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Use of Elevated Levels of Copper Sulfate to Eliminate Snails

David Wise, Charles Mischke, and Todd Byars

The digenetic trematode *Bolbophorus* sp. has been implicated as a cause of mortalities and reduced production in farmed channel catfish. Control of the disease is dependent on prevention and breaking the life cycle of the trematode by reducing snail populations in the pond. Current treatment methods rely on the application of hydrated lime or copper sulfate to the margins of the pond. These treatments have been shown to be effective in controlling snail populations and limiting infection rates, provided the snails are concentrated along the margins of the pond. Recent laboratory tests indicate that increasing the concentration of copper sulfate may be effective in killing snails dispersed throughout the pond without directly killing catfish. The effects of copper sulfate on snail mortality and on the pond environment were evaluated in experimental and commercial catfish ponds. All concentrations are reported as ppm copper sulfate pentahydrate ($CuSO_4 \cdot 5H_20$).

The first step in establishing a treatment level was to determine the concentration of copper sulfate needed to kill 50% of the snails in 24 hours (referred to as a 24-hour LC50). Laboratory tests showed copper sulfate crystals had a 24-hour LC50 of 2.4 ppm. There was a significant linear relationship between temperature and LC50 values for copper sulfate. As temperature increased from 59°F to 68°F, (15°C to 20°C) the LC50 values decreased from 4.4 ppm to 0.72 ppm copper sulfate, representing a seven-fold increase in toxicity.

To determine the minimum dose of copper sulfate that would effectively eliminate snails without directly killing catfish, a series of dose titration trials were performed. The trials were conducted in plastic tanks containing 200 gallons of pond water and in 0.25-acre ponds. Catfish and snails were confined (net pens) in each test unit and dosed with a range of copper sulfate solutions. These titration trials indicated the minimum effective dose (snail mortality >90%) of copper sulfate ranged between 2.5 and 5 ppm copper sulfate. Fish mortality was not observed at or below 5 ppm copper sulfate in the tank

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Use of Elevated Levels of Copper Sulfate to Eliminate Snails
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studies. However, fish mortality (2 out of 16 fish or 12.5%) was observed in one of the three net pens in the pond treated with 5 ppm copper sulfate.

In an effort to verify the minimum effective dose, replicate 0.25-acre and 10-acre experimental ponds were treated with 2.5 and 5 ppm copper sulfate. All treatments were delivered as a solution of copper sulfate granules dissolved in pond water. Treatments were applied to larger ponds using a chemical boat. Replicate pond treatments verified that treatment doses of 2.5 and 5 ppm copper sulfate were effective in killing snails. Average snail mortality in the 0.25-acre ponds ranged between 98% and 95.5% at the low treatment dose and was 100% at the high treatment dose. Fish mortality was observed in one of the three replicate ponds at each treatment dose. Similar results with respect to snail toxicity were observed in the toxicity trials conducted in 10-acre ponds. Average snail mortality ranged between 92% and 98% following treatment with 2.5 ppm and between 98% and 100% following treatment with 5 ppm copper sulfate. In contrast to the 0.25-acre pond trials, no fish mortality or behavioral signs of toxicosis were observed following treatment. In all pond trials, dissolved oxygen depletions were not observed for up to 168 hours after treatment. Mortality in the 0.25-acre ponds during both the dose titration and the verification trials may have been caused by exposure of confined fish to high concentrations of the applied chemical before it was completely mixed with the pond water.

The treatment was then evaluated in a 13-acre commercial channel catfish production pond containing moderate numbers of snails. Results of the commercial field trial were comparable to tests conducted in the experimental ponds at 5 ppm copper sulfate. Average mortality of snails confined in cages ranged between 95.4% and 97.7%. The treatment was also shown effective against natural populations of snails along the margins of the pond. The average number of snails per foot of pond bank decreased from 21.5 snails to 0.18 snails 24 hours after treatment, representing a 99% reduction in viable snail populations in the habitat along the pond bank.

Treatment of the commercial pond resulted in changes in fish behavior and mortality. Within 4 hours of treatment, an increase in the number of moribund fish was observed. Affected fish appeared lethargic or exhibited a spiraling swimming pattern. However, it is not thought that these observations were solely related to the chemical treatment. Prior to treatment, mortality rates were characterized as chronic and were estimated to be 150 to 200 head/day resulting in an estimated total mortality in excess of 20,000 pounds. Moribund and dead fish were diagnosed with bacterial infections (*Edwardseilla ictaluri* and *Flavobacterium columnare*), parasitic infections (*Bolbophorus* sp.), acute nitrite toxicosis, and clinical symptoms consistent with visceral toxicosis of catfish. It was estimated that approximately 2,000 pounds of fish were lost within the first 24 hours after treatment. Salt was added to treat nitrite toxicosis and after the first 24 hours, the daily mortality rate returned to pretreatment levels.

These trials indicate copper sulfate can be used as an effective treatment against ram's horn snails in commercial channel catfish production ponds. Copper sulfate treatments between 2.5 and 5 ppm copper sulfate were effective in killing snails throughout the water column with minimal risk to the health of the fish. In most trials, pond treatments killed in excess of 95% of the test snails. These studies were conducted mid October to early November when pond water temperatures were between 68°F to 75°F (20°C to 24°C), and bloom densities were below that which is typically observed during the summer months. Under these conditions, the concentrations of copper used were not shown to affect dissolved oxygen concentrations and, under typical production conditions, were not shown to affect fish behavior or mortality of healthy channel catfish. However, the 2.5 ppm copper sulfate treatment rate was toxic to smallmouth buffalo, and grass carp exhibited clinical signs of toxicosis and limited mortality at a treatment rate of 5 ppm. A copper sulfate treatment of 5 ppm was also shown to be toxic to fish in poor health; however, the viability of these fish was highly questionable.

Considering that copper did not appear to be toxic to fish in trials conducted in the 10-acre experimental ponds, copper treatments ranging between 2.5 and 5 ppm appear to be safe to channel catfish under the conditions and water quality characteristics of this study. However, caution should be used when the health status of the fish is in question, at high pond water temperatures, or when bloom die-offs are likely to cause oxygen depletions.

Cormorant Deterrent Systems for Moderate Size Farms

Charlie Hogue

A deterrent system has been developed that can reduce or possibly eliminate cormorant activity of catfish operations. Cormorants are a significant problem to catfish farmers and their population levels are increasing each year. According to a recent survey by the USDA National Agriculture Statistics Service, commercial catfish growers in 13 states reported that wildlife losses (mostly from migratory birds) accounted for $13.3 million in inventory in 2003. Farmers spent an additional $7.1 million on harassment activities to keep cormorants off their farm. Labor costs, wear and tear on trucks and levees, guns, and ammunition are a major expense every year. Some farms report spending more money chasing birds in the winter than spent checking oxygen in the summer.

Moderate size farms with three or four ponds have been able to deter cormorants from their farm completely. The system has also proven effective in protecting individual fingerling ponds on larger production facilities. The system is based on the fact that, unlike ducks, cormorants land on a pond at long angles. By using metal fence posts, strings, and flags, a series of obstacles is created that discourage cormorants from landing in the pond.

To construct the system, metal fence posts are placed directly opposite each other every 60 feet on the two long levees of a pond. Next, a #12 untarred string with orange flagging tied every 15 feet is suspended across the pond from two opposite posts. The string and flagging should be 2 to 3 feet above the water surface. The approximate cost to protect a 10-acre pond is only $100 and only takes about a half of a day to install. When it comes time to harvest the pond, the posts and strings can simply be taken down and put back up after harvest.

While this system might not be feasible for completely protecting large foodfish operations, this system has been used effectively on several Black Belt farms. This method could also be used on remote ponds in the Delta that are difficult to effectively watch for cormorant activity.

Welcome to New Personnel at NWAC

Sarah Harris

Dr. Peter Silverstein joined the USDA/ARS Catfish Genetics Research Unit (CGRU) as a Research Virologist/Microbiologist in June 2004. Dr. Silverstein is a native of New York City. He received his undergraduate education at Duke University, M.A. from Lehman College of the City University of New York, and Ph.D. in 1996 from the College of Veterinary Medicine at Auburn University where his dissertation research focused on characterization of the immediate-early genes of channel catfish virus (CCV). Dr. Silverstein comes to us from the Department of Pharmaceutical Chemistry at the University of Kansas (Lawrence) where he studied drug transporters responsible for the efflux of numerous therapeutic agents, including antivirals and antibiotics. Dr. Silverstein's expertise in molecular virology, combined with his broad background in pathogenesis of viral and bacterial diseases, will add an important component to the work at CGRU. The focus of Dr. Silverstein's work will be the identification of host factors responsible for disease resistance in channel catfish. Some of this research will look at mechanisms of resistance to channel catfish virus, while other projects will focus on the role of macrophages and monocytes in disease resistance. He can be reached at (662) 686-3545.

Dr. Terry Greenway, a research immunologist, joined the research team at NWAC in October 2004 as an Assistant Research Professor with the Mississippi Agricultural and Forestry Experiment Station. Dr. Greenway is a native of Arkansas, and received his BS in Biology and his MS in Animal Science-Parasitology from the University of Arkansas. He recently completed his doctorate in Veterinary Medical Science-Immunology at Mississippi State University College of Veterinary Medicine where he investigated the ability of bacterial enterotoxins to act as mucosal adjuvants (substances which augment immune responses to vaccines) in poultry. Dr. Greenway's research at NWAC will revolve around vaccine development and vaccine delivery strategies for catfish. He can be contacted at (662) 686-3583.

Experimental Evaluation and Economic Analysis of a Fingerling-to-Stocker Phase in the Commercial Farming of Channel Catfish

Lou D'Abramo, James Steeby, and Terry Hanson

In 2004, the first controlled study of the fingerling-to- stocker growth phase of a three phase (fry to fingerling, fingerling to stocker, and stocker to final food size) modular system was completed. This modular system, an alternative to the traditional multiple-batch farming of channel catfish, offers some distinct advantages. The modular system addresses the need to produce consistently larger-sized fish and improves control of inventory. Additionally, any changes in weight specifications from processing plants can be effectively addressed during the relatively short duration of the final growout period through modification of the number and size of stockers produced in the fingerling-to-stocker phase ponds. The modular system also offers a decrease in the probability of water quality and disease problems during the final growout phase because stocking density, and therefore the total pounds of fish in the pond, will be lower. Economic loss arising from bird depredation can be minimized because the high density fingerling to stocker culture phase can be localized in a specific area of the farm. The length of the fish harvested for stocking into phase-three ponds for the final growth phase exceeds the 4- to 8-inch range of lengths that has been documented to be most susceptible to cormorant depredation. Final growout can then be conducted in ponds located further away from activity centers with decreased risk of catastrophic losses due to bird depredation.

Pond-run fingerlings of a mean length of 4.33 inches were stocked into experimental earthen ponds at three densities, 40,000, 50,000 and 60,000/acre. There were five replicate ponds for each density treatment. A 36% crude protein fingerling feed was fed to satiation once daily during a 180-day growout period that extended from April 30 through November 2. At all three densities, the fish fed voraciously and growth rates were good. Particular attention was directed to the management of dissolved oxygen, principally achieved through a fixed in-pond aerator that provided the equivalent of 4 horsepower/acre as needed. Pond aeration was initiated when levels of dissolved oxygen decreased or were anticipated to decrease to 6 ppm. If levels continued to decrease to 3 ppm, then paddlewheel aeration was added. For each pond, the times when aerators were on as well as the total amount of food fed were recorded each day for the entire period. At the end of this growout phase, mean survival, total production, and feed conversion ratio were determined from the group of ponds representing each of the density treatments (Table 1).

The mean fish weight achieved for this fingerling-to-stocker phase was 94% of the 250 pounds/1,000 goal that had been set with no significant treatment-dependent differences. Although the lengths of fish harvested from each of the treatments were not significantly different, a reduction in individual weight was obvious as density increased from 50,000 to 60,000/acre. Meeting the objective of a mean harvest weight of 0.25 pound appeared to be attainable because water temperatures for the 2004 growing season were unseasonably cool, contributing to lower food consumption and lower growth rates. In fact, only once did a daily feeding rate ever exceed a level of 200 pounds/acre. Also, there were a number of days when feed was not distributed to the ponds due to weather conditions or disease outbreaks in some ponds.

Economic Analysis

The economic analysis compared engineered enterprise budgets for the multiple-batch system versus three variations of the fingerling-to-stocker phase of the modular production system. The analysis was based upon an enterprise budget developed for a

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Table 1. Production data for different stocking density treatments.

Fingerling density (fish/acre)	Survival (%)	Feed conversion ratio	Fish size at harvest (lbs/1,000)	Production (lbs/acre)
40,000	64	1.5	202	5,145
50,000	73	1.4	208	7,516
60,000	73	1.4	188	8,151

1,100-water-acre farm because previous evaluative work was done with a producer who was using a modular system on a farm of similar size. In the fingerling-to-stocker phase of the enterprise budget, we used our experimental results to incorporate costs for fingerlings, feed fed, and number of aeration hours in conjunction with harvest number and weight. An additional four laborers were included for the modular system because more harvests are required relative to the multiple-batch system.

Beginning with the weight of the harvested stocker fish from each experimental treatment, the stocking density of the growout phase was 4,800/acre and a final growout weight was assumed to be 1.7 pounds. Fixed costs for a 1,100-acre channel catfish farm were used for all budgets. The modular system had 4 horsepower/acre aeration in the fingerling-to-stocker ponds and 2 horsepower/acre for the final phase of food fish production, whereas all multiple-batch food-size fish production ponds had 2 horsepower/acre.

The number of stockers produced per acre was dependent upon initial stocking density. Therefore, the number of acres allotted to the stocker-to-food size growout phase increased as the initial stocking density of the fingerling-to-stocker treatments increased because fewer pond acres are needed for the fingerling-to-stocker phase at the higher initial stocking densities of fingerlings. Thus, for a 40,000/acre fingerling stocking rate, 120 acres are required to produce enough stockers for the remaining acres of production of food fish. Likewise, for the 50,000 (60,000)/acre stocking density of fingerlings, 140 (120) acres were required to produce stockers for the remaining 960 (980) acres of ponds for production of food fish (Table 2). The economic questions that were addressed in this research are: 1) Using the same 1,100 acres of ponds, how do the net returns realized from using the modular system under the three different fingerling to stocker scenarios, and consequently with a lower number of foodfish acres, compare to a multiple-batch foodfish production system, 2) how are net returns affected by different initial stocking densities and corresponding final growout acreage.

Results of the economic analysis, specifically net returns per acre and cost of production estimates, for the three scenarios of the modular system and one multiple-batch system are presented in Table 2. The multiple-batch and 40,000/acre modular systems yielded similar net returns. However, the net returns for the two higher stocking rates, 50,000 and 60,000/acre, of the modular system exceeded those of the multiple-batch system. Variable costs of production, or breakeven price to cover cash production costs, were similar for the modular system using the 40,000/acre stocking rate for the fingerling to stocker phase and the multiple-batch system. For the higher stocking rates of the fingerling-to-stocker phase of the modular system, the per pound cash production cost was two and three cents less, and the per pound

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Table 2. Comparison of acreage distribution, net returns, and cost of production for different modular and multiple-batch catfish production systems.

	Modular system fingerling stocking rate (per acre)			Multiple-batch system
	40,000	50,000	60,000	
Area distribution, acres:				
Between stocker and final food fish	920	960	980	
Between fingerling and stocker fish	180	140	120	
Fingerling to food fish				1,100
Net returns per acre, $/acre:				
N.r. above variable costs	$ 637	$ 775	$ 841	$ 649
N.r. above variable + fixed costs	$ 251	$ 389	$ 455	$ 225
Costs of food fish production, $/lb:				
Covering variable expenses	$ 0.58	$ 0.57	$ 0.56	$ 0.59
Covering variable + fixed expenses	$ 0.65	$ 0.63	$ 0.62	$ 0.66

2004 CVM Aquatic Diagnostic Laboratory Summary

Al Camus, Pat Gaunt, and Michael Mauel

Diagnostics

In 2004, the Aquatic Diagnostic Laboratory (ADL) at Stoneville received a total of 1,770 fish case submissions, 778 diagnostic and 992 research. Diagnostic cases were received from 96 farms, or approximately 25% of the Mississippi industry. In addition, 978 water quality samples from 60 farms were analyzed. Compared to 2003, the total number of case submissions decreased slightly from 832, while the number of water samples increased from 851. The ADL staff would like to stress that we are here to serve the industry and encourage producers to continue to take advantage of this valuable free service.

As in the past, individual case submissions represent a composite sample of fish collected from a single pond. The numbers reported are derived solely from submissions processed by the ADL 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 inspection for signs of disease, bacterial and viral cultures, histopathology, and water quality evaluation. The ADL works closely with 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 ADL supports the research efforts of other NWAC units, including MAFES, MSU-Extension Service, College of Veterinary Medicine, and USDA/ARS Catfish Genetics Research Unit. Furthermore, the laboratory provides an outlet for the dissemination of information gained from research efforts back to producers.

As in previous years, the bacterial diseases enteric septicemia of catfish (ESC) and columnaris disease dominated the numbers of producer submitted cases. (The seasonal incidence of the four major diseases is presented in Figure1.) Examined as a single disease, ESC accounted for 4.3% of cases, but in combination with other agents was diagnosed in 30.7% of cases (34.6% in 2003). While alone, columnaris accounted for 5.7% of cases, in combination with other pathogens, columnaris was present in 40.9% of all cases (44.7% in 2003), making it the most common disease seen by the ADL. ESC and columnaris were diagnosed together in 6.6% of case submissions. These numbers have remained relatively consistent over the past 8 years, where on average ESC was diagnosed in 36.4% and columnaris in 43.7% of all cases. Table 1 contains a summary of disease trends for 1997 to present.

Proliferative gill disease (PGD) was the third most commonly diagnosed disease, representing 10.7% of cases (10.8% in 2003). Saprolegnia, the cause of winter fungus, was present in 3.7% of cases, down from 5.4% in 2003. The number of channel catfish virus (CCV) disease cases rose from 8.9% in 2003 to 10.8% in 2004 and remained above the 8-year average of 5.4%. The number of channel catfish anemia (CCA) cases decreased from 5.2% in 2003 to 2.1% for 2004 and fell below the 8-year average of 3.8%. *Ichthyophthirius multifiliis* (Ich) cases increased from 0.5% last year to 5.0% in 2004, well above the 8-year average of 1.8%. Cases of visceral toxicosis (VTC) remained relatively constant at 3.2% versus 3.7% in 2003.

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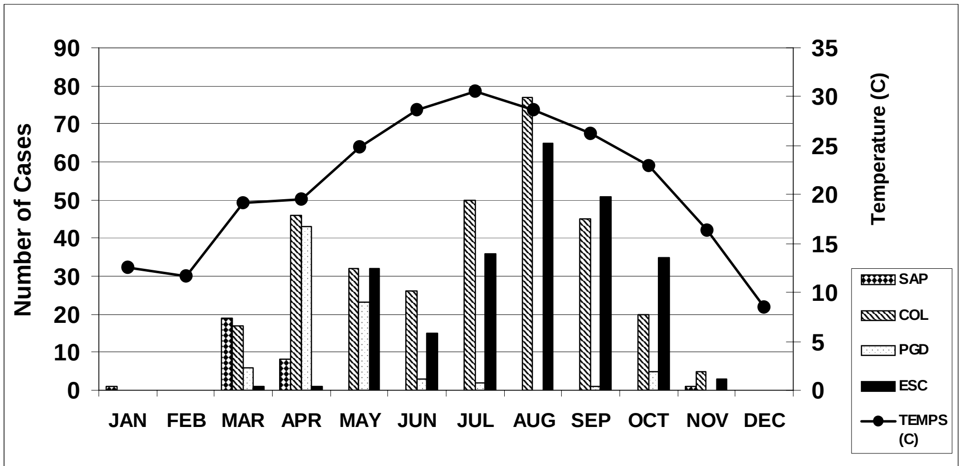

Figure 1. Seasonal incidence of major catfish diseases in 2004.

The percent of *Bolbophorus* trematode cases remained below the high of 5.6% seen in 2000, but rose from 1.1% in 2003. Resurgence of the parasite is largely attributed to the establishment of a resident summer population of white pelicans in Humphreys County. Farmers are encouraged to renew surveillance efforts and to control ram's horn snails (intermidiate host of the parasite), particularly if pelicans are visiting their ponds. *Bolbophorus* trematodes are capable of killing fingerlings and increasing susceptibility to ESC, as well as decreasing feed consumption in larger fish.

A previously unknown streptococcal bacterial infection causing mortalities, spinal deformities, and reproductive failure in catfish broodstock was identified and characterized. To date, four outbreaks have been confirmed, but at present the significance of this emerging disease is unclear. Findings have been submitted in the form of a manuscript to the Journal of Aquatic Animal Health. Producers noting emaciation, humped backs, and bloody sores along the jaw at the time of broodstock selection are encouraged to contact the ADL.

Research

Research into the cause of CCA, a well-known but poorly understood cause of mortalities, demonstrated a rapid and complete resolution of the condition in affected fish following the administration of injectable iron in two separate trials. Research into potential causes for the development of iron deficiency anemia is ongoing.

A collaborative working group was formed to continue research into the cause of VTC. The working group is composed of scientists from the ADL, MAFES, USDA/ARS Catfish Genetics Research Unit, College of Veterinary Medicine, and State Chemistry Laboratory. In laboratory trials conducted at the ADL, the suspected toxin was found to affect a number of fish species in experimental challenges.

Extensive trials were conducted to evaluate the virulence of an isolate of CCV causing unusually high mortalities on a farm raising NWAC-103 strain catfish. Although considered preliminary, results of challenge trials indicate the field-isolate produces mortalities approximately twice as high as those caused by the original type strain of CCV archived by the American Type Culture Collection. The NWAC-103 strain was found to be intermediate in susceptibility to the field isolate in trials performed cooperatively with USDA scientists.

The FDA approval process for use of the antibiotic florfenicol (Aquaflor®) continued to move forward. Final approval of the drug for use in catfish is anticipated in 2005 and will provide farmers a new tool for combating ESC. Following the success of trials in catfish, the Schering–Plough pharmaceutical company funded new drug efficacy and dose titration trials for the use of florfenicol against *Streptococcus iniae* infections in tilapia. The results of these trials will be submitted to the FDA as a component of the drug approval application process.

A graduate student was recruited and has begun development of a real-time PCR assay to quantify numbers of *Henneguya ictaluri* spores in pond water. When validated, the assay will be used to predict proliferative gill disease outbreaks and evaluate the efficacy of control measures.

Table 1. Trends in disease diagnosis as a percentage of diagnostic case submission over time.

Disease	Average	2004	2003	2002	2001	2000	1999	1998	1997
Columnaris	44.1%	40.9	44.7	44.5	37.2	42.6	45.5	44.8	49.1
ESC	37.2%	30.8	34.7	39.8	36.4	33.5	41.2	41.2	33.6
PGD	21.7%	10.7	10.8	16.3	20.1	29.8	30.0	16.3	28.6
Saprolegnia	8.6%	3.7	5.3	10.1	10.4	10.5	8.7	8.6	6.4
CCV	4.6%	10.8	8.9	5.8	7.3	2.3	1.8	3.1	3.0
Anemia	4.0%	2.1	5.2	5.3	5.0	4.9	2.8	3.0	1.7
Ich	1.3%	5.0	0.5	2.2	1.8	2.7	0.7	0.5	0.8
Bolbophorus	2.9%	2.6	1.1	2.0	4.4	5.6	1.5	-	-
VTC	2.7%	3.2	3.7	2.0	2.5	-	-	-	-
No Pathogens	15.6%	20.8	18.3	16.2	19.2	15.0	15.2	11.4	13.6
No. of Cases	1452	778	832	1057	1602	2189	2007	1647	831

Streptococcosis, a Previously Unknown Disease of Channel Catfish Broodstock

Al Camus and David Wise

A previously unknown bacterial disease has been identified in channel catfish broodstock on four commercial operations in Mississippi. The cases were submitted to the Aquatic Diagnostic Laboratory at the NWAC during February 2002, September 2003, February 2004, and July 2004. Producers reported chronic low-level mortalities, poor reproductive success, and the presence of small skin sores, muscle wasting, and arched backs noted at the time of broodstock selection.

The diseased fish were in poor physical condition and had a variety of visible signs indicative of the disease. The most consistent finding was the presence of small (less than 1/4 inch) bloody sores located along the bottom of the lower jaw. Similar sores were often located at fin bases. Examination revealed the sores penetrated into underlying muscle and entered joints at the angle of the jaw and bases of fins. Tracts leading from the skin surface to the affected joints contained reddish-brown fluid.

The arching of the back (Figure 1) was due to spread of the infection to the backbone, resulting in the destruction and collapse of individual vertebrae. Collapsed vertebrae were often displaced to the point of crushing the spinal cord. Thick, reddish-brown fluid was also associated with sites of spinal damage and extended from the vertebrae into the adjacent muscles of the fillet.

Microscopically, tissue damage was limited primarily to bone, surrounding muscle, and the spinal cord. In areas of vertebral damage, inflammatory cells surrounded the spinal cord, a change known as meningitis. Examination also confirmed compression of the spinal cord. Inspection of the major internal organs revealed no significant changes in any fish.

Culture of affected tissue sites resulted in the isolation of a bacterium identified as a *Streptococcus* species, however, complete characterization of the organism is ongoing at this time. The bacterium was subsequently injected into laboratory-reared catfish, which developed sores and joint changes identical to those seen in the field cases. The poor condition, damage to joints, and involvement of the backbone suggest a slowly progressive course in which mobility and feeding activity is progressively impaired. It is likely that fish with damage to the spinal cord may be paralyzed in the lower body and tail, interfering with their ability to feed and spawn.

Several different species of related *Streptococcus* bacteria are known to cause disease in a variety of cultured fish in both fresh and saltwater. This group of diseases, collectively referred to as streptococcosis, causes major losses annually in certain fish species and appears to be increasing in incidence worldwide. Despite this, similar infections have not been recognized as a disease of channel catfish.

At present, the importance of this emerging disease and its distribution on commercial channel catfish aquaculture operations is unknown, but is the subject of ongoing investigation. It seems probable that suppression of the fish's immune system, possibly related to low winter temperatures, or stress related to spawning activity, may be required for the disease to manifest itself. Based on limited information provided by producers, it is evident that the problem may go undetected for long periods of time, as broodstock typically are observed closely only once annually. Producers are encouraged to examine fish for signs similar to those described above at the time of broodstock selection and report their observations or submit fish to the ADL at (662) 686-3305.

Figure 1. Broodfish with *Streptococcus* infection.

New Publications Produced by the Southern Regional Aquaculture Center

Craig Tucker and Sarah Harris
Southern Regional Aquaculture Center

In its 17 years of existence, the Southern Regional Aquaculture Center (SRAC) has distributed almost $10 million in funds to support aquaculture research and extension. Research conducted with these funds has lead to many innovations and improvements in aquaculture, but SRAC may be best known for the abundant literature produced through the “Publications, Videos, and Computer Software” project.

The SRAC “Publications” project is in its tenth year of funding and is under the editorial direction of Dr. Michael Masser and staff at Texas A&M University. To date, the “Publications” project has generated more than 170 fact sheets with contributions from 123 authors from throughout the southern region.

The efficiency and effectiveness of the SRAC “Publications” project is rooted in the benefits of using a region-wide pool of experts to develop educational materials and then allowing SRAC to cover the costs of writing, editing, and initial publication. This process assures that each publication is written by the most knowledgeable person in the region and it prevents duplication of effort among states.

During the past two years, research and extension scientists from the following institutions and agencies have contributed to SRAC publications: Auburn University, Clemson University, Harry K. Dupree Stuttgart National Aquaculture Research Center, Kentucky State University, Louisiana State University, Mississippi State University, Mississippi-Alabama Sea Grant Consortium, Purdue University, Texas A&M University, University of Arkansas at Pine Bluff, University of Florida, and University of Georgia. You will find information on just about any topic you can imagine from the list of 170 titles available from SRAC. To give you some idea of the variety of material available, here are some recent titles:

- Aquatic Weed Management: Herbicide Technology and Application Techniques
- Cost Economics of Small-Scale Catfish Production
- Pond Mixing
- Aquaculture Food Safety
- Trematode Infestations in Catfish
- Channel Catfish Virus Disease
- Partitioned Aquaculture Systems
- Growing Bull Minnows for Bait
- Hybrid Striped Bass Fingerling Production
- Crawfish Aquaculture: Harvesting
- Management of Ammonia in Fish Ponds
- Protozoan Parasites
- Saprolegniasis (Winter Fungus) and Branchiomyosis of Channel Catfish
- Crawfish in Earthen Ponds without Planted Forage
- Liming Ponds for Aquaculture
- Koi and Goldfish
- The HACCP Seafood Program and Aquaculture
- Aquaculture Research Verification Programs
- Catfish Broodfish Management
- Catfish Hatchery Management

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http://www.msstate.edu/dept/srac

In addition to the wide variety of information offered, you can print copies of all SRAC publications, obtain the address of your state Aquaculture Extension Specialist, and link to many other useful sites.

All SRAC Fact Sheets, as well as a variety of other printed materials, are readily available. If you have Internet access, the easiest way to obtain SRAC publications is to visit the SRAC website (see the box above) and browse the list of publications. When you find the publication of interest, simply click on the title and print. If you do not have access to the Internet, copies of SRAC publications can be obtained from Dr. Jimmy Avery, Aquaculture Extension Specialist at the NWAC in Stoneville or your local Aquaculture Extension Specialist.

U.S. Farm-Raised Catfish Industry: 2004 Review and 2005 Outlook

Terry Hanson

2004 Review

The U.S. catfish industry generated $438.5 million in farm sales in 2004. The growth of the catfish industry has been rapid with less than 6 million pounds being processed in 1970 to 662 million pounds in 2003. In 2004, production decreased by 4.7% to 630 million pounds with the top four catfish producing states, Mississippi, Alabama, Arkansas, and Louisiana, producing 95% of all catfish grown in the U.S.

During the first half of 2004, catfish producers faced rising feed costs while fish prices started to rise. As fish prices stabilized higher during the second half of 2004, catfish feed prices decreased due to record corn and soybean crops. Thus, 2004 could be described as a transition year for the U.S. farm-raised catfish industry, transitioning out of three prior years of low producer fish prices and into a period of higher fish prices. However, producers will need a string of good years to make up for three years of low revenues, lost equity, and cash flow problems.

Live Fish Prices. The average catfish pond bank price in 2004 was $0.696/pound, up $0.115/pound from 2003's average price of $0.581/pound (Figure 1). The 5- and 10-year monthly average prices follow a seasonal pattern of price increases from January through May and then decline throughout the rest of the calendar year. Producer catfish prices generally followed the seasonal pattern exhibited in the 5- and 10-year average price ranges in 2004, but went above the 10-year average price in the last three months of 2004 (Figure 1).

Producer Inventories. Catfish inventories of small-, medium- and large-sized food fish have continued to decrease since July 2001. For the top four producing states, July 2004 food size fish inventories were down 40 million fish or 9% from July 2003 levels. While large and small stocker fish were down by 4% and 3%, respectively, fingerlings and fry were down 13% from 2003 levels. Thus, indications are that catfish supply to the processors and to the producers will be lower in 2005 than in 2004. This should provide some stability to the current higher pond bank prices, keeping them within the 5- to 10-year average monthly price ranges.

Variable Costs. Catfish feed prices rose sharply in the first five months of 2004. May 2004 prices for 28% and 32% protein feeds had increased by $77 and $80/ton over May 2003 price levels, to $298 and $310/ton, respectively. Feed costs for an average 250-acre catfish farm producing food size fish experienced a 20% increase in overall cash feed costs since October 2003 (Table 1). However, since the end of May 2004 catfish feed prices have fallen to the $230 range. The 2004 corn and soybean crops have been the major cause of the drop in catfish feed prices and may bring catfish feed prices down to comparable 2001 and 2002 levels when catfish feed sold in the $200 to $210/ton range.

Another production price increase occurred with petroleum products (i.e., gas and diesel) in 2004. In October 2003 gasoline prices were approximately $1.50/gallon for on-road gas and $1.05 for off-road diesel. In June 2004 gas prices increased to $1.74/gallon and diesel prices rose to $1.19/gallon, 16% and 13% percent increases respectively (Table 1). Combined with feed cost increases, these input costs have increased catfish cash production costs by nearly 20% since October 2003.

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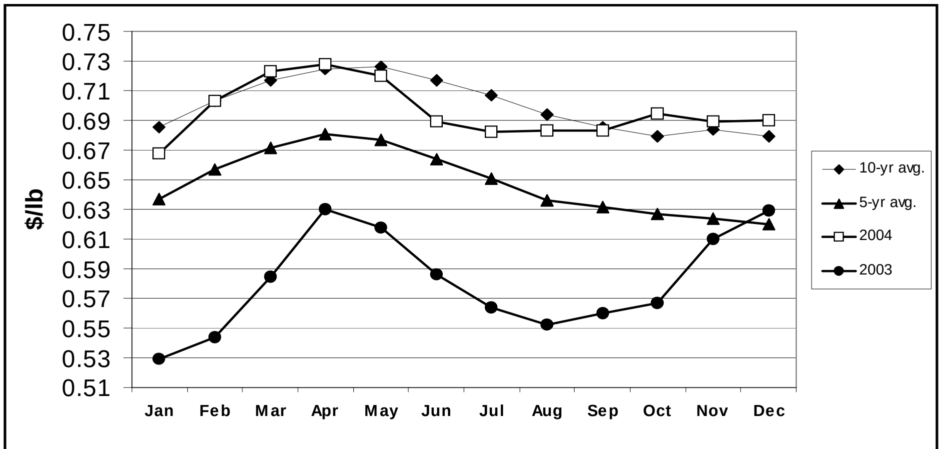

Figure 1. Average monthly catfish price received by producers.

Fillet Prices. The frozen fillet is the bellwether product form of the U.S. catfish processing industry, and as the direction of frozen fillet prices go for the processor, so goes the direction of pond bank prices for the producer. The price received by processors for frozen fillets began decreasing in April 2000 from a high of $2.88/pound to a low of $2.41/pound in December 2001, a drop of $0.47/pound or 16% over 20 months. From the January 2002 to December 2003 period, frozen fillet prices remained in the $2.36 to $2.46 price range. Only in 2004 did the fillet price rebound to $2.70/pound before declining to $2.60/pound in November. Though the 2004 price range increased dramatically, they are still below the 2000 price range of $2.70 to $2.88/pound; thus the industry has still not fully recovered from the 2001 to 2003 slump.

Imports. The primary competitive import is basa or tra (formerly called "catfish") frozen fillet products marketed to the food service industry. In 2003 the International Trade Commission and Department of Commerce ruled that unfair trading practices had been used, and imposed tariffs on Vietnam basa and tra exporters ranging from 37% to 64%. Imports of channel catfish were 60% below 2003, though it is difficult to track these fish as U.S. Customs put these fish into an "other" fish category where they could not be distinguished from other imported fish. However, in August 2004 *Pangasius* and Siluriformes "catfish" categories were added to the *Ictalurus* category in the International Trade Commission's import reporting. This accounted for the large reported "increase" in imports in August through December 2004. Imports of *Ictalurus* remained in line with its trend for the last year. Concern is now focused on possible Chinese production and export of *Ictalurus punctatus* to the U.S.

2005 Outlook

The growth in the U.S. farm-raised catfish industry is expected to continue but not at the rapid pace seen in the 1980's and 1990's. This reduced pace of expansion will be influenced by a number of factors, primarily the health of the U.S. economy and consumer consumption of fish products.

Because of the relatively low pond inventories of food size fish and import tariffs restricting some substitute fish products, U.S. farm-raised catfish will be in short supply in 2005. This shortage will keep pond bank prices stable, higher than in the past three years, and within the 5- to 10-year average monthly price ranges. Producer prices are likely to remain in the $0.65 to $0.75/pound range throughout 2005. Higher catfish producer prices and lower feed prices should bring positive net returns back to U.S. farm-raised catfish enterprises. On the demand side, an improving economy will increase the rate at which new jobs are created and should increase restaurant visits, adding to catfish sales and stimulate increased catfish production.

Interestingly, as the National Agriculture Statistics Service pricing series grows, a trend may be emerging regarding catfish pricing cycles. The catfish industry may be in a 10-year price cycle. Nominal catfish prices have gone below $0.60/pound three times, in 1982 ($0.55/pound), 1992 ($0.60/pound) and 2002 ($0.57/pound), i.e., at 10-year intervals, and after the low-price mark, prices have rebounded for two to three years. If this is a reliable cycle, it would appear that pond bank catfish prices may be headed upward for the next one to three years (2005 to 2007).

Table 1. Effect of feed and fuel price increases on a 250-acre catfish farm's variable costs.

		Fuel		Feed & Fuel
Oct-03	Feed	Gas	Diesel	Cash Cost
Price	$ 250/ton	$ 1.50/gal	$ 1.05/gal	
Farm Cost	$ 474,650	$ 15,800	$ 23,175	$ 513,625
Jun-04				
Price	$ 300/ton	$ 1.74/gal	$ 1.19/gal	
Farm Cost	$ 569,580	$ 18,331	$ 26,125	$ 614,036
Change in $	$ 94,930	$ 2,531	$ 2,950	$ 100,411
Change in %	20.00%	16.02%	12.73%	19.55%

Experimental Evaluation and Economic Analysis of a Fingerling-to-Stocker Phase in the Commercial Farming of Channel Catfish
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total cost of production was three and four cents less than corresponding costs for the multiple-batch production system (Table 2). Thus, combined with the previously stated non-cash benefits of the modular production system, the economic analysis additionally supports the modular production system as an alternative strategy to produce larger fish at a lower cost to producers -- a true necessity to successfully compete in the global market for fish products.

Both the 50,000 and 60,000/acre density for the fingerling-to-stocker phase of the modular system appear to offer promise, given the higher net return and a lower cost of production, even with the smaller stocker size produced at the highest stocking density. At 60,000/acre, the goal of a mean weight of 0.25 pounds for the stocker may be achieved with a slightly warmer growing season. Critical to the success of the fingerling-to-stocker system is sufficient fixed aeration to manage high levels of oxygen consumption caused by the high total weight of fish in the pond and the corresponding high feeding rates. Without sufficient aeration, fish growth will likely decrease due to less than optimal levels of dissolved oxygen and chronic disease (ESC) may lead to substantial mortality. The fingerling to stocker phase seems most suitable for larger farms where large numbers of stockers could be effectively transported short distances within a farm without incurring mortality. Safe transport of stockers to other farms located elsewhere may prove to be cost prohibitive because multiple shipments of a reduced number of fish (lower density) would be required to stock growout ponds.

During 2005, further research devoted to the fingerling to stocker phase of the modular production system will focus on the assessment of production using slightly larger fingerlings (5 inches total length) and a less expensive (32% crude protein) feed. Both approaches are designed to increase efficiency and reduce production costs. Continued verification discussions with producers who have already incorporated this phase into their production strategy through different approaches will continue to complement our small-scale research.

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