CHANNEL CATFISH (ICTALURUS PUNCTATUS) PRODUCTION IN GEOTHERMAL WATER

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ABSTRACT

Fish Breeders have been raising Channel Catfish (Ictalurus punctatus) in geothermal facilities for six years. The product produced is superior to other catfish on the market.

Concrete facilities and 6,000,000 gallons per minute of water allow densities of five to ten pounds per cubic foot of space and 10,000 pounds per second foot of water. Oxygen and ammonia are the principle factors limiting production. Disease is related to these factors.

Identifying the resource, facility design, financing, construction, production, processing, marketing and distribution are the main problem areas preventing expansion of geothermal fish farming.

INTRODUCTION

Fish Breeders of Idaho, Inc. has been raising channel catfish (Ictalurus punctatus) in high density concrete raceways for six years. The water is supplied by artesian geothermal wells. The total flow is 6,000 gpm at 90°F. Cold water from springs and streams is used to cool the hot water to 80°F to 85°F., the ideal production temperature.

The quality of channel catfish produced in the clean water is far superior to any other catfish on the market. A fish is like a sponge; it tastes like the water in which it is raised. The geothermal water produces a quality that has allowed Fish Breeders to introduce catfish into the gourmet markets and obtain high prices for catfish.

FACILITIES

Fish Breeders is located in the Snake River Canyon near Buhl, Idaho. The elevation is 3,000 feet. Yearly temperatures are from -10°F to 105°F. Ambient water temperature seldom exceeds 75°F. The climate is too cold and the growing season too short to grow catfish commercially without hot water. Geothermal water changes a non-commercial area to a 365 day optimum growing season.

The fish farm is located on a hill. Approximately 80 feet of elevation is used in the farm. This is very important in aeriating and reusing water.

The production facilities are concrete. Each section is 24 feet long, 10 feet wide and 4 feet deep. The space utilized by the fish is 770 cu. feet. The sections are arranged four in a series with a 2 foot drop between each section. The raceways are in pairs with a common center wall. The water passes through four sets of raceways, each raceway having four sections (16 section total), from the top of the hill to the bottom. The upper end of the farm is used for catfish production. The lower end of the farm is used for Tilapia production.

WATER SUPPLY

Four artesian geothermal wells supply 6,000 gpm of 90°F water. This water is mixed with cold water that varies from 32°F to 74°F to obtain a temperature of 80°F to 85°F. The geothermal water is used direct. No heat exchangers are utilized. The wells were drilled by Fish Breeders and are approximately 700 feet deep. The water flows through each raceway at 1,500 to 2,000 gpm.

STOCKING RATE

There are two densities to consider in producing catfish; pounds per cubic foot of space and pounds per second foot of water. Both are interrelated, but the degree of interrelationship is unknown. They will be considered separately in this report. The pounds per cubic foot of space is primarily limited by social factors. The pounds per second foot of water is primarily limited by water quality.

Channel catfish are social animals. In their natural environment they tend to congregate in groups. Eggs are laid in a mass. Sac fry congregate after hatching. Fingerlings, and even adults, spend much of their time in schools. They do not establish individual territories like shrimp or lobster. This is one major factor that makes them ideal for high density production. Channel catfish do establish a social pecking order. Stocking at high densities appears to interfere with this pecking order and reduces fighting.

Normal stocking densities are from 5 to 10 pounds of fish per cubic foot of space. Lower densities are used for small fish. Densities up to 20 pounds per cubic foot of space have been tested, but at this time are not recommended for commercial production.

The pounds of fish that can be produced per second foot of flowing water is limited by water quality. Water analysis of the water entering the raceway, compared to water analysis of the same water leaving the raceway, tells what the fish have put in the water and what the fish have taken out of the water. The factors of greatest importance are the oxygen removed and the carbon dioxide and ammonia added.

Oxygen removed is the first factor that limits production, however, oxygen is easily replaced by running water over waterfalls. At the same time oxygen is replaced, carbon dioxide is removed. Theoretically, oxygen can continuously be replaced and most of the carbon dioxide removed. by a chain of waterfalls. A two-foot drop will replace approximately 50% of the oxygen removed. There are ways of increasing the breakup and aeriation of the water to achieve saturation in a two-foot drop, however, this is usually not done.

Ammonia is not easily removed by waterfalls and will continue to accumulate until it becomes the principle limiting factor in raceway production. The ammonia can be in an ionic state or a gaseous state. The gaseous state is very toxic to fish and can be partially aeriated out of the water. The ionic state is less toxic, remains in the water and changes to nitrates. The amount of ammonia that will be in the gaseous state is related to pH, temperature and water chemistry. The amount of ammonia that fish can tolerate is dependent on these same factors plus the oxygen and carbon dioxide levels. The higher the oxygen level, the more ammonia fish can tolerate. The level of ammonia that fish can tolerate is between .5 ppm and 2.0 ppm.

The amount of oxygen removed, carbon dioxide produced and ammonia produced is dependent on the amount of food fed in the raceway, not the amount of fish in the raceway. 5,000 pounds of fish could be fed 1% body weight (50 pounds of feed), and the ammonia, carbon dioxide and oxygen levels would be basically the same as if 2,500 pounds of fish were fed 2% body weight (50 pounds). The limiting factor is the same amount of feed can be fed per second foot of water, and the amount of fish that can be stocked is dependent on the percent body weight that is fed.

Oxygen required to metabolize 50 pounds of feed is approximately 2 ppm from one second foot of water. In a raceway with four sections and one second foot of water, the water will be aeriated three times, once between each section. Fifty pounds of feed can be fed in each section. This gives a total of 200 pounds of feed that can be fed in the entire raceway. Assuming 50% reoxygenation and saturation of 8 ppm, the oxygen at discharge would be 3 ppm. This is an absolute minimum level for production. A total of 8 ppm oxygen would be utilized in metabolizing the 200 pounds of feed.

Approximately .2 ppm ammonia would be deposited in one second foot of water from metabolism of 50 pounds of feed. Feeding 200 pounds of feed in one second foot of water, the ammonia in the discharge would be .8 ppm.

Maximum recommended inventory for commercial production of channel catfish on water at Fish Breeders is about 10,000 to 15,000 pounds per second foot of water. Yearly production will usually be three to four times the carrying capacity.

Disease is usually a major concern in fish production. It should not be. 99% of all diseases are secondary expressions of poor water quality, poor feed quality and poor management (the human element). If good water quality is maintained, good feed is used and labor handles fish properly, disease should not be a problem.

In order for a commercial hatchery to obtain maximum profit, production must be pressed to the limit. This means carrying inventory will be increased to the point disease will develop because of overloading. It is management's job to balance carrying capacity to water quality and stay below the point where disease is a problem.

Here is summarized the problems expected in starting a geothermal fish farm. These factors have prevented a faster growth rate in geothermal fish farming.

Identifying the Resource. The extent of most geothermal sites considered for fish production have not been identified. Surface springs show a potential but do not tell the complete story. Wells must be drilled before the volume, temperature and water chemistry is determinable. These must be known before a production potential can be analyzed. Considerable money must be spent before a decision can be made recommending a site for geothermal fish farming. The person with a geothermal resource must first identify that resource, and then see if it is suitable for fish production.

Facility Design. People interested in building fish farms usually examine government hatcheries for models to copy. This is a poor place to study a good design. Poorly designed commercial farms go broke and disappear. Poorly designed government fish farms continue to operate indefinitely, consuming tax dollars.

An engineer's dream is too often a fish culturist's nightmare. The KISS rule is the only rule to follow. KEEP IT SIMPLE STUIPD. There has been little communication between fish culturists and engineers. This lack of communication has resulted in a situation where there are few, if any, engineers who understand the management of fish culture well enough to design a commercial fish farm. I cannot recall a commercially viable fish farm that was designed by an engineer. The entire industry has been designed and built by the fish farmers themselves. This does not mean there is no room in the design work for engineers. It means engineers are not in tune with the problems of fish culture and, therefore, behind the times.

Financing. Financing is difficult. Geothermal is considered high risk. Fish farming is considered high risk, and high density production even a higher risk. Capital expenditure is high, operating expenses are even higher. An executive of a large company looking at fish farming said they consider some businesses as cash generating and others as cash consuming. They considered fish farming as cash consuming. It is a good description of fish farming.

Contrary to common opinion, most fish farms that have gone broke did not do so because of underfinancing. Those started underfinanced have had a high success ratio, while those adequately financedl "spent it like they had it" and went broke. Too many mistakes were made too fast, and the investors ended up very disenchanted. Bankruptcy followed because of a lack of willingness, not ability, to refinance and do what was necessary to succeed.

Construction. If engineering follows the KISS rule, construction is simple. There is no substitute for good facilities. Concrete is usually best. The facilities will probably be the first fish farm the contractor has ever built.

Production. Trying to achieve more production than the water quality will allow causes most production problems. If the rules laid down earlier in this paper are followed, production should not be a problem. Keep good water quality, good feed quality and keep labor stress down.

Experienced personnel are not available. Personnel must be trained. There are many degree students graduating, but most do not have any experience. They need experience if they are being hired to run a new farm.

Processing. A processing plant will not be available in most situations. A producer will need to build a processing plant. Very little machinery is available for processing. Most of the labor is hand labor.

Marketing. No money is made raising fish until the fish are sold.

A common misconception is there is an unlimited market for fish products such as channel catfish. The truth is, there is an unlimited potential market for channel catfish and other good fish. The potential is unlimited. The existing market is full. There is no room for additional production without additional marketing. Markets must be developed, and they cannot be developed without fish. The fish must be raised before the market can be developed.

There were approximately 150,000,000 pounds of catfish sold in the U.S. in 1978. This production breaks down as follows: Brazilian imports 30,000,000 pounds; wild catfish harvested commercially in the U.S., 30,000,000; channel catfish raised on farms, mainly in Mississippi and Arkansas, 90,000,000; and 500,000 pounds raised in high density geothermal facilities. These catfish figures are listed in order according to quality and price, with the poorest quality listed first. There is a considerable difference in quality of product and price. The Brazilian fish sell as low as 60 cents per pound, and the geothermal produced fish sell for $2.85 per pound, wholesale. In catfish, as in any other product, one gets what he pays for.

Distribution. Most geothermal resources are not near large market areas for fish. Distribution can be a major problem. The easiest market to develop is the fresh market. This complicates distribution, for the fresh market delivery must be available on a dependable weekly basis. In Idaho, Fish Breeders are in a good distribution area because of the 25,000,000 pounds of trout raised within 15 miles of the farm. Each production and market situation will have to be viewed individually to solve the distribution problem.

These are the main problems inestablishing a geothermal fish farm. No phase can be left out. A project will need to master each phase to be successful.

IN SUMMARY

If you want to raise fish to get rich, you will probably go broke. If you want to raise fish because you like the challenge of fish culture, you will probably get rich. The best advice is to start small and grow slow.