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Aquaculture in Power Plant Effluent

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"The fish you eat in King's tonight Slept in Chesapeake Bay last night"
That catchy couplet used to be prominently displayed in a New York seafood restaurant. Maybe it is still there.

One day, however, not every fish and shrimp we eat will have spent its life in a bay, or even a river. Even now, the catfish we eat tonight may have slept in a power plant cooling canal last night. Catfish are cultured commercially in an electric plant discharge canal at Lake Colorado City in West Texas. This aquaculture enterprise by James F. Kelley is an outgrowth of a research project of Texas electric Service Company seeking to take the waste energy found in the warm discharge waters and convert this energy to growing fish during fall, winter, and spring months when normal Texas water temperatures are too cold for fish growth.

The Texas Electric aquaculture research program is only one of several projects in the state which uses power plant effluent in fish growing experiments. While re-use of water is not the major goal in these undertakings, it is significant, and as one researcher from Texas A&M University Wildlife and Fisheries Department summed it up: "one day someone will point to this vast amount of heated water being wasted and tell us we've got to use it."

When that time comes, plenty of data will be available to guide commercial fish and shellfish farmers in the production of seafood in power plant effluents. Among numerous research projects now being conducted in this area are three which this newsletter describes: a Sea Grant-funded shrimp culture project by the Texas A&M University Agricultural Extension Service at the Central Power and Light Company's new Barney M. Davis power station at Flour Bluff, near Corpus Christi, the Texas Electric project mentioned above; and a multi-faceted mariculture operation of the Texas A&M

Experiment Station by the Wildlife and Fisheries Sciences Department at the Cedar Bayou plant of Houston Lighting & Power (HLP).

Cedar Bayou Research

The HLP plant at Cedar Bayou discharges a maximum of 1,460,592,000 gallons per day from three units. This huge volume of water goes into a 2600-acre reservoir, and after it has cooled down to the temperature of the bay water, it spills out into Trinity Bay. The mariculture program there, compared with others to be discussed, is a veritable three-ring circus. Dr. Kirk Strawn, professor of fisheries sciences at Texas A&M, directs five graduate students in a year-round mariculture program involving three types of culture, all using the power plant effluent.

The three types of culture take place in 1) a laboratory, 2) fish ponds, and 3) cages in the cooling water. The purpose of all three is to use the fish in the way miners once used canaries in a cage. Miners were testing air quality; whereas this is a test of water quality, explained Nick Parker, graduate student research assistant. He added, "We're screening these organisms to ascertain their maricultural potential."

In the laboratory, called the greenhouse, approximately 30 species of fishes are grown and studied. Variables include temperature control, feeding rate, and stocking densities in waters of a natural salinity.

Goal to Extend Growing Period

There are 25 quarter-acre fishponds through which coolant water, ranging from 57 to 104 degrees F., is pumped. Although gravity flow into the ponds is possible, the power plant officials elected to pump rather than cut into the dike 25 times for the flow to enter each separate pond. Running continuously, the flow takes about two and one-half days to go through a pond. It leaves the pond through a 4-inch pipe and returns to Cedar Bayou. Ponds are stocked with shrimp, redfish, speckled trout, spadefish, pompano, croaker, mullet, black drum, flounder and spot. Finding ways to extend the growing period by using heated water is major goal in the pond experiment.

The cage project, the third method, takes place in the vast cooling lake as well as the intake and discharge canals. Various species are cultured under several different conditions to compare their growth, survival and potential for mariculture. Variables are diet, population, density, cage design, and position in the system.

Floating cages, 120 linked together, are stocked with fingerlings. Cages vary in size. The smallest is 2 feet in diameter, 2 feet deep; the largest is a 3 x 4 foot rectangle, 3 feet deep. Strawn explained, "We're investigating advantages of raising two or more species together to find the most efficient way to reduce fouling of the cage and to utilize the available food."

Cages, Parker pointed out, maintain fish in their most natural environment, but in an artificial enclosure. Ponds are a natural enclosure, but here water does not reflect the rapid changes in temperature and salinity. The greenhouse is the most unnatural of all, but it does provide easy access and observation of fish while monitoring growth and survival at selected temperatures and natural salinities.

There is no fish culture project in the open lake at present, but Strawn says the cooling lake has "real possibilities for culture." The production of shrimp, blue crab, and finfish is high, he commented. The lake in recent years was the site of a Sea Grant oyster culture projected under the direction of Dr. Sammy Ray of A&M College of Marine Science, Galveston.

18 Test Tubes

At Central Power and Light Company's Barney M. Davis station there are 18 shrimp mariculture ponds, which project supervisor Dr. Fred Conte calls his 18 test tubes. "Here we experiment in the areas of shrimp stocking densities, different shrimp species, different feeds and fertilizers, and other pond management techniques we want to investigate."

Currently the work is concentrated on maturation of shrimp. Animals are becoming sexually mature and exhibiting reproduction behavior in the pond. This past August the researchers spawned their first shrimp from the pond. This represents the first reported natural spawning of captive shrimp without artificial stimulation.

Water from the 1100-acre cooling lake reaches the ponds by pump or by gravity flow. Except for temperature, water leaving the lake to enter the ponds is essentially the same as water from Laguna Madre, the source of the plant's cooling water. A filtration system, which removes organisms from the water before it reaches the plant, is a benefit to the mariculture operation because it removes grass and other foreign matter before it reaches the ponds.

Heated Water Benefits

"Heated water," Conte said, "enables us to extend our activities into winter. If we didn't have heated water, we would have mortalities unless the winter is mild. Heated water is most beneficial from October through March."

The 1974 shrimp harvest of 1500 pounds per acre with six-inch shrimp weighing 9/10 of an ounce indicates dramatic progress, and confirms the project leader's conviction that shrimp mariculture can become a new industry, especially with the ample supply of warm water available.

"Considering that the South Texas coast offers some of the most ideal sites for shrimp mariculture in the United States, the development of this new industry would have a significant impact on the coastal economy and make a substantial contribution to United

States' capabilities for supplying shrimp," commented Dr. Jack C. Parker, program manager for marine fisheries and mariculture, Sea Grant Program at Texas A&M University.

At Texas Electric Service

John E. Tilton, research biologist at Texas Electric Service Company, says the use of thermal effluents associated with the generation of electric power can be developed not as a different aquaculture method but *as a tool to be used for efficiency of operation, as a space saving device, and as a method of speeding growth and lengthening the growing season.* He points out that the utility industry has impounded or developed water supplies in many localities where water for aquatic productivity would not otherwise be available, thus enlarging the aquaculture base.

The Texas Electric steam-engine generating station at Lake Colorado City is typical, circulating large quantities of cooling water through steam condensers. There it picks up waste heat and returns to the lake through a special canal, unchanged except for added heat and increased oxygen--both assets to catfish culture. On its return to the lake, it mixes with the colder lake water and is cooled before reentering the plant in a continuous cycle.

While the water is in the canal, temperatures will be 15 to 20 degrees F. above the lake temperature and in a good range for catfish production during fall, winter and spring. During the aquaculture planning phase at Texas Electric, the possibility of pumping the warm water from the canal through a series of small ponds was studied, but high pumping costs and losing the advantage of the free flow of water were considered disadvantages. Instead, the researchers opted for the method of raising fish in cages as the Asians have done for years. Where the canal widens into a pond about 5 acres and the current is reduced, circular cages 47" in diameter and 36" deep float. An electrically driven barge is used for feeding, inspection and harvesting of fish.

Warm Water Assets

By using the heated canal the operation has several advantages: 1) Water temperature can be maintained at a range to give optimum growth and eliminate seasonality in production. Channel catfish do best at about 85 to 86 degrees F. Using plant heat discharge permits the fish farmer more days with optimum temperatures than the farmer operating without supplemental heat. (Heat cannot economically be added to open ponds because of cost.) As a result, profit can be made on a year-round operation instead of 6-7 months, the usual growing season. 2) Pumping costs can be reduced. Because the plant moves large quantities of water (100,000 to 500,000 gallons per minute), pumping costs can be reduced significantly. 3) The large volume and flow of water results in waste removal and in maintaining the desired dissolved oxygen concentration in the water--both of vital importance where there is a high density fish population.

The Lake Colorado city operation is now commercial, but it is no longer a project of the Texas Electric Service Company. Like the other utility companies, Texas Electric carries out and /or supports research, but leases the waters for commercial production. It is an opportunity for these companies to demonstrate that heated discharge water, sometimes call a "pollutant," may be beneficial for commercial fish production.

Water conservation, Tilton believes, would "mean using every drop of available water to its maximum. This might be for aesthetics, recreation, electrical production, municipal supply, and so on. If it were possible to utilize a single reservoir by making it attractive, keeping it clean enough for water supply, providing swimming, boating and fishing, using it for power plant cooling and other industrial purposes which provide jobs and higher standard of living--and on top of all these act ivies, provide several million pound of high quality protein--, this would be the ultimate in water conservation."