning

The Freedom High School aquaculture program was started by chance in a basement agriculture classroom in 1989. I read an article about a dairy producer in northern Wisconsin converting his dairy facility into an aquaculture operation and decided to share the idea with my class. During the discussion, I mentioned that this may be the future of agriculture in Wisconsin. One of the students then said, "If this is the future of agriculture, why aren't we doing it here?"

That was a good question.

My student's question got me on the phone to determine what the rules were for raising fish, what equipment was necessary, and what options for learning I could provide my students. After many phone calls to government agencies, a staff member at the Wisconsin Department of Natural Resources (DNR) recommended that I contact Fred Binkowski at the University of Wisconsin-Milwaukee (UW-Milwaukee). I called Fred and explained that I was an agricultural educator and that I was thinking about starting an aquaculture experience in the classroom.

Fred had many questions. The first was, "What equipment did I have?" Well, I had secured two ten-gallon aquariums (Fig. 3). Next was, "What sort of budget/funding did I have?" That was easy. I had no designated budget. I am sure Fred thought I was crazy. However, he gave me the name of the manager at the DNR Fish Hatchery in Wild Rose and told me to tell him what I wanted to do; Fred assured me the hatchery could provide some fish for our project. Within a week, I had arranged to pick up ten trout and ten salmon fingerlings for our ten-gallon aquariums. Our aquaculture project had begun.

I introduced my agricultural education students to the topic of aquaculture through an introductory activity using classroom discussion, internet research and our start-up aquaculture lab featuring two small aquariums. I covered four important topics: history and development of aquaculture, aquaculture systems and components, water quality and testing, and aquaculture careers.

Figure 3. Our first aquaculture lab: a 10-gallon aquarium.

Slow and steady growth

The second year of our project, 1990, began with a huge increase in production. I secured a 40-gallon aquarium from a rummage sale, and the Wild Rose Fish Hatchery gave us 30 trout and salmon fingerlings. I also began to infuse aquaculture topics into a couple of agricultural classes to build interest and give students the opportunity to learn more about fish production.

In our third year, 1991, the Freedom High School agriculture program had grown large enough to hire a second agricultural science educator. Kevin Champeau was hired and took over the animal science classes, infusing them with more aquaculture topics. Together, Kevin and I looked for options for expansion of our aquaculture project. There was an old, shallow pond on the school property. It gave us an idea.

In 1992, Kevin secured a $500 sustainable agricultural grant from Wisconsin Rural Development Center to enhance our outdoor lab facilities. (This was the beginning of Kevin's unplanned grant-writing career.) We revitalized the prairie and woodlot areas adjacent to the pond and worked with our local Future Farmers of America (FFA) Alumni and Supporter Group who donated $1,800 to dredge the pond. This would be the beginning of significant annual financial support from this group. They believed in the program and literally kept us going. While Fred Binkowski was still skeptical of the viability of our pond plans in a high school setting with very limited funding, he was able to provide us fish to stock the pond, along with his unlimited technical guidance (Fig. 4).

Figure 4. Students observe the release of yellow perch to the pond as Fred Binkowski described the husbandry practices (biology and water quality) necessary to raise this breed of fish.

Looking to expand our indoor production, we found an unused storage/junk room in the old junior high building located near our classrooms. As luck would have it, the space included a water line—essential for fish production.

We then secured two old stainless steel cheese vats for fish tanks (Fig. 5). With Fred's help, we installed makeshift biofilters, aerators and other equipment to create our first official recirculating aquaculture systems (RAS). We stocked one with perch from a wild pond and the other with cultured tank perch from Fred's lab at UW-Milwaukee. The students were charged with feeding fish and managing their health, testing and recording water quality, and determining which tank of fish had faster growth and why. This new lab, assembled with found materials, plus our wit and imagination, allowed for more advanced training and provided authentic hands-on learning opportunities for students—and for Kevin and me as their teachers.

Figure 5. Our first makeshift recirculating aquaculture system (RAS) built with donated stainless steel cheese vats.

Running our makeshift system was a definite challenge. We learned a lot alongside our students, even some things we never would have imagined. For example, the wild fish were not accustomed to containment and loved to jump out of the tanks. With the students, we designed and built screened tank covers to protect these daredevil fish. This first recirculating system, while functional, clearly challenged our knowledge, experience and patience. But because the students were so interested in learning and solving the problems, we stuck with it.

While working with the RAS and the pond, we realized that there was enough student interest to start a full-semester *Introduction to Aquaculture* course. This course began in 1995. It was so successful that we added an *Advanced Aquaculture* course in 1996. These courses allowed the teachers and students to focus solely on aquaculture. They provided the much more advanced and detailed curriculum we needed for students interested in the next level.

Our indoor lab still presented challenges based on location, electricity, size and water disposal issues, which at that time we had yet to resolve. However, there was a lot of positive buzz circulating about our project and its success, and we were encouraged to continue. We began to see students from outside our agriculture classes coming down to see the fish. The students were learning about our aquaculture program by word of mouth. To build on that student interest, I started placing attention-grabber riddles in the school announcements, such as "What has 800 fins, 100 pairs of gills, and swims all day in the Ag Department?" Outside the school, we began to do presentations at educator meetings and conferences. Soon our fellow educators were spreading the word too. We attended various conferences with Fred to bolster our education and build our network of contacts (Fig. 6).

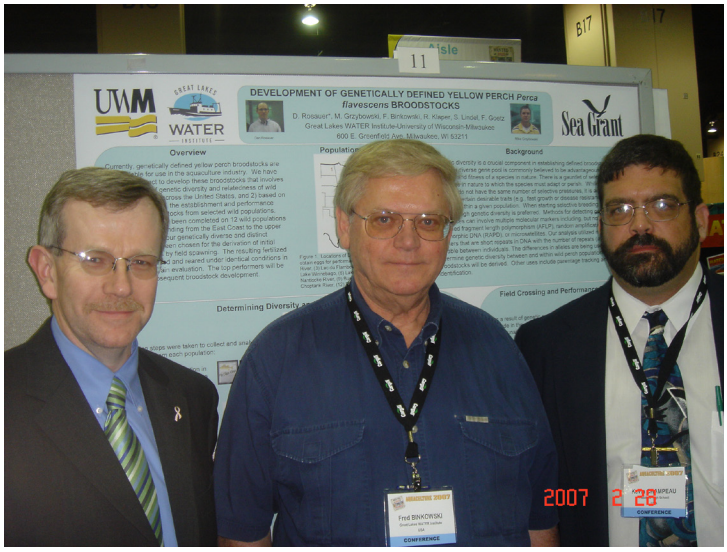


Figure 6. Paul Larson, Fred Binkowski, and Kevin Champeau (l to r) at the 2007 World Aquaculture Society Conference in San Antonio.

We received a $17,000 grant from the Wisconsin Department of Agriculture, Trade, and Consumer Protection that allowed us to upgrade the RAS (Figs. 7, 8 and 9) and install net pens in the pond (Fig. 11) to conduct more experiments in raising fish. In the late 1990s, we began hosting meetings for teachers and conducted workshops both on site and at various teacher conferences across the state, such as the Wisconsin Association of Agricultural Educators conference. We hosted one- to two-hour presentations ourselves, and invited Fred to co-lead a half-day workshop.

Figures 7 and 8. Paul Larson and his student reading a meter and netting fish.

Figure 9. New lab with three biofilters (white tanks on left) and three 600-gallon production tanks (round blue tanks, right foreground, and center background).

A full lab and classroom facility

In the early 2000s, a school referendum was proposed for a field house and extra classrooms dedicated specifically to aquaculture at Freedom High School. It passed, and in 2002 our brand-new dedicated aquaculture lab opened. The new lab had plenty of water, floor drains and the significant increase in space we needed for larger tanks and projects.

This new space also allowed for further changes to the curriculum, including introductory and advanced lab courses, in addition to the existing aquaculture and advanced aquaculture classroom courses. We also worked with other teachers at the high school and found great opportunities for cross-curriculum integration. These included:

- Technology Education – construction, plumbing and electric
- English – writing reports and lab outcomes, communicating findings
- Math – calculations related to water testing, fish tank density and feed ratios
- Science – fish health biology and water chemistry, including the complex nitrogen cycle
- Social Studies – history, societal cultures and economics

While we primarily raised yellow perch, experiments were also conducted with catfish, tilapia, walleye, salmon and shrimp. Additionally, as our knowledge and experience advanced, we experimented with hatching salmon eggs and triggering off-season spawning of yellow perch from a tank of broodstock fish.

The new lab and our innovative program brought more excitement and publicity. Multiple newspaper and TV stories covered our activities, and we continued consulting with other teachers interested in starting their own aquaculture programs. Freedom High School became the flagship school for aquaculture curriculum, facilities plans and general aquaculture knowledge.

Figure 10. Installation of new biofilters built with donated materials in 2018.

In 2018, our lab got an unexpected upgrade through our aquaculture education network (Fig. 10). We had a call from an agriculture teacher who was teaching aquaculture in Luxemburg, Wisconsin. He had a student who knew a person that had a fish farm that was being dismantled. That practitioner donated his bead biofilter (white tank in photo) to our lab. While we were setting up the bead biofilter, we added second biofilter (black tank) which increased our capacity from 1,600 to 4,000 gallons of water.

"We've come a long way from the day that student asked "If this is the future of agriculture, why aren't we doing [aquaculture] here?" Was it a challenge? Yes. Did we take risks and learn alongside our students? Yes. Has it been easy? Not at all. Would I do it again? In a heartbeat.

Reflections

By Kevin Champeau

As of 2023, Paul and I have both retired. We taught aquaculture classes and ran our labs for more than three decades, showing hundreds of students this viable alternative agricultural practice. One new animal sciences instructor has been hired at Freedom High School, and a second student teacher has been placed there to fulfill their practice teaching requirement. The student teacher earned their associate degree in agriculture education, and just happens to be an alum of the Aquaculture Program at Freedom High School. (See Heenen testimonial, page 2.) It is heartening to know that our program has inspired new educators, and that those people will pick up this important work and carry it forward.

Because Paul and I started this path purely based on curiosity, and literally built the program as we learned the material, we decided to put the basics of a start-up high school program together here in one place. We hope our story will serve any fellow high school teacher who sees the same benefits we did in teaching aquaculture science.

Figure 11. Cage harvest from the pond system. 1999.

Don't be concerned if you don't know anything about aquaculture. When our students watched us learn along with them, they saw that learning is a lifelong activity, especially in agriculture, where things never stay the same. We modeled inquiry learning at its best. If a question came up that we couldn't answer, we worked together to figure it out. These questions were often the source of our independent studies students' work.

Aquaculture also supports various teaching methods, so any teacher can connect with any student. In our three decades, Paul and I used a mix of each of these methods:

- Lectures and class discussions
- Hands-on experiences in our school labs
- Internet research to solve specific questions or problems we experienced
- Field activities (both with our on-campus pond and with teacher-led field trips)
- Independent study
- Guest lecturers

Keys to our success

Without any one of the following aspects coming together exactly when we needed it, our Aquaculture Program at Freedom High School would not have moved forward as well as it did. Paul and I have been inspired by the generosity and support given to us, and by our home communities that are steadfast agriculturalists.

- **Dedication and belief in the importance of aquaculture to Wisconsin's agricultural industry.** As educators, we are first and foremost dedicated to agriculture. It is a topic near and dear to us because grew up in communities that depend on it economically. We knew from childhood the importance of producing animals and food for our community's nourishment and livelihood. We wanted to get more young people involved in agriculture because of its extreme importance not only to us as individuals, but to the entire American infrastructure. At the same time, we could see that the traditional dairy and beef industries were floundering. So, we wanted to teach something different, and aquaculture presented that new opportunity. It allows us to teach traditional topics such as genetics, nutrition, and husbandry, but in a new and exciting way.
- **Relationship with UW-Milwaukee's School of Freshwater Sciences.** If not for the relationship with Fred Binkowski, three-quarters of our accomplishments would not have happened. Our connection with him—and his incredible network and resources—were integral to our success. We are confident that Fred thought Paul's idea (especially with no budget) was ridiculous, but that didn't stop him from encouraging us, because he is just as dedicated to education as we are. Fred introduced us to the University of Wisconsin Sea Grant Institute and so many other invaluable resources.
- **Tremendous assistance from Wisconsin Sea Grant.** Sea Grant has been a fantastic resource, not only for building our aquaculture network, but also for support of our program and labs. Fred Binkowski applied for funding from the University of Wisconsin Sea Grant Institute Advisory Services Program by highlighting the unique and important work we were doing at Freedom High School.
- **Supportive FFA alumni and the town of Freedom community**. Our FFA Alumni and Supporter Group provided direct financial support and conducted fundraising drives on our behalf. As an example, they ran a fundraising drive to purchase computers which provided access for every student in the Agriculture Education program to conduct their own online inquiries and research. FFA also brought in our local community as supporters, not only in fundraising, but also encouraging parents of our students to spread the news of our program by word of mouth. That parental support was invaluable.
- **Support of the Freedom Area School District**. Our district leadership was willing to let us take risks with the agriculture curriculum and try new things—including managing the first high school fish lab in Wisconsin. That meant allowing a classroom full of water and actual livestock inside the building, as well as approving unusual (and often high-priced) supplies to go into the budget. They approved our two new courses. Ultimately, they embraced the "wow factor" of our program not only for the students, but also for themselves, and so they were willing to push the boundaries.

Passing the torch

In spring of 2019, Paul, Fred and I taught a 2-day workshop for pre-service Agriculture Education students at UW-Platteville and UW-River Falls (Fig. 12). The program is intended to present strategies for teaching aquaculture in high school classrooms, as well as give new educators comfort with the subject matter. We always reminded the program participants that the material that we presented will allow them to achieve success much more quickly and easily than when we started. While this training is designed for teachers before they are hired by schools, it is also beneficial for teachers who are already in the classroom.

Figure 12. Ben Wiedenman, Paul Larsen and Kevin Champeau teaching aquaculture education to students in the Agriculture Education Program at UW-Plattville and UW-River Falls, 2019.

As of 2024, Paul and I have retired and two full-time agriculture sciences teachers have filled our spots to continue the programs at Freedom High School. We will thrilled that an alum of the program, Dani Heenen (see Heenen testimonial, page 2), served as a student teacher at Freedom to fulfill the student teaching requirements to earn her BS in Agricultural Education at UW-River Falls.

We recommend that educators contact the US Department of Agriculture (usda.gov), National Sea Grant program (seagrant.noaa.gov), as well as the state and local Sea Grant education/ extension programs, and state department of agriculture to build your resources. Remember it all starts with just one phone call.

Chronicle of the program

30 Years in the making

1989
Review of newspaper article and initial class discussion.

1990
Aquaculture content infused within traditional agricultural courses such as animal science. Two ten-gallon fish tanks were added to classroom in which salmon and trout fingerlings were raised.

1992
Pond work begins. The old pond was dredged and stocked with yellow perch. Later the class experimented with cage culture.

1993
First RAS lab set up using old stainless steel cheese vats.

1995
Aquaculture semester course introduced.

1996
Advanced semester course and aquaculture lab classes added.

2002
Referendum passed; new lab opened. Two 800-gallon tanks were purchased, which provided a total 1,600-gallon water capacity w/filtering; the increased capacity allowed the class to create separate systems and to vary the species raised. Students designed and maintained the systems.

2010
Hatched salmon eggs using a Heath incubation cabinet (Fig. 13).

2015
Established a brood stock tank and prepared to collect eggs from adult perch.

Figure 13. Eyed salmon eggs in Heath incubation cabinet.

2017
Experimented with incubating and hatching yellow perch from eggs.

2018
Biofilter updates. Continued raising yellow perch and added new species including walleye, catfish, bluegill and trout.

2021
Experiments continue in raising yellow perch, walleye and bluegill from fingerlings.

Infusing aquaculture into an introductory agricultural science course

Rather than creating a new course for students, Paul and Kevin recommend that educators start teaching aquaculture simply by infusing the topic into a course they are already teaching. For ideas, see the cross-curriculum integration opportunities section below. Infusing the topic into an existing course allows the educator to refresh their course with new and interesting subject matter, as well as gauge student interest, before going through the work of writing a new teaching plan. They also recommend reaching out to local practitioners and university programs for guidance along the way and to build a network of resources.

Paul introduced his agricultural education students to aquaculture through an introductory activity featuring classroom discussion, internet research and their small aquaculture lab facility (two ten-gallon aquariums).

They began with these three introductory questions:

1. Why is aquaculture important or needed?
2. What advantage(s) does Wisconsin have for aquaculture?
3. What advantages does aquaculture offer?

They then covered the following four topics: history and development of worldwide aquaculture, aquaculture systems and components, water quality and testing, and aquaculture careers.

History and development of worldwide aquaculture
Paul used this chart (Fig. 14) to discuss the history of aquaculture, noting that while it may be new to this class, it is not a new concept. Depending upon the number of days used for a unit, he had students research how aquaculture has changed since 1998 when the chart ends. Research could include individual countries' use of aquaculture or specific species most often used in aquaculture. An excellent resource for current information on aquaculture production is "The State of World Fisheries and Aquaculture 2020," by the Food and Agriculture Organization of the United Nations, available for download at http://www.fao.org/3/ca9229en/ca9229en.pdf.

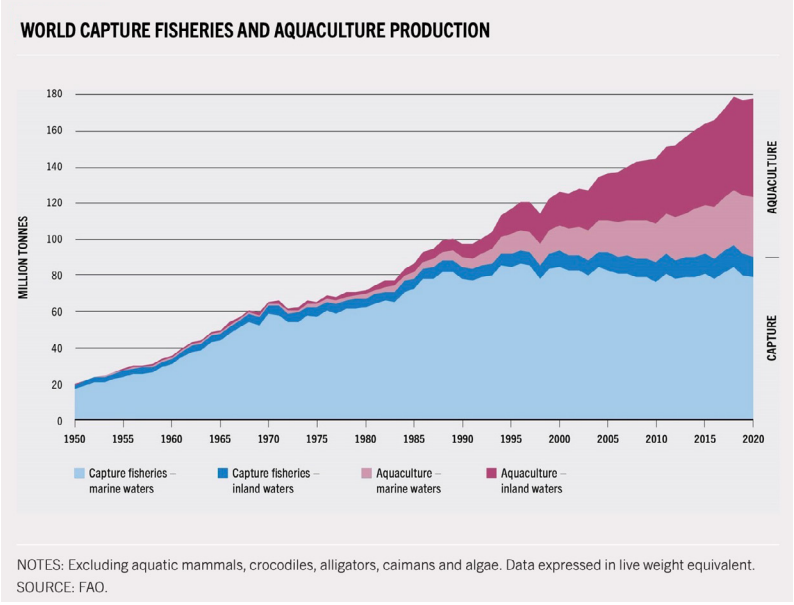


Figure 14. World capture fisheries compared to aquaculture production. Source: Food and Agriculture Organization of the United Nations. Reproduced with permission.

Another point of research is the ancient history of aquaculture. While there is evidence of the Chinese practicing pre-aquaculture techniques to provide year-round food supply in 6,200 BCE, and Egyptians integrating plant- and fish-growing operations as an early form of aquaponics in 4,000 BCE, China is generally credited with the first commercial aquaculture development and practices around 1,000 BCE.

Aquaculture systems and components
Paul covered two indoor aquaculture systems: flow through and recirculating. After it was built in 1993, the large recirculating system in Freedom High School's lab served as a model for discussing its components: production tanks, settling tanks, bio-filter tanks and aerators. Again, depending upon unit length, student research could be done on systems or components and purposes of the various components.

Water quality and testing
Water quality is the next discussion point. Paul demonstrated the tests routinely conducted on the aquaculture system – temperature, pH, dissolved oxygen, etc. Where appropriate he used Hach Test Kits or various meters to test the quality of water in the tanks. He discussed the acceptable parameters for water quality and potential causes of poor water quality – overfeeding, excessive fish waste, temperature, etc. Students then tested the water quality in the tanks in the lab.

Aquaculture careers
Paul wrapped up the unit by discussing potential careers related to aquaculture or natural resources and what post-secondary schooling options are available for advanced study.

Cross-curriculum integration opportunities

The following semester-long or year-long courses (in bold) are required standards for 12th grade education in the state of Wisconsin. Different states will have different requirements; however, as an example, here are additional aquaculture topics that fulfill portions of each standard.

Biology

- Plant Biology and Horticulture
- Fish Health & Nutrition
- Genetics
- Anatomy and Reproduction
- Embryology
- Aquatic Microbiology

Chemistry

- Water Chemistry
- Biofilter Function and TAN (Total Amount Nitrogen) Transformation

Technology & Engineering

- Alternative Energy
- Trades—plumbing, carpentry, electrical, welding

Mathematics

- Math—figuring the area and volume of non-cubic tanks, such as a natural pond
- Algebra—figuring required food ration for species, time of lifecycle, and tank size

Business Management & Entrepreneurship

- Appropriate business scales of aquaculture and aquaponics: from home models such as Port Fish (portfish.org) to multi-million-dollar facilities such as Superior Fresh (superiorfresh.com)
- Profit vs Nonprofit Management
- Species Selection for Market
- Laws, Rules and Permits

Information & Technical Literacy

- Water Testing, Data Collection and Presentation
- English and Grammar—report writing

Health Science

- Nutritional Benefits of Eating Fish
- Alternative Food Sources for Humans
- Fish Nutrition
- Fish Health and Pathology
- Biosecurity

Environmental Science

- Natural Resources and Conservation
- Native Species Restoration and Preservation
- Ecology and Climate Change

Agriculture, Food & Natural Resources

- Animal Husbandry
- Aquaponic Crops

Marketing, Art & Design

- Communication—marketing materials
- Advertising and Branding

Aquaculture advisors, partners, and inspiration

University of Wisconsin-Milwaukee's School of Freshwater Sciences

By Fred Binkowski

As a tenured senior scientist at UW-Milwaukee's School of Freshwater Sciences (SFS), previously the Great Lakes Water Institute, my research was focused on Great Lakes fisheries ecology. Paul Larson called me with an interesting question: how to start an aquaculture lab in a classroom. Paul, an agriculture teacher at Freedom High School, was looking for a new way to teach his students sustainable agriculture. He had heard that a local dairy farmer started practicing aquaculture, he discussed it with his class, and the students were interested in learning about this agricultural practice as an alternative to dairy farming.

Paul didn't have any background in aquaculture, nor did he have a budget for supplies, nor was there space secured for such an operation. What he did have was pure motivation fueled by his students' interest, and a willingness to learn by trial and error. I was motivated by his passion for teaching, his gumption and his curiosity.

Figures 15 and 16. Fred Binkowski hosts a Freedom High School field trip to UWM's aquaculture labs. October 2017.

After our initial get-to-know-you conversation, Paul called me back and said, "I have an aquarium," and I said, "Go get some fish."

First, I suggested a fish store, but then arranged for him to get some trout and salmon fingerlings from the Wisconsin DNR Fish Hatchery located in Wild Rose. Along with that, I gave him just enough information to get started, knowing he would have questions that I could answer as he progressed. I didn't want to overwhelm him with extensive aquaculture information right at the start.

Paul got his fish, and that was the kick-off of the project. Soon there were practical questions, "What we should feed the fish?" or "Why aren't my fish looking healthy?" and other husbandry concerns. I gave him some resources where he could search for his own answers such as The World Aquaculture Society's classic book "Fish Hatchery Management" and Aquaculture magazine (it's Annual Buyer's Guide is a good resource for equipment and supplies).

The entire project moved forward in this conversational way. I gave Paul, and soon Kevin

Champeau joined him, as much information as they needed for each step until they mastered it, and then we moved to the next level. They began to build their own knowledge base and started to solve their own problems. Sometimes when they encountered a challenge, I would ask them what they thought they should do. If they had a sound plan, I told them so. I might offer a few extra ideas to explore as well, but they clearly had a penchant for researching the exact information they needed.

The Freedom High School program flourished and grew. It was Paul and Kevin I was teaching, and they taught the kids. A parent of one of the students said, "I don't know what you did to my kid, but he won't shut up at the dinner table. He just keeps talking about aquaculture," and that sounded great to me. I just gave Paul and Kevin the seeds for the program, but they ran with it and turned a little idea into a huge success.

Following is a list of my contributions to the Agriculture Program at Freedom High School.

Aquaculture Husbandry and Technical Support

- Hands-on technical support associated with aquatic husbandry; system design, construction and operation; troubleshooting expertise.
- Technical support associated with pond management practices.
- Technical equipment and supply items, and demonstrated equipment use.
- Thousands of perch fingerlings from my SFS lab.
- Information resources from technical, professional and educational organizations.

Education (Student education)

- Guest lecturer for Freedom High School aquaculture classes, and recruited other SFS personnel for same.
- Guest lecturer and equipment demonstrator for the pond work.
- Assisted in organizing field trips for high school students (Figs. 15 and 16).

Education Outreach (Teacher education)

- Organized and supported presentations at the World Aquaculture Society conference in San Antonio, Texas (Fig. 6).
- Organized and supported presentations at the Mid-West Fish and Wildlife conference in Indianapolis, Indiana.
- Organized and co-led the in-service aquaculture workshops at the Wisconsin Association of Agricultural Educators.
- Organized and co-led the Aquaculture and Aquaponic workshop in 2019 at UW-River Falls and UW-Platteville.

Milwaukee County House of Correction Fish Hatchery

Elizabeth Culotta wrote two articles about this partnership in 1987 which were published in the *Milwaukee Journal Sentinel*. The following is a condensed version of those articles.

In 1984, a partnership was forged with UW-Milwaukee's Center for Great Lakes Studies marine biologist Fred Binkowski, House of Correction officer Tony Grabowski, and Milwaukee County Parks under the direction of County Executive Bill O'Donnell. The program involves inmates, professors and fishermen combining their talents to ensure good fishing in Milwaukee County parks during the summer (Fig. 17).

Inmates helped raise 10,000 seven-inch hybrid sunfish for stocking in county ponds in its third year of hatchery operations. The hybrids, bred by Binkowski, were the offspring from male bluegills and female green sunfish. They were the perfect fish for this project because they grow fast, can survive warmer water temperatures of summer, and are "pan-ready" easy to catch.

The program was supported by then county supervisor Bill O'Donnell, and quickly attracted the support of the Great Lakes Fishermen's Club, the Center for Great Lakes Studies at UW-Milwaukee's Great Lakes Research Facility, and the Wisconsin Department of Natural Resources.

The farm facilities, including the fish tanks, at the House of Correction were built by inmates who also cared for the fish. Because fish hatcheries are labor-intensive, inmate labor cuts the cost inputs of the operation, while providing inmates with vocational education. Local contractors who toured the facilities were so impressed with the quality of the concrete tanks that they hired two former inmates for their firms.


Journal photo by Jack Orton
Fred Binkowski (from left) of the Great Lakes Research Center, inmate Ronald Winiarski and Officer Tony Grabowski checked data at the Milwaukee County House of Correction fish farm in Franklin

Figure 17. Photo from 2009 MJS article showing Fred Binkowski, inmate Ronald Winiarski and Officer Tony Grabowski working together at the Milwaukee County House of Correction fish farm.

The scientific team received annual support from the Milwaukee County for its role in breeding the hybrids, organizing the inmates and fish, and training inmates to care for the fish. Inmates got marketable work experience and science knowledge, and Milwaukee fishermen got plenty of fishing during the summer. It was a win-win-win.

In 2012, Sherry Tussler, executive director of local nonprofit agency Hunger Task Force, leased House of Correction buildings from Milwaukee County, to grow and harvest food. This included the fish hatchery operation and gave inmates additional training in local food systems. Today the fish farm is under the direction of the Hunger Task Force. The primary species for stocking the County parks is yellow perch, of which this program produces 20,000 to 30,000 market-size fish annually.

Growing Power, Inc.

Growing Power was an urban agriculture nonprofit organization headquartered in Milwaukee, Wisconsin. It was founded by Will Allen, a former National Basketball Association (NBA) professional basketball player, and a son of sharecroppers. Vocal about the low earnings of farmers and his own experiences of discrimination and racism as a Black farmer, Allen criticized the marginalization and exploitation inherent in the U.S. food system. Allen led Growing Power to practice sustainable food production, as well as economic and community growth through the creation of community food systems.

Its facilities included seven large greenhouses, a kitchen, indoor and outdoor training gardens, aquaculture system and a food distribution facility. The farm grew a wide variety of fruit and vegetables, and also farmed tilapia and perch. The aquaculture systems were designed and built as a partnership with scientists at UW-Milwaukee's School of Freshwater Sciences. Worms, bees, goats, chickens, turkeys and ducks were also raised there.

Growing Power conducted workshops and demonstrations in aquaculture, aquaponics, vermiculture, horticulture, small or large-scale composting, soil reclamation, food distribution, beekeeping and marketing. Workshop participants included teachers from the Wisconsin Department of Public Instruction, as well as teachers from private schools. It also ran numerous collaborative projects, including a partnership with the Boys and Girls Club of Greater Milwaukee to provide job training to city youth, in addition to hosting interns year-round. Thousands of people from across the globe toured the facilities every year.

The farm on Milwaukee's north side was originally an abandoned greenhouse that Will Allen bought in 1993 operating Will's Roadside Farm. He then merged with the non-profit Growing Power in 1999. In 2008, he was recognized with a MacArthur Fellowship (also known as a genius grant) for his work on urban farming, sustainable food production and economic growth, and in 2010 Time Magazine included Allen in their list of the top 100 influential people.

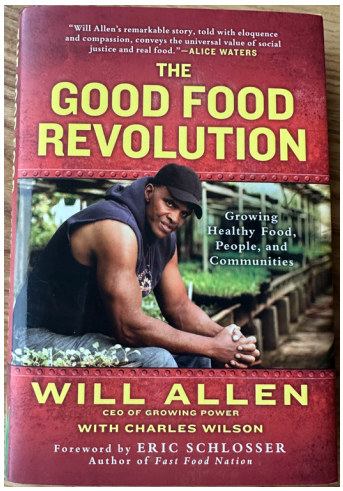


Figure 18. Cover of Will Allen's 2012 book *The Good Food Revolution*.

The Milwaukee organization's successes in attracting international attention to urban agriculture and community food systems causes led to establishing a Chicago branch of Growing Power. The leadership team of the Chicago location formed the nonprofit Urban Grower's Collective, to "continue the legacy of Growing Power." The Urban Grower's Collective was co-founded by Will Allen's daughter, Erika Allen.

In his book *The Good Food Revolution* (2012, Fig. 18), Allen writes, "I wanted to help provide affordable alternatives to junk food in inner-city communities... offering people a chance to heal themselves. I wanted Growing Power to control the production, marketing, and distribution of food on a community level—and to strengthen the neighborhood in the process. I saw my work as trying to create a new model for the food system: one that was better for small farmers, customers, and the earth" (p. 145).

PortFish, Ltd.

According to Pat Wilborn, founder of PortFish, Ltd., eating locally is important. He agrees with author and journalist Michael Pollan who suggests that eating locally is the best way to access food at its nutritional peak, which is beneficial to personal health. Eating locally also supports local food economies and is less damaging to the environment than the conventional corporate food system.

Inspired by these ideas, Wilborn began his journey learning to produce vegetables using aquaponics systems. In 2009, he founded (and funded) a non-profit local food center that relied on an aquaponics system as its primary growing medium, which he set up in his home after his grown children moved out. He called this model 1. He built and operated two more increasingly complex systems, models 2 and 3. For each recirculating aquaculture system (RAS) model, he had an initial set of objectives, which changed and evolved over time. The experience of working through each model increased his knowledge and skills to the point where he now successfully produces greens that are distributed to the local community through community supported agriculture (CSA).

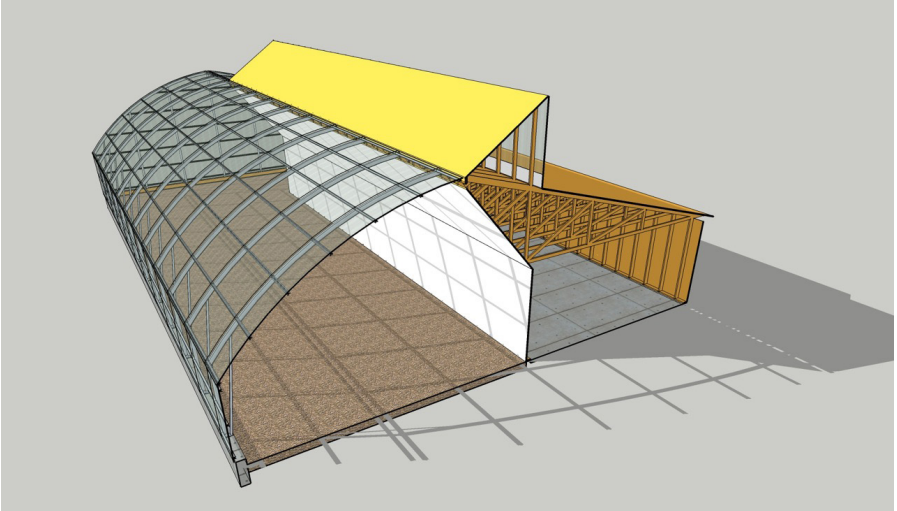


Figure 19. Model 3 design by Kubala-Washatko Architects.

Model 1 evolved from Wilborn's curiosity about if aquaponics actually worked. He designed and built a simple system in his home using an aquarium and houseplants and successfully grew fish and plants using fish waste as the nutrient source.

Next, he wanted to know how it all worked, so he built model 2 to learn the science of aquaponics. This was a more complicated endeavor requiring an expanded design and construction: a 12-by-12-foot bi-level solarium and fish habitat incorporating the back porch of his home. With this new system, he learned the basic principles of microbiology, water chemistry and fish husbandry of aquaponics.

Ten months later, as he observed other aquaponic startups across Wisconsin, Wilborn began looking for a location for a larger scale model 3. His objective was to scale up and build a pre-production food system; one that could guide him to a full-scale market-oriented local food business that would bring locally grown, nutrient-rich food to the community. He also was driven by a desire to share what he learned with like-minded entrepreneurs, providing them a template and data. To accomplish this, Wilborn designed model 3 by attaching a 36-by-48-foot greenhouse to an existing 25-by-95-foot agricultural storage building (Fig. 19). It housed two 1,750-gallon aquaponics systems that fed 1,680 square feet of raised bed plant surfaces, troughs and gutters. The system design houses up to 1,600 4- to 8-inch yellow perch.

Figure 20. Year-round growing operations in greenhouse with retractable thermal curtains.

With the increasing complexity of models 1, 2, and 3, Wilborn's skills in building and maintenance also developed, along with expertise in managing the primary participants of any aquaponics system: the fish, the plants and the bacteria. He developed a deep understanding of the relationship of water, light and photosynthesis, as well as handling pests, environment and supplements (Fig. 20).

With a goal of developing a full-scale enterprise that serves as a local food center, Wilborn found that a number of other issues come into play, such as generating revenue, marketing, system sustainability, organizational management, and recruitment and management of employees and volunteers. Wilborn plans to address these issues as the objectives of the future model 4, which will be a vehicle for an even larger-scale production of food for local communities, one that incorporates newer technology in green energy.

Wilborn believes the time spent in this endeavor has been both rewarding and therapeutic, but not without its challenges. After years in this venture, the personal benefits far exceed the economic inputs. He was deeply influenced by local experts like Will Allen, founder of Growing Power and Fred Binkowski, UW-Milwaukee School of Freshwater Sciences.

Media coverage

Milwaukee Journal Sentinel, Dec 24, 2006, by Bill Glauber

Rural schools cultivate modern agriculture classes

Teachers hope students join industry work force

By BILL GLAUBER
bglauber@journalsentinel.com

Freedom — If Chad Kortz gets his way, the Friday fish fry might never be the same.

Kortz aims to deliver farm-raised yellow perch to the masses. He's just 19 and years from realizing his dream. But every dream has a start.

And for Kortz, the dream starts here, in a converted milk house on his uncle's farm. From a bunch of old plastic barrels and tanks, Kortz has created a 1,500-gallon recirculating aquaculture system.

There's a Rube Goldberg quality to the operation: gurgling water, filters that look like plastic toys and a bucketful of fish food pellets. But it works. Once a year, since 2003, Kortz has harvested as many as 700 fish, filleting, vacuum-packing and selling them to neighbors.

"I'm a fish farmer instead of a dairy farmer," Kortz said. "But they're similar. You have high start-up costs. A lot of animals are susceptible to disease, and you have to take care of them."

Kortz is making his way in a rural economy, adapting to change, picking up new skills for a new century.

He once dreamed of following in his father's footsteps and becoming a dairy farmer. But in 2002, his father got out of the dairy business, and Kortz had to find a new farm passion.

He discovered it at Freedom High School, where a second-generation agricultural science teacher developed a first-rate academic program.

For years, Paul Larson, 41, a no-nonsense teacher, has worked with youths such as Kortz, bringing modern agriculture into the modern classroom. It's all a far cry from the way Larson's father taught agriculture science, when lessons included knot-tying and belt-lacing.

"Agriculture needs a trained work force," Larson said. "The kids may not be farmers. But they'll serve in the agriculture-related industries as food processors, consultants, veterinarians, feed specialists, agricultural mechanics."

And there's even a place for fish farms. It was Larson who lured Kortz into exploring an interest in raising fish by having Kortz help build the school's impressive aquaculture system.

Larson and fellow teacher Kevin Champeau, 43, are at the cutting edge of agriculture education. The lab is first rate. There's a greenhouse, aquaculture tanks and plenty of course and lab work. The students are computer-savvy, adept with microscopes. Some come off the farm. Others are suburban kids.

"We have many students interested in animals," Larson said. "We try to capture their attention in middle school, get them into ecology and conservation and help them become better environmental stewards."

Champeau, the son of a dairy farmer, also is eager to expose the kids to all facets of agriculture, even those from the city. Wisconsin's future, he says, depends on young people joining the agricultural work force.

"The whole definition of rural in the state of Wisconsin is changing," Champeau said. "We have more and more people moving out here from the big city."

But even as people move into this community between Green Bay and Appleton, Freedom retains its small town feel.

"There is a future for the small town," Champeau said. "Kids will leave here to get an education. But they will come back. And they will work."

David Hacker, 16, scoops yellow perch out of a vat for sizing at Freedom High School in Outagamie County. Students raise the fish and sell them. Teacher Paul Larson has worked to bring modern agriculture into the classroom.

Ag students at Freedom find growing demand for perch

Freedom

The Friday night fish fry is a weekly reminder there could be more opportunities for commercial perch production in Wisconsin, believe two agriculture teachers at Freedom High School.

As a result, Kevin Champeau and Paul Larson are introducing their 100 ag students to all phases of aquaculture at a revitalized pond near the school in this Outagamie County community.

"I think there are a lot of opportunities for these enterprises," said Mr. Champeau. "There are a number of unused resources, such as small farm ponds that haven't been tapped for food value."

The ⅛-acre pond is situated in the 13 acres of fields and woods that are part of the high school grounds. The pond was unproductive for about 20 years until the two ag instructors began trolling for ideas on how to put the pond to better use. It formerly was used by biology classes.

Mr. Champeau said the project was a year in the planning, including writing and obtaining a $500 sustainable agriculture discovery grant for the project through the Wisconsin Rural Development Center, Mount Horeb. These grants are sponsored by the American Family Insurance Group, Elmer G. Biddick Charitable Trust, GTE North, Midwest Bio-Ag and Arnold Svacina.

Besides learning about a small business and perch production, students were introduced early on to another aspect of the world about them.

Photo by Judy Brown

Angling for alternatives

A perch fishing project conducted at Freedom High School may provide additional ag enterprises in the area. From left, standing, Kevin Champeau and Paul Larson, ag instructors, and students, Sara Burke, Doug Moser, Rick Van De Loo, and Norman Angotti.

"We had to get fish holding and dredging permits and comply with watershed rules. There was a lot of red tape we had to work through," said Mr. Champeau.

Dredging costs were picked up by the Freedom FFA Alumni, which donated $1,800 to the project.

Both teachers said they also were aided in the project by Fred Binkowski, a marine biologist at the University of Wisconsin-Milwaukee, who provided cultural information and arranged for the delivery of 400 four-inch perch to the school pond about a month ago.

"We're hoping to have a hands-on look at fish production and hope to raise them to market size," said Mr. Larson, who added the market for perch is just beginning to open up.

Research is being directed toward hybrid and yellow perch, he said. As an alternative agriculture crop, he noted cost of production of commercial perch production is around $3.50 per pound, while market prices range from $8.50 a pound in Chicago to $6.50 a pound in Milwaukee.

While the school doesn't have an aquaculture class, both teachers are incorporating aspects of the project into other classes. Students in Mr. Larson's conservation and freshman introductory classes now hear about the aquaculture project and Mr. Champeau has expanded the unit on dairy and livestock to include fish production.

According to Mr. Champeau, more and more landowners are becoming interested in their own ponds. And the school's pond might be just the vehicle to stir student interest at home, he pointed out.

"Eventually someone might say this might be something to try at home," he said. "This project gives them an opportunity to see what happens."

—Judy Brown

The Country Today, Oct 28, 1992, by Judy Brown

The *Post-Crescent*, Nov 4, 1992, by Mary Murphy

WEDNESDAY, NOVEMBER 4, 1992 THE POST CRESCENT THE POS

Mary Murphy photo

FREEDOM HIGH SCHOOL agricultural students prepare to check their aquaculture project.

Freedom ag students into aquaculture

By Mary Murphy
Post-Crescent correspondent

FREEDOM – High school agriculture students learned about a different kind of planting last week.

They gave a helping hand to Chris Ney, UW Milwaukee Biological Studies Department, in planting 200 yellow perch in a refurbished pond behind the school.

The task of converting the unused pond to an aquaculture center for the district agricultural program, began three years ago when Paul Larson, who headed the department, looked into the possibility of using it as part of the agriculture program.

"Their were many hurdles and unexpected turns along the way," said instructor Kevin Champeau. For instance, it was found that the 4-foot depth was not sufficient for raising fish.

Help was obtained from the state Department of Natural Resources on specifications, water provisions and water samplings; and from fish specialist Fred Benkowski of the UW-Milwaukee Biological Studies Department, who inspected the site and ultimately located the perch for the school.

Instructor Kevin Champeau applied for and received a $500 "sustainable agricultural grant" from The Wisconin Rural Development Company to begin the project. The Freedom FFA Alumni provided $1,700 needed to dredge the pond to 15 feet, Champeau said.

"Our goal was to make aquaculture production available to the students, and give them firsthand experience," he said. "It also diversified the program." Champeau said those who have been involved are pleased with the finished project, and the students enjoyed their hand at stocking the perch with Ney.

The high school agricultural department class has 100 students enrolled in grades 9-12. In addition to aquaculture, they study livestock and dairy production, crops and soils, horticulture and conservation, and ag business.

A new program this year implements a one-quarter semester program of ag studies into the curriculum for each of the Middle School 7th graders with Larson and Champeau share duties as instructors.

University of Wisconsin Sea Grant's *Littoral Drift*, 1995, by Phil Davis

Sea Grant
University of Wisconsin

OUTREACH: Model Fish Farming

Phil Davis

UW Sea Grant aquaculture specialist Fred Binkowski enjoys the remarkable distinction of having received two awards from Future Farmers of America (FFA). First, FFA named Binkowski an honorary local chapter member, then later gave him an award for distinguished service at the state FFA convention.

Both awards were given for good reason: Binkowski helped start a model aquaculture operation for the agriculture students at Freedom High School, a rural school located 10 miles outside of Appleton in Freedom, Wis.

Three years ago, Freedom High ag teachers Paul Larson and Kevin Champeau approached Binkowski about helping them set up an aquaculture unit. Binkowski suggested using an already-existing pond on school property. The teachers had the 1/8-acre pond drained, dredged and refilled, increasing its depth to 12 feet so that it wouldn't freeze solid in winter. After Binkowski donated several hundred yellow perch from the Aquaculture Institute's lab at the UW-Milwaukee Center for Great Lakes Studies, Freedom High's aquaculture program was up and running.

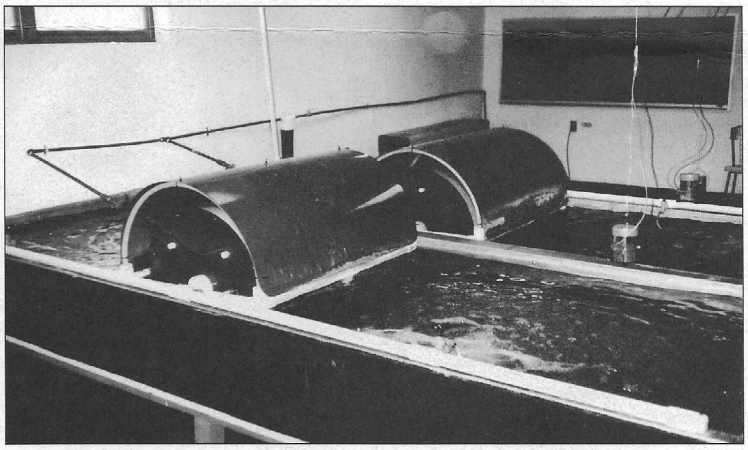
Last year, the school built an indoor facility using two 600-gallon stainless steel tanks replete with an automated feeding system, an aerator and a recirculating system. Funded by a number of local organizations and various grants, the indoor operation enables students to practice aquaculture year-round. The outdoor unit was eventually upgraded with an aerator and fish feeder. In addition, the school was awarded a $17,000 grant from the Wisconsin Department of Agriculture, Trade and Consumer Protection. The money allowed the school to upgrade its recirculation system and install net pens in the pond for fish-rearing experiments.

The result is that Freedom High now has, according to Binkowski, the state's most advanced school aquaculture program. In addition, an unprecedented 40 students signed up for a course devoted to aquaculture offered for the first time last fall. The course was so successful there is now talk of setting up an advanced aquaculture class.

"The school now has the unique situation of students *volunteering* to go back to school during the summer," says Binkowski. "They're not raising fish for commercial sale, but it's invaluable experience. From a scientific point of view, students are learning about microbiology, recirculation technology, feeding strategies, water quality, and fish disease and medication. They're also learning first-hand about agri-business."

-Continued on page 4-

Above, students at Freedom High School assist in fin clipping as part of their aquaculture class. The indoor recirculation tanks shown below currently contain yellow perch. Photos by Kevin Champeau and Paul Larson.



Freedom High

-Continued from page 2-

Although the aquaculture program is only three years old, Champeau says that students have already proven that they can successfully raise fish and maintain life in the tanks.

"Our next step is to look at making it all more efficient," he says. "The possibilities are endless. We received an incubator, which allows us to try and hatch our own eggs. We're also going to look at other phases of marketing. Whether kids ultimately decide that they want to pursue aquaculture, this program should give them some direction in a production-related career or a different agri-business later on."

Reprinted from Wisconsin Sea Grant's *Littoral Drift*