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Sink or swim The future of seafood

New technology may bring aquaculture to new territory

Local scientists are developing water recirculation technology that may bring aquaculture inland, but it needs to keep cheaper for it to be applied for profit, because foreign seafood farmers are watering down the market.

ARCADIA -- Seafood could start moving from coasts to cow pastures, and it won't be crawling on any vestigial limbs; scientists have found ways to grow the ocean's bounty on dry land. Now they have to make it turn a profit.

Cutting-edge research at Mote Marine Laboratory's Center for Aquaculture Research is making tank-based, inland fish farming cheaper, cleaner and sustainable. Mote scientists are crafting closed-circuit water recycling systems that produce negligible environmental impacts, which could be used some day in rural locations across the state as part of a fully integrated aquaculture industry, with feed producers, hatcheries, grow-out facilities and processors.

However the specter of global trade and real estate woes are casting a pall over Florida's aquaculture industry, and making fish farming in the Sunshine State a risky business.

The Florida Department of Agriculture Division of Aquaculture reports that is increasingly difficult for fish farms to compete against foreign rivals, who are not all financially encumbered by strict labor laws and environmental safeguards.

"We are getting killed right now by global trade, we are seeing the industry shrink -- it's pure economics," said Paul Zajicek, one of the division's biological administrators.

"When we had that real estate bubble, a lot of farms sold, their property got astronomically valuable. You look at our land prices in general -- with the competitive nature of seafood in the world, land price alone makes it impossible."

Yet Mote scientists believe the technologies they are developing now could be a boon to fish farms in America, where reports say the appetite for seafood is all but insatiable.

All you can eat

U.S. Department of Commerce reports say Americans are consuming more seafood than ever before. A total of 298.2 million U.S. residents consumed 16.5 pounds of seafood per person in 2005, compared to 1980, when 225.6 million Americans were consuming 12.5 pounds per person.

Rising seafood demand is not native to the United States, and global aquaculture is doing all it can to fill the gap.

The United Nations reported in 2006 that nearly half the seafood consumed worldwide came from fish farms. If current trends hold true, worldwide aquaculture production must double to 80 million metric tons annually by 2050 to meet global demands.

National Oceanic and Atmospheric Association's aquaculture reports also say seafood prices may rise as demand in foreign countries increase and less is exported.

Currently, NOAA says the United States imports "significant volumes" of seafood from countries like China, India, Vietnam, Thailand, Indonesia, Bangladesh, Japan, Chile and Norway, creating an annual seafood trade deficit of more than \$9 billion.

"The United States is far behind many other countries (in aquaculture), Zajicek said. "Even countries in the Caribbean basin are growing cobia and mutton snapper -- the Bahamas have got net pens. We are way behind, but it's because environmental concerns have blocked progress."

Safety first

Environmental concerns such as nutrient-rich water outflow, wasteful water use practices, and the introduction of non-native species are central to aquaculture regulation.

"Regulations are much more relaxed in other countries. We are more environmentally conscious about the impacts of aquaculture," said Dr. Kevan Main, director of Mote's Aquaculture Research Center. "We are not willing to accept those kinds of consequences."

Traditional aquaculture operations pump large volumes of water through the trenches and ponds where the fish are grown to balance nutrient, effluent and ammonia buildups, which are a byproduct of fish farming.

A 2006 survey by the department found that Florida has the most stringent aquaculture regulation in the country, Zajicek said. Each of Florida's more than 1,100 small fish farms are subjected to surprise inspections at least twice a year by the department's expert inspectors, who each have a master's degree.

The National Offshore Marine Aquaculture Act may also one day set standards for marine aquaculture products grown offshore in federal waters and sold from Florida's ports, but that legislation is mired in Congress.

Marine aquaculture operations, which use the open-ocean holding pens to grow fish, also have to worry about biofouling, red tide and hurricanes.

"If you are going to decide to do (aquaculture), you better have a cast-iron constitution, Zajicek said, because the deck is stacked against U.S. fish farmers at almost every turn.

Luckily for the aquaculture industry, Mote Marine's operation isn't wrapped up in profit projections; it is riding on the spiny, prehistoric back of the Siberian Sturgeon, *Acipenser baerii*.

Just add water

After recovering from a devastating fire in 2006 that gutted part of the facility, the Mote Aquaculture Park in east Sarasota County near Myakka now boasts about 78 tons of sturgeon swimming in its tanks -- or "still on the fin."

Sturgeon produce caviar, one of the most highly prized delicacies in the world.

Driving up the center of the park, it looks more like a state-of-the-art plantation, with mowed grounds, verdant ponds, oak hammocks, and cupolas adorning its headquarters.

Mote began experimenting with different sturgeon species in 1998; caviar and meat are now harvested now on a regular basis.

The meat goes to local markets and restaurants, and the caviar is under contract with the noble Parisian Petrossian brand. Current market price for a kilogram of Mote's caviar is approximately \$4,900.

A parallel financial study of the operation is in process, but the goal of Mote's research is not to make money. One of its key goals is to develop low-cost water-recycling technology.

In many cases, the materials used to build Motes' fish farm are similar to what most farmers use today in irrigation and spraying systems: PBC pipes and valves, servo-controlled faucets, and electric pumps and motors.

"What we are trying to develop is elegantly simple engineering; where there is a lot of elegance in the actual engineering, the operation of it will be more simplified," Michaels said. "So you don't need to be a rocket scientist to run a fish farm, that's the ultimate goal."

Bacteria condos

In addition to the nutrients from food sources, fish produce severe metabolites.

"The fish produce ammonia through urine, that has to be dealt with," said Jim Michaels, head of Mote's sturgeon operation. The fish also produce feces, which is collected by tubular solids filters during a relatively easy process.

Separating fish urine from water is a bit more complicated.

"We have bacteria, and this bacteria that will convert that (urine) to an intermediate product called nitrite, which is also toxic to fish," Michaels said. "Then there is another bacteria that eats nitrite for a living and converts it to nitrate, which is much less toxic to fish."

During this process, the good bacteria lives on thousands of what Michaels calls "bacteria condos," which look like tiny pasta-shaped plastic bits. These thousands of plastic bits churn in a open-to-the-air tub with the contaminated water until it's clean.

"But you still get to a point where you build up this nitrate, and at some point that becomes detrimental to the fish," Michaels said. "So either you live with that and balance it with the amount of new water coming in, or you figure out how to get rid of it."

To solve that problem, Mote has adapted a technology commonly used in wastewater treatment facilities. This process uses another form of bacteria that converts the nitrates in the water to nitrogen gas, which is harmlessly released from the water into the atmosphere.

"Our goal now is to hold the water in our systems for 20 days, so we have a 5-percent per day discharge," Michaels said, adding that the current discharge rate is somewhere between 10 and 20 percent.

What water and sediment released now, Michaels said, is filtered naturally through a series of ponds and the nutrients are absorbed by wetland plants, which are then used for wetlands mitigation across the state.

Using gravity and variable frequency drives, Michaels said they are completing this process with minimum energy.

"It terms of pumping, we're moving 2,200 gallons a minute in four tanks with less than 5 horsepower (speed)," Michaels said.

High-tech takes time

Mote's Center Director Kevan Main said it could be five to 10 years before this water recycling technology becomes prevalent and ready for use in inland areas.

"The whole industry cannot convert to this technology today," Main said. "We have to develop the technology and perfect it, and as we do that we drive its cost down."

So far Mote has invested approximately \$25 million in the center during the last seven years. Main said the center's physical infrastructure is worth \$10 million -- the same amount of capital she recommends prospective sturgeon farmers start out with.

"The technology is expensive; sturgeon is the only fish it makes economic sense to grow right now," Michaels said. "One of our goals is to drive the cost of this technology down, so it can be applied to more species, and so that the cattle farmer who may want to try something -- and doesn't necessarily want to try sturgeon -- may have an opportunity to try growing another type of fish in an inland facility, away from all the geopolitical issues on the coast."

The state expects aquaculture to evolve in coming years, possibly with this technology, but it all depends on the bottom line.

"Will recirculation systems get cheap enough to produce a 70-cent fish at the gate?" Zajicek asked. "Probably not. But something like a sturgeon -- maybe a pompano -- could work. All these fish are challenging to raise -- if it was easy, we would be doing it already."

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