Relational Symmetry and TimberFish Evolution

Jere Northrop

This document presents a photographic record of some of the projects that were instrumental and formative for the theoretical structure of the Relational Symmetry Paradigm and the technologies that are derivative from it. They include bench, proof of concept, field trials, and prototype systems as well as full scale operating systems.

The Microbial Tank Farm prototype, 1973

Here I am working with the Relational Systems group at the Center for Theoretical Biology at the State University of New York at Buffalo. However, I am living in the country so in my spare time I am fermenting weeds in barrels, converting them into a microbial biomass, and feeding them to fish, well, minnows actually (this is the first prototype that would eventually become TimberFish).

The microbial biomass

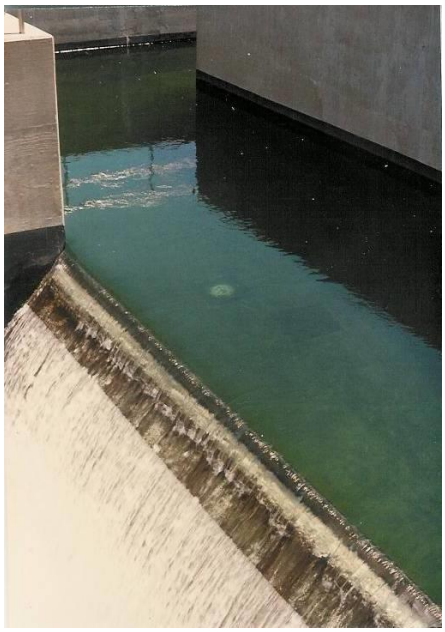
Feeding the biomass to minnows.

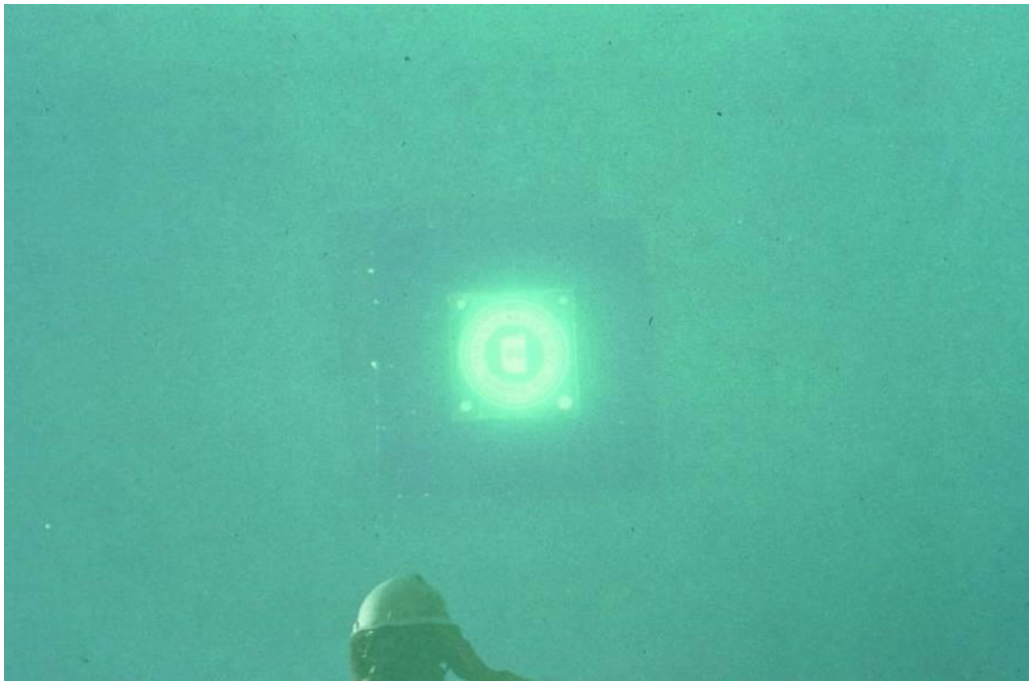
This led to a first round of entrepreneurial startups focused on environmental issues. But this was the 1970s and outside of wastewater treatment there was not a lot of interest so I went to work in a municipal wastewater treatment plant.

Town of Amherst, NY Advanced Wastewater Treatment Plant
1979 - 1989

This was a 36 MGD state of the art advanced wastewater treatment plant where I was both chemist and process superintendent for ten years. The plant was a two stage pure oxygen activated sludge system with biological nitrification and phosphorus removal systems, anaerobic sludge digestion, multiple hearth incineration, and rapid sand filtration for effluent polishing. We made our own oxygen and sodium hypochlorite for disinfection.

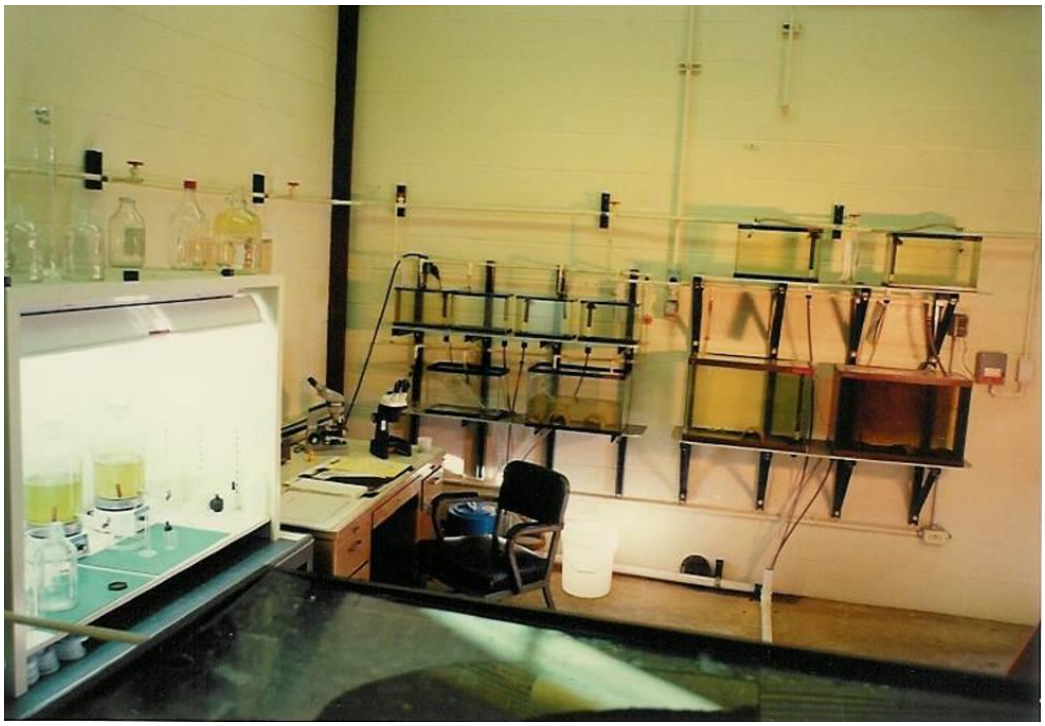
Here are photos of the final effluent at the end of the chlorine contact tank. The light colored circle is a seal of the Town of Amherst under 8.5 feet of water. You could read the heads of the dime, nickel, quarter, and fifty cent coins at the corners of the seal. That's my reflection taking a photo of it.





I developed a biomonitoring system where we grew trout, fathead minnows, daphnia and gammarus in our effluent prior to disinfection. This is the trout tank continuously fed non chlorinated plant effluent.

This is the biomonitoring lab where fathead minnows, daphnia, Gammarus, and algae were grown in non chlorinated plant effluent.



We also grew trout in a pond fed with non chlorinated plant effluent and harvested them. Effluent from this pond was returned to the plant influent.

Since I ran the lab as well, I analyzed the trout and ate them. The green salad in the bowl is watercress that grew around the edges of the non chlorinated effluent trout pond. I ate that too.

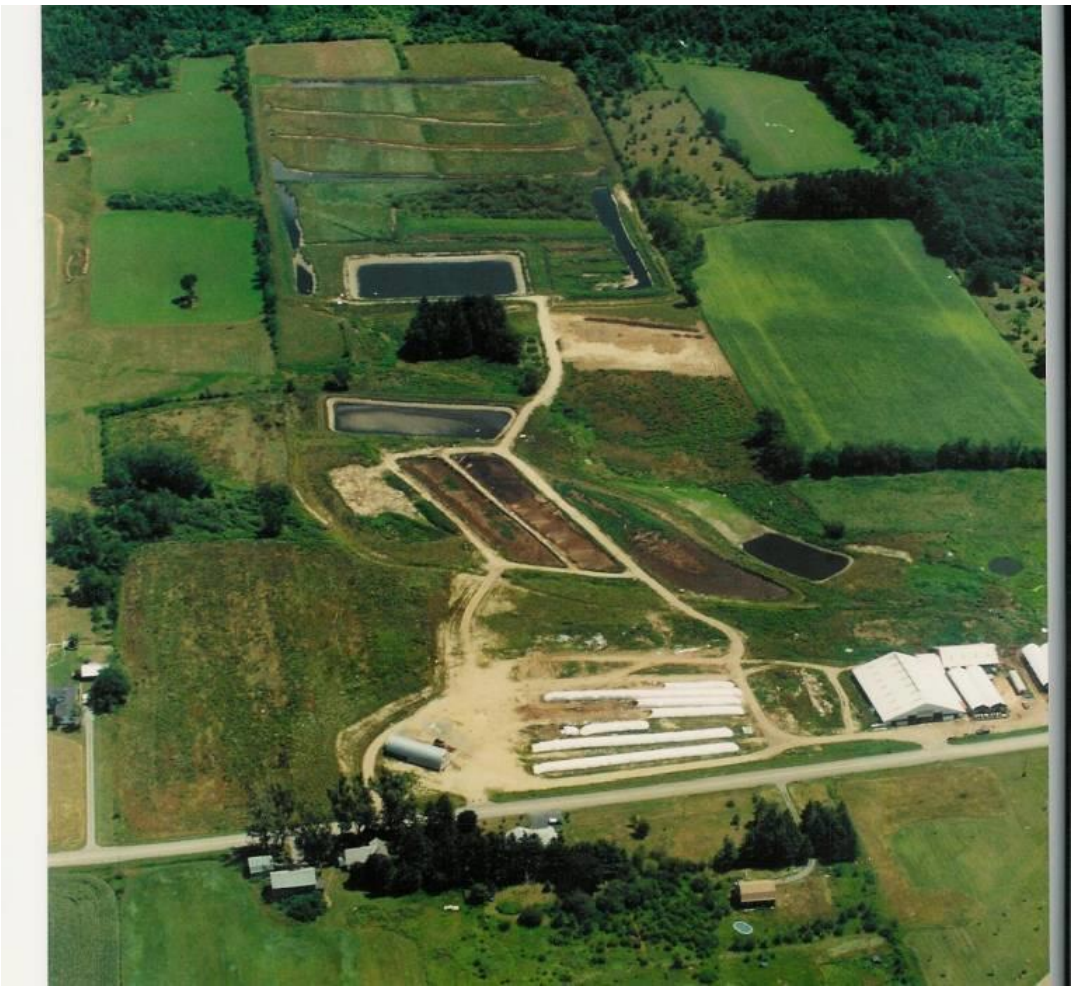
The activated sludge and biological nutrient removal technologies that were incorporated in municipal wastewater treatment plants proved to be very successful at dealing with point sources of water pollution. However, environmental pollution problems continued to grow and the focus shifted to non source pollution mainly associated with agriculture.

The municipal experience had enhanced the understanding of how large complex systems of microorganisms work ecologically, and this again presented an entrepreneurial opportunity.

Bion Environmental Technologies 1989 to 2008

I developed and patented the initial technology and was president for the first ten years, director and chief technology officer after that. We build over 30 manure and nutrient management systems for large animal agriculture and fruit processing facilities.

This is a large dairy farm system in Florida. The ponds (lagoons) and wetland structures surrounded by berms comprised our system. Manure from the barn was flushed into the first lagoon, then sent to a second pond, and then to the irregularly shaped polishing ecoreactor (recycling constructed wetland). From there it was spray irrigated onto hayfields.



This is a smaller dairy farm in New York. Here manure was flushed from the white dairy barn in the lower right into the two parallel brown solids ecoreactors that produced BionSoil. Effluent then flowed into the bioreactor for microbial growth and this was returned as flush water to the barn. Excess water was then pumped into a second bioreactor behind the evergreen trees and this water was recycled through a constructed wetland behind the second bioreactor. The clean effluent from the constructed wetland was used for land application.

These systems utilized a low oxygen nitrification - denitrification technology I developed as well as the constructed wetlands for effluent polishing.

This is a large hog farm in North Carolina. The purple color is from anaerobic photosynthetic purple sulfur bacteria. An article about this system was published in Forbes, 11-15-1999. See [Hog Heaven (forbes.com)]

TECHNOLOGY

ENVIRONMENT

Hog Heaven

Pig farmers are in trouble if they can't find some way to clean up the waste. A new composting technology may come to their rescue.

BY STEPHAN HERRERA

HOG FARMING IS A MIXED BLESSING to North Carolina. It brings in $1.3 billion a year but produces 37 billion gallons of waste that stink up the place. In 1995 heavy rains flooded a hog farm's waste lagoon, pouring 23 million gallons into the New River and Pamlico Sound, fouling drinking water and killing fish. Lawmakers were angry.

"The hog farmer is now public enemy number one in environmental circles," says Garth Boyd, who manages hogs for Murphy Family Farms, North Carolina's largest pork producer.

The Environmental Protection Agency plans to impose tough new waste disposal rules on big animal farms. These will come on top of North Carolina state requirements and could cost farmers there $600 million.

The rules could benefit one little Denver-based outfit, Bion Environmental Technologies. Bion has developed a hog-waste system that tames odor, eliminates toxicity and turns common pig manure into nutrient-rich organic fertilizer. Its biggest market is North Carolina, second only to Iowa in hog production, and a big user of organic fertilizer for golf courses, nursery plantings and strawberry farms.

Murphy Family Farms is a customer. The company spent $250,000 on a Bion system for its French's Creek farm in White Lake, N.C. and has since ordered one more system.

"The farmers with the Bion system came out of hurricanes Dennis and Floyd with their systems intact," says Evan Jones, a professor emeritus of biochemistry at North Carolina State in Raleigh.

Bion's system is an adaptation of the classic urban sewage treatment plant. Hog waste is flushed from barns and pens into a series of shallow plastic-lined earthen pools. An aerator agitates the first pool by pumping oxygen into it, thus promoting the growth of microbes that oxidize the odor-causing ammonia into nitrates. Those nitrates are reduced to nitrogen gas, which is then vented into the atmosphere. Meanwhile, as the slurry moves through the system, solid wastes are removed and prepared for sale. You can stand next to these treatment pools and scarcely smell a thing.

What comes out of the final pool, three months later, is a muddy soil that is dried to make a black, odorless powder which is good fertilizer (with 4% nitrogen, 2% phosphorus and 1% potash). Right now Bion is offering it to customers at low prices.

Contrast the conventional handling of hog waste from giant farms: The waste is channeled into giant lagoons, where it sits for two to six months and then is collected as a liquid fertilizer, which farmers can spray on fields. Those lagoons can be smelled for miles.

Microbiologist Jere Northrop hatched the idea for the Bion system while managing municipal waste systems in upstate New York. Northrop, 57, founded Bion in 1989 with his brother, Jon, who serves as chief executive.

The company is still tiny, with revenues under $250,000, and it is still losing money. But it is growing rapidly. It moved 16,000 tons of fertilizer last year and will more than double that number this year.

Bion has gotten a lot of phone calls since Hurricane Floyd upended farms along the coast. The company's market-building days may be coming to an end, and with them, the days of giveaway systems and discount fertilizer. F

Bion's Jere Northrop and Murphy Family Farms' Garth Boyd—with pigs.

WILL NORTHUP

This is the bioreactor for a large Florida dairy farm barn and pasture runoff treatment system that used metallic salts addition for enhanced phosphorus control.

The solids ecoreactor for that system.

Water samples from the system, left to right. Barn washwater, pasture runoff influent to Bion system, bioreactor with microbes and phosphorus precipitate, final effluent. This system reduced barn and pasture runoff to less than one part per million of total phosphorus.

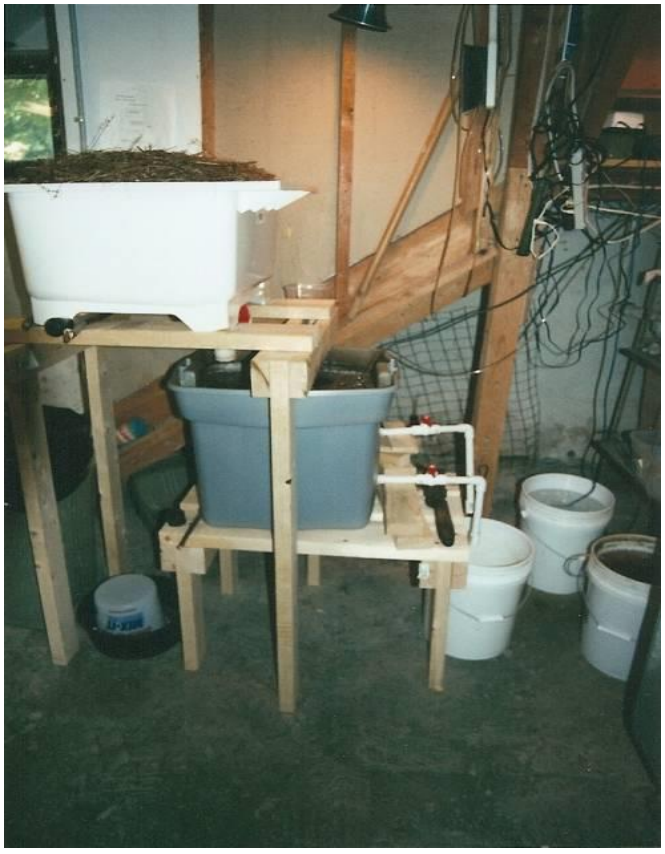
This is a treatment system for a large citrus processing plant in Florida

This is a phosphorus removal system for a sugar cane plantation in South Florida. It reduced phosphorus concentrations down to 20 parts per billion (ppb). Phosphorus concentrations in the drainage canals usually were in the 200 ppb range and regulatory discharge limits were 50 ppb.

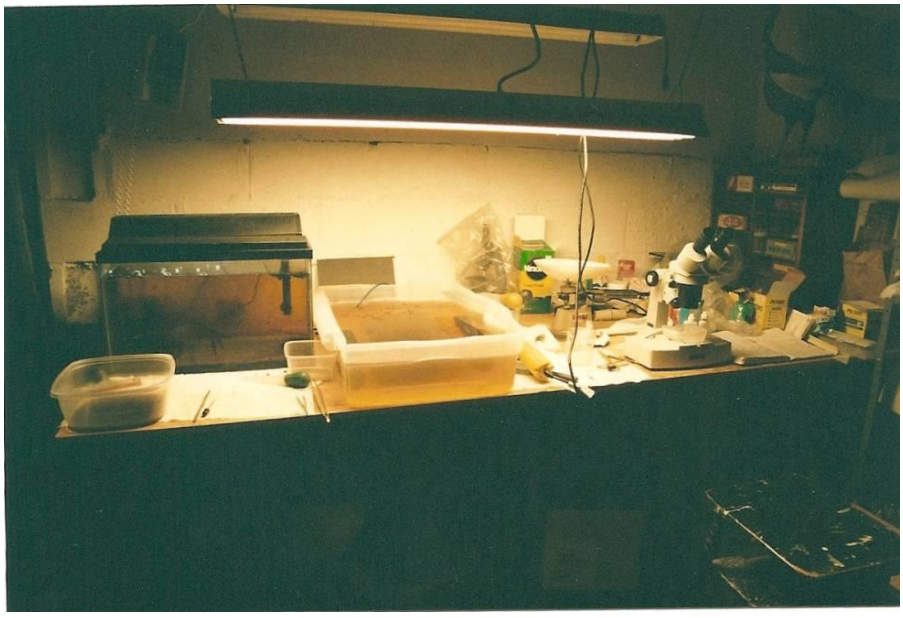
TimberFish 2008 to present.

The Bion systems primarily dealt with wastewater treatment and the production of a beneficial soil product. The market for the systems was regulatory driven (erratic to non existent) and since there was no economic benefit for the farmers and fruit processors, adoption stagnated. So I started again and this time focused on integrating fish production as the key marketing element for a successful commercial system that could pay for itself, and hence not depend on regulation.

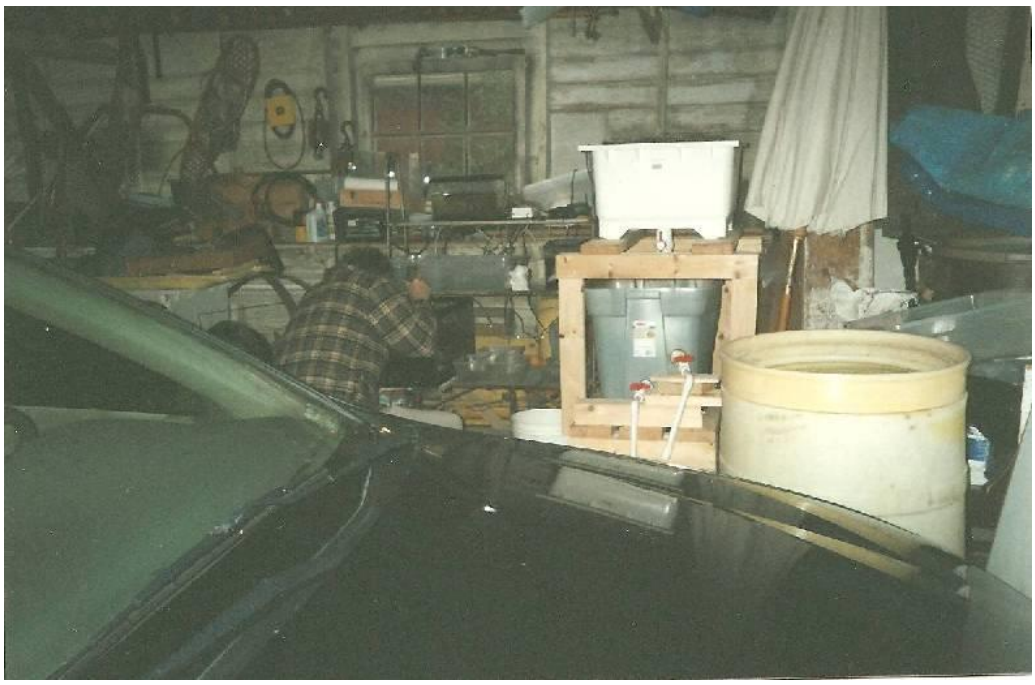
All good technical entrepreneurial startups are supposed to begin in your garage but in this case TimberFish started in the basement. Here is an initial bioreactor for the production of a microbial biomass.



Weeds and sticks were in the white tank in the upper left hand corner. They were periodically irrigated with effluent from a microbial bioreactor (gray tank). A microbial biomass was occasionally settled out from this effluent and then transferred to worm farm prototypes and fish tanks.



And then it was suggested that the whole system should be moved into the garage.



From the garage we moved into the woods.

This is one of the first proof of concept systems in Westfield, NY.

These two pictures show rainbow trout that were initially stocked and then grown to marketable size in this system for one year.

The system ran all winter. Here I check it out in January.

Again we harvested fish, and ate them.

The success of the proof of concept trials in the woods in Westfield led to an independent third party field trial at the Freshwater Institute in Shepherdstown West Virginia. The Freshwater Institute is a program of The Conservation Fund and is one of the premier research institutes in the world on recirculating aquaculture systems.

Here is the experimental prototype they constructed and operated to evaluate the TimberFish Technology.

And here are trout grown in this system.

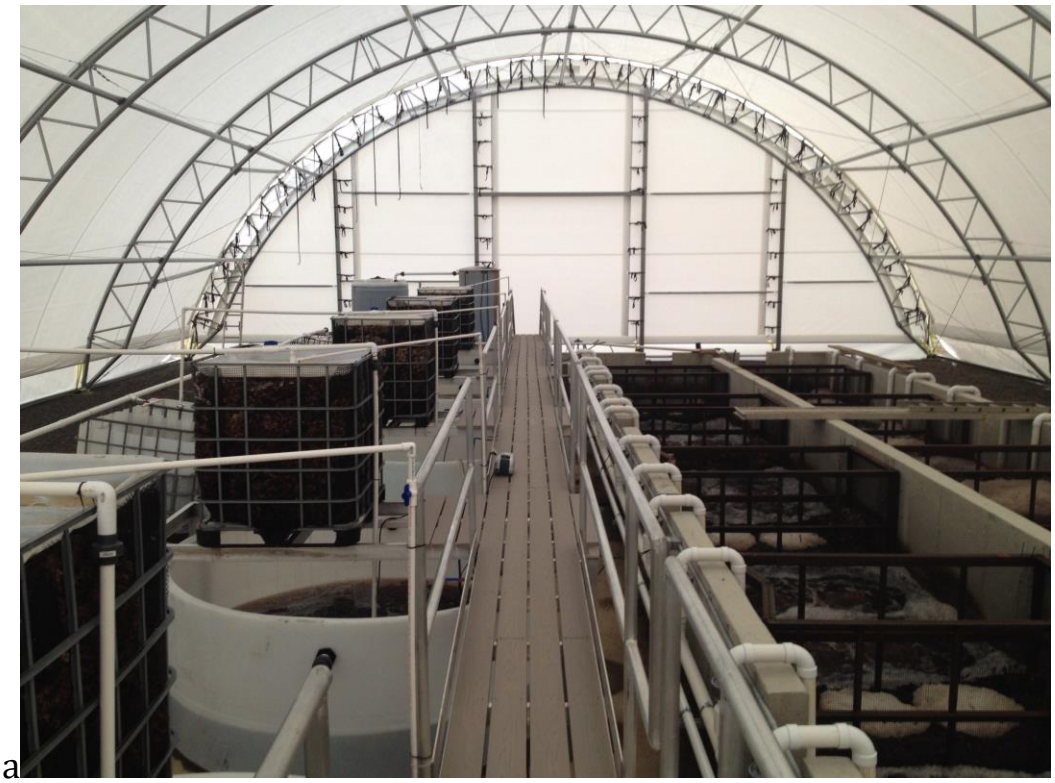
All of this experience culminated in the TimberFish facility at the Five & 20 Spirits & Brewing location in Westfield, New York.

This system began producing biomass in September 2016

It continued to grow biomass and degrade stillage during the winter of 2016 – 2017.

Fish tanks were added and we were ready to begin growing fish in September, 2017.

The system was enclosed in a building for the winter.

a 

Using this system we have grown Yellow Perch, Channel Catfish, Largemouth Bass, and *Macrobrachium rosenbergii*, a freshwater giant river prawn better known as freshwater shrimp.

Here are pictures of the Channel Catfish and freshwater giant river prawns that were grown within the system.

The wood chip biofilter on top of each fish tank proved to be a good habitat for aquaponics. Here you can see watercress growing all over the biofilter above the catfish growth tank.

We then built a mobile demonstration system for the TimberFish system that could be mounted on a trailer.

This was displayed in the Town Commons in Amherst, Massachusetts in June, 2019.