EXTENSION NEWSLETTER

AFFC Increases Outreach Activities in 2022

Sunni Dahl, Julia Palmer, and James Tuttle, AFFC

Being an active community member is a top priority for personnel at the Alabama Fish Farming Center (AFFC). One of the most effective ways of accomplishing this goal is by doing more educational outreach within the community. Our main objective is to create more awareness about the commercial catfish industry, diagnostic and water quality services for commercial and recreational ponds alike, opportunities working with Extension, as well as essential research projects involving numerous topics within aquaculture and natural fisheries. By setting up demonstrations and speaking with community members of all ages at events, people are informed about the information and services the AFFC can provide. This information includes general information about the catfish farming industry, Auburn University's School of Fisheries, Aquaculture, and Aquatic Science programs, job opportunities in aquaculture and fisheries, and promoting consumption of local, farm-raised catfish.

Figure 2. AFFC booth at the King Catfish Festival.

Figure 1. AFFC personnel Julia Palmer holding a catfish for students to touch (left) and holding a Kindergartner up so she can see the fish. (right)

Last year, the AFFC acquired a 270-gallon tank system with a viewing window. This tank is excellent for events because it allows us to show off farm-raised catfish anywhere. Seeing live catfish then sparks beneficial conversations and inquiries about the industry. For example, this display system has been set up at the King Catfish Festival at The Depot in Greensboro, Alabama, for the past two years. Employees and students from the AFFC spent the day engaging with people of all ages and handing out recipe pamphlets donated by The Catfish Institute, encouraging people to eat more catfish.

This October, our 270-gallon system was at Keenland's Pumpkin Patch in Gallion, Alabama. With each school field trip that attended the pumpkin patch, employees from the AFFC were there to speak to the students, teachers, and their families about farm-raised catfish and answer any questions they may have. The viewing tank remained set up on the farm for everyone attending the pumpkin patch to see the catfish. The Keen family also provided a wagon ride around the ponds so visitors could see part of the catfish production process from a farmer's point of view.

Figure 4. AFFC personnel Julia Palmer, Sunni Dahl and James Tuttle at WOW.

Recently, the AFFC attended the World of Work event (WOW) at Shelton State Community College in Tuscaloosa, Alabama. On October 13th and 14th, over 4000 high school students attended WOW to see and interact with potential workforce opportunities. The AFFC took the new electrofishing boat to show students and tell them about all the different and unique projects and daily responsibilities the AFFC staff are currently working on and to promote the U.S. catfish industry. Students were especially interested in hearing about our massive catfish aging project, how our boat works, as well as future potential projects with the electrofishing boat.

Figure 3. AFFC personnel James Tuttle, Sunni Dahl and Julia Palmer showing the electrofishing boat at WOW.

Anyone interested in having the AFFC attend an event should contact Sunni Dahl at (334)-624-4016. We will be glad to come out and advocate for Alabama's catfish industry, Alabama Extension, and Auburn University's School of Fisheries, Aquaculture, and Aquatic Sciences.

Alabama Catfish Conference '23

January 10, 2023

Hale County College & Career Center

Greensboro

Dr. Terry Hanson Retires from the School of Fisheries, Aquaculture, and Aquatic Sciences

Luke Roy, AFFC

Dr. Terry Hanson obtained a B.S. degree in Biology and Studio Arts from Allegheny College in Pennsylvania in 1977. Shortly after, he joined the U.S. Peace Corps as a *Fisheries Specialist Volunteer* in the Republic of Niger in West Africa (1978-1980). Following his return from Africa, he completed graduate work at Auburn University with two master's degrees (Fisheries and Allied Aquaculture in 1984, Agricultural Economics in 1985). He then returned to the Republic of Niger (1985-1986), serving as a *Logistics Coordinator* for the International Red Cross and Red Crescent Societies' drought program and later as an *Associate Peace Corps Director for Agriculture Programs* for the U.S. Peace Corps in Tunisia, North Africa (1986-1989). Following his work in Africa, he returned to Auburn as a *Senior Research Associate* in the Department of Agriculture Economics and Rural Sociology and completed a Ph.D. in Agriculture Economics (1998). Dr. Hanson served as a faculty member in the Department of Agriculture Economics at Mississippi State University (1998-2008) and then returned to Auburn in 2008, where he served as an *Associate Professor* and later *Professor* until his recent retirement when he became an *Emeritus Professor*. Throughout his career, Dr. Hanson published extensively in his field, contributing an impressive number of journal articles, book chapters, Extension articles and other publications. He served as a major professor to 30 graduate students and as a committee member on 47 graduate committees. In 2022, he was granted the *Lifetime Achievement Award* by the U.S. Aquaculture Society and secured numerous other awards throughout his career.

Figure 1. Dr. Terry Hanson (1982).

In the first semester following Dr. Hanson's arrival from Mississippi State in 2008, Terry began appearing at the Fish Center every Friday. His family was still living in Starkville so his kids could finish the school year. He would come to the Fish Center on Fridays to work before returning to Starkville to be with his family on the weekends. Fish Center staff quickly noted his willingness to dive right into meeting with members of the Alabama catfish industry to determine how he might be able to get involved to help solve important industry issues. At the time, I had been working at the Fish Center for a couple of years, but the grant funding that paid my salary was quickly running dry, so I was looking for other job opportunities. Shortly after his arrival, Terry secured funding to carry out several projects in west Alabama with the catfish industry, including a catfish research verification project. He approached me to see if I would be interested in staying at the

Figure 2. Dr. Terry Hanson retired from Auburn University in September 2022.

Fish Center as he could pay my salary to help carry out these new projects. As a result, I stayed three additional years before moving to the University of Arkansas at Pine Bluff to work with Dr. Carole Engle's Extension team. While in Arkansas, I continued to work with Terry on projects and our collaboration continued when I returned to the Fish Center for my current position. Having worked with Terry for 14 years, I observed first-hand a sincere commitment to helping Alabama and U.S. catfish producers, most notably with timely and relevant research and Extension programs. Terry was not afraid to take on the more difficult problems faced by the industry, even if those problems were outside his primary area of expertise. He was instrumental in leading several research teams examining pivotal issues of importance to the U.S. aquaculture industry during his time at Mississippi State and Auburn. I have always admired his willingness to serve as a liaison between faculty on campus and producers in west Alabama when tackling the most complex industry issues, as well as his steadfast commitment to U.S. aquaculture producers and the domestic aquaculture industry. I was also impressed with his work ethic and willingness to work on and off the clock to help commercial producers. While Terry is perhaps best known nationally for being an accomplished and award-winning researcher in aquaculture economics, I also witnessed first-hand his heart for Extension and a genuine desire to help others.

Terry has been a loyal friend and supporter of the Fish Center. On multiple occasions, he helped pay the salary of Fish Center staff and graduate students through grant dollars secured through his research grants to carry out applied work in west Alabama. In addition, Terry frequently helped the Fish Center secure critical funding, equipment, and supplies necessary to help support the west Alabama aquaculture industry. Not surprisingly, shortly before he retired, he donated a portion of his final remaining funds to help the Fish Center purchase a backup generator. It's hard for us to imagine the aquaculture team at Auburn without Terry Hanson. The Fish Center is very much indebted to his generosity and willingness to help support our mission to serve the west Alabama catfish industry. We want to thank him for his service to the Fish Center and the west Alabama aquaculture industry. We also wish him the very best in retirement!

Ammonia in Catfish Ponds

Anita Kelly and Luke Roy, AFFC

Over the past several years, producers in Alabama have had problems with high ammonia in catfish ponds during the summer. Ammonia comes from the fish when they digest feed and excrete ammonia in feces and from their gills. The amount of ammonia increases as feed rate increases. Ammonia is also formed when bacteria in the pond decompose organic matter, such as uneaten feed or dead algae and plants. When ammonia concentrations get high enough, fish cannot extract energy from the feed efficiently (causing reduced growth), become lethargic, are more susceptible to disease and can die.

Ammonia is the most important water quality parameter after oxygen for fish production. When water quality is measured, most kits provide a test for total ammonia nitrogen (TAN). TAN is a combination of un-ionized ammonia (NH_3), which is toxic to fish, and ionized ammonia (NH_4), which is considered much less toxic to fish. When water pH is less than 8, NH_4 is the predominant form of ammonia. Above pH of 8, NH_3 is the dominant form and increases substantially as pH increases (Fig. 1). The proportion of ionized to un-ionized is also affected by water temperature. Regardless of pH, more toxic ammonia is present in warmer water than cooler water.

Ammonia is broken down in ponds through the process of nitrification. Bacteria break ammonia down to nitrite and then nitrate. Nitrification rates in ponds are highest during spring and fall because ammonia concentrations and temperatures are optimal for conversion. Alabama farmers are reporting high ammonia concentrations in summer. Possible reasons for these high ammonia concentrations are algal die-offs, feeding fish above recommended rates, or high organic loads in the pond bottom. Algae are essential for removing ammonia and do so during photosynthesis. When the algal bloom in the pond crashes (all die), the primary mechanism of ammonia removal is no longer present.

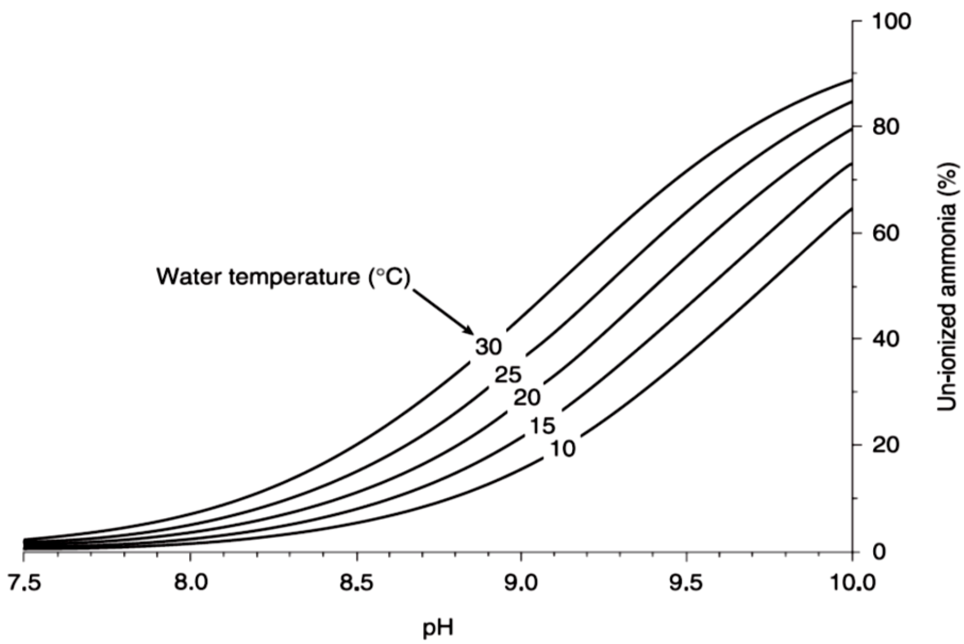

Figure 1. The proportion of toxic, un-ionized ammonia increases as a function of pH and temperature. To determine the proportion of un-ionized ammonia in a water sample, draw a line from the pH of the water straight up to the line closest to the water temperature. From that point, draw a line to the right until it intersects the graph's vertical axis. That point estimates the percentage of un-ionized ammonia in the water sample. To estimate the un-ionized ammonia concentration, multiply that number (divided by 100) by the total ammonia concentration.

Ammonia Management

What can be done when ammonia concentrations are high in a pond? Unfortunately, there is little that can be done. Since most ammonia in fish ponds is from the feed, stopping or reducing the feeding rate and reducing the protein concentration in the feed will help, but it can take a long time for ammonia reductions to occur. To avoid ammonia issues in the summer maximum daily feeding rate should not exceed 150 pounds per acre. The potential for high ammonia in ponds and the risk associated with the sub-lethal effects (disease, slow growth, higher feed conversion) can be minimized by not exceeding the maximum daily rate. We realize that farmers growing hybrids, particularly with intensive aeration and higher stocking rates, often feed in excess of 150 lbs per acre. Hybrids will easily consume more than this amount, however, if farmers choose this feeding strategy the chance of encountering both acute and chronic ammonia issues rises substantially. Multiple batch production strategies also require more aggressive feeding strategies than single batch approaches. Farmers must make decisions based on their previous experience and past performance of ponds. Pond ammonia levels should be closely monitored if higher feeding rates are chosen as a production strategy.

While little can be done to correct high ammonia concentrations, culture practices that minimize these problems are essential. This means stocking fish at reasonable rates, harvesting fish frequently to prevent the standing crop from getting too high, and using good feeding practices that maximize the proportion of feed consumed by fish.

Elevated Water Temperatures Observed in Commercial Catfish Ponds in 2022 Compared to 2021

Luke Roy [1,2], Anita Kelly[1,2], Sunni Dahl[1,2], Jesse James[1,2], Terry Hanson[2]
AFFC[1] and SFAAS[2]

Figure 1. HOBO temperature loggers were deployed in several catfish ponds in west Alabama by the Alabama Fish Farming Center.

The Fish Center deploys temperature loggers each year to track pond water temperatures in commercial aquaculture ponds. The loggers are made by Onset (Cape Cod, Massachusetts) and we typically use Tidbit temperature data loggers, which are deployed in 3-4 ponds at different farms in west Alabama (Fig. 1). These data are collected as a precautionary measure, for the purpose of documenting higher than normal pond water temperatures. In 2022, pond water temperatures were much warmer than in 2021 (Fig. 2 and Fig. 3). The overall implications for prolonged elevated pond water temperatures have not been widely studied in the catfish literature, however, optimal water temperature for catfish fingerling growth were documented to be between 80 – 86 °F (Hargreaves

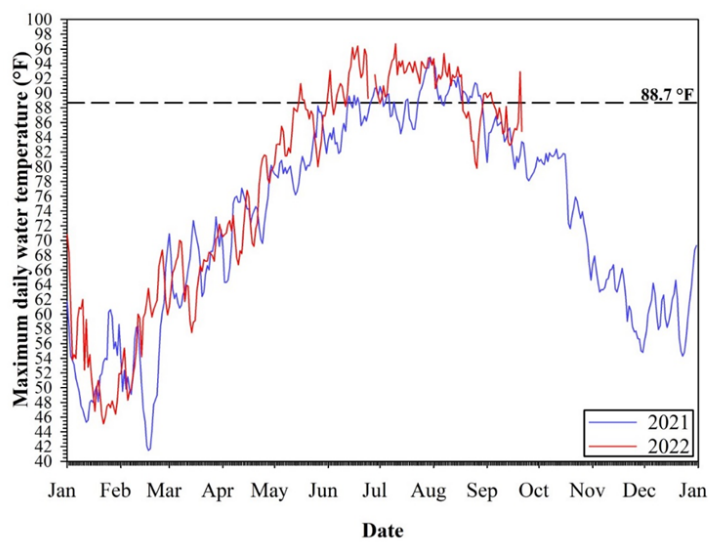

Figure 2. Maximum daily water temperatures from commercial catfish ponds in west Alabama in 2021 and 2022.

and Tomasso 2004). Armour (1991) proposed that maximum weekly average temperature for fingerling catfish should not exceed 88.7 °F, hence, this temperature is placed on Figure 2 and 3 as a basic reference.

Further Reading

Armour, C.L. 1991. Guidance for evaluating and recommending temperature regimes to protect fish. U.S. Fish and Wildlife Service Biological Report 90(22), 13pp.

Hargreaves, J.A. and J.R. Tomasso. 2004. Environmental biology. Pages 36- 68 in Biology and Culture of Channel Catfish, edited by C.S. Tucker and J.A. Hargreaves. Amsterdam: Elsevier.

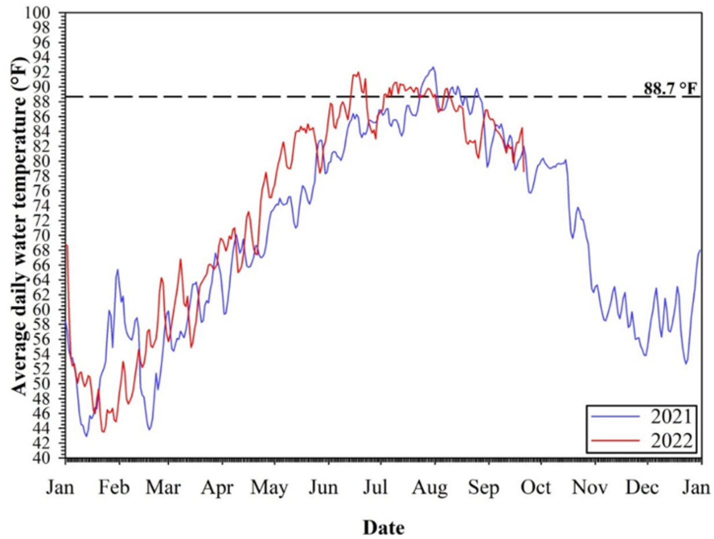

Figure 3. Average daily water temperatures from commercial catfish ponds in west Alabama in 2021 and 2022.

How Accurate is Your Fingerling Inventory?

Anita Kelly, AFFC

Recently, AFFC personnel have had many producers raising concerns about the number of fingerlings they are receiving and stocking into their ponds. Not having a good count of fingerlings can result in inventories being over or under expectations at the end of the growing season. To answer the question, "*How accurate is the number of fingerlings I receive from my supplier?",* AFFC has purchased a fish counter. We want your help. Let us know when you are getting fingerlings in, and we will come and count the fish. Initially, it will be from one compartment until we can get a process for counting from more than one. The process will start with us emptying one hauling tank compartment into a holding net. We will count fish manually and with the counter to determine the accuracy of the counter. Our goal is to be able to release fish from the hauling tanks through the counter and get counts that go with the weights you have received. We plan to start the study after January 1, 2023. Please call the AFFC (334-624-4016) to schedule if you want to participate.

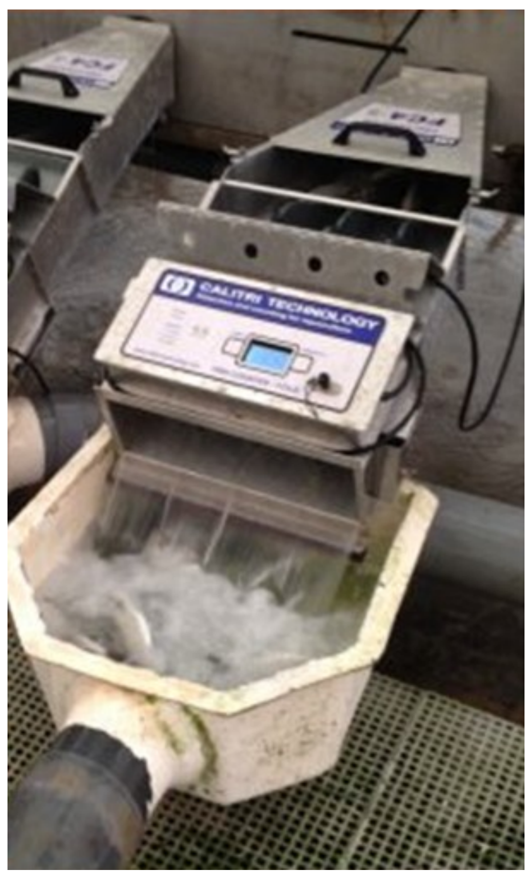

Figure 1. Fish counter.

RESEARCH ROUNDUP

Physiological Effects of Commercial Harvest and Transport of Hybrid Catfish During Warmer and Colder Months

Anita Kelly[1,2], Luke Roy[1,2], Jesse James[1,2], Hisham Abdelrahman[1,2], Shelby Marsh[1,2], and Joe Tomasso[2]

[1]AFFC and [2]SFAAS

The hybrid catfish (female channel catfish *Ictalurus punctatus* X male blue catfish *Ictalurus furcatus*) is rapidly expanding in the catfish industry of the southern United States. Currently, over 50% of catfish grown in the U.S. are hybrid catfish. However, in Alabama, producers are still raising a much larger percentage of channel catfish (< 20% of production in Alabama was hybrid catfish in 2021). Hybrid catfish appear to tolerate handling and transport well, but no studies have specifically addressed these stressors.

The objective of this study was to characterize physiological stress in hybrid catfish during capture from ponds, transport, unloading, and after electrical stunning at a processing plant. We monitored survival, and much like your doctor diagnosing a complaint, we monitored four blood chemistries that are indicative of handling problems in fishes. Plasma cortisol is a hormone that increases in concentration when the fish is frightened or disturbed, as during seining and transporting. Plasma glucose increases during transport, just more slowly than cortisol. Plasma lactate increases in concentration when fish are not getting enough oxygen or are extremely active. Plasma osmolality is an indication of water and ion balance and falls in freshwater fishes that are having difficulty maintaining proper water and ion balance.

Figure 1. Catfish were typically held overnight to allow sub-market size hybrid catfish to grade out of the sock.

Fish from ten ponds (five harvested in the summer and five harvested in the winter) were sampled before and after they were seined, held in a holding net (sock) in the pond, loaded into truck-mounted transport tanks, and unloaded into holding tanks at the processor (Fig. 1). Fish were also sampled after being electrically stunned before

Figure 2. Project personnel took blood samples, before seining, after seining, after holding in a sock, after loading onto the truck, before unloading at the plant and after stunning.

processing. To assess the role of temperature on handling and transport responses, the fish in ponds with the five higher temperatures (77–90°F; fish harvested in warmer water) were grouped and the fish in ponds with the five lower temperatures (48–61°F; fish harvested in colder water) were grouped.

The initial sampling in each pond was accomplished by angling. In general, it took less than 5 minutes to hook, land, and take a blood sample from the fish (Fig. 2). Seining took 1–3 h and blood samples were taken within 20 minutes of the completion of seining. Fish were held in socks before transport for 2–24 h and sampled just before loading onto transport trucks. At the time of loading, water temperature in the transport tanks was 50°F. Therefore, no salts were added to the transport tanks. Transport times from the farm to the processing plant were 15–45 minutes. Project personnel followed the transport truck to the processing plant following harvest.

All fish survived seining, holding, transporting, and unloading. The electrical shock caused considerable mortality, but we did not quantify the percentage of dead versus stunned fish.

Concentrations of all of the blood chemistries increased in response to handling and transport. The increases were greater in the fish harvested in warmer water. All responses were as expected in fish captured from a pond, held in a sock, and transported. However, none of the responses were indicative of severe physiological dysfunction. Based on our findings, it appears that hybrid catfish tolerate harvest and transport well. The fish survived, demonstrated an expected stress response, appeared to remain largely aerobic (receiving adequate oxygen) during the events, and maintained water balance.

This project was supported by a grant from the Alabama Agricultural Experiment Station and is a component of USDA Hatch projects ALA016-1-19053, ALA016-1-19075, and ALA016-1-18032. Support of the cooperating farmers, processing plant, and Alabama Fish Farming Center staff is gratefully acknowledged.

Evaluating New Dietary Additives for Promoting Healthy Channel Catfish Production

Abdulmalik Oladipupo[1], Anita Kelly[1,2], Allen Davis[1], Leticia Fantini Hoag[1], and Timothy Bruce[1]
SFAAS[1] and AFFC[2]

Many bacterial pathogens impact the U.S. catfish industry, and disease control can be challenging for producers. Columnaris disease in channel catfish is primarily caused by *Flavobacterium covae* (formerly known as *F. columnare*). Using antibiotic treatments comes with the risk of developing resistant pathogens, accumulating antibiotic residues, and potential environmental impacts. Producers have limited options with antibiotic treatments, and the choice of antibiotic may not always be effective for the pathogen in question. Given the issues with bacterial pathogens on AL catfish farms, finding new potential vaccines and therapeutants are critical, especially if incorporated with dietary ingredients to enhance catfish health.

Figure 1. Tank feeding trial for AG175 and MFG50.

There has been a lot of interest in using substances that stimulate the fish's immune system (immunostimulants) for disease prevention. These immunostimulatory ingredients serve as potential replacements for antibiotic treatments in catfish ponds. Dietary protein sources or inclusion levels are essential to fish health and nutrition. Therefore, evaluating protein source inclusions, both animal and plant-based, may enhance overall fish performance in pond culture. The current project evaluated two immunostimulants: a protease complex (AG175; Jefo Nutrition) and an organic acid substance derived from reed-sedge peat (MFG 50; Kent Nutrition Group). An Auburn University AAES AgrSEED award is supporting this project work.

A 60-day trial was conducted to examine the effects of supplementary protein level, dietary formulation, and immunostimulant addition on the growth performance, immune response, and resistance to experimental *Flavobacterium covae* infection in channel catfish. Five diets were tested: 1) a high-quality fishmeal diet (32%; HQFM); 2) a high-protein soy-based diet (32%; CHP); 3) a low-protein soy-based diet (28%; CLP; predominately used in industry); 4) a low-protein soy diet supplemented with AG175 at 1.75 g/ton; 5) MFG 50 in a low-protein diet at 5 lb/ton (Fig.1). Following feeding for 60 days, we sampled juvenile channel catfish for growth perfor-

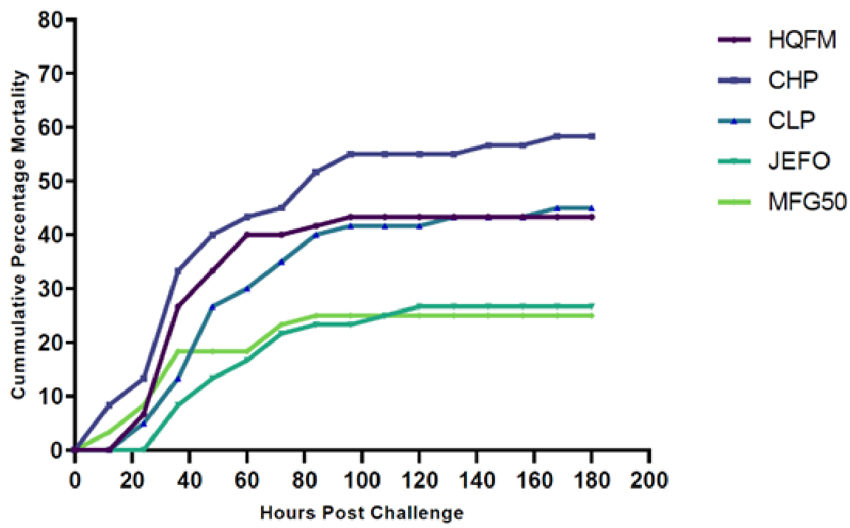

Figure 2. Mortality trends from the challenge trial with F. covae.

Figure 3. Pond study feeding AG175 and MFG50 to channel catfish.

mance and baseline health indicators. A subset of fish from the five diets was then subjected to an immersion-based *in vivo* challenge trial with *F. covae* (Fig. 2). At 60d post-initiation, there were no dietary differences in percent weight gain or specific growth rate, but the 32% protein diets generally appeared to perform the best. The cumulative percent mortality (CPM) from the challenge with *F. covae* was different across dietary treatments. Mortality in the supplemented diets (AG175 and MFG50) was lower than in non-supplemented diets and significantly lower than in the high-protein soybean diet (CHP). These challenge data (Fig. 2) suggest that the immunostimulant additions may be beneficial in protecting the fish from *F. covae* compared to low-protein channel catfish diets.

In addition to the laboratory trials, a long-term feeding trial is underway to evaluate the effects of AG175 and MFG50 on growth and survival of channel catfish in an on-farm production system at the E.W Shell Fisheries Center at AU (Fig.3). Sub-adult channel catfish stocked in in-pond raceways were divided into three diet treatments (28%; CLP, JEFO & MFG50). After 60 days, diets provided with the JEFO demonstrated increased growth compared to the basal diet. Fish are sampled monthly for growth parameters, and the trial will last for 9-months, including an overwintering period. The combination of production and laboratory trials will shed light on the ability of these probiotics to influence fish growth performance and health.

Does Virulent *Aeromonas hydrophilia* Remain in Soils?

James Tuttle[1,2], Timothy Bruce[2], Ian Butts[2], Luke Roy[1,2], Benjamin Beck[3], Anita Kelly[1,2]
[1]AFFC , [2]SFAAS, [3]USDA/ARS Aquatic Animal Research Unit

While the commercial catfish industry in west Alabama has faced and overcome many obstacles, one constant obstacle is disease outbreaks caused by parasites and bacteria. One of the most harmful pathogenic bacteria is virulent *Aeromonas hydrophila,* or vAh. This bacterium is responsible for causing mass mortality events. Infected fish can display numerous clinical signs, including sores or lesions on the skin, loss of appetite, erosion at the base of fins, pop-eyes that have red infected areas around them, ulcers, bright red muscles and internal organs due to hemorrhaging (Fig. 1). Since the first major vAh outbreak in 2009, researchers have left no stone unturned concerning the bacteria as well as developing treatment strategies for this disease. However, this current thesis project investigating the presence and persistence of pathogenic bacteria in pond bottoms has never been done before and might reveal some interesting findings.

In well-established ponds, pathogenic bacteria, including vAh, can form biofilms to protect themselves from environmental stressors. But is it possible that specific mechanisms allow vAh bacterial populations to persist in the bottom soils of commercial catfish ponds? The bottoms of catfish ponds can consist of a wide variety of biological matter, including fish waste, uneaten food, dead algae or plant materials, and an incredible number of bacteria responsible for breaking down and recycling this organic matter. There have also been instances in which farmers experience chronic vAh infections within the same ponds, almost at the same times each year. Considering all the available nutrients in pond bottoms and known mechanisms of the vAh bacteria, it is imperative to evaluate how sediments in catfish production ponds can influence long-term survival and persistence of vAh.

Figure 1. Photograph of typical clinical signs of vAh seen in infected catfish in west Alabama. Internal hemorrhaging, bright red muscles, empty stomach and GI tract, and organ failure.

Briefly, sediments from four currently operating ponds were collected and sterilized to conduct this persistence trial. A stock solution of vAh was mixed with the sterilized soil and dechlorinated city water (Fig. 2). No fish or feed were placed in the chambers. This experimental design allowed the vAh to establish itself initially and control other variables. The only source of initial nutrients present for the vAh would be already existing organic matter and chemical components of the sediments. Therefore, this experimental design would be most effective at focusing only on how the vAh populations behave in the sediment.

Bacteria were counted by extracting one gram of sediment at 24 hrs, 48 hrs, 3 days, 5 days, 7 days, and eventually weekly. The sediment samples were plated onto agar

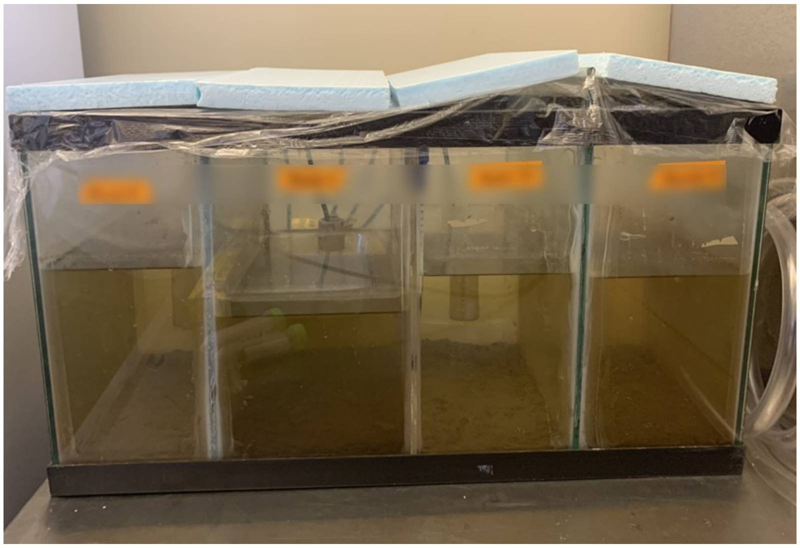

Figure 2. Persistence trial single tank set up containing four chambers with four different soil types, separated by glass panes and silicone. An air stone was housed within the PVC pipe on the back wall of the aquarium.

plates and incubated at 82 °F for 24 h to allow the bacteria to grow. Live colonies of vAh on the agar were then counted.

A pilot trial was conducted first with water temperatures maintained at ~70 °F in one tank with four chambers of one soil type each. There was first an initial population increase in colonies of vAh per gram of soil. Eventually, a background species of *Pseudomonas* began appearing by day 28 on the selective media, and the population of vAh decreased by 95% from the initial population by day 59. Despite competition from other bacteria and relatively low water temperatures, viable colonies of vAh were still present in the sediment even after 113 days (Fig. 3).

After a successful pilot trial, a full persistence trial was done using three tanks with four sediment types each and maintaining the water temperature at 82 °F. Due to the higher water temperature, the rise and fall of the vAh population occurred over a much shorter period. The 95% decrease from the initial population was reached on day 21, and by day 28, the population of vAh had plateaued. *Pseudomonas* also appeared in these soil samples; however, it only took 48 hrs post-inoculation for this background bacteria to establish in all 12 chambers. Across all four different soil types in triplicate, the population trends of growth and decline in the full persistence trial were very similar to those vAh population trends that occurred in the pilot trial but at a more rapid rate.

This data indicated that vAh could survive over extended periods in the absence of a fish host and external nutrient sources and that temperature significantly impacts the rate of bacteria growth and decline. This project also opens the door to further research questions that can be answered. Such as: can vAh colonies that are persisting in the soil come out and infect fish? What mechanisms and genes does vAh use to survive in the soil? Do those mechanisms change over time or at different temperatures? What is the best way to manage that risk or deal with soil-dwelling pathogenic bacteria? This project has undeniably added another level of understanding as to how the bacterial pathogen vAh behaves in pond sediments. It also may be a potential explanation for why chronic outbreaks regularly occur in the same ponds yearly. Hopefully, the complete answer to that issue will come sooner rather than later.

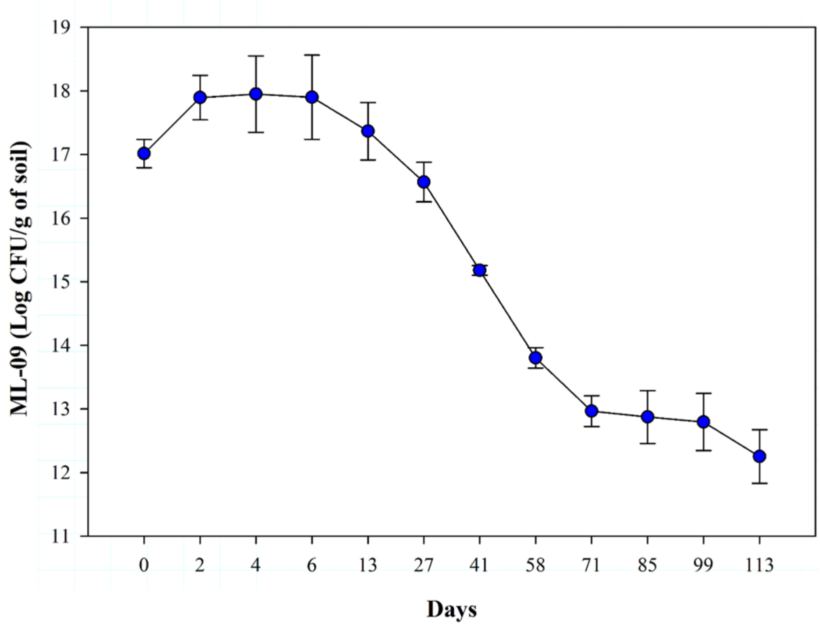

Figure 3. Graphic depicting change in vAh populations across all sediments in pilot persistence trial over a period of 113 days.

Grant Dollars Secured to Study the Impact of High-water Temperature on Growth, Digestibility, and Immune Parameters of Channel and Hybrid Catfish Fed Different Plant and Animal Protein Diets

Luke Roy[1,2], Timothy Bruce[2], Anita Kelly[1,2], D. Allen Davis[2]
[1]AFFC and [2]SFAAS

The Alabama catfish industry accounts for 33% of U.S. catfish production. Producers feed their fish a commercial diet, which can comprise close to 50% of the variable operating costs on a farm. Recently, several commercial catfish producers have noted that feeding has been diminished compared to previous years, particularly in summer when water temperatures are highest and can exceed 89°F for extended periods. Farmers have reported reduced feeding, routinely brought in sick fish with guts full of undigested feed to the diagnostic laboratory, and in some cases, have reported reduced overall production compared to previous years in affected ponds. When Anita Kelly at the Fish Center examined these fish, they were determined to be pathogen and parasite free. The only symptom was large quantities of undigested or partially digested feed in their guts.

Most of the protein from catfish diets originates from plant-based sources such as soybean meal or other grains. It is well documented that plant protein sources contain more fiber than fish meal. The inclusion of fish meal has been reduced or eliminated in favor of higher inclusion rates of plant or alternative animal protein sources such as porcine-based meat and bone meal. This, in combination with the increased use of grain by-products, both contribute to possible reductions in digestion. The purpose of this study is to examine fish performance, digestibility, and immunological parameters of channel catfish (year 1) and hybrid catfish (year 2) offered a 32% plant-based diet (basal diet) compared to diets containing reduced plant-based protein and additional animal protein (menhaden fish meal or porcine-based meat and bone meal diet) as well as a commercial reference diet at two temperatures (77°F vs. 89°F). Our hypothesis is that, at high water temperatures, diets with the highest level of plant proteins will not be as digestible as diets containing higher levels of animal protein.

This project will be carried out by an M.S. graduate student to be co-advised by Tim Bruce and Luke Roy. The research will be carried out in temperature-controlled tank systems at the E.W. Shell Fisheries Research Station at Auburn University. Information gathered will provide feedback to the commercial catfish industry on whether existing feed formulations should be modified to improve feed efficiency and digestibility, particularly for hotter months of the growing season. We would like to thank the many West Alabama aquaculture industry members who provided letters of support to help fund this project.

Shrimp Production Update:

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SFAAS

Feed is one of the primary costs associated with commercial production of Pacific white shrimp (*L. vannamei*). This cost is the combined outcome of both feed cost, feed management and production. Some sectors of the aquaculture industry are rapidly shifting from hand feeding to automated feeding systems which have boosted production, reduced the time to market, and improved feed utilization. As the industry shifts toward automated feeding systems using passive acoustic monitoring (PAM), it is vital to reevaluate protein levels in diets for the best production outcomes. The use of acoustic monitoring adds another level of complexity to feed management because it has the potential to automatically adjust feed amount based on demand from shrimp, which may vary with nutrient content of the feed. Leveraging funding from the United Soybean Board, USDA, HATCH and Alabama Department of Marine resources, we investigated the effects of protein on production metrics in shrimp. For this work four practical diets with different levels of dietary protein (25, 30, 35, 40%) were formulated. These diets were designed to contain low levels of animal protein (2-8%) and high levels of soybean meal (33 to 57%) as dietary protein levels were increased. Shrimp post larvae were obtained from Homegrown Shrimp (Indiantown, FL) and acclimated on-site for a short nursery period. These juvenile shrimp or 0.002 oz (0.045g) were stocked at a density of, 104,000/acre (25 shrimp/m^{2}), into 16, 0.247 acre ponds. Ponds were fed a commercial 1.5mm diet (PL Raceway 40/9, Zeigler Brothers) until day 16, after which the four different protein diets were fed at a fixed rate. After 30 days, feed was offered to ponds with the AQ1 passive acoustic monitoring system, which uses feedback from the shrimp via hydrophones in the ponds to determine feed inputs, which are theoretically driven by the shrimp's consumption. The system was programmed to allow the shrimp to feed on demand from 0800 to 2200h daily, with a max daily feed input of 35 lb/pond (~142 lb/acre/day).

The statistical analysis of yield, FCR and survival showed no differences between treatments ($p>0.05$), but average weights of the shrimp were significantly smaller when offered the 25% protein diet. Overall, the shrimp and/or the feeders did not seem to respond to dietary protein levels as feed inputs, and patterns were quite similar. Since feed inputs were not significantly different and the cost per unit of feed increases as the dietary protein increases, this led to statistically higher feed cost ($p=0.02$) for the higher protein diets (Figure 1).

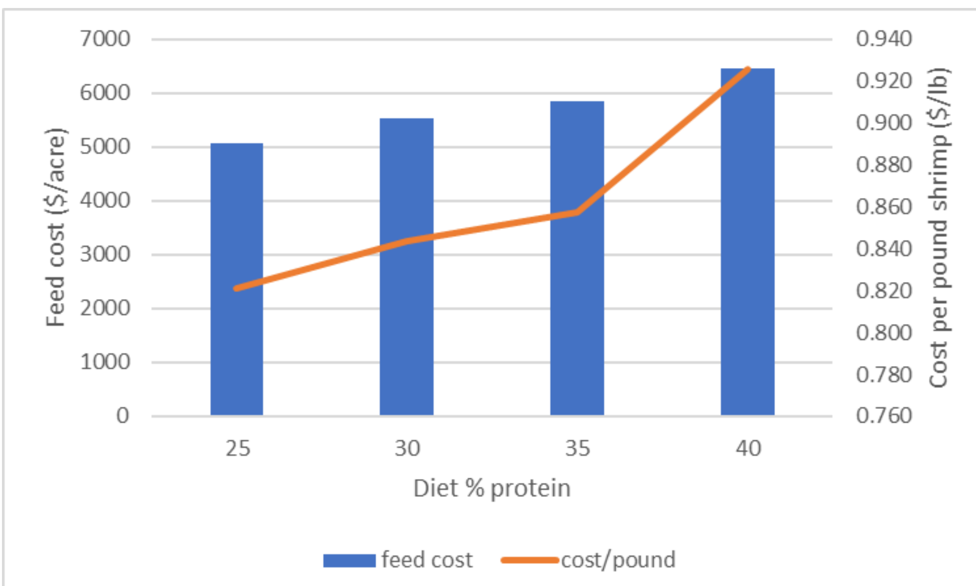

Figure 1. Observed feed cost expressed as $/acre of production and cost/pound of shrimp when reared over a 12-week period in outdoor ponds at a density of 25 shrimp/m^2 (104,000/acre).

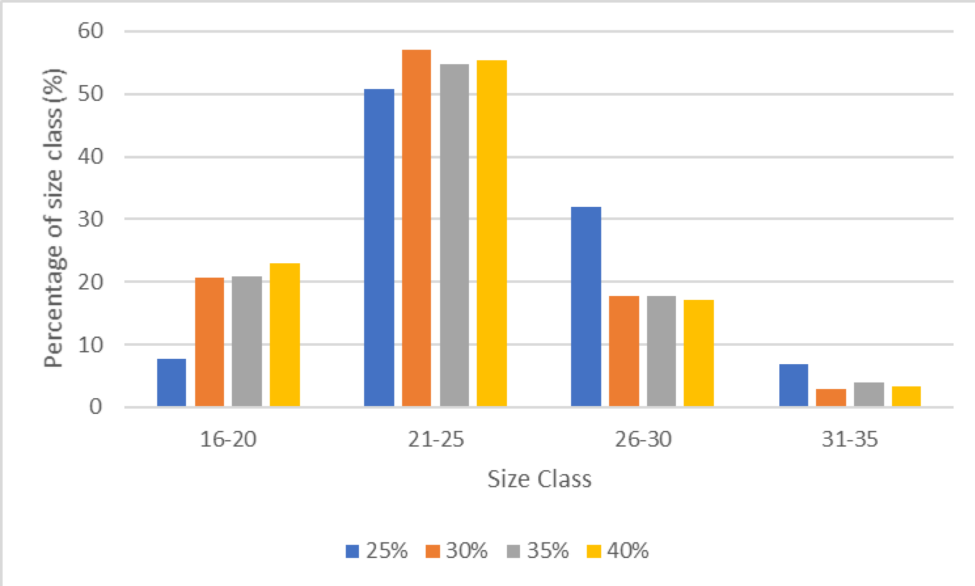

Figure 2. Size class distribution (shrimp/lb) of shrimp reared on the various diets under pond production conditions.

However, the cost of feed per pound of shrimp produced was not significantly different (p=0.48) across the treatments. The 25% diet produced a numerically smaller biomass of shrimp and lower individual weights among the shrimp. This caused there to be a difference in the shrimp class size distribution (Figure 2) which ultimately led to a sequential increasing of the estimated value of the shrimp, ranging from $24,436/acre for shrimp fed the 25% diet to $28,883/acre for shrimp fed the 40% diet (Figure 3).

The 40% diet resulted in significantly higher cost, showed no differences in production or economic outcomes compared to the other diets, and would represent a higher risk if overfed. Hence, we would not recommend the 40% protein diets. Based on cumulative results, we concluded the 30-35% protein diets would be the most efficient for use in pond production of Pacific white shrimp.

Pond production results demonstrate what happens under commercial-like conditions, and there are a lot of variables that cannot be controlled. We also wanted to evaluate the different feeds in more controlled production systems, so we used an outdoor green-water system run parallel to the ponds and an intensive indoor biofloc tank system. The outdoor tank trial was conducted using water pumped from a culture pond in which water quality was equalized across all tanks and stocked with 30 shrimp per 211 gallon (800L) tank, while the indoor system was stocked with 120 shrimp per 211 gallon (800L) tank; each tank was maintained individually. Each tank trial used different feeding rates, one of them being the standard feed rate (100% of each of the 4 diets providing different level of offered protein) and adjusted rates to allow the total input of protein to be equal (but different quantities of feed). Figure 4 demonstrates the relationship between final biomass and total protein input based on final survival of the shrimp in the green-water trial. As expected, FCR was reduced as dietary protein levels increased, as it required less feed

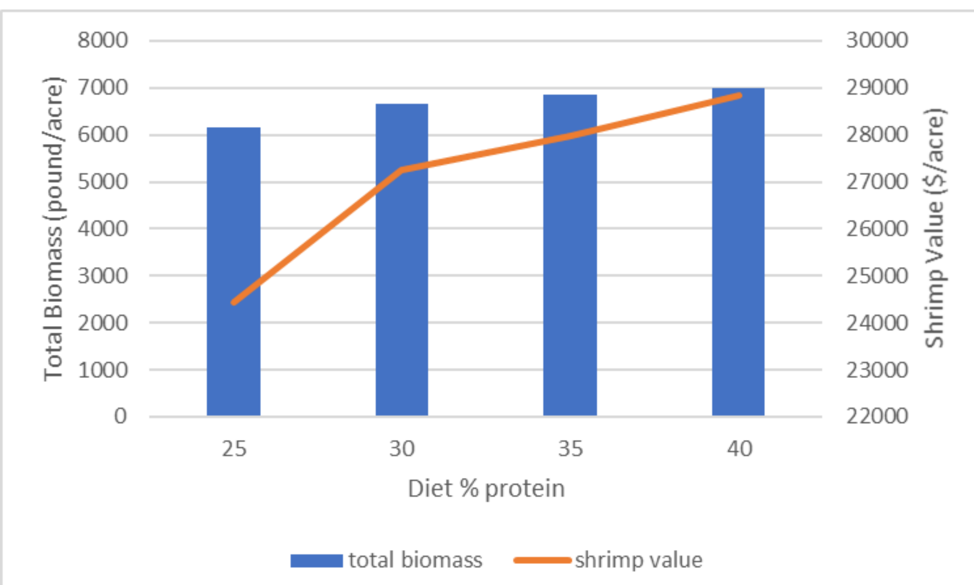

Figure 3. Final biomass and estimated shrimp value based on size class distribution of shrimp reared on the various diets under pond production condition.

to produce a given amount of growth. Similarly, the biofloc trial results demonstrated that the increase in crude protein (CP) content of the feed resulted in a corresponding increase in final mean weight and final biomass (Figure 5). The shrimps fed the 35% CP diet at 114.3% had the highest final mean weight (14.1g; 0.497oz), weight gain (13.87g; 0.489oz), and weight gain percentage (4490%). This trial demonstrated that the shrimp raised in an intensive biofloc system performed better in terms of growth and feed utilization when provided feeds with higher protein levels.

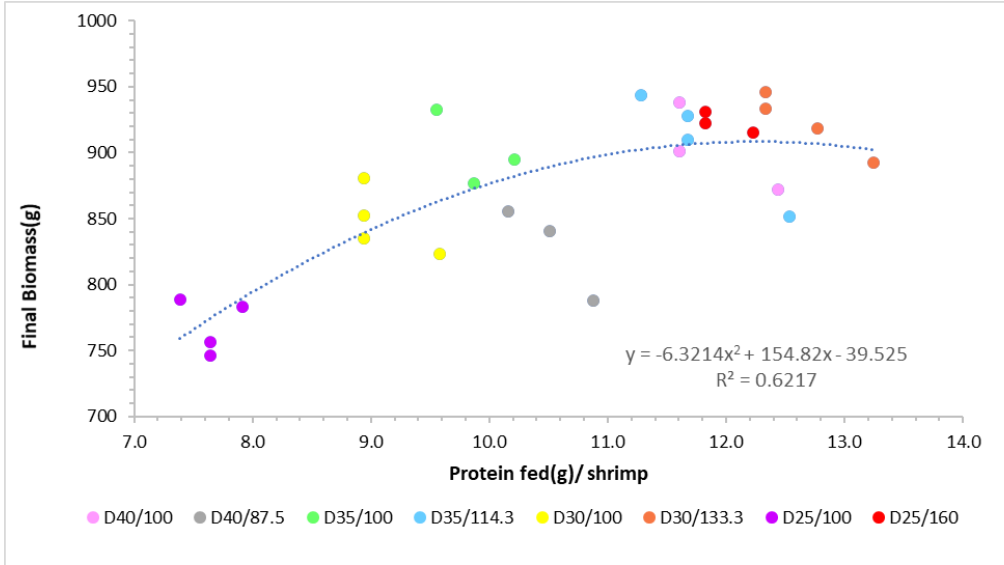

Figure 4: Final biomass (g) plotted against protein offered (based on final survival) of juvenile shrimp (~0.41g ± 0.01) stocked at a density of 30 shrimp per tank and reared with different levels of protein intake under semi-intensive conditions in tanks.

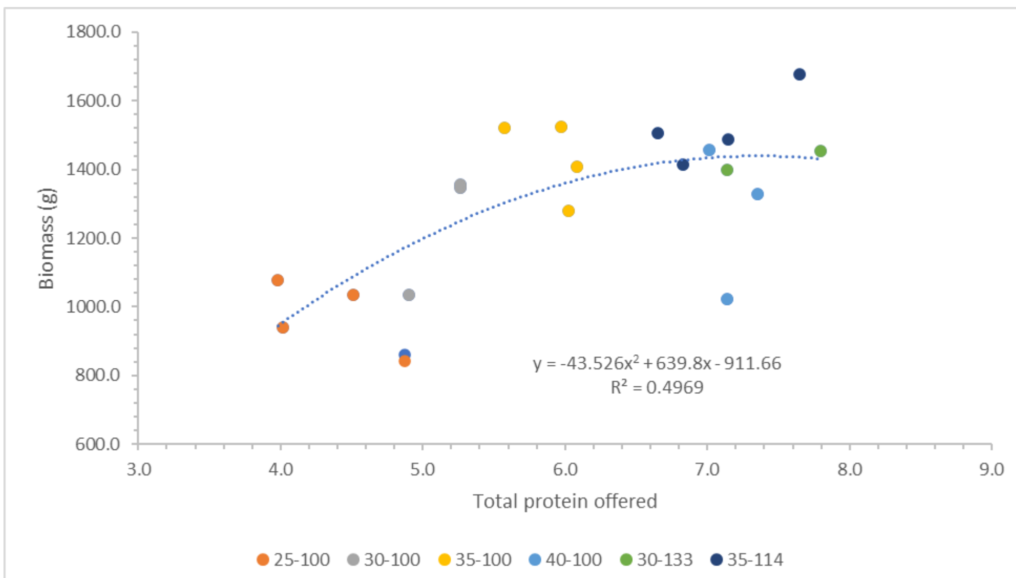

Figure 5: Final biomass (g) plotted against protein offered (based on final survival) of juvenile shrimp (0.31g ± 0.01) stocked at a density of 150 shrimp per tank and reared for 70-days with different levels of protein intake under intensive biofloc conditions.

Results of these trials demonstrate that soy optimized feeds work across various protein levels as well as system intensity with excellent results. The data validates the concept that daily nutrient intake is the primary driver of performance in shrimp across several production technologies. The use of low protein diets resulted in generally higher costs and lower levels of production, but more efficient protein use. Pushing the production limits with either the high protein feed or lower protein fed at higher feed rates was generally not the most effective. In either case, as protein input increases, so does nitrogen loading which may lead to poor water quality. Restricting protein intake by using a lower protein feed (eg. 35%) or reducing the quantity of feed when using the 40% protein diet seemed to produce the best overall results. The results clearly demonstrate that the nutrient content of the diet and feed management are interrelated so that when considering protein level of the feed one must also consider feed management practices.

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