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Acoustic Method for Fish Counting and Fish Sizing in Tanks

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Background

For American aquaculture to prosper, farmers need access to technologies that can lower the costs of raising fish to marketable size. Water, energy and feed costs are all examples of expenses that today significantly constrain where and which species are reared.

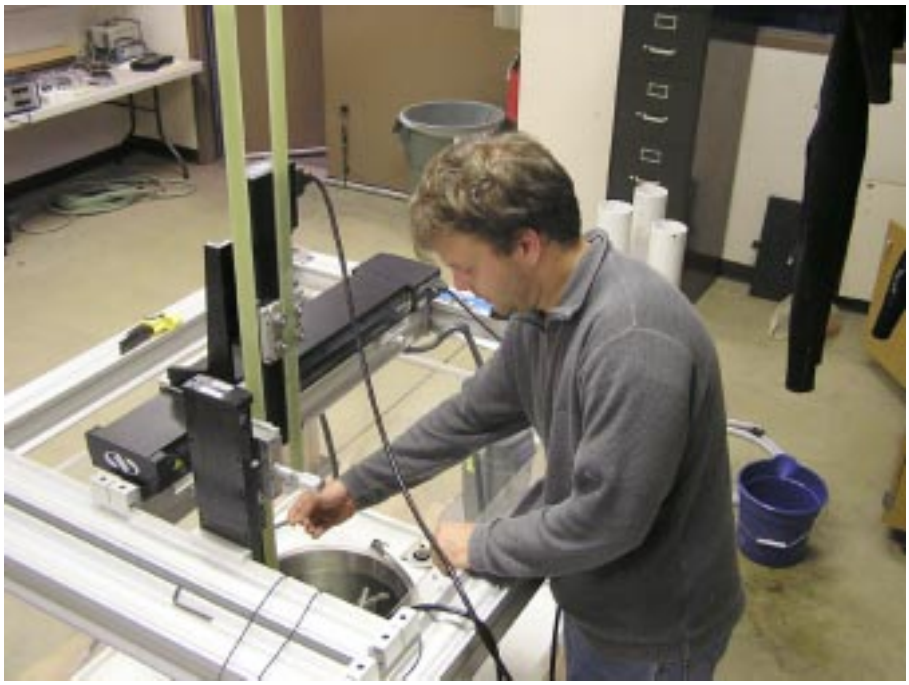
Take for example Kent SeaTech, a large hybrid striped sea bass farm east of San Diego. The viability of this business is greatly enhanced by its ability to use geothermally heated water to grow its fish. As with many species, sea bass grow faster in warmer water.

Even with this boon, however, the farm must constantly optimize how fish are distributed among its 97 tanks to maximize feed-conversion rates, minimize losses from disease, and maintain a steady supply of harvestable fish.

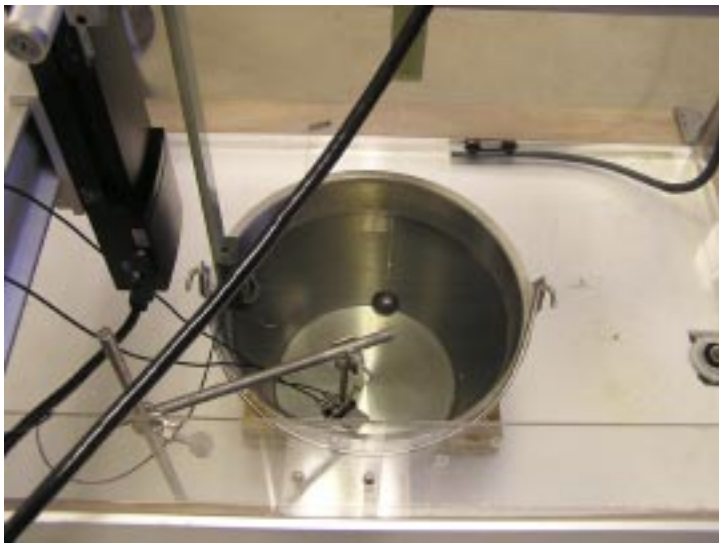
To do all this requires inventorying tanks regularly. Currently, this is a very labor-intensive process. It takes an eight-man crew two full days to net and weigh sub-samples of fish in each tank so that each tank's biomass can be estimated—the key statistic needed for calculating feed-conversation rates. To effectively control feeding rates, the farm inventories its tanks monthly.

Project

The goal of this project is to develop a portable acoustic device that will quickly, passively and accurately count and size fish in commercial tanks. Such a device would allow farms like Kent SeaTech to significantly reduce labor costs and human error associated with manual statistical subsampling. Equally important, it would



Philippe Roux, a physicist from the University of Paris, is building an acoustic fish counter for commercial aquaculture farms with support from California Sea Grant.



The prototype for the acoustic fish counter sits inside a steel bucket. The hanging metal ball represents "a perfect fish." Photos: Christina S. Johnson, California Sea Grant

reduce stress on fish associated with being netted, removed from the water and weighed.

W.A. Kuperman of Scripps Institution of Oceanography and Philippe Roux, a visiting researcher from the University of Paris, are currently working on a prototype for such a device. During the course of their Sea Grant project they will test it at Kent SeaTech.

Science

The basic physics behind designing an acoustic counter is simple and fundamentally similar to the physics of sonograms and echolocation. By emitting pulses of sound and listening to their return echoes, an image of an object can be reconstructed. The challenge of this project is to decode the very complex patterns of reverberations in a water-filled chamber filled with a high density of moving fish.

Despite the formidable challenges, Roux is confident they will be able to build the device. Roux cites past inventions as examples of what can now be done in acoustics. In France, Roux built an acoustic gun for noninvasively breaking apart kidney stones, and another for noninvasively burning brain tumors with sound blasts. He's also been part of a team of scientists led by Stéphane Conti of NOAA's Southwest Fisheries Science Center in La Jolla that has shown the feasibility of counting and "sizing" people in a squash court. In their experiments, the results of which appear in a recent article in *Applied Physics Letters*, the scientists showed that people scatter sound as if each person were a large, elongated chicken egg—an ellipsoid proportional to the height and width of the person.

Dr. Philippe Roux. Photo: Christina S. Johnson, California Sea Grant

In other encouraging work, scientists were able to use acoustics to count zebra fish in beakers. The trick now, Roux said, is to advance this counter so that it will be operational in tanks with very high densities of fish. To be commercially viable, the acoustic device must also be very accurate: less than one percent error. And, it must work in tanks of all different sizes, shapes and materials. Fiberglass, cement and metal—all these materials reflect sound differently. These differences must be calibrated before a final prototype is made available to industry, Roux said.

Education and Outreach

The father of five young children, Roux has also added an educational component to his project. In collaboration with the Birch Aquarium in La Jolla, he will design an interactive educational exhibit, "How many fish?" at which visitors will be asked to guess the number of fish in a tank and then obtain an estimate using the echo patterns of sound.

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