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THAD COCHRAN NATIONAL WARMWATER AQUACULTURE CENTER
127 Experiment Station Road
P.O. Box 197
Stoneville, MS 38776-0197
Phone: (662) 686-3242 FAX: (662) 686-3320
http://tcnwac.msstate.edu

Feed Conversion Ratio for Pond-Raised Catfish: Research vs. Farm Level

Edwin Robinson[1] and Menghe Li[1]

Feed conversion ratio (FCR) is a measure of how efficiently an animal converts feed to body mass and it is determined by dividing the weight of feed fed by live weight gain over some time interval. Because feed cost currently accounts for nearly 60% of variable operating costs in commercial catfish culture in the United States, the efficiency at which catfish convert feed to body mass is perhaps the single most important factor in determining profitability. It has been demonstrated in numerous research studies that catfish grown to a marketable size convert feed efficiently. In research ponds we typically get an FCR of 1.8 or less for catfish raised from fingerlings to a size of 1 to 1.5 pounds; whereas, the five-year average farm level FCR (feed sold/fish sold) over the catfish industry is about 2.5.

Since FCR is based on weight gain any factor that affects weight gain impacts FCR including culture practices, fish health, genetics, environment, fish size and body composition, feeds, and feeding. Thus there are many potential reasons for this disparity in FCR values between research and the farm, but in large part it is simply the scale on which commercial catfish are cultured compared to research. Because of the smaller size of ponds used in research, the environment (at least dissolved oxygen concentrations) can be more easily managed. In addition, feeding is more precise in research conditions and in some cases uneaten feed can be accounted for. Also mortalities can generally be accounted for and weight is sometimes included in the calculation of FCR. Further, most research is based on an annual growth cycle where the fish are clean harvested and the ponds

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Feed Conversion Ratio
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drained so all fish are accounted for. Researchers fare little better than catfish producers when research projects are conducted on a scale similar to that used in commercial catfish culture. When we conduct feeding trials in large ponds over multiple years, topping fish and under stocking with fingerlings, FCR values increase.

Research FCR values obtained under semi-controlled environments closely reflect the physiological efficiency that catfish are capable of in converting feed. Actually feed consumed by healthy fish raised in commercial ponds is basically converted as efficiently as fish raised in a research environment, but this efficiency is lost through primarily unaccounted mortalities, wasted feed, and delayed harvest that results in fish that are too large for efficient feed utilization. Also the average size of fish processed by the industry has increased over the past 15 years. In addition to reduced feed efficiency, growing larger fish also requires the fish be kept in the pond longer increasing the chances more mortality will occur resulting in increased FCR.

Regardless of the reasons for the inflated farm level FCR, it is the economic reality and it needs to be improved, but that it is easier said than done. To begin to make changes we must evaluate what can reasonably be done on a commercial scale to improve FCR. First it is necessary to recognize even though the feed could be an issue it is rarely the problem, but is generally the first suspect. The reality is regardless of the manufacturer all commercial catfish feeds are formulated to provide a balance between energy and nutrients essential for rapid and efficient fish growth, and they are highly palatable and digestible.

Feeding is one area that is critical and subject to improvement. There may be no one “best” way to feed catfish and it is a choice based on the economics of individual farms, but feeding is perhaps the single most important task on a catfish farm, particularly given the high cost of feed today. It is a highly subjective process where the feeder decides how much to feed based on certain mostly subjective criteria. If fish are overfed and feed is wasted, FCR will increase dramatically. If they are somewhat underfed feed efficiency is increased but generally live yield is decreased. However, severe feed restriction will increase FCR because most of feed ingested goes to maintenance, rather than growth. One thing that should be done regardless of feeding strategies to use an experienced person to feed and to feed carefully to reduce the amount of wasted feed.

Another suggestion to improve FCR is to limit the number of large fish produced by using a “single-batch” cropping system or harvest more often if the multiple-batch system is used. Limiting large fish is important because an underlying principle in animal production is that young, smaller animals grow faster and utilize feed more efficiently than older, larger animals. The primary reason smaller animals are more efficient in utilizing feed is that rapid gains exhibited by young, smaller animals are generally lean (protein) gains which have less than half of the energy density compared to body fat, and thus it is more efficient to deposit a pound of lean tissue versus a pound of fat. Other suggestions to improve FCR include keeping controllable environmental factors in recommended ranges (especially adequate aeration), stock at reasonable rates, and stock as large a fingerling as economically possible. There are anecdotal reports of producers that follow these suggestions achieving a 2:1 FCR over the farm.

[1] Mississippi State University - MAFES

Do Mosquitofish Have Any Effects on Catfish Production Ponds?

Charles Mischke[1], Matt Griffin[2], Terry Greenway[1], and David Wise[1]

Mosquitofish, *Gambusia* sp., have been spread throughout the world as biological control agents for mosquitoes and are now the most widely distributed freshwater fish in the world. Along with this wide distribution has come a poor reputation - mosquitofish are listed among the 100 worst invasive species in the world. Mosquitofish have been blamed for native fish and amphibian displacement in many countries where they have been introduced.

Mosquitofish (*G. affinis*) are native to the southeastern United States and are commonly seen in catfish ponds. Although most producers and researchers are aware of mosquitofish presence, it is not known if mosquitofish affect catfish production ponds.

We investigated mosquitofish effects on water quality, zooplankton populations, disease occurrence, and catfish production. Fourteen ponds were used in the study; half the ponds were stocked with mosquitofish and half were not.

In contrast to previous studies, we saw no mosquitofish effects on zooplankton or phytoplankton populations or on any water quality variables measured. Catfish production ponds are considered hypereutrophic and may provide more varied foraging opportunities for mosquitofish than in natural lakes. Mosquitofish may also feed on uneaten catfish feed. The mosquitofish, being an opportunistic omnivore, has multiple foraging opportunities in catfish production ponds, presumably leading to less predation pressure on any one zooplankton group. Increased foraging opportunities for mosquitofish in catfish production ponds can explain why no differences in zooplankton were seen in our study versus studies conducted in natural lakes and ponds.

Wild fish, such as mosquitofish, could serve as reservoirs for disease-causing organisms, leading to increased disease incidence. Conversely, diverse fish populations could alter disease progression or lessen potential disease risk by disrupting life cycles or serving as aberrant or dead-end hosts to fish pathogens. In this study, there was no evidence of catfish infectious disease-causing organisms or parasites in any mosquitofish submitted to the diagnostic laboratory. For catfish, all ponds had some common protozoan parasite incidence normally considered inconsequential to catfish health. No infectious diseases were found, suggesting mosquitofish have little to no effect on disease occurrence in catfish production ponds.

There were no differences between ponds with and without mosquitofish in production metrics. Small stocker-size catfish may be able to use a small fish such as mosquitofish as a forage fish; however, total feed fed and feed conversion ratio were not different between the two treatments indicating limited use of mosquitofish as forage by catfish.

Despite their reputation as destructive invaders, mosquitofish had little impact on catfish production ponds. In eutrophic catfish production ponds, there apparently exists abundant forage opportunities for mosquitofish, limiting undue predation pressure on any individual zooplankton group. Mosquitofish presence had no impact on water quality variables and did not affect disease occurrence. Based on results of this study, fish farmers need not worry about encouraging or discouraging mosquitofish colonizing catfish production ponds.

[1] Mississippi State University - MAFES
[2] Mississippi State University - CVM

Managing Summertime Off-Flavors in Catfish

Craig Tucker[1] and Kevin Schrader[2]

Summertime phytoplankton blooms in channel catfish ponds often contain blue-green algae that produce musty or earthy odors. The odorous compounds are absorbed by fish across their gills and deposited in fatty tissues, giving fish undesirable "off-flavors." When fish are declared off-flavored by processing plant taste-testers, many farmers automatically assume that blue-green algae are responsible and treat ponds with an algicide hoping to kill the algae and allow fish to become "on-flavor."

Using algicides to combat off-flavors does not always work because not all off-flavors are caused by algae. Catfish become off-flavored when any odorous compound is deposited in edible tissues. For example, off-flavors can be caused by inadvertent pollution, such as small spills of diesel fuel. Off-flavors can also develop when fish eat foods containing odorous compounds. Diet-related off-flavors are rare in summertime because high-quality commercial feeds are formulated so that they do not cause flavor problems. In wintertime, however, catfish are not routinely fed and they may scavenge for food in the pond. Some of these food items, such as dead fish or decaying plant matter, may give fish undesirable "decay" or "fishy" flavors.

The only off-flavors that are "treatable" are those caused by algae growing in warm water. The key to successful off-flavor management involves identifying and treating only those problems that will respond to algicides. This is analogous to proper disease management where you diagnose the disease before you treat it.

Off-flavor Ecology

The following are key facts about off-flavors in catfish grown in northwest Mississippi and southeast Arkansas:

1) Most summertime flavor problems are of the musty-earthy type. Musty off-flavors are caused by 2-methylisoborneol (MIB) and earthy off-flavors are caused by geosmin.
2) Only a few blue-green algae species produce MIB and geosmin. MIB is produced by *Planktothrix perornata*. Geosmin is much less common and, when present, is usually produced by species of *Anabaena*.
3) Once the odor-producing blue-green algae disappear, MIB and geosmin production stops and odorous compounds are purged from fish. Purging rates for MIB and geosmin are highly temperature-dependant: they are purged within days in warm water but much more slowly (weeks to months) in cold water.
4) All other off-flavors are slowly purged from fish at all water temperatures.

These four facts can be used to develop a management plan for pre-harvest off-flavors. If the plan is followed, off-flavor treatments can have a high probability of success. Also, by treating only problems that will respond, you will not waste time and money on treatments that have no chance of working.

Water Temperature

Odorous blue-green algae do not grow in cold water. If fish are off-flavored in cold water, the odorous compounds were either produced by algae during a previous period of warm water or the off-flavor was not produced by algae (such as off-flavor derived from foods consumed during scavenging). In either case, it is pointless to use algicides because there are no odor-producing algae to treat. If fish are off-flavored in cold water, the only option is resampling fish in a couple of weeks to see if flavor quality has improved. Sampling more frequently is seldom productive because off-flavors purge slowly in cold water.

Taste-testing

When fish are off-flavored in warm water, the first step is to determine the type of off-flavor. This is critical because only musty-earthy off-flavors produced by blue-green algae are treatable using algicides. Determining the off-flavor type is simple. Cook a small, unseasoned piece of fish fillet in a microwave oven. Smell the fillet immediately after cooking and then taste a portion. MIB gives fish a musty-camphorous flavor that is difficult to describe, yet is very distinctive even at low concentrations. Geosmin gives fish an earthy-moldy flavor that is somewhat reminiscent of the odor of freshly plowed soil or a damp basement. If the off-flavor is not in the musty-earthy category, the proper decision is to wait a week or two and taste the fish again. But, if a musty-earthy off-flavor is present, the next step is to determine whether the odorous compound is actively being produced in the pond. This is done by examining the pond water for odor-producing algae.

Microscopic Examination

Fish pond phytoplankton blooms continuously change. Populations of odor-producing algae seem to appear from nowhere, persist for days or months, and then disappear. Blooms of odorous algae may never be found in some ponds while occurring several times every year in other ponds. Bloom phenomena are mysterious, and the only way to know what algae are present is to examine a drop of pond water under a microscope.

Common odor-producing blue-green algae in northwest Mississippi and southeast Arkansas are easy to identify microscopically (Figure 1). The blue-green alga *Planktothrix perornata* is a free-floating, straight filament that is slightly bent and gradually tapering at one end. It is a relatively large plant compared with most other filamentous blue-green phytoplankton and contains many gas-filled vesicles that make the filament look dark and grainy when viewed under a microscope.

Species of *Anabaena* are easy to recognize. Filaments are free-floating, straight or coiled, and consist of a series of spherical or barrel-shaped cells that look like a string of beads.

If fish have musty-earthy off-flavors and either *Planktothrix perornata* or *Anabaena* are seen under the microscope—even in very low numbers—then musty-earthy compounds are being actively produced in the pond. Treating the pond with the proper algicide will kill the odorous algae and allow fish to purge the off-flavor.

If fish have musty-earthy off-flavors but odor-producing algae are not present, that means that the algae that produced MIB or geosmin have recently disappeared from the pond as part of the natural cycle of the bloom. In this case, the farmer is fortunate because the off-flavor will rapidly disappear from fish without needing to treat the pond with algicides. Fish should be sampled for flavor quality daily because musty-earthy off-flavors usually disappear from fish rapidly in warm water.

The bottom line is that algicides only work when odorous algae are present. If fish are declared off-flavor and odorous algae are not present, then the problem is essentially untreatable and the only recourse is to sample fish periodically to determine when the flavor has purged from fish naturally.

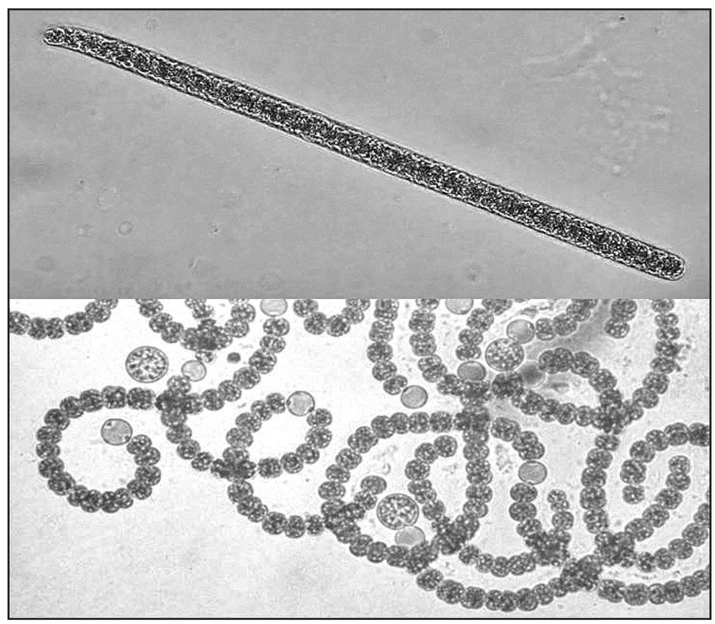

Figure 1. Microscopic views of *Planktothrix perornata* (top) and a species of *Anabaena* (bottom).

[1] USDA-ARS Warmwater Aquaculture Research Unit
[2] USDA-ARS Natural Products Utilization Research Unit

Pumping Performance of a Slow-Rotating Paddlewheel for Split-Ponds

Travis Brown[1] and Craig Tucker[1]

Commercial catfish farmers are intensifying production by retrofitting ponds with variations of the partitioned aquaculture system. The split-pond system is the most common variation used commercially. The split-pond consists of a small fish-holding basin connected to a waste treatment lagoon by two conduits. Water is circulated between the two basins to remove fish waste and provide oxygenated water to the fish-holding basin.

Although much research has been devoted to algal and fish production dynamics in variations of the partitioned aquaculture system, little information is available on basic engineering considerations for devices to circulate water in these systems. This study determined performance characteristics for a slow-turning paddlewheel (SRP), which is one type of pump used to circulate water in split-ponds. We evaluated relationships among power input, rotational speed, and water flow rate.

This study was conducted in 2012 at the Thad Cochran National Warmwater Aquaculture Center, Stoneville, Mississippi. The split-pond system consisted of a fish-holding basin (0.15 acres; 4.9-foot average water depth), a waste-treatment lagoon (0.55 acres; 3.0-foot average water depth), two open channels connecting the two basins, and one SRP pump. Channels had concrete foundations and cinder-block walls. The channel fitted with the SRP pump was 16.1-feet-long × 10.3-feet-wide and the other channel was 10.3-feet-long × 10-feet-wide. Both channels had a total wall height of 6 feet and an average water depth of approximately 4 feet. No fish were present in the system during this study.

The SRP pump was powered by a 5-hp, 3-phase electric motor (Blador, Fort Smith, Arizona) that had a rated rotational speed of 1,750 revolutions per minute (rpm). A combination of gear drives and sprockets reduced rotational speed to approximately 2.94 rpm at 30 Hz. A variable frequency drive was installed to allow control of the paddlewheel rotational speed. The actual power supplied to the electric motor was obtained directly from the variable frequency drive. The estimated power required for maintaining flow in channels is due to friction head loss and was calculated using a series of equations.

Water flow rate at the four rotational speeds (1, 2, 3, and 4 rpm) was measured and ranged from 4,548 to 9,330 gallons per minute (gpm) with a measured power input of 0.11 to 1.80 horsepower (hp) (Figure 1). Measured power input was greater than the estimated power requirement at all water flow rates. This is likely due to mechanical losses associated with the gear drives and the sprocket and chain assembly. When rotational speed of the SRP was accelerated, water flow rate increased (Figure 2). However, there was a dramatic decrease in water discharge per unit power input (gpm per hp, a measure of pumping efficiency) as rotational speed increased. For example, at 1.0 rpm the water discharge per unit power input was 40,729 gpm per hp as compared to 10,749 gpm per hp at 4 rpm.

The amount of power required to circulate water in a split-pond with a SRP pump depends on the maximum water flow rate required by the system which is a function of paddlewheel size and rotational speed. Because SRPs operate for long periods in the split-pond (12 to 18 hours per day during midsummer), design should account for the decreased pumping efficiency as rotational speed increases. That is, SRP pumps should be sized to achieve targeted flow rates using rotational speeds of 1 to 2 rpm rather than attempting to use an under-sized device at very high rotational speeds. Elevated rotational speed for this particular unit increased torque and field observations indicated that the SRP pump we tested should not operate above 2 rpm for extended periods of time to minimize the likelihood of paddlewheel cavitation, shaft torque surge, and reduced operational life. In addition, correct design of SRPs should be taken into consideration to reduce the possibility of mechanical failure.

In summary, SRP pumps operated at 1 to 2 rpm are highly efficient, although efficiency decreases dramatically as rotational speed increases. The SRP that we tested, with a rotational speed of 1 rpm, will circulate approximately 4,500 gallons per minute at an annual operating expense of approximately $30 if electricity costs 12 cents per kWh. This flow rate will support approximately 23,000 pounds of catfish. Information in this study can be used to design SRP pumps for split-ponds and to adjust water flows throughout the season by using variable-speed motors to change rotational speed and flow rates in response to fish growth. Long-term studies are underway to compare operational issues and costs associated with the use of various pump types in split-pond aquaculture systems.

For detailed information concerning this article please refer to the following publications:

Brown, T.W. and C.S. Tucker. 2013. Pumping performance of a slow-rotating paddlewheel for split-pond aquaculture systems. North American Journal of Aquaculture 75:153-158.

Brune, D.E., G. Schwartz, A.G. Eversole, J.A. Collier, and T.E. Schwedler. 2004. Partitioned aquaculture systems. Pages 561-584 in: C.S. Tucker and J.A. Hargreaves, editors. Biology and culture of channel catfish. Elsevier, New York, New York.

Brune, D.E., C. Tucker, M. Massingill, and J. Chappell. 2012. Partitioned aquaculture systems. Pages 308-340 in J. H. Tidwell, editor. Aquaculture production systems. Wiley-Blackwell, Ames, Iowa.

[1] USDA-ARS Warmwater Aquaculture Research Unit

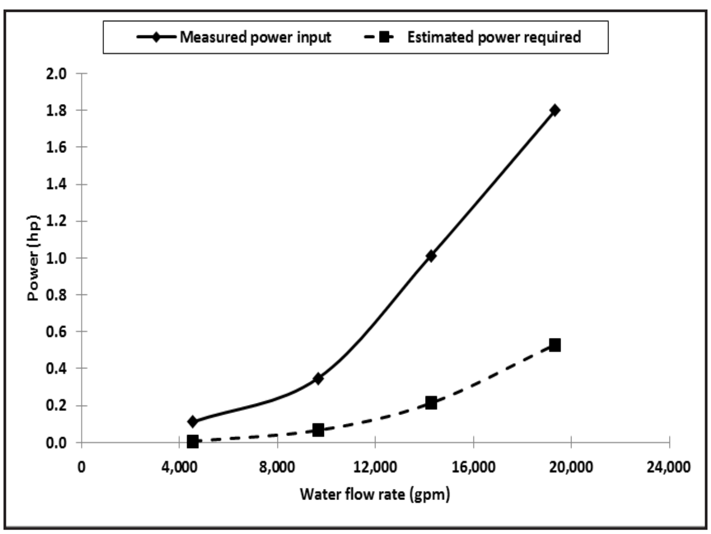

Figure 1. Measured power input and estimated power input to circulate water with a slow-rotating paddlewheel in a split-pond aquaculture system. All values are for open channels.

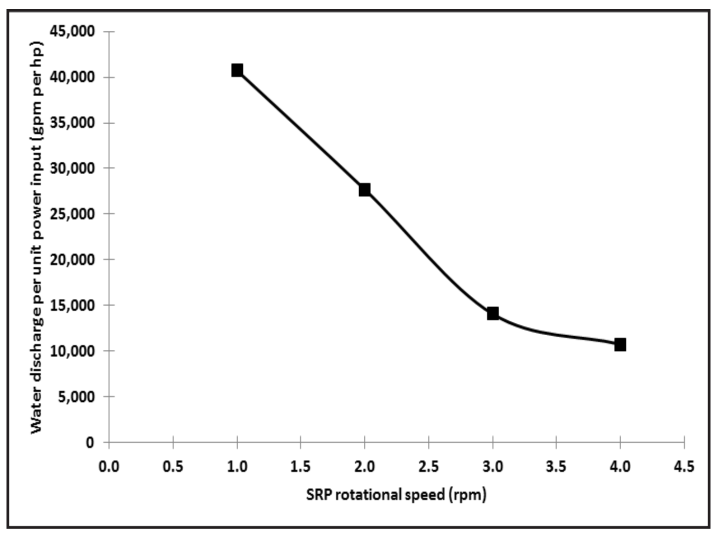

Figure 2. Water discharge per unit power input in relation to rotational speed of a slow-rotating paddlewheel (SRP) in a split-pond aquaculture system.

Development and On-Site Field Testing of the Power-Tube Airlift Aerator and Chances for Commercialization

Travis Brown[1] and Les Torrans[1]

Aeration of ponds when dissolved oxygen (DO) concentrations are low is the principal management tool that allows for higher feeding rates, increased production, and decreased cost per unit fish produced. Recent research conducted at the USDA-ARS Warm-water Aquaculture Research Unit has shown that feed conversion ratio (FCR) can be improved by raising the minimum DO concentration to 1.6 mg/L. Catfish will also consume more feed and grow faster if the minimum DO concentration is not allowed to drop below 3 mg/L. This faster growth results in a shorter production period, better survival, improved FCR, and reduces economic risk.

Traditional 10-horsepower electric paddlewheel aerators have proven to be the most efficient aerator for routine aeration of commercial catfish ponds, although they do have a performance limitation. While they efficiently transfer large quantities of oxygen to the water (measured in pounds of oxygen transferred per horsepower-hour), they also move a great volume of water. The end result is that the concentration of oxygen in the water is only increased a small amount (perhaps only 1 mg/L) by aeration. During routine aeration this is sufficient, but when the pond DO concentration is very low from a bloom die-off, this can result in problems ranging from reduced feed consumption and growth to complete fish kills. Adding more aerators (tractor-powered sidewinders or paddlewheels) increases the current in the pond, but in many cases can't overcome the tremendous oxygen demand resulting from the lack of photosynthesis and decomposing bloom. The fish can maintain their position at the aerators for a while, but if pond conditions do not improve quickly, they eventually become exhausted and drift away from the aerators into water devoid of oxygen, resulting in a major fish kill. Unfortunately, most farmers have experienced this tragic loss.

Subsurface aerators are an option to paddlewheel aerators. However, fish ponds are seldom more than 5 feet deep and technologies such as diffused-air systems require greater depths to operate efficiently. A new aerator developed by researchers in Stoneville, known as the "Power-Tube Airlift" (PTA), has the ability to use low pressure air to increase the transfer rate and efficiency to a level comparable to paddle-wheel aerators. The PTA was also designed to move less water than a paddlewheel aerator but enough water to create a zone of elevated DO large enough for a great biomass of fish.

Two commercial-size PTAs were fabricated and installed in an 8 acre traditional catfish pond on-site. Each PTA consisted of a 3-foot diameter intake, a 4-foot diameter outflow, and a blower powered by a 10-horsepower, 3-phase electric motor (Figure 1). A main air supply line was plumbed into a sparger assembly positioned at a 25-foot water depth on the outflow side of each unit. The high-volume discharge through the sparger (larger bubbles) provided "lift" to move the water through the PTA. These larger bubbles increased water pumping efficiency. Approximately 10 to 15% of the total air flow was diverted to a diffuser grid (smaller bubbles) placed at an 8 foot water depth on the intake side. These smaller bubbles increased oxygen transfer to the water. For a preliminary field test in 2012, hybrid catfish stockers (600 pounds per 1,000) were conservatively stocked at about 2,100 fish per acre for food fish production. Dissolved oxygen was continuously monitored with an automated monitoring system that controlled the operation of the PTAs throughout the study.

The two PTA aerators were able to maintain DO concentrations of about 2.3 mg/L greater than the outside area of the pond. For example, during a 2-week period in July 2012 the average morning DO concentration for the outside area was 1 mg/L while the aeration zone was maintained at 3.3 mg/L. The aeration zone was approximately 0.6 acres or about 7% of the total pond volume. A total of about 6,000 pounds of catfish per acre were harvested that weighed an average of 3.1 pounds each with a 91.2% survival rate and FCR of 2.2. In 2013 we stocked hybrid catfish fingerlings (120 pounds per 1,000) at rate comparable to split-ponds (9,200 fish per acre). We expect to harvest close to three times the biomass (total weight) of food fish this year as compared to the 2012 study which will be another important field test using this technology.

A total of $22,685 ($11,343 each) was required to build and install these aerators. Partial budget analysis of 2012 production using PTA aerators indicated a net change of -$61 per acre as compared to using paddle-wheel aerators. The negative net change was due to elevated fixed costs associated with additional expenses of the PTAs. The higher stocking rates this year should provide a greater profit and further economic analysis will need to be conducted.

In summary, two commercial-size PTAs were designed to perform similar to 10-horsepower paddlewheel aerators but move less water and are able to concentrate the aeration effort more precisely. This is an advantage because fish do not have to expend as much energy swimming against water current to be close to the aeration source as compared to paddle-wheel aerators. In addition, repairs and maintenance costs are lower with PTAs due to a simplified design with fewer moving parts. Maintenance is also much easier since the primary driving force of a PTA is located on the levee as compared to paddlewheel aerators which are in the water. Lastly, most farms have a limited supply of tractor-powered aerators and PTAs could be used as an alternative during emergency conditions. Unfortunately, the initial investment of one PTA is twice of what a new paddlewheel aerator costs and ponds have to be drained and dried prior to installation. These two factors can be seen as huge disadvantages to farmers due to initial costs and practicality issues. Catfish food fish production will continue on-site using PTA technology to verify our initial research findings and to prove our concept through demonstration with the goal of moving to eventual on-farm field trials.

Some of the material discussed in this article comprises the subject matter of a patent application currently pending with the US Patent and Trademark Office.

[1] USDA-ARS Warmwater Aquaculture Research Unit

Figure 1. Two commercial-size power-tube airlift (PTA) aerators installed in an 8 acre pond in Stoneville. Arrows indicate direction of water outflow during operation from each PTA when the pond is flooded.

Effects of Fish Barrier Screening Material on Water Flow in Split-Ponds

Travis Brown[1] and Craig Tucker[1]

Ponds serve two functions as fish-culture units. They hold water and fish, much like the walls of an aquarium, and they produce oxygen and treat wastes produced during culture. Split-ponds separate those two functions to make management easier. A large lagoon that provides the ecological services is connected to a much smaller basin that confines the fish. The operative word in that last phrase is "confines" because if fish escape from the small confinement area, they will be very difficult to capture and the advantages of the split-pond disappear.

Fish escape is prevented by using screens or barriers across the two conduits connecting the fish-holding basin and the waste treatment lagoon. Fish barriers reduce channel cross-sectional area and restrict water flow to some degree depending on the type of screen and opening size. This is important because water flow transports oxygenated water into the fish holding basin and transports wastes out. Restricting water flow might therefore affect the performance of split-ponds. So, we evaluated changes in water flow caused by two different types of fish barriers in the open channels.

We conducted this study in the prototype 0.7-acre split-pond system at the Thad Cochran National Warmwater Aquaculture Center. One set of barriers (one for each channel) was constructed from polymer-coated steel-mesh wire (1-inch × 1-inch openings) mounted to a square aluminum tubing frame (1.25-square inch, wall thickness of about 1/8 inch). The second set of barriers tested used the same aluminum frame as the first barrier type, but the mesh material was expanded metal with ¼-inch × 1-inch openings. Rotational speeds (1, 2, 3, and 4 revolutions per minute (rpm)) of a slow-rotating paddlewheel pump were tested and water flow rate was measured with and without fish barriers in the open channels to determine changes in water flow caused by friction as water flowed through the screens.

Fish barriers reduced water flow compared to that in channels without barriers, and flow reductions increased as paddlewheel rotational speed increased (Figure 1). Fish barriers constructed out of polymer-coated steel-mesh wire reduced water flow rate less than barriers constructed out of expanded metal. For example, at 4.0 rpm, flow rate was reduced from 19,330 gallons per minute (gpm) to 17,320 gpm for channels with polymer-coated steel-mesh wire and to 14,847 gpm for channels with expanded metal barriers. This trend was expected based on differences in mesh open area in the steel-mesh wire and expanded metal. The polymer-coated steel-mesh wire has about 80% open area whereas the expanded metal has about 58% open area. The frame of the fish barriers further restricted the open surface area of the channel by approximately 11%. The total cross-sectional area of the open channel was 39.6 square feet and the combination of frame and barrier material reduced the open surface area to 28.0 square feet (71% of the open channel area) for the polymer-coated steel-mesh wire

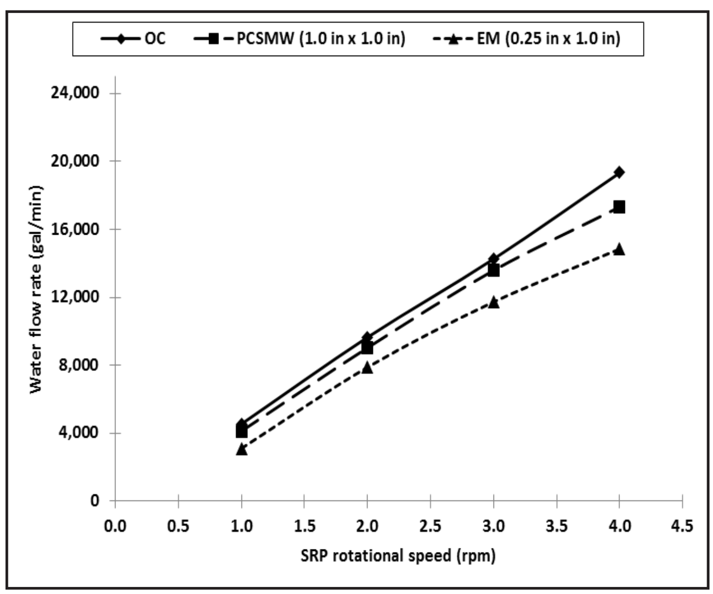

Figure 1. Resulting water flow rate at different rotational speeds of a slow-rotating paddlewheel (SRP) using open channels (OC), polymer coated steel-mesh wire fish barriers (PCSMW), or expanded metal fish barriers (EM) installed in a split-pond aquaculture system.

and 20.4 square feet (52% of the open channel area) for expanded metal. Reduced water flow has been observed in similar production systems such as in-pond raceways after installing smaller mesh (1/2-inch × 1-inch) fish barriers before stocking fish.

In conclusion, fish barriers installed in conduits connecting split-pond sections should have the maximum mesh size possible to retain fish so that reduction in water flow caused by frictional losses across the barrier are minimized. Biofouling or fouling with grass or other debris will further reduce open channel area. Flow reductions and labor needed for cleaning the fish barriers can be reduced by using screens with large open areas to remove larger debris before water flows through the fish barriers. Various types of bar screens have been developed for use at the headworks of wastewater treatment plants to pre-filter the waste stream before entering the treatment plant. Similar devices could be developed for split-ponds to collect floating debris which would allow for easier maintenance of fish barriers.

For detailed information concerning this article please refer to the following publications:

Brown, T.W. and C.S. Tucker. 2013. Pumping performance of a slow-rotating paddlewheel for split-pond aquaculture systems. North American Journal of Aquaculture 75:153-158.

[1] USDA-ARS Warmwater Aquaculture Research Unit

Potassium Permanganate is not an Effective Pond Disinfectant to Control *Dero digitata*

Charles Mischke[1], David Wise[1], Matt Griffin[2], and Terry Greenway[1]

Proliferative gill disease (PGD), commonly referred to as hamburger gill disease, is a major problem in farm-raised channel catfish. PGD represents the most commonly diagnosed parasitic disease and approximately 17% of the total cases submitted to the National Warmwater Aquaculture Center Aquatic Research and Diagnostic Laboratory.

The parasite requires the intermediate host, *Dero digitata*, to complete its life cycle. One commonly used method to reduce disease caused by parasites requiring multiple hosts is to disrupt the life cycle. Catfish farmers have tried several chemical treatments to disinfect ponds, thus disrupting the PGD life cycle through elimination or reduction of *Dero* populations. Some treatments are believed to reduce PGD incidence, but have not been experimentally validated.

Disinfection with various chemicals in the hatchery is a routine part of good hatchery practice. However, pond disinfection is considerably more difficult to achieve. Lime, potassium permanganate, and niclosamide (Bayluscide®) have all been used in attempts to eliminate pathogens and disease vectors from ponds before stocking, but their effectiveness is unknown.

Potassium permanganate is an oxidizing agent that has been used to treat several fish diseases, especially crustacean and protozoan parasites (20 mg/L for 1 hour), and has been used as an equipment disinfectant at 10 mg/L for 30 minutes. It is particularly effective for treating *Trichodina* or *Ambiphrya* infestations and external columnaris infections. Potassium permanganate is believed to be an effective disinfectant at high rates in ponds before stocking. It is believed potassium permanganate disinfects ponds and reduces *Dero* populations, but this practice has not been verified experimentally.

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Potassium Permanganate
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We evaluated potassium permanganate as a pond disinfectant to reduce *Dero* populations before stocking fish. In the first study, 2 liters of catfish pond mud and 18 liters of pond water were placed in each of sixteen 20-liter microcosms. Four microcosms were dosed at each of four treatment levels (0, 10, 20, and 30 mg/L) of potassium permanganate. After treatment, all *Dero* present in the sample were counted. In the microcosm study, all treatment levels significantly ($P<0.05$) reduced *Dero* populations relative to controls (Table 1).

In a second study, benthic populations were compared from ten 0.1 acre ponds before and after treatment with 20 mg/L potassium permanganate. However, in the field trial, there were no significant ($P<0.05$) differences pre- and post-treatment with potassium permanganate at 20 mg/L in *Dero* populations or total benthic organism populations (Table 2).

Treatment with potassium permanganate at 20 mg/L is not an effective pond disinfectant. This treatment level did not eliminate or even significantly reduce *D. digitata* populations. Although it was believed such high levels of potassium permanganate should 'sterilize' the pond, and previous toxicity studies (and the current microcosm study) of potassium permanganate to *Dero* indicated much lower levels of toxicity, it is clear this treatment is not effective.

[1] Mississippi State University - MAFES
[2] Mississippi State University - CVM

Table 1. Comparison of mean and standard error of *Dero digitata* numbers in microcosms after treatment with potassium permanganate. ANOVA followed by Fisher's PLSD was used to detect treatment differences. Mean values sharing the same letter were not significantly different ($P<0.05$).

Treatment	Mean	Standard Error
Control	60a	29.6
10 mg/L	1b	0.7
20 mg/L	0b	0.2
30 mg/L	0b	0.0

Table 2. Comparison of mean (+/- SEM) *Dero digitata* numbers and all non-*Dero* benthic macroinvertebrate numbers before and after treatment with 20 mg/L potassium permanganate. A paired t-test was used to determine if the difference between pre- and post-treatment was different from zero.

	Before Treatment	After Treatment	Mean Difference	P-value
Dero	561 (256.0)	115 (48.8)	447 (264.3)	0.1253
Non-*Dero*	878 (246.2)	1055 (141.8)	-177 (238.5)	0.4769

Delayed Feeding of Channel Catfish Fry Stocked in Ponds

Charles Mischke[1], Terry Greenway[1], Matt Griffin[2], Menghe Li[1], and David Wise[1]

Most catfish farmers prepare their fry ponds before stocking by implementing some fertilization program that continues until fish are stocked. Typically, fertilization is discontinued and ponds begin receiving commercial feeds immediately at stocking. If proper fertilization practices are implemented, large numbers of desirable zooplankton for channel catfish fry culture are attained and are able to sustain catfish fry stocked up to 100,000 per acre. Therefore, no commercial diets are required up to the first 6 weeks of culture.

Current catfish fry pond preparation practices include filling ponds at least 10 days before stocking and applying inorganic fertilizer at an initial rate of 18 pounds of nitrogen per acre and 1.8 pounds of phosphorus per acre, followed by subsequent applications at half the initial rate until fry are stocked. After fry are stocked, they are typically not observed coming to the surface to eat feed for the first 4 to 6 weeks. It is not known if fry consume commercial feeds for the first 4 to 6 weeks after stocking, but it is believed feed may serve as a secondary food source and as a fertilizer to keep the pond fertile. Overfeeding at this stage has been considered better than underfeeding because of low fish biomass and the pond's ability to assimilate any nutrients from excess feed. However, with current high feed prices and low fish prices, wasting feed should be avoided.

If abundant natural food organisms are available in fry ponds, it may be possible to delay feeding commercial diets and allow fry to survive and grow exclusively on the pond's natural productivity. Catfish fry readily consume zooplankton and actively selected cladocerans and copepods. Furthermore, these large zooplankton meet or exceed all channel catfish fry nutritional requirements. In previous studies, commercial diets supplemented with zooplankton afforded weight gains of 40 to 50% over cohorts fed commercial diets alone in a 19-day laboratory feeding trial.

We compared production variables between catfish nursery ponds fed according to industry standards, that is feeding daily starting immediately at stocking, to an alternative practice of delaying feeding for 6 weeks after stocking in an effort to utilize natural pond

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Table 1. Comparison of harvest variables (converted to a per acre basis) between channel catfish in ponds fed with a standard feeding practice (feeding immediately at stocking) and an alternative feeding practice (delayed feeding for 6 weeks). Numbers represent the mean value of 6 ponds ± SEM. Different letters after values within a row indicate significant differences (P < 0.05).

	Treatment		
Variable	Standard Feeding	Alternative Feeding	P-value
Average Fish Weight (lb)	0.08 ± 0.005	0.08 ± 0.007	0.8597
Total Fish Weight (lb/ac)	4,700 ± 460	4,280 ± 160	0.3797
Total Number Harvested (number/ac)	59,470 ± 8040	55,560 ± 6110	0.7023
Survival (%)	59.6 ± 8.0	55.6 ± 6.2	0.6985
Feed Fed First 6 Weeks (lb/ac)	110 ± 0.0	0 ± 0.0	N/A
Feed Fed Final 12 Weeks (lb/ac)	6,640 ± 100	6,150 ± 170	0.0381
Feed Fed Total (lb/ac)	6,700 ± 100a	6,130 ± 170b	0.0154
Feed Conversion	1.5 ± 0.14	1.4 ± 0.02	0.7574

Holding Hormone-Injected Channel Catfish Females in Hatchery Pond Improves Efficiency and Reduces the Cost of Producing Channel × Blue Hybrid Catfish Fry

Nagaraj Chatakondi[1]

U.S. farm-raised catfish production has declined due to higher production costs, influx of foreign fish, and attractive land alternatives. Raising hybrid catfish can increase production because of the fish's improved growth, survival, and tolerance to common diseases and stressors. Hybrid catfish constitute a rapidly increasing percentage of the catfish processed. Recent research at USDA-ARS Warmwater Aquaculture Research Unit has contributed to the increase of hybrid fry production to 175 million in 2013 (300% increase in the last 5 years) and improved production methods to increase production in ponds.

Hybrid catfish fry production involves hormone-induced spawning of channel catfish, fertilizing stripped eggs with blue catfish sperm, and hatching fertilized eggs in troughs in the same manner as channel catfish in hatcheries. Hybrid fry production requires more labor, a continuous supply of mature broodfish, holding tanks, heated water, resources, and a more regimented production schedule. There is a need to increase the efficiency of hatchery production and reduce the cost of hybrid fry production by innovative approaches.

A high volume of water (100 to 300 gallons per minute) is required for a commercial hybrid catfish hatchery. This oxygen-rich, optimal temperature (79 to 82 °C) water resource is continuously discharged from the hatchery into the drainage system. One potential use of this discharged hatchery water is to channel this resource into a pond and use it as a holding vat or raceway. It was hypothesized that holding hormone-injected broodfish during latency in a hatchery pond would improve the efficiency of hybrid fry production and facilitate cost reduction in the hatchery production of hybrid catfish fry.

At the USDA-ARS Warmwater Aquaculture Research Unit a hatchery pond (0.3 acre × 5 feet) was built adjacent to the existing hatchery in 2011. The discharge of 100 to 200 gallons per minute from the hatchery typically passes through screens and discharged into a sump, the water from the sump is pumped into the hatchery pond and excess water is released into the drainage. Hormone-injected broodfish are suspended in individual soft-mesh bags to reduce the stress of repeated handling.

Two methods of holding hormone-injected catfish during latency were compared in a spawning trial: hatchery pond and concrete tank. Approximately 4-year old "Delta" strain channel catfish females were seined and 32 gravid females were individually hand selected and transported to the hatching facility. The fish were held in a concrete vat supplied with continuous water and air for 3 hours to reduce the stress of seining and transportation. Individual fish were injected with 20 µg mammalian LHRHa (luteinizing hormone releasing hormone analog)/Kg BW and were held in a marked soft-mesh nylon bag. After the initial priming dose, fish were suspended 6 inches below the water surface in a concrete tank or a hatchery pond.

After 15 hours, broodfish held in the bags were given a resolving dose of 80 µg mLHRHa/Kg BW through the marked bag and were either suspended in a tank or hatchery pond. After 26 hours of the resolving dose, ovulating females were identified with the presence of eggs on the nylon-mesh bag. Nylon bags with ovulating females were brought into the hatchery, anesthetized, and stripped in pre-weighed greased bowls. The stripped eggs were quantified, quality of the eggs measured with a pH meter, and fertilized with blue catfish sperm. Fertilized eggs were water hardened and incubated in baskets until hatch.

The reproductive responses measured (ovulation, latency, egg quality, fertilization, hatch and fry produced per kilogram body weight (Table 1)) did not differ between the hormone-injected broodfish suspended either in hatchery pond or concrete tank.

Advantages of suspending hormone-injected broodfish in hatchery ponds include: 1) hatchery space and construction costs associated with concrete vats, water, and air supply can be reduced, 2) a higher number of hormone-injected broodfish can be suspended in the hatchery pond to increase hybrid catfish fry production, 3) a simple technology that can be easily adopted, 4) re-use of oxygen rich, optimal hardness, and warm water, and 5) an increase in hybrid catfish fry production using hatchery pond would reduce the cost of hybrid fry, fingerling, and foodfish production.

Disadvantages of using the hatchery pond method include: 1) failure of pumps or reduced water flow in the hatchery pond could affect the reproductive performance of hormone-injected broodfish, 2) rain or wind conditions may alter the temperature conditions in the hatchery pond, 3) loss of bags or escape of fish from the bags in hatchery pond, and 4) additional labor to suspend fish, inject hormones, and periodical checking for ovulation.

[1] USDA-ARS Warmwater Aquaculture Research Unit

Table 1. Mature channel catfish were either held in tanks or a hatchery pond after a priming dose of 20µg mLHRHa/Kg BW, 15 hours later followed by a resolving dose of 80µg mLHRHa/Kg BW to stimulate ovulation. Mean responses measured in various regimes did not differ (P > 0.05).

Regime (Priming/Resolving)	Ovulation Response	Latency (h)	Egg Quality (pH)	Fertilization (%)	Hatch (%)	Fry/Kg BW (#)
Tank/Tank	5/8	54.6	7.3	94	44.6	1769
Pond/Tank	7/8	58.8	7.2	84	51.1	1410
Tank/Pond	6/8	55.7	7.4	90	41.8	1572
Pond/Pond	8/8	63.2	7.2	93	51.3	1688

Figure 1. Hormone-injected broodstock in mesh bags are either held in a vat or hatchery ponds.

2013 Aquatic Research and Diagnostic Laboratory Summary Report

Lester Khoo[1], Pat Gaunt[1], and Matt Griffin[1]

The Aquatic Research and Diagnostic Laboratory is dedicated to the success of Mississippi's commercial catfish industry through service, research, and teaching. Our staff and fish health professionals strive to support the industry's efforts to produce a high quality, economical, and profitable product. Our goals are derived from the needs of the industry and aimed at developing management strategies for controlling the impact of diseases that affect profitability. These goals can only be accomplished through mutual respect, cooperation, and the maintenance of a close supportive relationship with our clients.

In 2013, the Aquatic Research and Diagnostic Laboratory (ARDL) received a total of 697 producer submitted fish diagnostic cases (Table 1). These cases were received from 24 different farms. This is a 9.4% increase in the number of submissions over the 635 cases in 2012. There were an additional 137 cases submitted by researchers for a total of 772 cases. There were 1201 water quality samples that were analyzed representing a 9.8% decrease from the 1332 samples received in 2012.

Individual case submissions represent a composite sample of fish collected from a single pond on a given day. The numbers reported are derived solely from submissions processed by the ARDL and do not necessarily reflect actual disease incidence in the field. Routine diagnostic procedures include evaluation of gill clips and skin scrapes for parasites, external and internal examination for signs of disease, bacterial and viral cultures, histopathology, and water quality evaluation. The ARDL works closely with Mississippi Agriculture Forestry and Experiment Station (MAFES) fish health professionals to offer treatment recommendations, monitor disease trends, provide surveillance for new and emerging diseases, provide field service investigation, and maintain a database of epidemiologic information on diseases of catfish. The ARDL supports the research efforts of other NWAC units, including MAFES, Mississippi State University Extension Service, College of Veterinary Medicine, and USDA/ARS Warmwater Aquaculture Research Unit. Furthermore, the laboratory provides an outlet for the dissemination of information gained from research efforts back to producers.

Bacterial diseases dominated the number of cases submitted as in previous years. The more usual trend of higher numbers of columnaris cases versus enteric septicemia of catfish (ESC) continued from the previous year. There were a total of 301 columnaris cases and 268 ESC cases representing 34.7% and 30.9% of the total cases seen. Interestingly, 18 different farms were affected by each of these diseases. As single entities there were 101 cases of *Edwardsiella ictaluri* and 71 cases of *F. columnare*. Unfortunately, there were cases of antibiotic resistance. There were 5 cases of ESC that were resistant to Terramycin and Aquaflor, 1 case of *Aeromonas hydrophila* that was resistant to Terramycin and 1 case of *Edwardsiella tarda* that was resistant to Romet. There were 15 cases of *A. hydrophila* of which 14 were of the more virulent *A. hydrophila* and this was limited to one farm. The Terramycin resistant *A. hydrophila* case was not the more virulent

Table 1. 2013 annual case summary for the Aquatic Research and Diagnostic Laboratory.

Disease	Number of Cases	% of Total Cases
Columnaris	301	34.7%
ESC	268	30.9%
PGD	101	11.6%
Saprolegnia	14	1.6%
CCV	9	1.0%
Anemia	38	4.4%
Brown Blood	4	0.5%
Ich	1	0.1%
VTC	0	0.0%
Health Check	1	0.1%
Bolbophorus	80	9.2%

strain. There were a total of 9 cases of *E. tarda*, 8 of which were producer submitted cases and the last one was from a researcher.

Proliferative gill disease (PGD) remained the most commonly diagnosed parasitic disease and was seen in 101 submissions. There was one case *Ichthyophthirius multifiliis* (Ich) but this was from a non-catfish case. There was a marked *Bolbophorus* sp. trematode cases. There were 80 of these cases compared to only 18 from the previous year. Farmers are encouraged to continue surveillance efforts and to control rams horn snails (intermediate host of the parasite) with lime or copper sulfate treatments, particularly if pelicans have been observed visiting their ponds. *Bolbophorus* sp. trematodes are capable of killing fingerlings and increasing susceptibility to ESC, as well as decreasing feed consumption in larger fish. This can result in significant economic losses even with mild infestations.

Saprolegnia was seen in 14 cases submitted. There were only 9 cases of channel catfish virus (CCV) disease fairly similar to what was seen in 2012. Anemia made up 4.4% of the cases which a little higher than the previous year. There were no cases of visceral toxicosis of catfish (VTC) submitted to the laboratory. However, there were unconfirmed reports that this disease had occurred on some farms but fish were not submitted. These last two diseases are still diseases of research interest because of the economic impact. Producers are highly encouraged to submit cases of these diseases.

With the interest in hybrid catfish, we have listed the numbers of hybrid as well as blue catfish cases submitted by month in the Table 2. Listed here are the specific number of those diseases for each of those catfishes. Hybrid and blue catfish made up 25.8% of the submissions to the ARDL in 2013.

[1] Mississippi State University - CVM

Table 2. Number of blue catfish and hybrid catfish cases submitted in 2013.

BLUE CATFISH

Disease Name	**Number of Cases**
Anemia	1
No infectious agents identified	1
Urinary distension, Saprolegnia	1
Total	**3**

HYBRID CATFISH

Disease Name	**Number of Cases**
Anemia	6
Anemia, Saprolegnia	1
Bolbophorus	4
Channel Catfish Virus	5
Columnaris	39
Columnaris, Bolbophorus	4
Columnaris, Channel Catfish Virus	2
Columnaris, *Edwardsiella tarda*	2
Columnaris, PGD	4
Columnaris, Saprolegnia	4
Edwardsiella tarda	2
ESC	52
ESC, Bolbophorus	1
ESC, Channel Catfish Virus	1
ESC, Columnaris	28
ESC, external Columnaris	1
ESC, Henneguyosis	1
ESC, Methemaglobinemia	1
ESC, PGD	5
External Columnaris	3
External Columnaris, Henneguyosis	1
Gas Bubble Disease	2
No infectious disease agents identified	19
Trichodina	1
PGD	4
Saprolegnia	1
Saprolegnia, Anemia, Ext. Columnaris	2
Saprolegnia, Ext. Columnaris	2
Vibrio cholera	3
VHS testing	15
Total	**216**

SRAC Funds Four New Catfish Projects in 2014

Jimmy Avery[1], Sarah Harris[1], and Kristen Walters[1]

SRAC will provide funding for four new catfish research and Extension projects in 2014.

Studies to Improve the Control of Virulent *Aeromonas hydrophila* and Evaluate the Impact of Environmental Factors on its Abundance. *Aeromonas hydrophila* is the causative agent of an ongoing epidemic in farmed catfish. While the original epicenter was in western Alabama, this disease epidemic has now spread to Mississippi and Arkansas. There is an urgent need to understand the environmental and human factors that contribute to its spread, develop effective disinfection and management practices that can result in improved biosecurity, and to develop control measures for farms afflicted with this epidemic.

Auburn University, Mississippi State University, and the USDA National Wildlife Research Center will collaborate on the project. SRAC is providing $375,000 in funding over the next two years.

Split-Pond Aquaculture Systems: Design Refinements for Catfish Production and Evaluation for Culturing Other Species. Split-ponds consist of a fish-holding basin connected to a larger waste-treatment basin by structures through which water is circulated using high-volume pumps. Researchers will determine the best split-pond designs for catfish and baitfish aquaculture. Engineering aspects will include evaluation of five different pumping systems and various fish barriers. Additional studies will determine the effect of dissolved oxygen management in the waste-treatment section on system water quality, fish flavor quality, and fish production.

Researchers at the USDA-ARS Warmwater Aquaculture Research Unit, Mississippi State University, Auburn University, USDA-ARS Natural Products Utilization Research Unit, and the University of Arkansas at Pine Bluff will collaborate on the project. SRAC is providing $465,00 over the next three years.

Implementation of Collective Action Alternatives Identified for the U.S. Catfish Industry. The objective of the project is to provide support and guidance as the catfish industry moves forward to implement a federal marketing order, an appropriate cooperative structure, and closer vertical coordination between producers and processors through mutually agreeable contract models. Alternative contractual models will be reviewed and evaluated in terms of their applicability, and potential impacts of provisions of the marketing order and cooperative structure will be evaluated.

This project brings together the expertise of five economists from University of Arkansas at Pine Bluff, Auburn University, University of California at Davis, and University of Missouri. SRAC will provide $125,000 for one year.

Improvement of Blue Catfish Germplasm for Hybrid Catfish Production. Blue catfish males are killed and their testes removed to obtain sufficient fresh sperm for hybrid fry production. The reliance on fresh sperm, which has a useful life of 2 to 4 days, is a barrier to genetic improvement of economically important traits of hybrids. The objectives of this project are to develop a repository of cryopreserved sperm from diverse blue catfish populations to initiate genetic improvement of hybrid catfish, and to develop a database for efficient storage and retrieval of cryopreserved blue catfish sperm.

Work will be conducted by researchers at the USDA-ARS Warmwater Aquaculture Research Unit and Louisiana State University. SRAC will provide $45,000 over three years.

Additional projects funded in 2014 include Year 19 of the Publications project and a project to determine the best method to remove the adhesion of baitfish eggs.

[1] USDA Southern Regional Aquaculture Center

Mark Peterman Named New Extension Aquaculture Associate for East Mississippi

The Mississippi State University Extension Service has hired Mark Peterman to serve as Extension Aquaculture Associate for East Mississippi counties effective March 1, 2014. Mark will be housed at the Oktibbeha County Extension Office in Starkville.

Mark received a Bachelor of Science degree in Fisheries Management from MSU in 1997. After graduation, he served as assistant facility manager at the MSU South Farm Aquaculture Unit and became sole facility manager in 2000. As facility manager, Mark conducted and supervised aquaculture research, was responsible for fish production, and managed sales.

In 2002, Mark became facility manager at the MSU Coastal Aquaculture Unit in Gulfport. The Coastal Aquaculture Unit was comprised of 36 earthen ponds and a wet/dry laboratory. The water source was brackish, warmwater from a neighboring electric power generating plant. The major species cultured were channel catfish, freshwater prawn, striped mullet, red drum, and cocahoe minnow. Mark also conducted Extension activities that impacted aquaculture production, live bait distributors, and recreational fisheries. In addition to these duties, Mark also served as the facility manager for the Experimental Seafood Processing Laboratory in Pascagoula. His responsibilities dealt with the microbiological aspects of Food Science pertaining to seafood processing (fresh and saltwater fish and shellfish species). The major research effort was related to the post-harvest processing of gulf oysters. His extension activities there served area seafood processors and commercial fisherman.

In 2006, Mark became a member of the farm management team for Auburn University's School of Fisheries, Aquaculture, and Aquatic Sciences. The facility included a variety of indoor/outdoor and closed/flow through fresh warmwater production systems including small (0.05 acre) to large (>20 acre) ponds, raceways, tanks, and aquaria. Fish production included fish identification, hatchery, feeding, growth, disease diagnosis/treatment, water quality analysis/conditioning, grade/stock/harvest/transport, marketing, sales, nuisance vegetation identification/control, pesticide application, and wildlife damage management. The major species cultured were channel catfish, blue catfish, hybrid catfish, largemouth bass, bluegill, red-ear sunfish, grass carp, common carp, and tilapia. Mark also conducted Extension activities related to recreational fisheries and aquaculture production.

Mark completed a Master of Science degree in Aquaculture from Auburn University in 2011. He has also done additional graduate work at MSU and Auburn University. Mark is a member of several professional organizations including Catfish Farmers of America, World Aquaculture Society, American Fisheries Society, Alabama Fisheries Association, and the Aquatic Plant Management Society.

Mark can be reached at:

Mark Peterman
Oktibbeha County Extension Office
106 Felix Long Drive
Starkville, MS 39759
Office Phone: 662-323-5916
E-mail: markp@ext.msstate.edu

Industry-Wide Survey on Opinions of Intensive Pond Systems

The catfish industry is evolving with the adoption of alternate production systems like split-ponds, intensive aeration, and in-pond raceways. Current conditions in the catfish industry require the monitoring of these new production systems to systematically evaluate their relative advantages and disadvantages and their cost reduction potential. It is important to know why producers have chosen to invest in these new systems and why others have not.

The University of Arkansas at Pine Bluff is conducting a multi-state survey on new catfish production technologies in Alabama, Arkansas, and Mississippi. The objective of the survey is to collect information and opinions pertaining to these systems from both farmers who have and have not invested in these new systems. A few catfish producers from each state have been chosen randomly for this purpose. NWAC Extension staff has already sent a request to these selected Mississippi producers to participate in this survey.

Your collaboration in this survey is extremely important and should help analyze and evaluate these new systems. Please contact Ganesh Kumar (870-575-8254) (email: gkumar@uaex.edu) to give your valuable opinion through a short phone interview. The survey will take only about 10 minutes of your time. Your individual information will be kept entirely confidential. Thank you for your cooperation.

Delayed Feeding of Channel Catfish Fry
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productivity and reduce feed. Twelve 0.1 acre ponds were fertilized and stocked with swim-up fry (4 to 5 day posthatch) at 100,000 per acre. Ponds were then randomly assigned to either the standard feeding protocol (feeding immediately at stocking) or the alternative feeding protocol (delaying feeding for 6 weeks).

After 18 weeks, there were no differences in water quality or zooplankton abundance between the two treatments. Fish length was not affected by treatment throughout the study, and survival and total weight harvested were similar. Total pounds of feed fed were significantly reduced in the delayed feed treatment, averaging 570 pounds per acre less feed fed.

However, caution should be used if implementing a delayed feeding strategy. Zooplankton populations should be monitored to ensure adequate natural forage to sustain the catfish fry. Also, this data applies only to channel catfish – a current study is underway to determine if hybrid catfish respond similarly.

[1] Mississippi State University - MAFES
[2] Mississippi State University - CVM