THAD COCHRAN NATIONAL WARMWATER AQUACULTURE CENTER

NWAC NEWS

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NWAC NEWS

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Mississippi State University and U.S. Department of Agriculture Cooperating

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Optimizing Dissolved Oxygen Levels

Brian Ott[1]

Earthen catfish aquaculture ponds are complex and dynamic systems that can be challenging environments in which to raise fish. How we construct and utilize these ponds has changed over time, however, one constant remains; dissolved oxygen (DO) is the most important water quality variable on commercial catfish farms. No other water quality variable poses the level of risk both acutely (through catastrophic mortality) and chronically (through reduced production) as dissolved oxygen.

As production intensifies, either through increased stocking rates or a population of growing catfish, additional aeration capacity is needed.

Most oxygen in a catfish pond is produced during daylight hours through photosynthesis by phytoplankton and declines at night when photosynthesis ceases, and oxygen consumption is greater than production. Warmer temperatures, larger animals, more feeding, and a larger phytoplankton bloom all increase the amount of oxygen consumed at night. Fortunately, DO can be effectively managed through mechanical aeration.

Catfish species used in aquaculture are quite resilient to hypoxia (low DO) compared to other fish species and is a critical aspect of their commercial success. Historically, keeping DO above a point at which fish died was deemed a success. However, research conducted by scientists at USDA-ARS WARU discovered that if minimum DO falls below 3.0 mg/L, over the course of a production cycle, catfish will eat less feed and production is reduced. This work was completed with channel, blue, and hybrid catfish and was tested down to minimum DO of 1.5 mg/L, where there was a 50% reduction in feed consumption. Down to 1.5 mg/L, there is no effect on Feed Conversion Ratio (FCR), but extending a production cycle to get fish to size means there is more opportunity for losses to predation, disease, or a catastrophic event; all of which will deteriorate FCR. It is possible a minimum DO above 3.0 will allow for even greater production, but further increasing aeration capacity and worse oxygen transfer at higher DO means this is likely a cost-prohibitive strategy.

As production intensifies, either through increased stocking rates or a population of growing catfish, additional aeration capacity is needed. Aeration rate should be scaled to the peak part of the production cycle so that emergency aeration will be unnecessary or rarely needed. If the number of aerators for a pond cannot be changed, the expected total biomass at harvest should be carefully considered when deciding stocking rates. Utilizing split-ponds supplies oxygen directly to fish and efficiently utilizes aeration capacity. Likewise, concentrating aerators in one zone of a standard pond can reduce aeration costs and increase DO for that area.

Future work at NWAC will continue research to improve aeration strategies. Determining how and where aeration is applied will be questions of interest for advancing the precision of catfish aquaculture and may impact other processes such as nitrification of ammonia. Regardless of what future recommendations are developed, keeping your minimum DO above a 3.0 mg/L will always be the threshold to maximize feeding and production of catfish.

[1]*USDA-ARS Warmwater Aquaculture Research Unit*

Researchers Develop New Tools to Study Myxozoan Parasites

Justin Stilwell[1], Al Camus[2], Geoff Waldbieser[3], David Wise[4], Lester Khoo[1], Cynthia Ware[1], and Matt Griffin[1]

Myxozoans are a mysterious group of parasites that cause a range of diseases in wild and cultured fish. Proliferative Gill Disease (PGD) in channel and hybrid catfish, otherwise known as "hamburger gill", is widespread throughout the industry and caused by the myxozoan *Henneguya ictaluri*. The parasite follows an indirect life cycle with a waterborne actinospore stage released by the bottom dwelling worm *Dero digitata*, and a myxospore stage that develops in the fish. The myxospore matures in the gills and is released from the fish back into the environment where it is ingested by the worm, completing the life cycle. Continuous exposure to the waterborne stage results in significant gill damage leading to morbidity and mortality, with mortality approaching 100% in severe outbreaks. NWAC scientists, in collaboration with scientists from the University of Georgia, have developed new molecular tools to study these organisms in the environment and the fish.

Metagenomics is the study of the total genetic material (DNA), or a specific DNA target, within environmental or animal samples. Researchers used metagenomic DNA sequence analysis to evaluate the presence of *H. ictaluri* and other myxozoans in the pond environment and fish tissues. This tool was applied to diagnostic cases submitted to the NWAC Aquatic Research and Diagnostic Laboratory from 2017-2019. The myxozoan communities involved in PGD cases were different between channel and hybrid PGD cases, with *H. ictaluri* present in greater abundance in channel catfish than hybrid catfish in two of the three years studied (**Figure 1A**). Importantly, *H. ictaluri* was present in all channel and hybrid catfish PGD cases across all years (**Figure 1B**); however, *H. ictaluri* was not the most abundant myxozoan in almost half the cases examined, suggesting other myxozoan species may also contribute to PGD.

Metagenomic DNA sequencing was also used to investigate how channel and hybrid catfish affect myxozoan community dynamics in ponds. Experimental ponds dedicated to channel or hybrid catfish monoculture were maintained over three production cycles. Previous work revealed hybrid catfish suppress *H. ictaluri* in these systems, with *H. ictaluri* present in greater abundance in

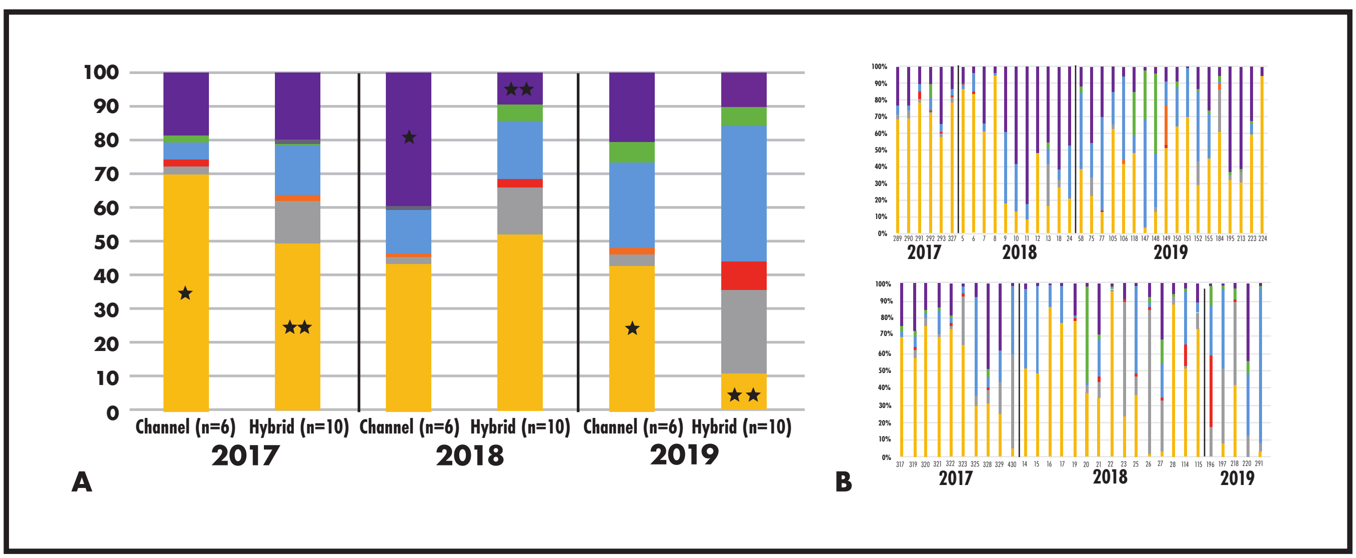


Figure 1. *Relative abundance of* Henneguya *spp. in gill tissues from clinical PGD cases submitted to the Aquatic Research and Diagnostic Laboratory at NWAC by year (A) and by individual case (B). Species are color-coded as follows: unknown, purple; Raabeia-type, green;* Henneguya mississippiensis, *blue;* Henneguya bulbosus, *orange;* Henneguya adiposa, *red;* Henneguya exilis, *gray;* Henneguya ictaluri, *yellow.*

channel catfish ponds after the first year. Hybrid catfish ponds also had less myxozoan diversity compared to channel catfish ponds, suggesting myxozoans associated with channel catfish are not well adapted to hybrid catfish.

In addition to these metagenomic studies, a technique called *in situ* hybridization (ISH) was used to track the development of the parasite in the catfish over time. *In situ* hybridization can detect specific DNA sequences within tissue sections, which is particularly valuable because there are times when it is difficult to differentiate the parasite from host cells (**Figure 2**). Channel and hybrid catfish were exposed to pond water from an active PGD outbreak and samples collected for 20 weeks. Immature stages were present in both channel and hybrid catfish 10-days post-challenge and mature *H. ictaluri* myxospores were seen in channel catfish gills beginning 14-weeks post-exposure and extending to the end of the study, which was nearly 5 months after the initial exposure. However, no *H. ictaluri* life stages were observed in any hybrid catfish from 7 weeks post-challenge to the end of the study, meaning the parasite growth was stopped or significantly delayed in hybrids. This points to the possibility that hybrid catfish do not reseed ponds with mature myxospores, thus breaking the parasite life cycle.

Collectively, these data support previous work that showed arrested development of *H. ictaluri* in hybrid catfish under laboratory conditions and lower levels of *H. ictaluri* in hybrid monoculture systems. However, PGD still occurs in hybrid catfish systems, which raises questions as to how *H. ictaluri* persists within or is introduced to these ponds. It is possible these laboratory challenges do not recreate the exposure levels that hybrids experience in ponds, so the doses are insufficient to induce formation of myxospores as seen in channel catfish exposed to the same water. Alternatively, parasite development may be delayed in hybrids past the 20-week window assessed in these studies. NWAC researchers are currently investigating *H. ictaluri* development in hybrids past this 20-week window.

While the factors driving PGD outbreaks in hybrid ponds remain elusive, this research revealed significant differences in myxozoan development in the channel x blue catfish hybrid which may be exploited to prevent parasite levels in ponds from reaching catastrophic levels.

[1]Mississippi State University – CVM
[2]University of Georgia
[3]USDA-ARS Warmwater Aquaculture Research Unit
[4]Mississippi State University – MAFES

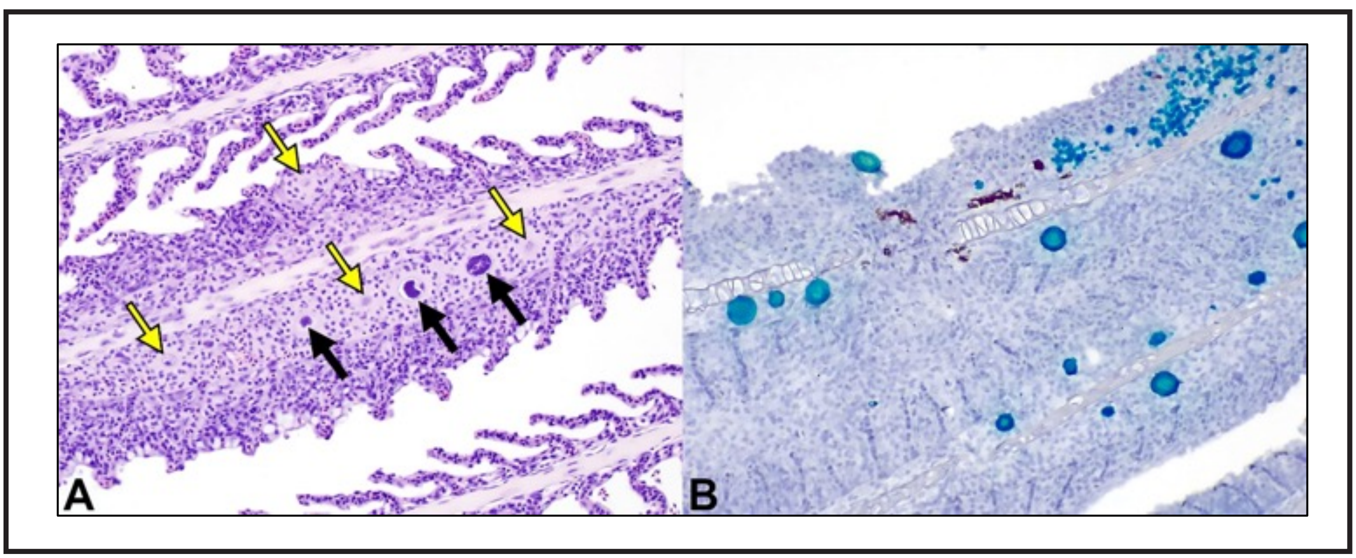
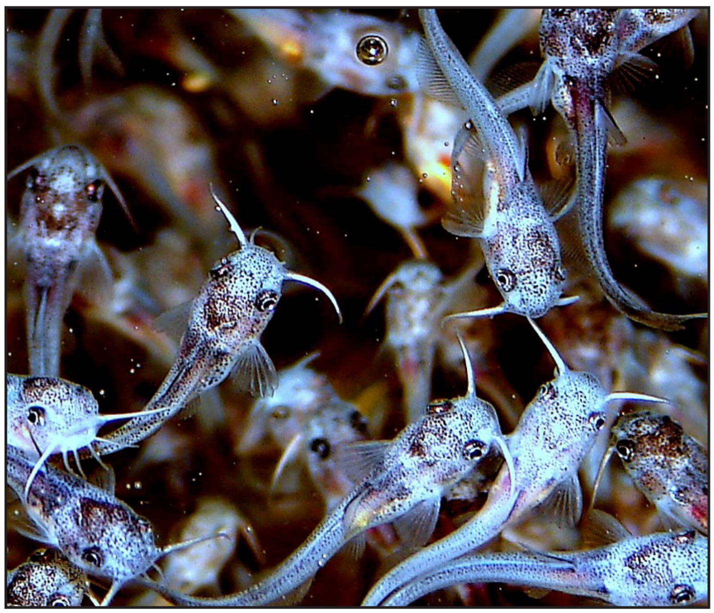


Figure 2. *Histological sections of catfish gills. (A) H&E staining demonstrating the characteristic immature stages of myxozoan parasites (black arrows) and suspect myxozoan life stages (yellow arrows) that are more difficult to differentiate from the host cells. (B) In situ hybridization labeled gills; developmental stages of* H. ictaluri *life stain bright blue and are easily discerned from catfish tissues.*

Can Rotenone be Used to Prepare Fry Ponds?

Charles C. Mischke[1], Bradley M. Richardson[2], David J. Wise[1], and Ambika Tiwari[1]

Rotenone is a natural toxicant derived from tropical plant roots. It has been used as a piscicide to manage or assess fish populations since the 1930s. Fisheries managers have used rotenone to control undesirable fish, eradicate exotic species, quantify fish populations, eradicate fish to control disease, and restore threatened or endangered species. In aquaculture, the primary use of rotenone is to eradicate unwanted fish from ponds before stocking. In fingerling culture, most unwanted fish can be removed before stocking by draining the pond if levee-type ponds are used. If pond bottoms are uneven, pools left in the basin are typically treated with rotenone. In some circumstances, such as hill ponds, draining is not always possible, and an entire pond may need to be treated before stocking.



Rotenone application has been reported to cause significant declines in zooplankton populations with cladocerans and copepods being the most susceptible and possibly taking months to recover. Because copepods and cladocerans are preferred by catfish fry, rotenone application could have significant effects on nursery pond production. Effects of rotenone on zooplankton and time required for recovery has not been studied in eutrophic aquaculture ponds typically drained and refilled yearly.

We quantified rotenone application effects to either mostly drained ponds or full ponds (0.1 ac) in northwest Mississippi on water quality, phytoplankton, zooplankton, and aquatic macroinvertebrates during May (73 °F)/June (86 °F) when most catfish fry ponds are stocked. For Study 1, nine ponds were drained to about 6” water. Six ponds were treated with 4 μL/L rotenone; three treated ponds were then treated with 4 mg/L potassium permanganate ($KMnO_4$). The three additional ponds were drained but untreated. All ponds were then filled and fertilized with urea. In Study 2, six full ponds were treated with 4 μL/L rotenone. Three of those ponds were then treated the next day with 4 mg/L $KMnO_4$. Three ponds were left as untreated controls.

Applying rotenone to these experimental ponds with 6” of water (Study 1) had no effect on water quality, phytoplankton, or zooplankton. Neutralization with $KMnO_4$ did not affect any measured variables. Desirable zooplankton numbers for catfish culture reached 100 organisms/L 11-14 days after treatment (**Table 1**). In Study 2, when a whole pond was treated with rotenone, desirable zooplankton numbers reached 100 organisms/L 7 days after treatment if neutralized with $KMnO_4$ and about 11 days after treatment without neutralization (**Table 2**). Rotenone treatment did not reduce predatory macroinvertebrate risk, and this should be addressed using additional management strategies.

Even though zooplankton may have recovered, the Prinfish™ label requires three consecutive samples to confirm rotenone concentrations are below detection levels before stocking fish and a fish bioassay should always be conducted before stocking fish in treated ponds.

[1]*Mississippi State University – MAFES*
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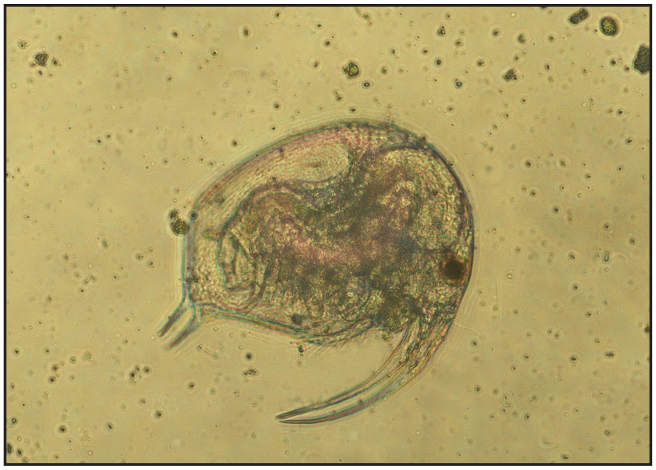

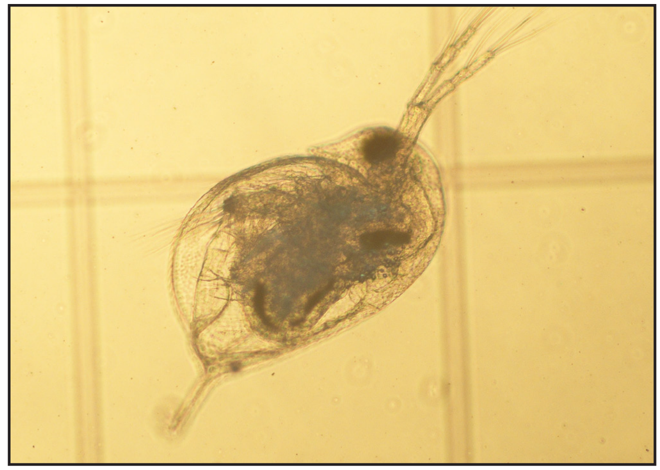

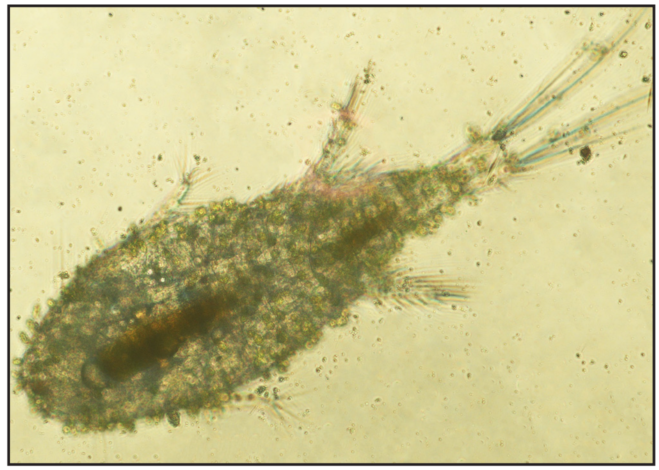

Table 1. *Days (±SEM) from ponds drained to 6”, then treated with rotenone, rotenone plus potassium permanganate ($KMnO_4$), or untreated control ponds to reach a total desired zooplankton for catfish culture (sum of copepods, cladocerans, and ostracods) of 100 organisms/L. No significant treatment differences were detected ($P>0.1$) using ordinary one-way ANOVA followed by Tukey’s multiple comparison test.*

Treatment	Mean days to 100 organisms/L (±SEM)
Control	13 (2.1)a
Rotenone	14 (0.0)a
Rotenone + $KMnO_4$	11 (1.7)a

Table 2. *Days (±SEM) from full ponds treated with either rotenone, rotenone followed by potassium permanganate ($KMnO_4$), or untreated control ponds to reach desired zooplankton for catfish culture (sum of copepods, cladocerans, and ostracods) of 100 organisms/L. Treatments not sharing the same letter were significantly different ($P<0.1$) using ordinary one-way ANOVA followed by Tukey’s multiple comparison test.*

Treatment	Mean days to 100 (±SEM)
Control	1 (0.0)a
Rotenone	11 (1.0)b
Rotenone + $KMnO_4$	7.3 (1.3)c

Relative Economic Risk of Commercial Catfish Farming Strategies

Morgan Cheatham[1], Ganesh Kumar[1], Jeff Johnson[1], Jimmy Avery[2], and Suja Aarattuthodi[1]

Commercial catfish production strategies involving channel and hybrid catfish entail various levels of economic risk. Economic risk is defined as the variations in cost of production or profit caused by fluctuations in production, marketing, or financial factors. This study utilized commercial farm data to quantify the economic risk associated with six common production strategies involving channel and hybrid catfish raised under varying levels of intensity.

Commercial catfish production data from 320 ponds across 38 catfish farms in the tristate region was employed to perform risk analysis. Farming practices were divided into six distinct production strategies based on species (channel catfish or hybrid catfish), management practices (single batch or multiple batch), or variables such as stocking rate and aeration rate in either traditional open ponds or split-ponds. The three channel catfish production strategies included low intensity single batch, medium intensity multiple batch, and high intensity single batch with intensive aeration. The hybrid catfish production practices included medium intensity single batch, high intensity single batch with intensive aeration, and high intensity split ponds. Risk variables considered included gross yield, survival, stocking density, fingerling price, feed price, FCR, electricity and fuel costs, wage rates, repair and maintenance costs, harvesting costs, and interest on investment.

Fish yield, feed price, and FCR contributed most to variations in breakeven prices above total costs (BEP/TC). Multiple batch farming of channel catfish was the least risky production strategy (**Table 1, Figure 1**), exhibiting greater probabilities of achieving lower cost of production due to relatively lower variations in yield. This makes it the most preferred choice for risk-averse farmers. Among the hybrid catfish production strategies, split ponds and intensively aerated ponds dominated the low intensity production strategy (**Table 1, Figure 2**). Low yielding strategies such as low intensity single batch production of channel catfish and medium intensity single batch production of hybrid catfish were the riskiest among the six strategies considered and exhibit low probabilities of achieving a BEP/TC less than the expected fish price (**Table 1, Figures 1 & 2**).

This study utilized commercial farm data to quantify the economic risk associated with six common production strategies involving channel and hybrid catfish raised under varying levels of intensity.

Medium intensity multiple batch and high intensity channel catfish production strategies were more susceptible to price (market) risk while hybrid catfish production strategies were more susceptible to yield (production) risks. Price risk was not a significant contributor to economic risk for any production strategy in short-run (1-year) conditions as fish prices remained relatively high and less fluid. This study also found that split-pond system is the dominant strategy (least risky) on larger farms as opposed to smaller farms, suggesting it as a means of achieving economies of scale. Producers with high volume production goals may benefit from adopting intensive systems while more risk-averse producers may choose medium intensive multiple batch production of channel catfish.

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

Table 1. Certainty levels (probability of making profits) and mean values of BEP/TC for various catfish production strategies under the long-, and short-run economic conditions.

Production strategies	Certainty level (%)	Mean BEP/TC ($/lb)
10-year price conditions[a]		
Channel-single batch-low intensity-5,000 head/acre	47%	1.19
Channel-multiple batch-medium intensity-8,000 head/acre	89%	0.99
Channel-single batch-IA-high intensity-9,000 head/acre	83%	1.01
Hybrid-single batch-medium intensity-6,500 head/acre	53%	1.10
Hybrid-single batch- IA-high intensity-10,000 head/acre	72%	1.02
Hybrid-split pond-high intensity-13,000 head/acre	78%	1.00
1-year price conditions[b]		
Channel-single batch-low intensity-5,000 head/acre	68%	1.24
Channel-multiple batch-medium intensity-8,000 head/acre	100%	1.05
Channel-single batch-IA-high intensity-9,000 head/acre	99%	1.07
Hybrid-single batch-medium intensity-6,500 head/acre	74%	1.15
Hybrid-single batch- IA-high intensity-10,000 head/acre	86%	1.08
Hybrid-split pond-high intensity-13,000 head/acre	92%	1.05

[a]feed price of $393/ton; fish price of $1.10/lb.
[b]feed price of $450/ton; fish price of $1.27/lb.
IA: intensive aeration

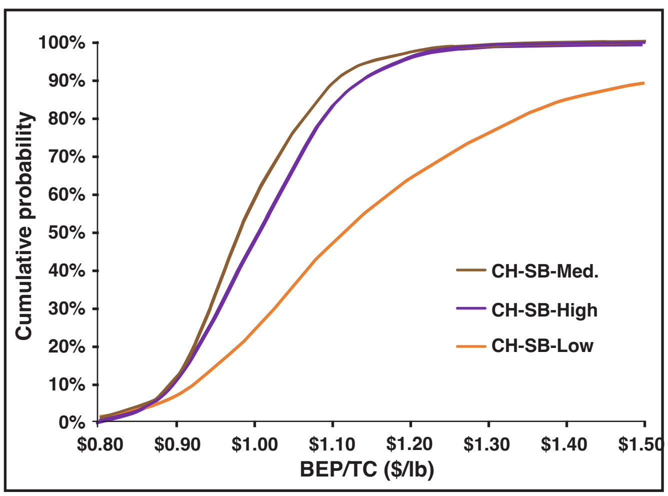

Figure 1. Cumulative probability of BEP/TC for commercial channel catfish production strategies (310-acres) under long-run fish ($1.10/lb) and feed ($393/ton) prices.

CH=channel catfish; MB= multiple batch; SB= single batch; IA= intensive aeration. High, Med., and Low denotes level of culture intensity.

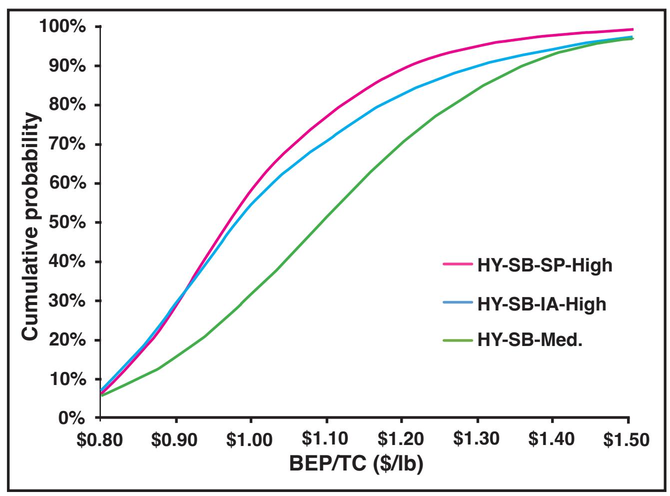

Figure 2. Cumulative probability of BEP/TC for commercial hybrid catfish production strategies (310-acres) under long-run 10-year average fish ($1.10/lb) and feed ($393/ton) prices.

HY= hybrid catfish; SB= single batch; SP= split pond; IA= intensive aeration. High, Med., and Low denotes level of culture intensity.

Economic Impact Generated by the U.S. Catfish Industry

Shraddha Hegde[1], Ganesh Kumar[2], Carole Engle[3], Jimmy Avery[4], Jonathan van Senten[5], and Suja Aarattuthodi[2]

The U.S. catfish industry plays a significant role in the rural economies of Alabama, Arkansas, and Mississippi. The U.S. catfish industry's contributions to tristate economies were estimated using the IMPLAN (Impact Analysis for Planning, MIG, Inc.) database and software. IMPLAN employs input-output modeling techniques to estimate the direct, indirect, and induced economic contributions by the industry in terms of the output, employment, labor income, and value added. An analysis-by-parts approach allowed for the segregation of specific effects of supply chain sectors such as hatcheries, feed mills, foodfish farms, and processors.

> **"The results showed that farms, which included hatcheries and food fish operations, contributed $711 million in total economic output while generating 2,973 jobs.**

The results of this study estimated a total economic output of $1.9 billion and a total employment of 9,166 jobs generated from a direct output of $1.1 billion and a direct employment of 4,298 people in the catfish industry in 2019. This suggests that every dollar spent by the catfish industry in the tristate regional economy generated an additional $0.73 (output multiplier of 1.73). Similarly, the employment multiplier was 2.13 which suggests an additional 1.13 jobs created for every person employed directly in the catfish industry (**Table 1**).

Among the three states, Mississippi had the highest contribution with $1.2 billion economic output and 6,390 jobs created in the state economy. Alabama had a total economic impact of $496 million with 2,109 jobs created. Arkansas had $47 million in total economic output with 245 jobs created in the state economy. Higher contributions in Mississippi and Alabama as compared to Arkansas are due to the larger area under catfish production in these states and the existence of feed mills as well as processing plants.

Results also highlighted the complex interconnections of the catfish industry with other industries in the region. About 97% of the other industries in the tristate regional economy interacted with the catfish industry. The catfish industry supports several secondary industries through input purchases from grain farming, banks, truck transportation, electric power generation, and farm machinery manufacturers. Further, the household spending of people employed by catfish primary and secondary industries support numerous tertiary sectors such as health care and real estate.

Major actors in the catfish industry, i.e., farms and supply chain partners (feed mills and processing plants) were analyzed separately to estimate their contribution in the tristate region. The results showed that farms, which included hatcheries and food fish operations, contributed $711 million in total economic output while generating 2,973 jobs. Supply-chain partners, on the other hand, produced an economic output of $1.2 billion and generated 6,192 jobs in 2019.

The catfish industry also generates nearly $78 million in local, state, and federal taxes in the tristate region out of which $46 million is generated in Mississippi, followed by $21 million in Alabama and $3 million in Arkansas (**Table 2**).

Editor's Note: This article is a summary of results of a recently published scientific article: Hegde et.al. (2021). Economic contribution of the U.S. catfish industry. Aquaculture Economics & Management. DOI: 10.1080/13657305.2021.2008050

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[2]*Mississippi State University - MAFES*
[3]*Engle-Stone Aquatic$ LLC*
[4]*Mississippi State University - ES*
[5]*Virginia Tech University*

Table 1. Economic impact of catfish industry in tristate region.

Type of impact	Employment	Labor Income	Value Added	Output
Alabama[a]				
Direct economic impact	794	$69,833,729	$56,082,508	$276,931,427
Indirect economic impact	711	$47,613,205	$69,915,440	$133,866,120
Induced economic impact	604	$25,311,130	$47,363,565	$85,517,250
Total economic impact	2,109	$142,758,063	$173,361,513	$496,314,797
Arkansas[b]				
Direct economic impact	115	$4,065,456	$4,851,938	$23,135,400
Indirect economic impact	87	$4,592,418	$7,528,290	$17,831,155
Induced economic impact	44	$1,793,668	$3,386,664	$6,204,925
Total economic impact	245	$10,451,542	$15,766,892	$47,171,480
Mississippi[c]				
Direct economic impact	3,390	$93,057,189	$149,010,827	$802,069,622
Indirect economic impact	2,095	$88,040,890	$144,351,967	$361,477,573
Induced economic impact	905	$33,780,933	$67,799,492	$124,514,004
Total economic impact	6,390	$214,879,011	$361,162,287	$1,288,061,199
Tristate region				
Direct economic impact	4,298	$192,678,334	$216,124,324	$1,102,136,449
Indirect economic impact	3,066	$151,354,974	$231,455,025	$552,099,888
Induced economic impact	1,802	$72,974,473	$138,884,686	$254,498,153
Total economic impact	**9,166**	**$417,007,781**	**$586,464,035**	**$1,908,734,490**

Note: Employment is measured as number of jobs. Values of individual state models will not sum to that of tristate model values due to apparent economic leakages in individual state model.
[a]Includes foodfish-producing farms, processing plants, and feed mills.
[b]Includes only foodfish-producing farms and catfish hatcheries.
[c]Includes catfish hatcheries, foodfish farms, processing plants and feed mills.

Table 2. Tax generation by the catfish industry actors in the three states and regional economy, 2019.

Tax categories	Alabama	Arkansas	Mississippi	Tristate
Federal tax	$13,105,248	$1,343,659	$24,235,993	$43,813,195
State and local tax	$7,420,781	$1,221,719	$21,750,540	$34,022,780
Total tax generated	**$20,526,029**	**$2,565,378**	**$45,986,533**	**$77,835,975**

2020 MSU CVM Aquatic Research and Diagnostic Laboratory Report

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

The Aquatic Research and Diagnostic Laboratory (ARDL) in Stoneville, MS received a total of 763 case submissions in 2020. Of these, 739 were submitted by producers and 24 were submitted by USDA and Mississippi State University researchers. There were also 429 water samples submitted for analysis.

Of the catfish cases, 338 were hybrid catfish, 408 were channel catfish, and 8 were blue catfish (**Table 1**). This reverses the trend from the previous 2 years where hybrid catfish cases exceeded channel catfish cases. Bacterial diseases continue to be the predominant diagnoses with 485 cases of columnaris disease, 281 cases of enteric septicemia of catfish (ESC) caused by *Edwardsiella ictaluri*, and 47 cases of *Edwardsiella piscicida* (formerly *E. tarda*) (**Figure 1**). There was a dramatic increase in columnaris disease cases and with ~64% of the total submissions represents a 10 year high for the disease (**Table 2**).

These data indicate *Edwardsiella ictaluri* is predominantly an issue for channel catfish with 189 cases, which accounted for ~ 67% of all *E. ictaluri* cases. Comparably, *E. piscicida* continues to be predominantly an issue in hybrid catfish, which contribute 91.5% of *E. piscicida* diagnoses. There were 11 cases of *Aeromonas hydrophila*, only 1 of which had lesions and biochemical codes (BBL Crystal enteric non-fermenter kit) consistent with the atypical *A. hydrophila* (aAh) associated with catastrophic outbreaks. Four cases had lesions suggestive of aAh but inconsistent biochemical codes. Of the remaining *A. hydrophila* cases, 3 did not have lesions or codes suggestive of aAh and 2 were from non-catfish.

Of the 277 cases of *E. ictaluri*, 97 (34.5%) had isolates deemed resistant to one or more antibiotics. While this is higher than last year, 46 cases were multiple submissions from the same pond(s) on the same farm on different days (10 ponds submitted twice, 7 ponds submitted 3 times; 1 pond submitted 5 times; 1 pond submitted 8 times). In addition, 6 of the 47 (12.8%) *Edwardsiella piscicida* (formerly *E. tarda*) isolates demonstrated resistance to 1 or 2 antibiotics. These numbers are a continual reminder of the importance of appropriate antibiotic stewardship in treating bacterial infections.

Table 1. *Major disease diagnosis as a percentage of diagnostic case submissions[1].*

Disease	Total # Disease Cases	% Total Disease Cases	Channel	Hybrid	Blue	Other
Columnaris	485	63.6%	277	206	1	1
ESC	281	36.8%	189	92		
PGD	102	13.4%	63	39		
E. piscicida[2]	47	6.2%	4	43		
Bolbophorus	57	7.5%	39	18		
Anemia	16	2.1%	9	7		
Saprolegnia	43	5.6%	18	24	1	
CCV	6	0.8%	6			
Brown Blood	6	0.8%	1	5		
Ich	6	0.8%		6		
VTC[3]	1	0.1%		1		

[1] A case may be represented by more than one disease.
[2] Biochemically *E. tarda* cases confirmed molecularly as *E. piscicida*
[3] Including suspect cases (unconfirmed by bioassay)

Proliferative gill disease (PGD) continues to be a leading parasitic disease with 102 cases in 2020 which reverses the downward trend over the past several years. Comparatively, there were 57 cases of *Bolbophorus damnificus* trematode, which represents 7.5% of total case submissions. There were also 6 cases of *Ichyophthyrius multifilis* (ich). There were 43 cases of Saprolegnia (winter fungus), 16 cases of anemia and 1 case of visceral toxicosis of catfish (VTC), which was confirmed by bioassay. There were also 6 cases of channel catfish virus disease (CCV) diagnosed in 2020 which were limited to a single farm.

We appreciate producers utilizing the diagnostic services at NWAC which affords us the opportunity to track disease trends within the industry.

[1]*Mississippi State University – CVM*

Table 2. *Ten-year trend of case submissions to the MSU CVM Aquatic Research and Diagnostic Laboratory.*

Disease	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**
Columnaris	26.8	19.6	24.0	34.7	49.9	54.3	40.7	45.5	49.1	48	63.6	45.6%
ESC	18.1	22.9	21.4	30.9	45.6	27	39.2	41.5	28.8	34.3	36.8	34.7%
E. piscicidia	1.3	2.2	1.7	1.0	1.6	2.0	6.9	8.4	7.1	11.1	6.2	5.0%
PGD	15.9	14.3	14.1	11.6	15.8	9.2	11	10.3	9.5	6.7	13.4	13.2%
Saprolegnia	4.5	4	5.4	1.2	3.4	3.7	1.9	3.5	6.4	3.6	5.6	4.3%
CCV	4.7	3.4	0.9	1	0.6	1.7	1.5	0	0.2	0.4	0.8	1.5%
Anemia	5	5.8	3.2	4.4	1.9	2.7	3.1	3	2	2.6	2.1	3.6%
Ich	0.5	0	0	0.1	0	0.3	0.3	0.5	0.3	0.4	0.8	0.3%
Bolbophorus	1.8	1.1	2.3	9.2	4.7	2.3	6.2	3.9	5	8.5	7.5	5.3%
VTC	1.9	1.5	6.1	0	0.6	0.2	0	0.2	0.5	0.3	0.1	1.1%
No Pathogens Identified	15.1	10.4	17.9	20.4	11.6	13.9	7.8	13.5	13.2	7.9	6.7	13.8%
Number of Cases	623	852	772	867	701	599	744	861	660	721	763	816.30

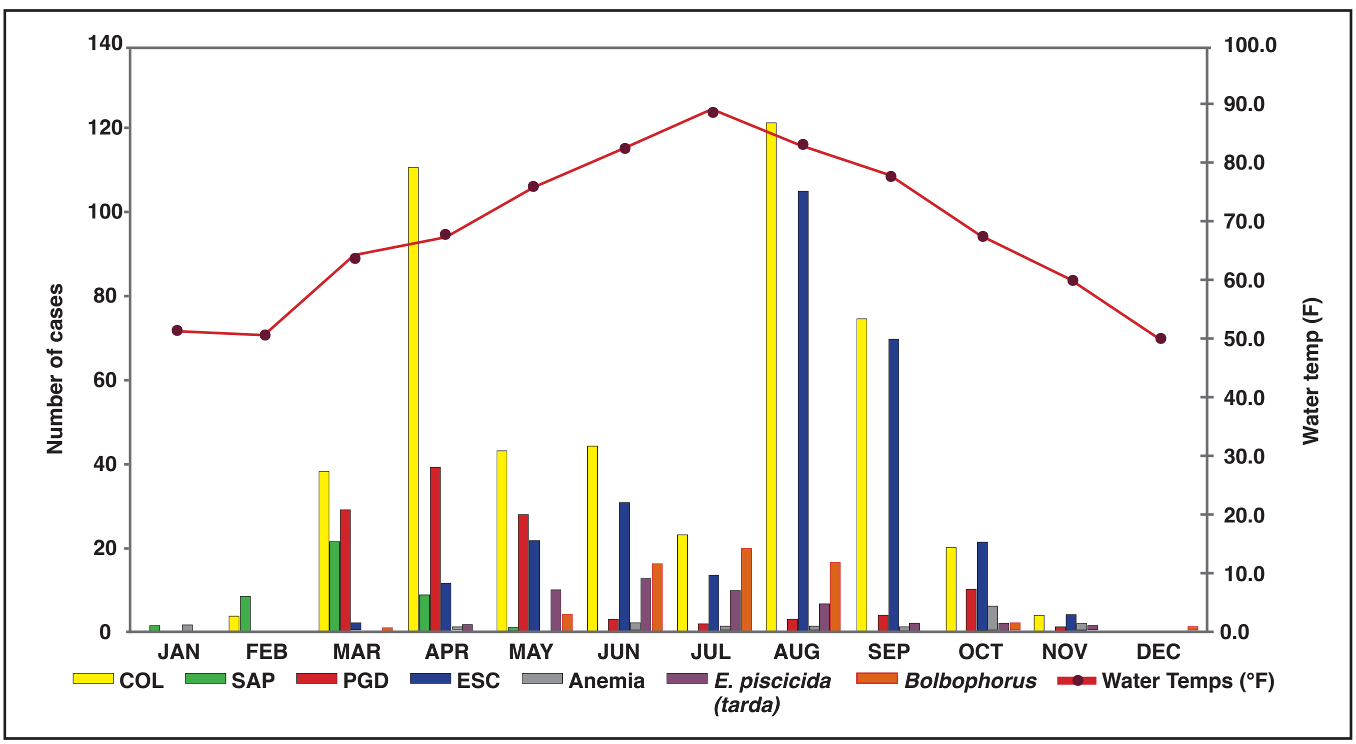

Figure 1. *2020 case submissions to the MSU CVM Aquatic Research and Diagnostic Laboratory.*

2021 MSU CVM Aquatic Research and Diagnostic Laboratory Report

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

The Aquatic Research and Diagnostic Laboratory (ARDL) in Stoneville, MS received a total of 586 case submissions in 2021. Of these, 570 were submitted by producers and 16 were submitted by USDA and Mississippi State University researchers. There were also 307 water samples submitted for analysis.

Of the catfish cases, 291 were hybrid catfish, 281 were channel catfish, and 7 were blue catfish (**Table 1**). This returns to the previous trend of 2018-2019 where there were more hybrid catfish than channel catfish submissions. Bacterial diseases continue to be the predominant diagnoses with 328 cases of Columnaris Disease, 243 cases of Enteric Septicemia of Catfish (ESC) caused by *Edwardsiella ictaluri*, and 42 cases of *Edwardsiella piscicida* (formerly *E. tarda*) (**Figure 1**). Columnaris disease remains the most prevalent disease diagnosed, accounting for 56% of cases, down from 64% of case submissions in 2020 (**Table 2**).

Edwardsiella ictaluri continues to be primarily an issue for channel catfish with 162 cases, which comprise ~67% of all *E. ictaluri* cases. Comparably, *E. piscicida* continues to predominantly affect hybrid catfish, which account for 95% of all *E. piscicida* cases. There were 5 cases of *Aeromonas hydrophila*, all of which had lesions consistent with the atypical *A. hydrophila* (aAh) associated with catastrophic outbreaks but biochemical codes (BBL Crystal Enteric Non-Fermenter Kits) were more consistent with typical *A. hydrophila*.

Antibiotic resistance continues to be a growing threat to the utility of approved medicated feeds. Sixty-four (26.3%) of the 243 cases of *E. ictaluri* had isolates deemed resistant to one or more antibiotics. This is a reduction from the previous year (34.5%), but still worrisome. Of note, the majority (65%) of these instances of resistance stemmed from repeat submissions from the same pond on different days. There were 6 cases (14.3%) of *E. piscicida* with resistance to one or two antibiotics. Importantly, antimicrobial resistance was observed in *Flavobacterium columnare* for the first time, with 6 cases (1.8%) demonstrating some degree of resistance to one or more compounds. These numbers are a continual reminder of the importance of appropriate antibiotic stewardship in treating bacterial infections.

Proliferative gill disease (PGD) continues to be a leading parasitic disease with 58 cases in 2021, of which the majority (67%) were in channel catfish. There were also 29 cases of *Bolbophorus*

Table 1. *Major disease diagnosis as a percentage of diagnostic case submissions[1].*

Disease	Total # Disease Cases	% Total Disease Cases	Channel	Hybrid	Blue
Columnaris	328	56.0%	201	127	
ESC	243	41.5%	162	81	
PGD	58	9.9%	39	19	
E. piscicida[2]	42	7.2%	2	40	
Bolbophorus	29	4.9%	5	24	
Anemia	11	1.9%	2	9	
Saprolegnia	12	2.0%	4	8	
CCV	0	0.0%			
Brown Blood	7	1.2%	1	6	
Ich	20	3.4%	1	17	2
VTC[3]	1	0.2%	1		

[1]A case may be represented by more than one disease.
[2]Biochemically *E. tarda* cases confirmed molecularly as *E. piscicida*
[3]Including suspect cases (unconfirmed by bioassay)

damnificus trematode, which interestingly was more common in hybrids, which accounted for 82.7% of trematode diagnoses. There were also 20 cases of *Ichthyophthyrius multifilis* (Ich). (It should be noted that all of the hybrid cases were from an outbreak on one farm.) There were 12 cases of Saprolegnia (winter fungus), 11 cases of anemia, and 1 case of visceral toxicosis of catfish (VTC), which was confirmed by bioassay. There were also 7 cases of brown blood. No channel catfish virus disease (CCV) was diagnosed in 2021.

We appreciate producers utilizing the diagnostic services at NWAC which affords us the opportunity to track disease trends within the industry.

[1]*Mississippi State University – CVM*

Table 2. *Ten-year trend of case submissions to the MSU CVM Aquatic Research and Diagnostic Laboratory.*

Disease	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Average
Columnaris	19.6	24.0	34.7	49.9	54.3	40.7	45.5	49.1	48	63.6	56	48.5%
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E. piscicidia	2.2	1.7	1.0	1 .6	2.0	6.9	8.4	7.1	11.1	6.2	7.2	5.5%
PGD	14.3	14.1	11.6	15.8	9.2	11	10.3	9.5	6.7	13.4	9.9	12.6%
Saprolegnia	4	5.4	1.2	3.4	3.7	1.9	3.5	6.4	3.6	5.6	2	4.1%
CCV	3.4	0.9	1	0.6	1.7	1.5	0	0.2	0.4	0.8	0	1.1%
Anemia	5.8	3.2	4.4	1.9	2.7	3.1	3	2	2.6	2.1	1.9	3.3%
Ich	0	0	0.1	0	0.3	0.3	0.5	0.3	0.4	0.8	3.4	0.6%
Bolbophorus	1.1	2.3	9.2	4.7	2.3	6.2	3.9	5	8.5	7.5	4.9	5.6%
VTC	1.5	6.1	0	0.6	0.2	0	0.2	0.5	0.3	0.1	0.2	1.0%
No Pathogens Identified	10.4	17.9	20.4	11.6	13.9	7.8	13.5	13.2	7.9	6.7	11.8	13.5%
Number of Cases	**852**	**772**	**867**	**701**	**599**	**744**	**861**	**660**	**721**	**763**	**586**	**812.60**

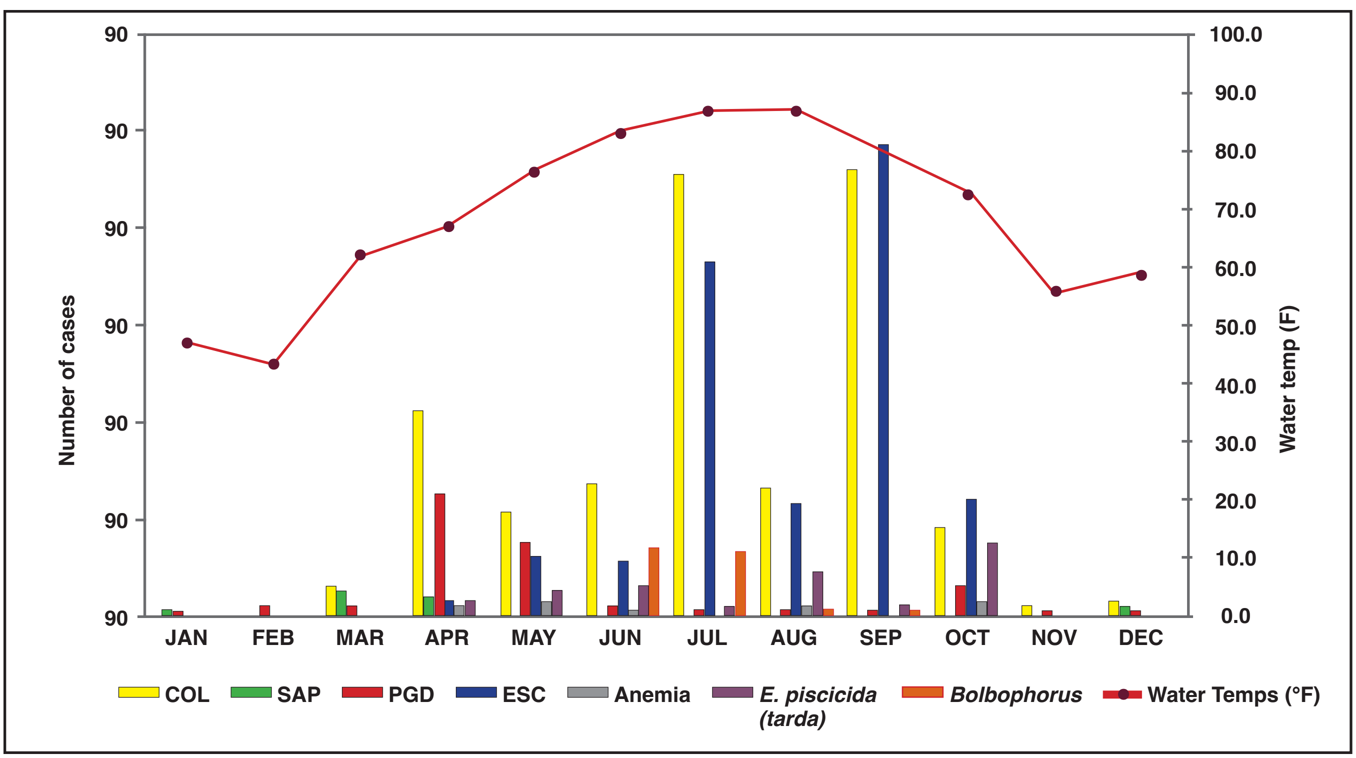
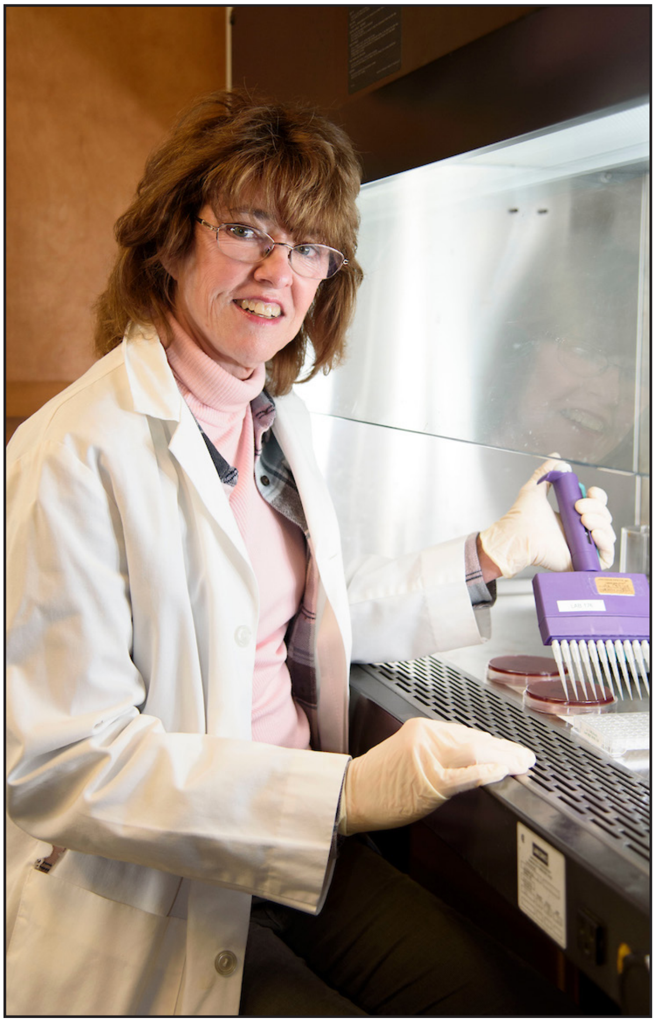


Figure 1. *2021 case submissions to the MSU CVM Aquatic Research and Diagnostic Laboratory.*

Patricia Gaunt Retires after 23 Years of Service to MSU

Lester Khoo[1]

Dr. Patricia Gaunt, Professor of Aquatic Animal Health, retired on April 25, 2022, after nearly 23 years of sterling service as a faculty member of Mississippi State University, College of Veterinary Medicine, Aquatic Research & Diagnostic Laboratory in Stoneville, MS. She earned all her academic degrees (Bachelor of Science (Zoology), Doctor of Veterinary Medicine, and Doctor of Philosophy (Veterinary Toxicology)) from Louisiana State University. Prior to becoming a faculty member at MSU, Pat was an ophthalmology instructor at LSU School of Veterinary Medicine, completed a veterinary internship at Texas A&M University, worked at a small animal private practice in Baton Rouge, and also owned her own veterinary practice. Upon completion of her PhD, she spent a year (1997-1998) in Stoneville as one of the aquatic veterinary interns and went on to work for the US Environmental Protection Agency after the internship. She returned to Stoneville in 1999 as an Assistant Professor, was promoted to Associate Professor with tenure in 2004 and made Full Professor in 2012. She was the Interim Director of the ARDL from 2006-2007.



Dr. Patricia Gaunt served as a faculty member for nearly 23 years.

There are several notable highlights and contributions that she made throughout her tenure. She is especially known for research on Aquaflor®. She spearheaded the research that allowed for the approval the antibiotic not only for use against *Edwarsidella ictaluri* in catfish, but also for the control of Columnaris disease and *Streptococcus iniae* for all freshwater-reared warmwater finfish. Prior to this, there were only 2 approved drugs for food fish which hampered our ability to control bacterial diseases that accounts for most the losses due to infectious diseases in catfish aquaculture. Her research also elucidated the etiology of visceral toxicosis of catfish as botulinum serotype E. She is also known for her work with the Clinical and Laboratory Standards Institute Working Group on Aquaculture which sets standards for antimicrobial susceptibility testing worldwide. She taught MSU veterinary students when they came out to the Delta and was director for the veterinary clinical toxicology course. She also taught clinical toxicology for LSU and Tufts University as well as food safety for Michigan State University.

Like her teaching, her service extended beyond the reaches of MSU and some of her notable appointments included Associate Editor and co-Editor for the Journal of Aquatic Animal Health, FDA CVM advisor, chair of the Certification Examination Committee for the American Board of Veterinary Toxicology, and member and chair of the AVMA Aquatic Veterinary Medicine Committee. She served as the attending veterinarian for Institutional Animal Care and Use Committee for both the USDA aquatic research units in Stoneville, MS and Stuttgart, AR and also for the USFWS center in Bozman, MT. She received numerous accolades for research and service and some of these include Food and Drug Administration Group Recognition Award: member of Resistance Monitoring Criteria for Aquatic Bacteria Group, the College of Veterinary Medicine Dean's Pegasus Award for Service, the Pfizer Award for Research Excellence - Mississippi State University College of Veterinary Medicine, and Catfish Farmers of America Researcher of the Year. She was nominated and received Emeritus Professor and continues some of her research even in retirement.

[1]*Mississippi State University – CVM*

Terry Greenway Retires

Jimmy Avery[1]

Dr. Terry Greenway, Assistant Research Professor, retired on December 31, 2021. Dr. Greenway received his BS degree (1978) in Biology from the University of Arkansas-Little Rock and his MS degree (1982) in Animal Science-Parasitology from the University of Arkansas-Fayetteville. He completed his PhD (2004) 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. Terry joined the faculty at NWAC in 2004. His research activities included assessing catfish immune responses to model antigens and bacterial pathogens, effects of adjuvants on immune responses to co-administered antigens and vaccines, characterization of humoral immunes responses in commercially raised catfish fingerlings, assessment of protective immune responses, and development of an oral ESC vaccination platform (vaccine and in-pond vaccine delivery). Dr. Greenway was also part of the team of NWAC scientists developing treatment regimens for the control of trematode infestations.

[1]*Mississippi State University - ES*

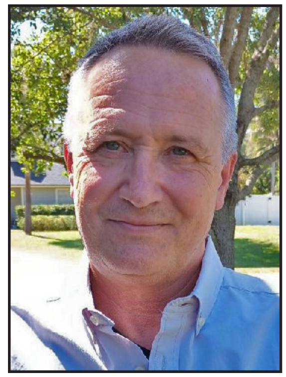
New Faces at NWAC

Jimmy Avery[1]

Dr. Bradley Richardson is a Research Fish Biologist hired by the USDA-ARS WARU in March 2021 to investigate pre-harvest factors that influence yield and quality in catfish production. Bradley is originally from Cobden, Illinois – a small orchard town on the southern tip of the state. He has a BS degree (2013) in Fisheries/Aquatic Biology, a MS degree (2015) in Biology from Murray State University, and a PhD (2020) in Forest Resources with a concentration in Wildlife, Fisheries, and Aquaculture from Mississippi State University. Dr. Richardson's dissertation focused on improving monitoring and decision-making for atypical *Aeromonas hydrophila* (aAh) outbreaks in catfish aquaculture. The research included evaluation of aAh prevalence during active outbreaks and latent periods, genomic changes in aAh over time, and modeling effects of disease characteristics on production.

In 2015, while finishing his MS degree, Bradley worked as a critical species technician with Kentucky Dept. of Fish and Wildlife Resources, monitoring commercial harvest of Asian carp, sturgeon, and paddlefish, as well as caviar production. In 2020, Bradley worked as a temporary researcher for the NWAC focusing on PGD and *Bolbophorus* management. Bradley is currently researching ways to utilize natural biological/ecological mechanisms to more efficiently manage catfish production ponds and improve commercial yield/quality. He is also trying to develop integrated methods for controlling catfish diseases within the industry.

Dr. Richardson holds memberships in the American Fisheries Society, World Aquaculture Society, American Malacological Society, and National Science Teachers Association. He can be contacted at brad.richardson@usda.gov or 662-686-3163.



Dr. Tim Pfeiffer was hired by USDA-ARS WARU in 2021 as a Research Fish Biologist focusing on improving technology and efficiency for warmwater fish production, pond and tank water quality management and conservation, and investigating novel aeration techniques for water movement and oxygenation. Dr. Pfeiffer is from Vero Beach, Florida where his family is located. He earned his BS degree (1981) in Marine Science from Oregon State University, a MS degree (1990) in Aquaculture from Auburn University, and his PhD (1997) in Aquacultural and Environmental Engineering at Louisiana State University.

Tim has served as a Fisheries Observer in the Bering Sea and a Peace Corp volunteer and Technical Trainer in Nepal and west Africa. He began his USDA aquaculture career at UAPB assisting in the development and evaluation of the in-pond grader. In 2002, Tim took a USDA position in Florida with the Sustainable Marine Aquaculture Systems project where he was responsible for designing and constructing a recirculating aquaculture system for the inland production of marine finfish. In 2011, Dr. Pfeiffer was hired by USDA's Foreign Agricultural Service as a Technical Advisor for Water Resources in southern Afghanistan. After a 13-month tour of duty he returned to the aquaculture industry as a RAS specialist and setup several school, aquarium, state, and commercial systems for research, education, display, and production.

Dr. Pfeiffer is a member of the World Aquaculture Society, Aquaculture Engineering Society, and American Society of Environmental Engineers and Scientists. He can be contacted at tim.pfeiffer@usda.gov or 662-612-3214.

Dr. Fernando Y. Yamamoto is the new catfish nutritionist hired by MSU in August 2021. Fernando is originally from Brazil, where he obtained his BS degree (2012) in Aquaculture Engineering at the Federal University of Santa Catarina and his MS degree (2015) in Animal Science and Pasture at the University of Sao Paulo. During his BS and MS degrees, Fernando investigated several nutritional aspects of freshwater characins native to the rainforest and some marine species, such as cobia and white-leg shrimp. He started his PhD at Texas A&M University in Wildlife and Fisheries Sciences in 2015 and investigated how feed additives and alternative ingredients can affect the health and gut microbiome of hybrid striped bass, channel catfish, tilapia, and red drum. In 2019 he graduated and continued to work at Texas A&M as a Research Associate until joining MSU. His goal at MSU is to develop sustainable catfish feed formulations and assist the industry in improving their production and the health of the farmed catfish.

Dr. Yamamoto is a member of the World Aquaculture Society, U.S. Aquaculture Society, and the National Aquaculture Association. He can be contacted at fyy5@msstate.edu or 662-686-3333.

Dr. Brian Ott was hired by USDA-ARS WARU as a Research Fish Biologist in September 2021. He will be investigating the impact of different pond production strategies on water quality, catfish growth, and catfish physiology. Brian is originally from Goshen, Indiana. He graduated from the College of Charleston with a BS degree (2003) in Marine Biology. He received a MS degree (2006) in Biological Sciences from the University of Alabama where he investigated the digestive physiology of pythons and boas. Brian joined the USDA-ARS WARU in 2007, providing technical and scientific support to Dr. Les Torrans and Dr. Craig Tucker while working on dissolved oxygen management of ponds and development of catfish incubator technology.

Brian later completed his PhD (2021) in Forest Resources from MSU. His dissertation focused on how different patterns of hypoxia impacted the physiological and molecular responses of channel catfish. This research included an assessment of different dissolved oxygen regimes that mirrored catfish ponds and how they impacted known regulatory mechanisms of fish appetite. Brian is planning to continue research of high intensity production ponds and how they impact fish growth and production. He seeks to develop a better understanding of how management decisions change the underlying processes impacting ammonia removal from different pond systems.

Dr. Ott is a member of the World Aquaculture Society and Catfish Farmers of America. He can be reached at brian.ott@usda.gov and 662-390-6850.

Dr. Lianqun (Lansing) Sun is a postdoctoral Research Associate who joined the MSU NWAC team in November 2021 to lead the analysis of seafood retail scanner data and home scan data for prominent US aquaculture species. Her expertise lies in determining demand and price elasticities for these species. Hailing from the eastern part of China, Dr. Sun has a diverse academic background, with a BS and MS in Economics from Utah State University and a PhD (2021) in Agricultural and Applied Economics from Texas Tech University.

Lansing's dissertation centered on analyzing the demand model and consumer's willingness to pay for eco-labeled household cleansing products using retail scanner data instead of relying on traditional surveys. Dr. Sun's passion for using applied economic theories and models in analyzing big data has led her to focus on retail scanner data and home scan data analysis in aquaculture economics and marketing. In addition to her core role, Dr. Sun actively participates in other economic projects, such as catfish production studies, cost of production analysis, and supply modeling. Her innovative data analytical skills and commitment has provided the latest marketing trends vital for US seafood producers and processors.

Dr. Sun holds memberships in the World Aquaculture Society and American Economic Association. She can be contacted at ls2222@msstate.edu or 662-686-3583.

Dr. Caitlin Older was hired by USDA-ARS WARU as a postdoctoral Research Biologist in August 2021. Caitlin was raised on a military base in Tokyo, Japan. She earned a BS degree (2016) in Biology and a PhD (2020) in Biomedical Sciences from Texas A&M University. Her dissertation research focused on characterization of the skin microbiota and cytokine profile associated allergic dermatitis in domestic cats.

After completing her PhD, she worked as a postdoctoral Research Associate at the Texas A&M Veterinary Diagnostic Laboratory, where she worked on developing a next-generation sequencing based assay to identify toxic plants in samples of rumen contents. Dr. Older is now applying her experience in molecular biology and bioinformatics to the catfish industry. She is focused on improving fish production by evaluating the effect of management practices on bacterial communities in the pond environment and better understanding bacteria relevant to fish health and production issues.

Dr. Older is a member of the American Fisheries Society and American Society for Microbiology. She can be contacted at caitlin.older@usda.gov or 662-686-3166.

Dr. Noor-ul-Huda was hired by MSU as a postdoctoral Research Associate in December 2022 to conduct research on anti-parasitic feed additives to prevent *Henneguya ictaluri* sporogenesis in channel catfish and assist in other fish health research projects. She is from Punjab, Pakistan. Noor-ul-Huda has three degrees from Pakistan - a BS degree (2009) in Science from Bahauddin Zakariya University, a MS degree (2011) in Zoology from University of Agriculture, and a MS degree (2014) in Fisheries and Aquaculture from Quaid-i-Azam University. For her PhD (2020) in Hydrobiology (2020) from the Chinese Academy of Sciences, China, she evaluated the impact of various feed supplements and alternative feed ingredients in gibel carp (*Carassius gibelio*) feed.

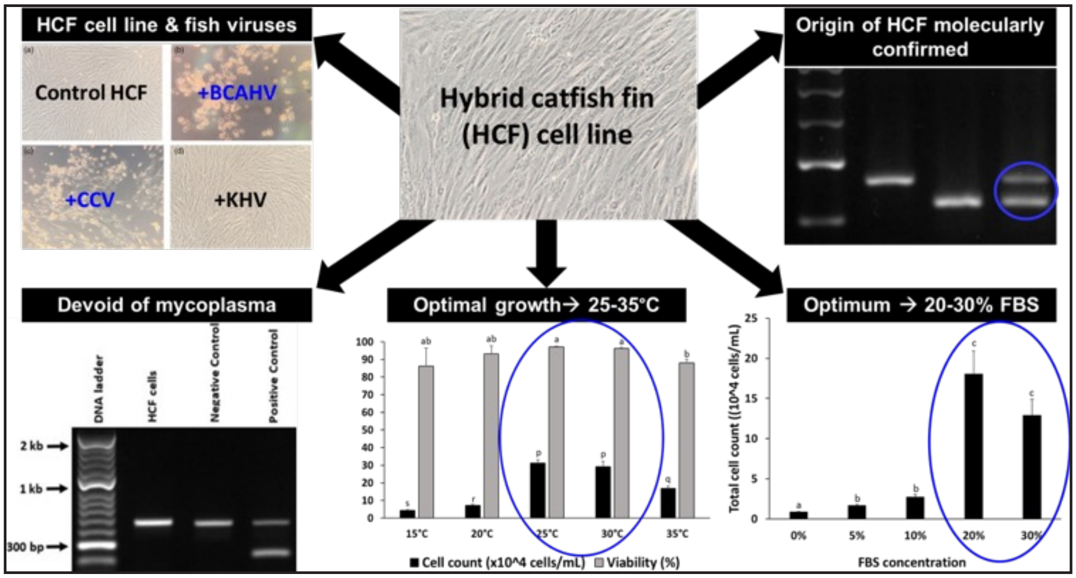
Dr. Noor-ul-Huda's skillset is predominantly in diet formulation, as well clinical and molecular approaches for immunological studies against bacterial/viral infections, gene expression assays, in-vitro (bio)assays, metabolomics, and metagenomic/gut microbiome studies. Before coming to Stoneville, she was the Assistant Director of Fisheries at the Saline Water Aquaculture Research Center of the Forest, Wildlife & Fisheries Department in Pakistan, responsible for planning and conducting research on salinity tolerant shell/finfish and live feed culture.

Dr. Noor-ul-Huda is a member of the American Society for Microbiology. She can be reached at nh868@msstate.edu or 662-636-9073.

[1]*Mississippi State University - ES*

A Catfish Cell Line to Aid Fish Virus Research

Suja Aarattuthodi[1], Lester Khoo[2], Brian Bosworth[3], and Ganesh Kumar[1]



Viruses are dynamic entities that constantly evolve and adapt according to the surrounding environment, available resources, and hosts. Being obligate intracellular parasites, their replication is entirely reliant on permissive host cells. Since procuring viruses from infected animals is not always practical, cell cultures are utilized as a reliable source of viruses for various research purposes.

Cell culture systems are applied in diverse research fields and are considered 'the gold standard' in virology. The OIE protocols recommend use of cell cultures in the diagnosis and confirmation of viruses in addition to molecular identification assays. Several fish pandemic viruses were studied in detail only after the development of appropriate fish cell lines. Cell culture-based research are preferred due to the ease of use, reproducibility, and increasing ethical demands for reduction of animal use in research. Propagation of fish viruses using cell cultures is vital in advancing virus research. For the emergent and emerging fish viruses, the pathogenicity, host range, and viral replication inhibition methods need to be studied, which are critical to establish management strategies including vaccines.

In order to facilitate research on catfish viruses such as channel catfish virus (CCV) and blue catfish alloherpesvirus (BCAHV), it is essential to have susceptible fish cell lines. However, currently, cell lines from channel and blue catfish are not available and the channel catfish ovary cell line previously available from cell repositories is contaminated by other host cells.

Limited availability of catfish cell lines necessitated initiation of cell cultures from hybrid catfish. A combination approach involving tissue explantation and enzymatic digestion methods were used to develop catfish fin cell cultures. These cultures were passaged over 150 times and transitioned into an established cell line. The hybrid catfish fin (HCF) cell line was characterized, growth conditions optimized, and host origin molecularly confirmed (**Figure 1**). The HCF cells showed optimum growth at 25-30°C, 20-30% FBS level and were free from mycoplasma contamination. The HCF cell line was susceptible to catfish viruses, while not supporting the replication of Koi herpesvirus (KHV).

The HCF cell line will be a reliable system for propagating catfish viruses and can subsequently be utilized to develop vaccines against these viruses. Cell line-based vaccine development is both efficient and cost-effective. Also, generating vaccines via cell lines will avoid reversion to pathogenic virus. The host-specificity of some viruses indicate a genuine need for new fish cell lines that will provide novel capabilities and potential to make major advances in the fish health field.

[1]*Mississippi State University – MAFES*
[2]*Mississippi State University – CVM*
[3]*USDA-ARS Warmwater Aquaculture Research Unit*

SRAC is Funding Vital Research Needs in the Region

Jimmy Avery[1,2]

The mission of the USDA-NIFA Southern Regional Aquaculture Center (SRAC) is to support aquaculture research, development, demonstration, and education to enhance viable and profitable U.S. aquaculture production to benefit consumers, producers, service industries, and the American economy. Projects that are developed and funded are based on industry needs and are designed to directly impact commercial aquaculture development in the southern region and the nation. Results of these projects will be made available to aquaculturists through refereed journal publications, articles in trade journals, conferences, and Southern Regional Aquaculture Center fact sheets. For more information on these or other SRAC projects, go to [https://www.srac.msstate.edu/projectreports.html.](https://www.srac.msstate.edu/projectreports.html)

These five projects started in 2022 or 2023:

Optimizing Production Systems for Removal of Ammonia

Researchers will investigate how nitrogen moves through two different commercial-scale aquaculture pond systems. Split-ponds and intensively aerated ponds will be used to evaluate accumulation and removal rates of ammonia, nitrite, and nitrate to determine if microbial processes differ. In situ measurements of nitrification and denitrification and a survey of the distribution of dissolved oxygen will be performed to characterize the function of these ponds. Microbial populations will be assessed using various molecular and sequencing methods.

Evaluation of Bird Depredation of Traditional and Non-Traditional Species

Fish-eating birds, such as Double-crested Cormorants, commonly feed on commercially produced catfish. Similarly, predation by Common Grackles and blackbirds at Arkansas baitfish and sportfish farms has been reported as a significant source of loss. The objectives of this project are to quantify the abundance and foraging patterns of fish-eating birds, rate of fish consumption, and ultimately economic impact of fish-eating birds frequenting catfish ponds in east Mississippi/west Alabama and baitfish production facilities in eastern Arkansas. This research will be used to inform the development of management strategies to mitigate losses.

Utilizing Feed Modifiers to Improve Larval Feeding Performance of Ornamental Fish Species

The addition of feed modifiers to larval diets has been shown to increase feeding incidence, specific growth rate, and survival. Alternative MDs, such as liquid larval diets, may also be viable live feed replacements due to their formulation mimicking the texture, palatability, and nutritional value of Artemia nauplii. The project is anticipated to provide scientific recommendations on the use of MDs enriched with feed attractants and liquid larval diets as a means of reducing the ornamental fish industry's costly and tenuous reliance on Artemia.

Development of Training Videos on Animal Care, Biosecurity, and Food Safety

This project will develop at least three videos. One video will address training requirements for businesses participating in the new USDA-AMS-PVP U.S. Farm-Raised Catfish Environmental Sustainability Certification Program. The second video will be an updated, professional training video that supports the Arkansas Baitfish Certification program for use by participating farms. The third video will be developed to meet training requirements of the most important certification programs for Southern

regional aquaculture businesses. All videos will be developed in close cooperation with industry.

Winter Fungus: Potential Management Options and Economic Impacts

Winter fungus infects many economically relevant fish species causing significant losses to aquaculture (food fish, ornamental, and sportfish) industries. Researchers will collaborate on this project for identification and differentiation of pathogenic and non-pathogenic *Saprolegnia* spp., evaluation of treatment efficacies (antifungals and nutritional supplements) for fish and eggs, and investigation of the intensity and economic impact of fungal infections on farms. Detailed study of Saprolegnia spp. is essential to develop effective pathogen-specific control strategies to limit disease incidences, minimize associated losses, and to enhance fish production efficiency.

The following projects are also ongoing:
• Publications, Videos, and Computer Software
• *Edwardsiella piscicida* -Septicemia in Hybrid Catfish and other Fish Species
• Utilization of Probiotics and Prebiotics in Finfish Hatcheries to Improve Survival
• Reduction of Artemia Use
• Understanding the Grocery Marketplace for Southern Aquaculture Products
• Emergence of Vibriosis in Catfish Hatcheries
• Rapid Detection Methods for Emerging Aquatic Animal Pathogens
• Vaccines for Columnaris in the U.S. Catfish Industry 

[1]USDA NIFA SRAC
[2]MSU – Extension Service

THAD COCHRAN NATIONAL WARMWATER AQUACULTURE CENTER

NWAC NEWS

Mississippi State University and U.S. Department of Agriculture Cooperating