Raising Mudminnows

Texas A&M University — Sea Grant College Program

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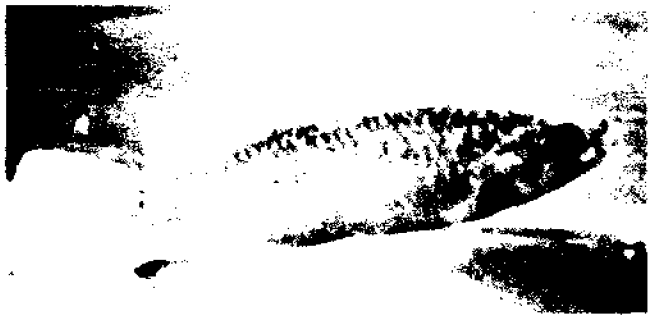

Fig. 1. Male mudminnow.

Fig. 2. Female mudminnow.

The gulf killifish *(Fundulus grandis)*, known in Texas as the mudfish or mud minnow and in Alabama as the bullminnow, is a highly desired live baitfish for saltwater fishing. While most effective and consequently most desired for flounder, it is used successfully for all major sportfish, especially in areas where live bait shrimp are not readily available.

Growing numbers of fishermen and greater awareness of this bait have caused an increase in demand. This, coupled with an erratic and declining supply of wild-caught mudminnows, provides an opportune environment for culture of this fish with considerable profit margins.[6]

General Characteristics

The mudminnow is an abundant marsh killifish which grows up to 6 inches in length. Most bait dealers want a 2.5-inch minimum length, although 3 inches or larger is preferred in some areas. The 2.5-inch size can be reached from egg in about four to five months, depending on stocking rate.

The female is a uniform greenish-silver. The male is darker with prominent spotting as in the illustration (figs. 1 and 2).

In culture, spawning occurs over an extended period, roughly from early March to mid-September.[9] Egg production peaks during March and April and, to a lesser extent, in late August and early September. It is high during cool summers, but low during exceptionally hot weather. The range of salinities at which egg production is highest has not been documented, but fish have spawned well anywhere from three to 20 parts per thousand (ppt). Eggs are laid within mats of Spanish moss provided by the culturist.

Hatching occurs in 10 to 21 days. Hatching time decreases with increased temperature and decreased salinity. Salinities of five to 40 ppt are favorable for hatching and for survival and growth of fry. Slightly lower and higher salinities are probably acceptable but have not been tested. Hatching of eggs and growth of fry are reduced at and above 60 ppt, and both survival and growth of fry are reduced in freshwater.

Fry can be reared on a variety of foods. They accept inexpensive and readily available agricultural by-products such as cottonseed meal and wheat shorts.[7]

They also consume natural foods, such as zooplankton, aquatic worms and insect larvae. These natural foods either feed directly upon bacteria and planktonic algae (green water) or on animals that eat them. Green water is produced by fertilization. Uneaten feed and waste products of the fish increase bacteria and algae.

The hardiness of these fish is another desirable characteristic. No mortality of young fish or broodstock was found in ponds where salinities measured less than one ppt, where there was virtually no dissolved oxygen on many mornings, or where water temperatures were low (45°F) or extremely high (95°F). Fishermen appreciate the mudminnow's wide tolerance to conditions in a bait bucket and their durability on a hook, as compared to the less hardy bait shrimp.

Spawning

The recommended culture technique consists of stocking 6,000 brood fish (4,000 females and 2,000 males, all 2 to 3 inches in length) per half-acre pond before the early March to mid-September spawning season. Broodstock should be fed 5 percent of their body weight daily with either minnow meal, floating catfish pellets or agricultural by-products.

Spawning mats should consist of about two pounds of cured Spanish moss sandwiched 2 to 3 inches thick between 2-foot by 3-foot sheets of plastic coated wire (15 gauge, 2 x 2 inch mesh) (fig. 3). Mats of pig bristle also show promise with lower cost and maintenance than mats of Spanish moss.

These mats should be evenly distributed around the water's upwind edge at

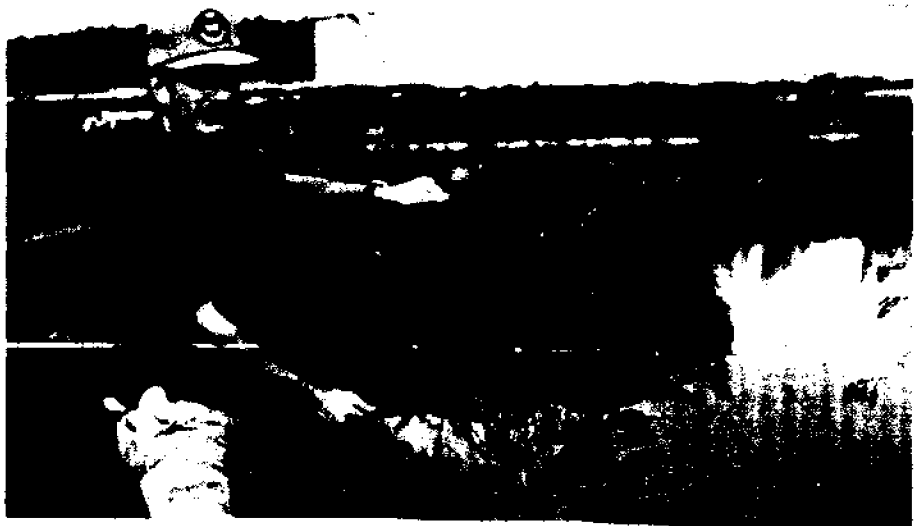

Fig. 3. Aquaculturist Peter Perschbacher, holds a spawning mat. The mat is constructed of Spanish moss enclosed in 2 x 2-inch plastic-coated wire mesh.

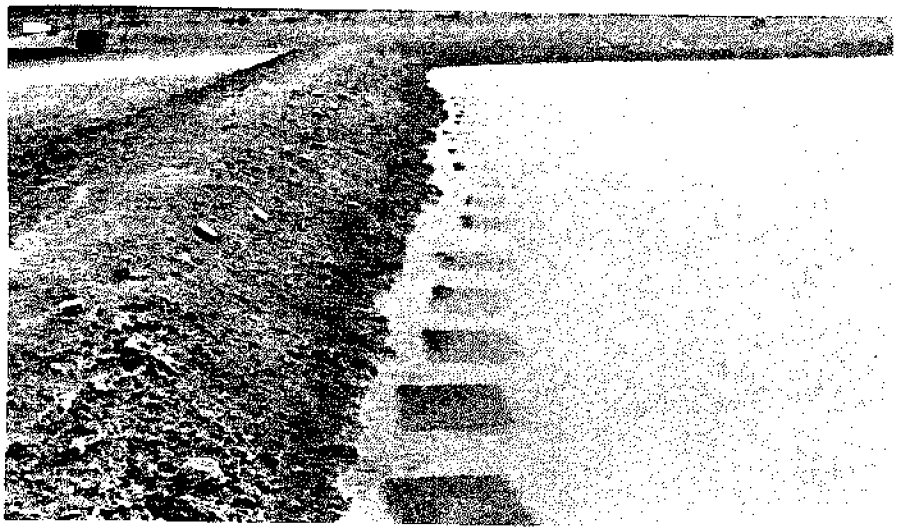

Fig. 4. Mats are distributed evenly on the upwind edge of the pond to avoid collection of silt and debris on the mats.

a rate of 25 per half-acre pond (fig. 4). It would be best to evenly space mats around the entire perimeter of the pond. In windy conditons, however, silt and debris can collect on the mats on the downwind side of the pond, smothering the eggs.

Mats should be covered with water and elevated at least 3 inches off the bottom, to enable spawning under the mat and prevent mudding of the mat. In our studies, the eggs were most abundant on the barely submerged shore edge of mats.

A given mat is left in the brood pond for one to seven days, depending on the rate of egg deposition. It is then transferred with adhering eggs to a second pond (fertilized and containing no fish) for hatching. Eggs should be stocked in this hatching pond within a week to minimize size differences and thus avoid cannabalism. If the eggs were left to hatch in the brood pond, most young fish would be eaten by their parents.

A given mat should be transferred to the hatching pond when it has 1,000 to 2,000 eggs. The number of eggs on a spawning mat may be estimated by counting the eggs within 10 randomly selected wire squares representing various parts of a mat. Multiply the average number of eggs per square by the number of squares per mat.

Hatching rates usually range from 50 to 80 percent, depending on egg density on the spawning mats, silt on the mats and oxygen levels in the pond. Greatest success will be achieved by transferring no more than 2,000 eggs per mat, keeping mats clean and maintaining dissolved oxygen above five parts per million in brood ponds and during incubation in hatch-and-growout ponds. To avoid overgrowth of mats by algae, brood ponds should not be fertilized.

Two-Pond System

In the hatch-and-growout (two-pond) system, mats of eggs are stocked into a pond and the hatched fish left to grow until of marketable size (fig. 5).

The desired stocking rate for a hatch-and-growout pond is approximately 80,000 fry per half-acre. Assuming an egg density of 2,000 eggs per mat and a hatching rate of 80 percent, it would take 50 mats per half-acre pond to reach this stocking rate. Along the Texas coast, fry stocked at this density in March should produce fish of commercial size for the start of fall flounder season.

Growth rates increase with lower numbers of fry per pond. Thus, less than 80,000 fry should yield fish of 2.5 to 3 inches in length for summer harvest or fish longer than 3 inches for fall harvest.[6]

When hatching success is higher than anticipated and the growth rate of the heavily-stocked fish appears low, excess young can be seined and either sold to a less fortunate producer or used to stock another pond. Under good culture conditions, a half-acre growout pond can be expected to produce a mid-July to August crop and a late fall to spring crop totalling as many as 160,000 fish.

Three-Pond System

The three-phase system is another method of mudminnow culture and requires three ponds — one for spawning, another for hatching eggs and raising fry, and a third for growout (fig. 6).

The advantages of a three-pond system are (1) knowing the number of fry stocked, which makes calculations of amount of feed to use more precise, and (2) ensuring uniform stocking rates. Disadvantages are (1) the need for a set of ponds used only for hatching and (2) the transferring of fry, which increases both labor cost and mortality of fry during their harvest and stocking.

In this technique as many as 1.5 million eggs per acre are stocked into hatch ponds one-half acre or smaller. Fry should be fed powdered minnow meal several times daily, distributed along the pond margins. Fertilization will aid fry growth by providing natural food.

When fry reach about one-half inch in length, they may be transferred into the growout ponds at 160,000 per acre by seining and draining the hatch ponds. A sample of fry should be weighed and the number counted to determine the number of fry per pound, which can then be used in obtaining the correct weight of fry to stock.

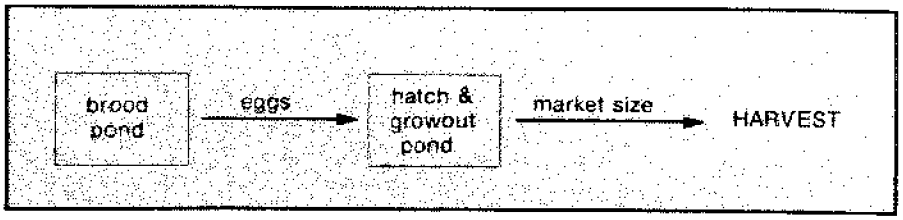

Fig. 5. The two-pond system.

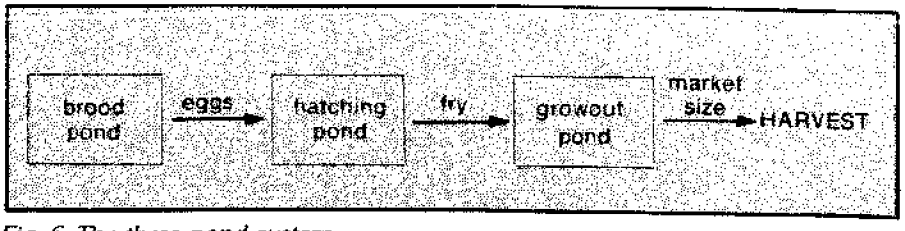

Fig. 6. The three-pond system.

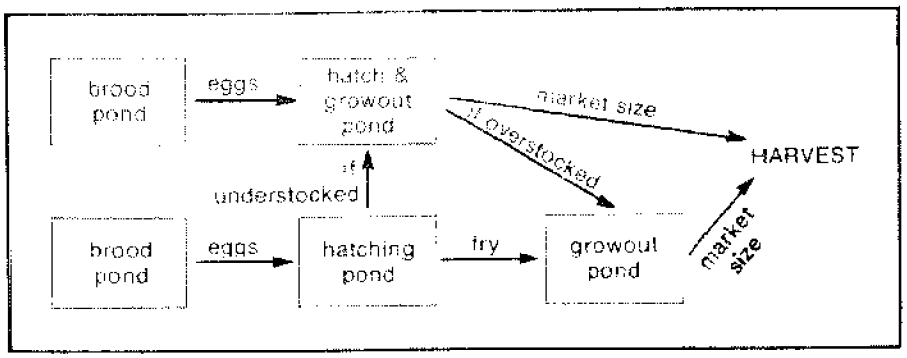

Fig. 7. The combination method.

Combination Method

A combination of the two pond and three-pond systems is recommended for maximum production (fig. 7). Hatching ponds could provide fry to bring understocked hatch-and-growout ponds up to desired stocking rates and to restock harvested ponds with head-started fish.

In addition, fish can be left crowded in a hatching pond for several months and be used to restock ponds after the end of the spawning season in September. At restocking, the largest individuals can be graded out with a minnow grader and either sold as bait or saved as broodstock in search of a strain which grows fast under crowded conditions.

Feeding and Fertilization

Providing "green water" by fertilization has the advantages of (1) yielding more even growth rates, (2) requiring less labor than feeding, and (3) shading out submerged vegetation.

In recent experiments, mudminnows (stocked at 33,000 per quarter acre clay pond) receiving only fertilizer grew as fast as and more uniformly than those receiving minnow meal at 3 percent body weight.[3] Commercial-sized fish (2.5 inches) were produced in 120 to 140 days from hatching.

Each fertilized pond received 40 pounds per acre of 12-12-12 fertilizer at approximately one-week intervals. These intervals were adjusted as required to maintain a 12-inch Secchi disk transparency. That is, a density of microscopic plankton (which gives water a green or brown color) was encouraged with fertilizer sufficient to obsure an object such as a Secchi disk (figs. 8 and 9) at a depth of 12 inches.[1]

A Secchi disk is simply a 6-inch diameter wood or plastic disk painted with alternating black and white quadrants and attached to a marked pole or string. Secchi disk readings of less than 12 inches indicate an excess plankton bloom. Thus, fertilization should be withheld until Secchi disk readings again exceed 12 inches.

Disappearance of a Secchi disk just under the surface indicates an overabundance of plankton, which can lead to plankton die-off and subsequent oxygen shortage. Exchanging water may be necessary to thin these dense blooms. If 40 pounds per acre of fertilizer does not produce sufficient plankton to obscure a Secchi disk at 12 inches, doubling or tripling of the fertilization rate will be required depending on water clarity.

At stocking rates above 33,000 fry per quarter acre (rates higher than presently tested in ponds receiving only fertilizer but recommended for efficient production) or with infertile water, natural foods produced by fertilization might be insufficient for good growth rates. It may be necessary to add supplemental feeds, such as minnow meal or a 50:50 mix of wheat shorts and cottonseed meal to the 3 to 5 percent body weight per day.

The estimated weight of fish in a pond can be determined by weighing 100 fish, calculating their average weight, and multiplying this by the estimated number of fish in a pond.[2] The estimated weight of fish in the pond is multiplied by either 3 or 5 percent to determine the daily feeding rate.

The feeding rate should be adjusted at least every two weeks. Check food consumption by placing a tray on the pond bottom. Observe the feed that falls on it when the fish are fed to see if it is quickly consumed or if some is left to decay.

Harvesting and Temporary Holding

Marketable fish can be harvested as needed, preferably with minnow traps baited with cracked crabs or with a seine. They should not be fed for a day prior to harvest. This will clear their guts to avoid fouling transport water and make them easier to trap. Wrapping the cracked crab in fine mesh will prevent trapped fish from filling their gut and prolong the use of the crab as bait.

Fish may be sold individually, or by the pound. They are either sold at the facility or transported to bait camps. When too few fish are left for efficient trapping or seining, drain the pond and harvest them in a catch basin at the deep end of the pond or in a cage attached to the discharge end of the drain pipe. Sufficient fish should be retained and kept over winter for use as broodstock next year.

Care must be taken in handling fish after harvest. They will become stressed and die if overheated or shorted on oxygen. Keep them shaded and agitate the water. Become familiar with how to transport live fish.[2] Rough handling and contact with dry surfaces will injure and eventually kill the fish.

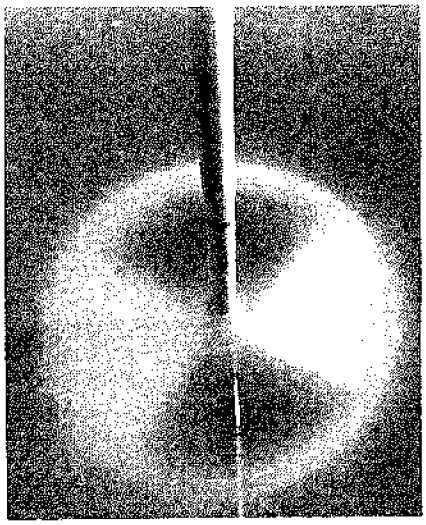

Fig. 8. Secchi disk.

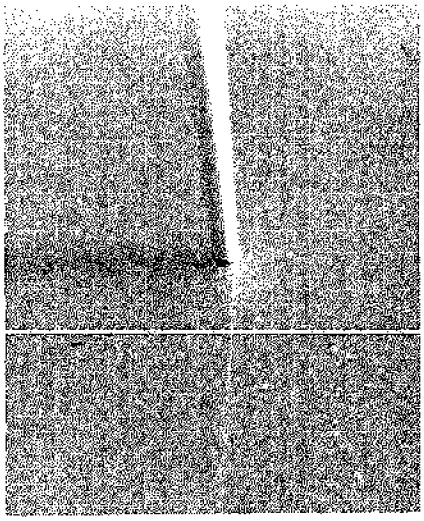

Fig. 9. Obscured secchi disk.

Fecal material and food in the water should be minimized. Mortality rates increase when fish are held in fouled water. Therefore, it may be necessary to occasionally exchange the holding water.

Bait dealers hold mudminnows for a minimum time before sale to the fishermen. They prefer to buy fish on Friday for weekend sales. Fish both caught and taken to the bait dealer on Friday should not be fed on Friday. The water in the hauling tank should be clean when the fish are loaded and the haul ing water discarded at delivery.

Fish caught several days before sale may be fed sparingly to maintain their condition and kept in either cages in a pond or in an aerated tank with water exchange. When a recirculating system is used, a large well-planned filter is needed for water treatment.[4] Fish to be hauled long distances should have their guts emptied prior to loading into hauling tanks, and they should not be fed during transport to minimize water fouling.

In addition to ponds for spawning, hatching and growout, provisions for holding ponds should be incorporated in the original farm design (fig. 10). If fish reach the desired size without being sold, they can be transferred to temporary holding ponds so that the next crop can be stocked. Feed the fish in the holding ponds at 2 to 3 percent body weight daily. Should they lose weight, increase the feeding rate slightly.

This technique of stockpiling fish also can help buffer production schedules from inevitable market fluctuations and help meet anticipated peak demands. For example, ponds of marketable fish from the spring stocking can be combined at high density for peak sales during the fall flounder season. In the same manner, fish from the fall stocking can be held over winter to supply the spring and summer market.

Be aware that when water temperatures fall below 20 degrees Celsius (68°F), fish will feed less and need to be fed only two to three times per week.

Management Considerations

Although a few problems in raising mudminnows have been noted, careful management can overcome these obstacles.

One problem is that brood fish will sometimes consume eggs before the spawning mats are transferred to a hatching pond. This predation results in a reduced yield of eggs per brood female. Changing mats frequently should increase the egg harvest.

Other factors reducing egg hatching are smothering by silt and algae and fungal infections spread from dead to living eggs. Future research may indicate that out-of-water incubation of eggs on damp spawning mats (air has 30-50 times higher density of oxygen than water) is desirable to eliminate silting, algal overgrowth and fungus.

Another problem is contamination by other species. The sheepshead minnow, *Cyprinodon variegatus*, can seriously contaminate ponds and outcompete mudminnows for food and space. They also can injure and kill mudminnows when held together following harvest. Contamination typically occurs through inadequate filtration of incoming pond water or by inadvertent stocking.

Careful sorting of fish at stocking and thorough filtration of incoming water are necessary to prevent the entry of these small killifish. Ponds already contaminated by sheepshead minnows should be drained and dried to kill adults, refilled for one to two weeks to allow remaining sheepshead eggs to hatch, and then drained and dried again.

Air-breathing predacious insects (beetles, back swimmers, etc.) should be controlled when fish are small. Mix a 1:8 ratio of motor oil to diesel fuel and apply two gallons per acre, allowing it to spread over the pond surface. Fill low-salinity ponds (5 ppt or less) just prior to stocking mudminnow eggs to minimize the presence of damselfly and dragon fly larvae which eat small fry. Oil does not kill these predacious insect larvae.

Mudminnows are relatively resistant to disease even under adverse environmental conditions. However, one Texas mudminnow farmer lost all fish in a pond in which the water turned acid.

The Claude Peteet Mariculture Laboratory[6] has documented parasitic, bacterial, and viral infections of mudminnows, but infections were severe enough to warrant treatment on only two occasions during six years of culture. In our studies, the only disease which was observed to cause mortality of mudminnows is a bacterial pathogen which primarily affects large fish.

Prevention, therefore, is the most effective disease management tool. Keep only young vigorous broodstock, and sell broodstock at the end of each spawning season. Maintain adequate nutrition through recommended plankton densities or feeding rates. Exchange water and use aeration in heavily stocked ponds.

If filamentous algae or other submerged vegetation covers the bottom and causes the water to clear, apply chemical herbicides or drain and dry the pond. When the ponds are first filled with water, striped mullet (*Mugil cephalus*)can be stocked at about 50 per acre to control filamentous algae.

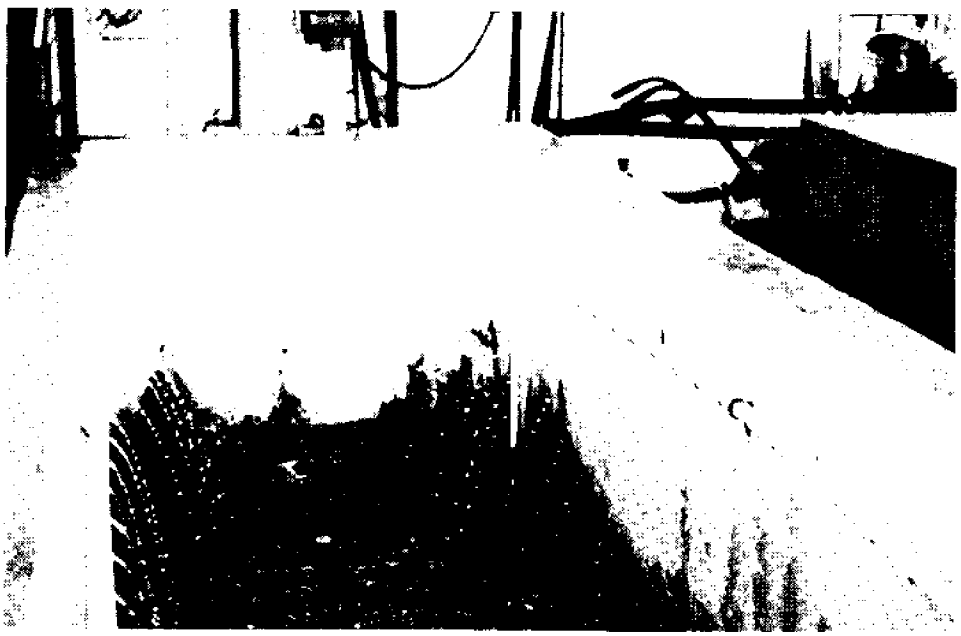

Fig. 10. Provisions for holding ponds or tanks should be incorporated into the mudminnow farm design.

Farm Size and Location

It is estimated that 60 acres of well-managed ponds would have supplied the 1982 potential market in East Texas. And up to 100 acres would supply the entire Texas market.

Farms with less than five to 10 surface acres become inefficient because a

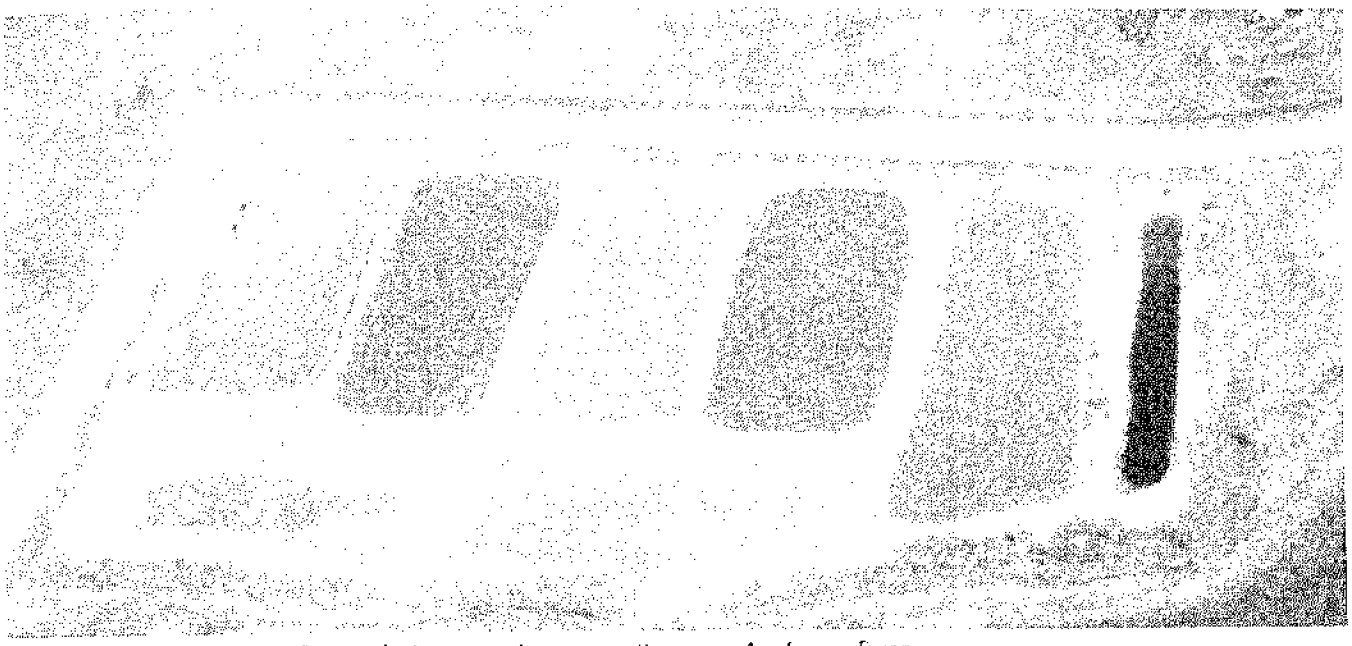

Fig. 11. The pond layout of a mudminnow culture operation near Anahuac, Texas.

high percentage of the area is required for egg production. To stock a half acre pond with 100,000 eggs within a week or less would require one to 1 1/2 acres of spawning ponds (fig. 11). Additional ponds are needed for temporary holding of market size fish (one to two acres) and for broodstock rearing (one-half to one acre).

Consequently, farmers with less than five acres of ponds should consider either producing eggs and fry for sale to growout operations or buying eggs and fry for growout. The percentage of a farm's pond area required for egg production could be reduced if recovery of spawned eggs could be improved or if eggs are stored out of water on damp spawning mats to delay their hatching until sufficient eggs are collected to fully stock a pond.

Choosing a good site is very important. Land should have soil with enough clay to avoid seepage, and ponds should be constructed to be fully drainable.

Avoid acid or iron pyrite-containing soils. When your soil is acid, mix lime into the pond bottom. If the pH of pond water falls below seven, either fine lime must be added or pond water replaced with water of adequate pH. Green water also will increase pH, while feeding decreases pH.

Contact your county marine extension agent and local Soil Conservation Service personnel for advice on testing soils, pond construction tips and maintaining water quality.

Permits will be required before pond construction is begun. The U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and state agencies should be consulted (in Texas contact the Texas Parks and Wildlife Department and Texas Water Commission).

Pumping water from a saltwater well will avoid many permitting and filtration problems associated with pumping directly from a bay, but the quality of the well water should be evaluated before construction. Any site with a wetlands designation, 2 feet or less above mean sea level high tide, will make commercial permitting practically impossible.

Market

Seasonal demand and markets must be carefully considered. For example, along the eastern part of the Texas Coast, mudminnows are used year around where bait shrimp generally are unavailable. In other areas demand is low in the winter and spring, increases in July and August when bait shrimp are unavailable, and is high during the September to November flounder run. When either heavy rains or strong onshore winds flood the marshes, wild-caught fish are not available and only pond raised fish can supply the market.

Mudminnows are used for bait outside of Texas, along much of the northern Gulf coast[1] from New Orleans, LA to Pensacola, FL. A similar species is used along the Atlantic seaboard. These areas are all potential markets for farm-raised fish.

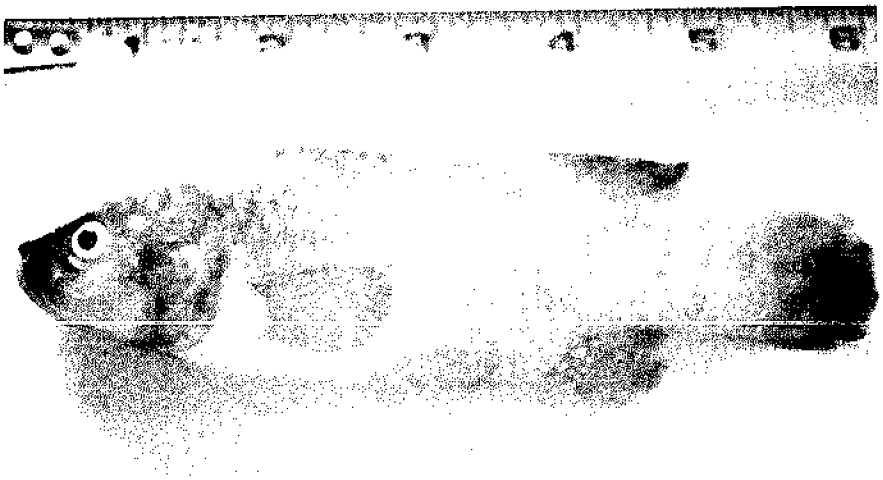

Fig. 12. The Texas record mudminnow caught May 20, 1985 measures 6 1/8 inches.

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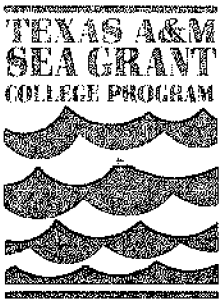

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