EXTENSION NEWSLETTER

Field trials to control the three primary diseases of the west Alabama catfish industry

Terry Hanson and Jesse James, School of Fisheries, Aquaculture & Aquatic Sciences, Auburn University

Stocking of the in-pond raceway units at the Williamson Cattle Company (WCC) farm was completed in June 2017. Each trivalent vaccine contained killed bacteria of *Aeromonas hydrophila*, *Flavobacterium columnare* and *Edwardsiella ictaluri* species.

The trivalent vaccine delivery to catfish varies and the treatments under trial are:

A. Manual vaccination by intraperitoneal injection with the trivalent vaccine (which contains an adjuvant to help the vaccine remain longer in the catfish)

B. Controls with no vaccine

C. Immersion into a concentrated bath of the trivalent vaccine without adjuvant

D. Immersion into a concentrated bath of the trivalent vaccine with an adjuvant to help boost the vaccine's effects

Each of three replicate ponds at the WCC farm had one raceway unit as a containment system for the trial fish. Each raceway unit included 16 cells (4 cells for each of 4 treatments). Each cell was stocked with 1,000 trial fish, for a total of 16,000 fish per pond.

The fish were fed the same feed throughout all four treatments. As the fish grew and began to feed more aggressively in their new environment, feed rations were adjusted accordingly. The mortality within the raceways have been low this year with no notable disease activity.

In November 2017, all cells were harvested and fish were weighed and restocked to continue the trial through until harvest size is attained next May 2018. This will give us the fall and spring disease temperature "windows" to further test the effectiveness of this trivalent vaccine.

We would like to thank our sponsors of this important research: Alabama Catfish Producers, Alabama Catfish Feed Mill, Alabama Department of Agriculture and Industries, Williamson Cattle Company, Harvest Select Catfish, Kennebec River BioSciences, USDA Aquatic Animal Health Unit at Auburn AL, Auburn University, Alabama Cooperative Extension System.

If you have any questions, please feel free to call:

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Permitting for double-crested cormorants

Thomas Graeter, USDA/APHIS/Wildlife Services

Previous to 2016, double-crested cormorants (DCCO) could be lethally taken in the state of AL under three authorities: 1) The Aquaculture Depredation Order (ADO) which was developed for the Aquaculture industry to help mitigate DCCO predation to commercial fish stocks (50 CFR 21.47) [This ADO is the authority that allowed for the lethal take at roosts, as well as allowed the producers to lethally take DCCO's on their farms]; 2) The Public Resource Depredation Order (PRDO) (50 CFR 21.48) which was developed to mitigate damage caused by DCCO's to wild sport fish and to natural resources or habitat which can be destroyed by roosting birds [e.g., islands on Guntersville Reservoir]; and 3) the traditional Migratory Bird Depredation Permit (MBDP) – the same one many of you have for pelicans, herons, and so forth. The typical MBDP were used by private individuals who had stocked sportfish ponds and were having DCCO issues which were not covered under the ADO since they are not commercial entities.

In 2016, the US Fish & Wildlife Service (FWS), who had administered these Orders, were sued by the environmental group Public Employees for Environmental Responsibility (PEER) on the grounds of an insufficient Environmental Assessment as required by the National Environmental Policy Act (NEPA). PEER contends the depredation orders which allowed for the lethal take of DCCO's were too liberal and that the US Fish & Wildlife Service had used flawed, outdated population estimates and lethal-take data when the depredation orders were extended. The judge ruled against the US Fish & Wildlife Service and ordered the depredation orders to be rescinded.

The Migratory Bird Depredation Permit (MBDP) will still be used for fish-eating birds (pelicans, herons, egrets) but now there will also be a separate MBDP required for the harassment and take of double-crested cormorants. In order to receive a MBDP for DCCO's, or any other migratory bird, an application package must be completed and submitted to the US Fish & Wildlife Service. The application package consist of a Form 37 issued by Wildlife Services in which it is recommended that a permit be issued (334-624-8711), a US Fish & Wildlife Service Form 3-200-13 (https://www.fws.gov/forms/3-200-13.pdf), and an application processing fee of $100 made payable to the US Fish & Wildlife Service. It is important to note that Wildlife Services can only **recommend** to the US Fish & Wildlife Service that a permit be issued, it is up to the US Fish & Wildlife Service to approve the permit application and to determine the number of lethal takes the permit will allow. At this time it is expected the take

allowed for double-crested cormorants will be conservative, as opposed to the former "no limit" previously enjoyed under the ADO.

Wildlife Service will also be issued a MBDP, with extremely limited take, which will allow for the continuation of roost dispersal as conducted in previous years.

This is the current situation; as things develop we will try to get the word out and keep all abreast of the current legal environment and all relevant changes. For questions and/or for the issuance of Form 37 please feel free to contact us at the Wildlife Services office.

Contact information:

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Look out *Aeromonas*, we're going to hit you with everything and the kitchen sink

Eric Peatman, School of Fisheries, Aquaculture & Aquatic Sciences, Auburn University
Benjamin Beck, USDA-ARS Aquatic Animal Health Laboratory, Auburn, AL

While *Aeromonas hydrophila* (vAh) cases dropped significantly in 2017, and big fish, toxic algae and falling fish prices likely represented greater threats to catfish producers' peace of mind and pocketbooks, significant progress was made in understanding and combatting this disease. Working collaboratively, the USDA-ARS (Aquatic Animal Health Research Unit) and School of Fisheries carried out over 40 experimental vAh infection trials ("challenges") in 2017. Below is a synopsis of our findings as well as some thoughts on future directions.

Challenge model: Waking the Beast

As you've likely heard previously, vAh + catfish ≠ disease and death under lab conditions. Mortality rates due to immersion of catfish in high doses of vAh are low and inconsistent. We began, therefore, by altering conditions for both the pathogen and the catfish host to approximate *potential* commercial conditions tied to disease. Adding these factors (described below) to the challenge model significantly increased mortality rates. We are now using this model to test genetic lines, vaccines, diets, and pond additives, some of which we hope will move toward industry testing in 2018. Decades of work on other catfish diseases (e.g., columnaris and ESC) have illustrated the difficulties of translating lab observations to pond implementation. We hope that by using a holistic, multi-pronged approach, and going where the data lead, advances on vAh will proceed more quickly.

Fish Factors

We identified that the time between last feeding and vAh infection was a critical factor controlling rates of mortality. Fish fed within 4 hours of challenge were significantly more susceptible than those fed 24 hours before. A full stomach is associated with shifts in gastric pH and a number of changes in the composition of catfish blood. We are currently testing the hypothesis that serum composition is a predictor of disease severity. Furthermore, as composition of the diet impacts rate of digestion and serum chemistry, we are also examining ingredients within experimental diets to examine their impacts on vAh infection and death; including the testing of new commercially available diets featuring higher fishmeal inclusion. Previous USDA-ARS work in 2016 demonstrated that clipping the adipose fin of a fish prior to immersion in vAh was a prerequisite of infection. Similarly, our findings to-date indicate that any small lesion that allows entry of vAh into the bloodstream can lead to an infection. Curiously, we

have not successfully infected fish via the digestive tract, either by feeding in the presence of abundant vAh or by gavage (directly delivered into stomach) of concentrated, activated bacteria in fed or fasted fish. There may be additional, yet unexplored factors (co-infection, chronic low oxygen, etc.) that allow for an oral route of infection, but our current data points to infection via blood as the critical route in acute outbreaks.

Pathogen Factors

We traditionally grow bacteria in very nutrient rich media that allows us to culture large amounts in a short timeframe. However, numerous studies across a diverse range of pathogens have illustrated that pathogens often are only highly virulent in less ideal settings, where they need to fight for scarce resources in order to survive and replicate. One common limitation for growth in natural pond environments is iron. As iron becomes scarce, bacteria (including blue greens) release molecules called siderophores to bind up and retrieve iron. Some bacteria, including Aeromonads, can recognize and utilize siderophores from other competing bacteria (xenosiderophores). In our case, we found that adding a xenosiderophore to the broth of vAh dramatically increased its virulence and resulting catfish mortality. We hypothesize that the effect is due to vAh "sensing" iron-limiting, competitive conditions due to its interactions with the xenosiderophore and responding by increasing toxin secretion and/or other virulence pathways. However, this remains to be confirmed. More importantly, we are moving on to determine if mineral availability and/or levels of competing microorganisms are predictive of commercial pond outbreaks.

Pond Factors

The strong association of vAh with certain ponds, farms, and regions, and not others is intriguing as we try to make sense of disease epidemiology. As mentioned above, we have begun to analyze soil and water chemistries in the context of disease histories. Our dataset is preliminary, but it has indicated a relationship between certain elements and ponds with no or minimal history of vAh outbreaks. We are also enlisting producers in cataloging water quality, feeding, stocking etc. to identify factors preceding outbreaks. We are always eager to get feedback directly from producers, both as to conditions associated with vAh incidence as well as successful strategies they employ to combat it. Perhaps it's best to mention in this section that we are also working with colleagues at Mississippi State University to determine the role of snails in vAh. While it remains unclear the extent to which snails can harbor or shed vAh, preliminary trials by our team suggest that trematode cercariae (such as *Bolbophorus*) shed by carrier snails could increase the susceptibility of fish to vAh. Our working model speculates that the burrowing of cercariae into the fish could create a portal of entry for vAh. A large-scale series of experiments are planned for Spring 2018 to test this theory.

Control Strategies

As mentioned above, based on a better understanding of fish-pathogen-pond dynamics, we are testing a simple vaccine (using killed vAh), water applications, and several diets for their ability to heighten resistance to vAh /decrease catfish mortality. In the interim, as we and several other groups examine the efficacy and practicality of pond-level implementation of these strategies, producers can take several steps to reduce vAh mortality. Careful feed management and restriction/cessation of feeding upon the first signs of disease appears critical. Regular management of potentially competing blue green populations through copper application has also been connected by producers to reduced vAh incidence. Lastly, using our challenge model, we have shown that commercially available hybrid catfish lines are 2-3X more resistant to vAh than are channel catfish. However, on the channel catfish side of the equation we are working with colleagues at the USDA-ARS Warmwater Aquaculture Research Unit in Stoneville, Mississippi to determine whether channel catfish families can be selected for vAh resistance. Challenge trials were completed in December and genetic analyses are currently underway.

Automatic feeding systems used in pond production of Pacific white shrimp *Litopenaeus vannamei*

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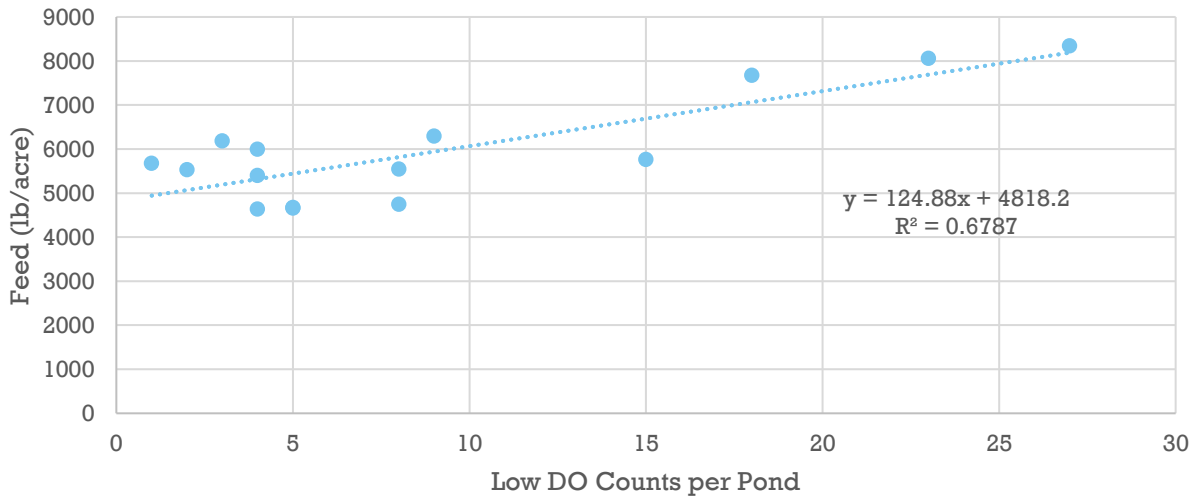
School of Fisheries, Aquaculture & Aquatic Sciences, Auburn University

The continued success of shrimp aquaculture will rely on improvements in feed management and reductions in the labor requirements for production. As grazers, shrimp have shown increased performance with multiple feedings spread throughout the day, but the labor required to increase the feedings can be prohibitive to some operations. Utilizing automatic timer feeders and acoustic demand feeders allow farmers to spread out the feeding without increasing the labor required to do so. The acoustic monitors allow feeding activity to be monitored to provide real time adjustment of feed input based on demand. This means improved feed application during times of active feeding. As one shifts feeding protocols and increases the quantity of feed, it is important to remember that feed inputs dictate the water quality within a pond. Increased feed inputs or over feeding can result in poor performance.

In a recent study we compared feed management strategies in pond culture of Pacific white shrimp (*Litopenaeus vannamei*) to evaluate the effects of feeding rates on the growth performance, production, water quality and economic returns. For this work a 13-week trial was performed at the Claude Peteet Mariculture Center, Gulf Shores, Alabama with 16, 0.25 acre ponds stocked at 153,846 shrimp/acre (initial weight 0.036g). Four treatments were used for this study; standard feeding protocol (SFP) which is based on an assumption of growth, FCR and an assumed mortality. This translates to 1.56 g of feed per week once the shrimp are > 2g. This is then used to calculate the quantity of feed which is fed twice daily by hand (8am and 4pm), two solar timer feeder treatments programed to feed SFP increased by 15 or 30%, divided into 6 feeding/day, 8am, 10am, 12pm, 2pm, 4pm and 6pm (Timer 15 and Timer 30), and on demand using the AQ1 acoustic feeding system, fed between 7am and 7pm, limited to maximum of 33 lbs/day (134 lbs/acre). All ponds were fed using Zeigler Raceway 1.5mm (40% protein and 9% lipid) for first 15 days then Zeigler SI-35

Figure 1. The linear regression (p=0.0002) of total feed inputs and the number of low DO (< 3.0 mg/L) events for morning DO readings for each pond.



2.4mm (35% protein and 7% lipid) shrimp grower diet for remaining weeks. All of the ponds were fed the same amount of feed the first 4 weeks, however the timer and AQ1 ponds were fed 6x/day started at week 3 with the AQ1 acoustic controls starting at week 5. Results after 13 weeks are presented in Table 1.

The final individual weights of 19.7, 25.1, 27.5, and 32.0g (SFP, Timer 15, Timer 30, and AQ1, respectively) were significantly different for all treatments. The differences in final weight resulted in significantly higher yield and value of shrimp. There was a significant increase in the feed input, 4685 lbs/acre in SFP and 8,032 lbs/acre in AQ1. However, no significant differences were seen in survival 58.5-63.9, FCR 1.07-1.24 or price of feed/lb shrimp $0.472 – 0.544. There were no significant differences in water quality with the exception of DO. The occurrence of low DO (<3.0mg/L), was significantly higher for the AQ1 treatment as compared to the other treatments as feed inputs were almost twice that of the SFP. Figure 1 shows the trend of low morning DO counts increasing with the total feed inputs.

The results demonstrated that increasing daily feedings through the use of automated feeding systems can significantly increase the production and value of *L. vannamei* produced in semi-intensive pond culture. While the increased production could offset the costs of the feeders and additional aeration requirements, further research and economic analysis is needed to fully analyze the costs and benefits of feed automation at a production facility. In conclusion, increases in feed input, application of the technology, and training of people to maintain the feeding system must all be considered when evaluating these technologies.

Table 1. Production results for *Litopenaeus vannamei* cultured in 0.1 ha ponds over a 13-week culture period using varying feeding techniques including a Standard Feeding Protocol (SFP) fed twice daily, SFP with a 15% or 30% increase fed 6 times per day (Timer 15 or Timer 30) and acoustic demand feeding (AQ1). [1]

Trt	Yield (lbs/acre)	Individual weight (g)	Survival (%)	FCR	Feed (lbs/acre)	$ of Feed/lb shrimp produced (usd)	Value ($/acre)[2]
SFP	4,321[a]	19.74[a]	63.9	1.13	4,685[a]	0.481	13,353[a]
Timer 15	5,023[a]	25.15[b]	58.5	1.12	5,542[b]	0.495	17,926[ab]
Timer 30	5,725[ab]	27.52[c]	61.2	1.07	6,065[c]	0.472	21,330[bc]
AQ1[3]	6630[b]	32.04[d]	60.9	1.24	8,032[d]	0.544	26,553[c]
P-Value	0.008	<.0001	0.7486	0.4099	<.0001	0.3663	0.0007

[1] Mean values (n=4) in the same column with different superscripts are significantly different ($P < 0.05$) based on analysis of variance followed by Student Neuman-Keuls multiple range test.
[2] Using the three year average (2014-2016) for Latin American farmed whole white shrimp as reported by Urner Barry.
[3] n=3

Is sustainable control of toxic algae a reality for catfish aquaculture?

Alan Wilson, Edna Fernandez, Riley Buley, and Luke Roy
School of Fisheries, Aquaculture, and Aquatic Sciences, Auburn University

Toxic algae, especially some blue-green algae, pose serious and sometimes fatal consequences for the health of cultured catfish. Some algae are also associated with the production of compounds, such as geosmin and methylisoborneol (MIB), that can make fish fillets taste earthy (off-flavor). Such problems add additional costs and headaches to an already overburdened industry.

Given that algal blooms often occur during warm temperatures and excess nutrient loads, i.e., typical conditions for catfish aquaculture ponds in Alabama and Mississippi, algal bloom management is a necessary component for all aquaculture farms. A variety of bloom control approaches exist, including physical (e.g., mixing, sonication), biological (e.g., herbivores), and chemical (e.g., algaecides). Chemical treatments, such as copper sulfate and potassium permanganate, are the most commonly used because they are usually effective at quickly killing algae. However, their effects on the algal community are short-lived and tend not to promote other, harmless algae, such as green algae. Consequently, harmful algal blooms quickly recur, thus requiring regular chemical treatments to maintain algal abundance at reduced levels.

Another often overlooked problem with algal bloom management in aquaculture is that not all algal blooms are harmful or toxic to farmed fish. In other words, green water doesn't necessarily mean toxic algae. In fact, only a handful of blue-green algae species are capable of producing toxins while other non-toxic algae can help utilize fish waste products and promote overall pond productivity. The use of an inexpensive compound microscope would allow a pond manager to quickly determine if the dominant algae present in a pond are potentially toxic. If the pond is dominated by harmless algae, chemical treatment could actually harm the water quality of the pond by resetting the system and allowing harmful algae to dominate. We can offer algal identification tools and training to support farmers, and suggest that aquaculture pond managers consider using microscopy to track

dominant algae in their ponds throughout the growing season.

Although less utilized, biological control of toxic algal blooms in aquaculture ponds may provide a cheap, sustainable, and efficient alternative to chemical and physical controls. Currently, most to all catfish aquaculture ponds have other fish species in addition to catfish. Often times, these non-target fish are small planktivores, such as shad, green sunfish, and bluegill. Anecdotal reports suggest that shad control algal blooms, so farmers rarely try to remove these fish. However, planktivorous fishes, including shad, actually promote algal growth by consuming zooplankton, which eat the algae. Removing shad and other planktivorous fishes should promote larger, more abundant zooplankton that could control algal blooms in catfish aquaculture ponds. The removal of planktivorous fish from catfish ponds, when possible, may result in some benefits as far as long-term management of algae.

A new project funded by the USDA-NIFA and led by Drs. Alan Wilson and Luke Roy from Auburn University's School of Fisheries, Aquaculture, and Aquatic Sciences aims to test the role of food web manipulations (called biomanipulation) as a sustainable method for controlling algal blooms in catfish aquaculture ponds. Based on recent data that show that *Daphnia*, a large-bodied zooplankton able to control highly toxic blue-green algae, Wilson and Roy will conduct whole pond experiments where *Daphnia* are added to catfish aquaculture ponds (with and without planktivorous fishes), and water quality dynamics will be studied during the growing season. The *Daphnia* are expected to reduce algal abundance to low levels, based on recent, smaller-scale lab and field experiments. Since the *Daphnia* produce resting eggs that fall to the sediment and hatch later as part of their life cycle, we expect that the *Daphnia* will return each winter/spring as long as planktivorous fish are not abundant.

As part of this new USDA-NIFA project, Wilson and Roy are looking for collaborators at commercial catfish farms to allow regular (biweekly to monthly sampling) water quality pond monitoring. They are also looking for access to recently drained and refilled ponds where planktivorous fish were removed for *Daphnia* inoculations followed by regular water quality monitoring. These collaborations will provide excellent background data about typical water quality dynamics in commercial catfish aquaculture ponds as well as the potential for *Daphnia* treatment to control toxic algal blooms. If you are interested in participating on this project, please reach out to Alan Wilson (wilson@auburn.edu; 334-246-1120) or Luke Roy (royluke@auburn.edu; 334-624-4016).

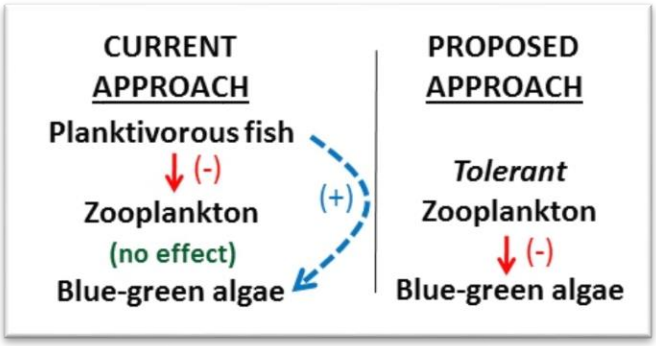


Figure 1. Conceptual model of the new USDA-NIFA project focused on using cyanobacteria-tolerant zooplankton, specifically *Daphnia pulicaria*, to control harmful algal blooms in catfish aquaculture ponds. Red lines show negative (-) interactions and the dashed blue line shows a positive (+) interaction. The current aquaculture approach of having high densities of planktivorous fishes likely promotes blue-green algal blooms since these fish consume large zooplankton. Without planktivorous fish, we contend that *Daphnia* can get abundant and significantly reduce blue-green algae to low levels.

What's cooking at the Fish Center?

Gregory N. Whitis, Alabama Fish Farming Center

Our industry's current policy of throwing away catfish over six pounds motivated me to submit a funding proposal to the State Catfish Committee. They agreed-- we need to find markets for these fish. They aren't going away. Even in the best circumstances, 10% of what we raise in either multiple batch or single batch culture are going to be fish larger than four pounds. And the research I am citing was done with channels. Hybrids are a whole 'nother ballgame.

I am currently working with two large fish markets. One is the 13-16 oz fillet market that some processors can service on dedicated processing lines using 4-4.5 pound fish. Although pricing strategies haven't been worked out, I am testing this size fillet in select restaurants as a catfish "loin" strip. So far, these strips when offered as a free appetizer in my marketing demo, have had positive reviews. Most consumers in my survey are not complaining about their thickness, "chewiness" or flavor. My hope is that restaurants and caterers contemplating switching to the cheaper imports, will opt to purchase these large fillets and strip them in-house to save money.

The second market is smoked catfish. I'm taking the "whales", those six to ten pounders, and smoking their 1-2 pound fillets in an electric smoker. In the first five batches, I have determined the target zone for salt brine strength to use. The feds require a certain salt concentration in the tissue. My next three batches should pin down exactly how strong the brine has to be and how long they have to be brined at 35-40 degrees. Hopefully, my research and development of a business plan for a commercial smoking enterprise will attract an entrepreneur to our industry. The smoked salmon industry sells over fifteen million dollars annually in the USA. I think they need some competition!
I did manage to test market smoked catfish at the very upscale Western Market Wine and Food Festival in Birmingham back in October. Alabama farm-raised smoked catfish was a hit at the show and almost everyone asked where they could get it!
Special thanks to Mrs. Tammy Spencer at Harvest Select Catfish and Dr. Juan Silva, food research scientist at Mississippi State University for their valued assistance.

2017 Disease impact report

Bill Hemstreet, Alabama Fish Farming Center

The 2017 Alabama Catfish Disease Survey was sent out in early October to all producers of Farm Raised Catfish in Alabama. The survey was responded to by all 77 producers in west Alabama representing a total of 17,031 acres of production of which 2,911 acres were hybrids. The survey showed that there were 1,552 ponds under commercial production with an average stocking rate of 7,765 head per acre. The reported total poundage lost to the five primary disease agents (Aeromonas, Edwardsiella, Columnaris, PGD, and Toxic releases) was approximately 6.3 million pounds of fish compared to 7.3 million lost in 2016. The estimated loss in dollars which included medicated feed costs, water treatment costs and lost feeding days costs was approximately $12 million dollars. The primary cause of losses in Alabama continues to be from *Aeromonas hydrophila* (3.4 million lbs) followed by columnaris (1.6 million lbs) and Edwardsiella (0.615 million lbs). Losses due to unidentified toxins were also significant (0.528 million lbs).

Catfish farming novel published in December 2017

Gregory N. Whitis, Alabama Fish Farming Center

My debut novel, *Blue Green*, is available at all Barnes and Noble Bookstores and in various electronic formats (Kindle, Apple, Amazon). As far as I know, it's the first novel ever written that uses a catfish farm for a setting. I'm sure some of the old timers in our industry will recognize many of the mini-stories and fictitious characters in the book. The book takes place in a fictional town in the Mississippi Delta. I shot the photo cover for the book at Morrisette Bottom in western Perry County near Uniontown. Special thanks to Mary Quitman Holmes for allowing me to use their family farm for this.

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