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Fish Farming in Barn and Pond

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Fish Farming in Barn and Pond

The cowbarn on the Philadelphia campus is once again occupied and Harnwell Pond at New Bolton Center is no longer placid. Both have a new purpose as sites for raising hybrid striped bass. The old, large room in the School's courtyard wing and the farm pond at New Bolton are vital components of a living laboratory that explores the raising of fish for market.

In 1997 the School received a grant from Delaware River Port Authority to study the feasibility of a state-of-the-art aquaculture facility at the Philadelphia Navy Yard to utilize existing buildings and to bring jobs to the area. Dr. Leon Weiss, the project director, formed a multi disciplinary team with members from the

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School of Engineering, the Wharton School, the Department of Environmental Studies as well as members of the School's faculty. Dr. David Nunamaker oversees the project at New Bolton Center. He is aided by Dr. Eric Birks, a physiologist, and members of the Center for Animal Health and Productivity. Dr. Hamish Rodger, an aquaculture specialist skilled in diagnostic pathology from the Institute of Aquaculture, University of Stirling, Scotland has joined the group, overseeing closed system fish farming and contributing to aquaculture activities at both Philadelphia and New Bolton campuses.

The cowbarn and Harnwell Pond are important as both are existing "spaces" that, with slight modifications, can provide an environment needed for raising fish, albeit through two different methods. The barn, a large room in an older, existing, urban building serves as a model for similar spaces in old manufacturing plants, empty warehouses and spaces such as those at the Navy Yard that could be converted to fish farming. The pond is similar to many of those located on farms in Pennsylvania.

Harnwell Pond was "renovated" by dredging and enlarging, the addition of a sediment basin to prevent silting, and inflow and outflow pipes. The pond, part of New Bolton Center's storm water management, is now 8 ft deep throughout and covers about two acres. Its renovation was completed in October 97 and by winter the pond had filled. Geese were discouraged by the "dog method." Dr. Nunamaker's Chesapeake Bay retriever harassed the birds so much that they fled to another pond. Geese and fish farming are not compatible because of the soiling of water and surrounding ground by the birds.

While work on the pond progressed, construction in Philadelphia commenced. New reinforced flooring was poured to bear the weight of heavy water tanks. A maze of water and drainage pipes was installed as were heavy-duty electrical services. To work on pumps and to change settings on equipment, a raised steel floor was built so that engineers can continually fine-tune the equipment for the closed circulation system. Two 2,400 gallon tanks, each with its own recycling system, were installed as were three 180 gallon tanks hooked up to a common recycling system. There is also a 1,600 gallon water holding tank where city water is stored while the chlorine vents out. Other equipment includes pumps and filtration systems as well as an array of measuring devices.

Dr. Hamish Rodger shows one of the large tanks to members of the School's Board of Overseers. Inset: fingerling shown with quarter.

The equipment in Harnwell Pond isn't quite as complicated. Here students, under the direction of Dr. Nunamaker, built floating docks and five large fish cages, four feet high and four feet in diameter, out of one inch plastic well pipe and heavy-duty ¾ inch plastic mesh. An aerator was installed to provide a continuous current and three pounds of oxygen per hour. It keeps the area from freezing during the winter and keeps the water cooler during the summer. By late spring the pond was ready for fish. The population selected was a bass cross, an established, reliable strain that can tolerate warmer water, is disease resistant, grows fairly uniformly and is adaptable to various environmental conditions.

The fish were purchased in different sizes: as 1-2.5 inch fingerlings, as 3-10 inch fish and as 400 g fish. They were put in the cages. Dr. Nunamaker and his group found that the highest mortality rate occurred among the larger fish, 25 of the 100 ten-inch fish died primarily due to trauma inflicted by the other fish, so the remaining 75 were released into the pond. The fingerlings were distributed in the cages in various densities and it was found that in a group of 300 to a cage 25 died. The group also found that when the fingerlings were at 150 per cage the mortality was lower and the growth rate was about the same as that of fish in the pond. Density influences weight gain and it is advantageous to have lesser density of fish in a cage. The lower densities had the greatest varieties in size.

For bass the industry is looking for fish of about 1¼ to 1½ lb. in weight at the time of harvest. To achieve this in pond grown fish, a farmer must invest about 1½ years if 2.5 inch fingerlings are set out. These are about five months old. From egg to market weight it takes a pond-raised fish two years.

These fish require attention, just like any other food animal. They are fed twice a day with a high-quality, fish-based diet. Bass are carnivorous and need certain fish oils in their food to thrive. Researchers at the Center for Animal Health and Productivity are working on a plant-based fish food that would be suitable and less expen-

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sive for farm raised carnivorous fish. In addition to feeding the fish, the water quality must be checked frequently for: pH values, dissolved oxygen, alkalinity, nitrogen content and temperature. These need to meet specific parameters for the fish to grow.

Dr. Nunamaker explained that triploid carp were released into the pond to control algae growth. He said that prey birds were not a problem because the cages have lids and sit below the surface.

The closed circulation tanks in Philadelphia pose a different set of problems. Here the fish are in an artificial, totally controlled environment. Worries are water quality and the management of waste products. Dr. Hamish Rodger directs the fish farming project in town. He explained that 2,000 striped bass of the same variety as at New Bolton were put in one of the large tanks in December. The fish were fingerlings, about 3 inches in length. They are fed salmon fish food using clockwork belt feeders.

Dr. Rodger demonstrates the feeder to Mr. Wayne Ferguson and Dr. Robert Marshak.

The water is kept clean through a biofiltering system where the water trickles over a plastic bed that is lined with bacteria. These metabolize wastes and ammonia. The group is also testing a "bubble bead filter" which combines mechanical and biofiltration. Liquid oxygen is added to the water and aerators are employed. The tanks are equipped with automatic probes for daily checking of levels of oxygen, pH, temperature and redox potential. Nitrite and ammonia are tested daily. Alkalinity and nitrate levels are tested every other day.

Waste is collected in traps that are cleaned frequently. Each day about 10% of the water in a tank is drained and replaced with de-chlorinated city water. The water temperature is about 70-75°F without any direct heat. The many pumps and other equipment in the room provide quite a bit of warmth, enough to keep the water at those temperatures even though it is much cooler outside.

Dr. Rodger said that heat pumps may be installed to more precisely control room and water temperatures.

He explained that closed system fish farming is not that profitable right now because of the high overhead costs for equipment, water, electricity and labor. The goal of the project at Penn is to fine-tune and modify existing equipment to make it more efficient and less costly to operate, keeping morbidity and mortality among the fish to a minimum. To that end the researchers hope to develop DNA probes for specific pathogens that affect bass and tilapia. The pathogens, primarily bacteria and parasites, can adversely affect production. The long term goal is to raise fish free of specific pathogens and to market the eggs or progeny of these.

Because these fish are raised in a controlled environment under optimal conditions their rate of maturation is accelerated. Tank raised bass grow to market weight in one year, from egg to 1½ lbs. That is half the time of pond fish, but the cost of raising on a daily basis is higher. Currently only bass are raised but Dr. Rodger hopes to add tilapia early in 1999. The group is also looking at the feasibility of raising shrimp in tanks. Plans are also in hand to add more tanks.

The fish farming project at the School is now up and running. In addition to the participation of the School of Engineering, the Wharton School will provide help with cost analysis and marketing studies. Penn's Department of Environmental Studies is also involved to consult on water and environmental issues.

Within the School the project has generated quite a bit of interest among students who now can have hands-on experience in pond farming and in closed system fish farming. Elective courses in aquaculture are offered for third-year students during the spring. The School also offers the Aquavet® program each May at the Marine Biological Laboratory, Woods Hole, MA open on an internationally competitive basis.

Will such fish farming be economically feasible? The studies at New Bolton Center and in Philadelphia should tell. One thing the researchers do know, compared to chicken, fish are more efficient in converting feed into market weight. It takes a 0.97 lbs. of fish food to yield one pound of fish. Theoretically a farmer could raise 4,000 fish per acre of pond and could earn between $6,000 — $10,000 if all goes well. If the cost of closed system fish farming can be brought down, a producer then could look at a similar profit.

For this to happen, processing needs to be in place, a transportation system from farm to processing plant needs to be developed as well as a system to transport live fish to specialty markets. All this is in the future, awaiting the answers from the research and farming efforts by Penn's multi disciplinary group. Hopefully they will have answers that lead to extra income for Pennsylvania farmers and create a new industry in empty buildings throughout the city and the Navy Yard.