A new wave for land-based aquaculture

Researchers hope to bring energy and economic activity to coastal communities

by Roger Hulan and Wade Kearley

Lord's Cove is home to some of the largest shore-bound waves and storm surges that the island of Newfoundland witnesses each year. That's why combining the unique geography of the surrounding area and the technological capability of the nearby Burin campus of the College of the North Atlantic (CNA) holds such great potential for wave energy research.

Dr. Michael Graham, at the Wave Energy Research Centre (WERC), taught biology during his first 15 years at CNA before becoming administrator for the Burin campus. It was toward the end of this time that he became involved in economic development. One evening, at a meeting of the Aquaculture and Emerging Fisheries Working Group, an unemployed fisherman said he wanted to get into aquaculture so he could stay in the area, but according to experts there were no suitable ocean sites.

"He said land-based aquaculture wasn't possible because it cost too much to pump water," recalls Dr. Graham. "And me and my big mouth said, 'Why don't you use wave energy?' I knew a little about the subject because I'd just helped my daughter with a Grade 9 project on wave energy for the science fair."

That was in 2002. Graham and colleague Leon Fiander became convinced that land-based aquaculture could happen in rural communities located near the sea. "All we had to do was figure out a way to harness the energy from waves, and then devise a way to use that energy to pump the water."

But first they had to get the funding for the research project. Graham says he essentially did this off the side of his desk, as "a labor of love." He and Fiander devised a rough budget, and applied for funding from ACOA (The Atlantic Canada Opportunities Agency). To their surprise, the application was approved for $500,000 under the Atlantic Innovation Fund. Fiander was working on his Master's degree in Environmental Science at the time, and part of his research was to design a land-based aquaculture system that would take advantage of the wave-powered pump.

"That was a great start," says Graham. "The next step to develop the wave pump was to find a location that met our site requirements. Lord's Cove fit the bill. The site has worked out really well for us."

STABILITY

The first wave pump they built wasn't stable underwater, so it was prone to capsizing when waves hit it. "But if we could keep it up straight, it worked," says Graham. "All we needed to do was solve the mechanics of that."

That project lasted for five years and focused on developing an economical wave powered pump to deliver sea water

to an on-shore aquaculture farm, and on developing the methods and technology necessary for land-based multi-trophic aquaculture farming (species representing different levels of the same food chain working together to sustain an aquaculture environment).

"While we were developing the pump we asked ourselves, 'If we had a wave-powered pump what would the aquaculture system look like?'"

Following that analysis they applied for a larger grant, and in 2011 were awarded $2.5 million to move to the next level and test an integrated prototype. Since that funding came in, Graham and Fiander have been working on the project full time. One of the first orders of business was to measure the conditions of the site, the wave heights, and the bathymetry (the topography of the ocean floor).

"With the help of the people in the local community, we renovated the retired fish plant, installed all the instrumentation necessary to measure the waves, and from the data we collected, we designed, built, and tested a scale model wave pump at the wave tank at NRC (National Research Council) in St. John's," says Graham.

SEQUENCE OF TANKS

Fiander says the aquaculture system combines efficiency and reduced environmental impact. "In essence what we are doing is we're maximizing the conversion of feed into saleable product," he says. "After pumping the water uphill to the test facility's uppermost tank, which is stocked with salmon, we allow the waste water from that tank to drain by gravity into a sequence of lower tanks where they feed other species. These bottom feeders such as sea urchins, and filter feeders such as mussels, actually also clean the water before it's released back into the ocean."

The researchers are now seeing growth in the fish and other organisms, but the water is still being pumped electrically. An improved wave-energy pump was to be installed in the spring of 2015, but due to logistical challenges the date was pushed back to the fall.

"We need to test the pump to see how big we can make it and how many we will need for the site," says Graham, explaining that the operation must be able to sell the fish and other organisms for a reasonable profit and scale up the model to commercial size.

Even as the project evolves, Graham can already point to a legacy of this work: the Wave Energy Research Centre in Lord's Cove is available to any researchers seeking to develop equipment or test devices in a harsh North Atlantic environment. He believes that, through WERC, the College of the

(Above photo) Mike Graham (left) checking out one of the aquaculture tanks with Adrianus Both, who was working as a technician on the project.

(Left photo) Leon Fiander (left) and Mike Graham in the boat at Lord's Cove, Newfoundland and Labrador, home of the Wave Energy Research Centre.

(Right photo) Lord's Cove residents (from left) Richard Hennebury and Gus Walsh on the wharf with Mike Graham, examining a prototype wave-powered pump designed to supply sea water to on-shore aquaculture facilities. (Photos courtesy of the College of the North Atlantic)

North Atlantic is well positioned to support aquaculture research.

"We have made the site more than just a research facility," he says. "It now has the ability to host businesses or organizations interested in testing their sea-based technologies in an actual naturally extreme environment setting, or by utilizing our resources to test integrated multi-trophic aquaculture research projects."

SPIN-OFFS

One opportunity that has arisen in the past year is working with Remotely Operated Vehicles (ROVs). "We currently have two students from the Marine Institute (MI) completing their work-term in ROV piloting, and we will likely take on two more in the fall," Graham says, noting an affiliation between CNA and MI has opened many doors over the past year.

"They need the work term to graduate from their program, and the amount of industrial activity in this field is kind of low around the province at the moment, so we were more than eager to help them gain the experience necessary for their program."

Graham says much of the new knowledge acquired at WERC is applicable in other areas. He is confident that the same technology that led to the development of the pump for aquaculture may also lead to the development of an inexpensive system for generating electricity from the flow of water as it is returned to the ocean.

But he says the most important outcomes of his work will ultimately be measured in the social sphere. "What we set out to do was to provide an alternative to having to leave rural communities or to commute long distances for work. Dying communities could be revived. If we see land-based multi-trophic aquaculture farms operating in several sites and powered by wave energy, then I'll feel like this project has been a huge success."

In fact, a community-based qualitative research study has been conducted to examine the social implications of establishing research facilities in rural Newfoundland and Labrador – specifically at Lord's Cove. The 38-page report, entitled "It's Just Nice to See the Light on Again," features interviews with 12 local residents and explores how they have responded to the establishment of the centre in their community, and what they anticipate the outcome of the research may be.

"Research aside, one impact we didn't expect was how much this initiative would instill a sense of pride in the community," says Graham. "They have fully supported every aspect of our work, and we value the contributions they have made along the way."

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