TWENTY-SEVENTH ANNUAL PROGRESS REPORT

For the Period Through August 31, 2014

Supporting research and extension projects based on industry needs and designed to directly impact commercial aquaculture development.

USDA United States Department of Agriculture National Institute of Food and Agriculture

May, 2015

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EXECUTIVE SUMMARY

This Twenty-seventh Annual Progress Report seeks to provide a summary of work completed and outreach activities of the Administrative Center during the past year. Full progress reports on the nine multi-year research and extension projects supported by SRAC during this reporting period are available at http://www.srac.msstate.edu/annualprogressreports.html. In the past year, SRAC funded projects totaling more than $2.2 million. These projects resulted in 9 journal articles, 22 Extension/Outreach publications, 31 oral presentations, 6 poster presentations, 4 digital products, and has supported 4 students.

The Center's "Publications" project is in its eighteenth year of funding. Sixteen new fact sheets and two web-based presentations were completed while several fact sheets are in the process of review or revision. To date, the project has generated 235 technical fact sheets, 7 mass media presentations, and 30 videos with contributions from over 225 authors. In the current reporting year, 148,493 visitors from 168 countries/territories used the SRAC Publications website to access SRAC publications 498,415 times.

Results of the "Market Trends" project have been shared with stakeholders through presentations, workshops, meetings, and field-day events. Summaries of market trends in 52 cities across the U.S. for the past five years have been sent to 19 catfish processing companies, and detailed customized reports have been sent to six catfish processing companies at their request. There were six stakeholders' workshops during 2013 held across the country. The catfish industry has requested help from project participants in organizing region-specific advertisement messages for the industry.

The "Catfish Broodstock Management" project aims to identify the most cost-effective method of increasing catfish fry production efficiency through manipulation of broodfish diets, gender ratios, and stocking densities. Diet modification has had few clear effects on fry production efficiency, which might allow the use of lower-cost diets with more plant ingredients. Use of a 1:1 ratio of male to female broodfish significantly increased reproductive efficiency of channel catfish compared to standard commercial practices. A higher percentage of females spawned at the higher stocking density. Late (January) consolidation of broodstock showed a slight advantage on subsequent spawning success compared to early (July) consolidation. Economic models have been developed to clarify the cost-effectiveness of the different feeding and management strategies. The higher broodstock spawning density resulted in cost per million fry produced that was 2.5 times lower than the cost per million fry produced at the low density broodstock spawning density.

The "Intensive, Pond-based Culture Systems" project will evaluate the production efficiencies of three new catfish production systems; smaller conventional earthen ponds with increased aeration rates, split-pond systems, and in-pond raceways. Based on these findings, a complete economic analysis will be performed and will provide the necessary guidance to make recommendations to farmers. The final impact of this project cannot be determined at this point as the data is incomplete. However, the comprehensive database that is emerging from this project will be a valuable guide for farmers considering investing in the new systems. The intensive monitoring of this project has documented extremely high fish production but also high variability. In most cases net production exceeded 12,000 lbs/acre with FCRs better than 2.0:1, with production up to 17,000-19,000 lbs/acre in the best cases. This dataset provides a more complete picture of the comparative production and economic benefits of these systems than has previously been available, and enables Extension personnel to better assist farmers to make informed decisions related to adoption of these new technologies.

The “Removal of Adhesive Proteins from Eggs and Egg Masses” project investigated a large number of compounds (>20) in an attempt to remove adhesive eggs from recently spawned egg mats. None of these treatments were successful in removing large numbers of koi or ballyhoo eggs from spawning mats.

The “Split-Pond Aquaculture Systems” project is evaluating important design or management options for producing catfish, including pumping systems and oxygen management, and will develop engineering design criteria for baitfish aquaculture. Four, 7-acre earthen ponds at the National Warmwater Aquaculture Center at Stoneville, Mississippi have been modified into split-ponds. Four pumping systems were installed: a) slow-turning paddlewheel, b) fast-turning paddlewheel, c) high-speed screw-type pump, and d) high-speed axial flow turbine. Work in Arkansas focuses on modifying split ponds for baitfish production and a prototype rotary screen fish barrier was designed to address the problem of small fish escape.

The “Collective Action Alternatives” project brings together a group of economists to examine changing market conditions and to identify alternative forms of collective action that might benefit the U.S. catfish industry. Work is underway to prepare the relevant packets of information on the expected benefits of the federal marketing order, cooperative structure, and closer vertical integration. Once these are completed, efforts to disseminate the materials at a variety of venues will be initiated. Given that this project is only in its first 6 months, results have not yet been finalized

The objectives of the “Blue Catfish Germplasm” project are to develop a repository of cryopreserved sperm from diverse blue catfish populations to initiate genetic improvement of hybrid catfish, and to develop a database for efficient storage and retrieval of cryopreserved blue catfish sperm and associated information. At the end of the reporting period, this project was less than 6 months along. Therefore, participants were not asked to provide summary results/outcomes.

A highly virulent and clonal population of *Aeromonas hydrophila* is the causative agent of an ongoing epidemic of motile Aeromonas septicemia in farmed catfish. Originally with an epicenter in western Alabama, this disease epidemic has now spread to Mississippi and Arkansas. The “Control of Virulent *Aeromonas hydrophila*” project will help identify the environmental and human factors that contribute to its spread, develop effective disinfection and management practices that can result in improved biosecurity, and develop control measures for farms afflicted with this epidemic. At the end of the reporting period, this project was less than 6 months along. Therefore, participants were not asked to provide summary results/outcomes.

INTRODUCTION

Mission

The mission of the 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.

Background

The Agriculture Acts of 1980 and 1985 authorized establishment of aquaculture research, development, and demonstration centers in the United States. With appropriations provided by Congress for the 1987 and 1988 FYs, efforts were undertaken to develop the five Regional Aquaculture Centers now in existence. Organizational activities for SRAC began in 1987, with the first research and extension projects initiated in 1988.

In 1980, Congress recognized the opportunity for making significant progress in domestic aquaculture development by passing the National Aquaculture Act (P.L. 96-362). The Act established USDA as the lead agency for aquaculture coordination and called for development of a National Aquaculture Plan. The next year, Congress amended the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (P.L. 95113) by granting, in Title XIV, Subtitle L, Sec. 1475(d) of the Agriculture and Food Act of 1981 (P.L. 97-98), authority to establish aquaculture research, development, and demonstration centers in the United States.

Congress envisioned the Centers as focal points in a national program of cooperative research, extension, and development activities that would be developed in association with colleges and universities, state Departments of Agriculture, federal facilities, and non-profit private research institutions with demonstrated excellence in aquaculture research and extension. Eventually, five such Centers were established—one in each of the northeastern, north central, southern, western, and tropical Pacific regions of the country.

Although government agencies, particularly the United States Department of Agriculture, have provided significant support for aquaculture research and development, much of that funding is earmarked for specific use by specific institutions. The USDA/NIFA Regional Aquaculture Center program is the only funding activity with the flexibility to stay abreast of industry development, identify problems on a region-wide scale, and implement cooperative, interstate projects to solve those problems.

Since its inception in 1987, the Southern Regional Aquaculture Center has become the most important regional aquaculture activity in the southeastern United States. In its 27 years of operation, the Center has disbursed more than $18 million to fund multi-state research and extension projects. More than 200 scientists from 30 institutions in the southeast have participated in Center projects.

Productivity from SRAC research projects has been excellent since the Center's inception more than two decades ago. Information derived from SRAC-funded projects has been transferred to producers and

other scientists in thousands of scientific papers and presentations. Currently funded projects continue this trend of high productivity.

Beginning with the first projects funded by the Southern Regional Aquaculture Center, interest among aquaculture research and extension scientists in Center activities has been excellent. In fact, funding and project coordination provided by SRAC has become so embedded in the fabric of southeastern aquaculture research and extension that it is difficult to envision what these activities would be like without the program. We are pleased with the participation by our research and Extension scientists in the Southern Region in ad hoc Work Group meetings and Steering Committees, and their willingness to serve as Project Leaders and Principal Investigators for the projects. We believe this broad-based representation has resulted in strong, cooperative research that will be of long-lasting benefit to aquaculture producers and consumers, and to the growth of the aquaculture industry in the Southern United States.

Acknowledgments

The Southern Regional Aquaculture Center acknowledges the contributions of the Project Leaders and Participating Scientists involved in the projects reported in this Twenty-seventh Annual Progress Report. Members of the SRAC Board of Directors, Industry Advisory Council, and Technical Committee have provided valuable inputs to the successful operation of SRAC during the past year. We particularly appreciate the assistance of the chairs of these vital committees.

We also thank the scientists and aquaculturists from across the country who contributed their expertise and valuable time to review SRAC project proposals and publications. Without their help, it would be impossible to maintain the high quality of this program.

ORGANIZATIONAL STRUCTURE

Research and Extension problem areas for the southern region are identified each year by the Industry Advisory Council (IAC), which consists of fish farmers and allied industry representatives from across the region. The Technical Committee (TC), consisting of research and Extension scientists from states within the region, works with the IAC to prioritize problem areas. The two groups then work together to develop "Problem Statements" describing objectives of work to solve problems with the highest priority. Using inputs from industry representatives, regional Work Groups of the most qualified research and extension scientists are formed. The Work Groups then plan and conduct the work. Regional aquaculture funds are allocated to participants in SRAC projects approved by the Board and NIFA. Reviews of project proposals, progress reports, and recommendations for continuation, revision, or termination of projects are made jointly by the TC and IAC and approved by the Board.

The thirteen states and two territories represented by SRAC are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, U.S. Virgin Islands, and Virginia.

Administrative Center

The Administrative Center is located at the Delta Research and Extension Center, Stoneville, Mississippi. Mississippi State University serves as the Host Institution. All necessary support services for the Board, IAC, TC, Steering Committees, and project Work Groups are provided by the Administrative Center. This includes monitoring status and progress of projects, preparing and executing Letters of Agreement, tracking administrative and project expenditures, reviewing progress reports, and assisting Project Leaders and participating institutional Grants Offices as needed.

Operation and funding are approved by the Board for inclusion in the Grant Application submitted annually to USDA/NIFA. The Center staff also prepares and submits to USDA/NIFA an Annual Plan of Work covering Center activities and projects to be funded. Following final approval, Letters of Agreement are prepared and executed with all participating institutions. The Center acts as fiscal agent to disburse and track all funds in accordance with the provisions of the grants.

Board of Directors

The Board is the policy-making body for SRAC. Membership provides an appropriate balance among representatives from State Agricultural Experiment Stations, Cooperative Extension Services, 1890 Institutions, and the Administrative Heads Section of the Board on Agriculture Assembly of the National Association of State Universities and Land Grant Colleges.

The Board is responsible for 1) overall administration and management of the regional center program; 2) establishment of overall regional aquaculture research and extension goals and allocations of fiscal resources to ensure that the center develops strong programs in both research and extension; 3) establishment of priorities for regional aquaculture research and extension education activities based on inputs from the TC and IAC and guidance from the National Aquaculture Development Plan; 4) review and approval of annual plans of work and accomplishment reports; and 5) final selection of proposals for funding by SRAC.

Members of the Board for the reporting period were:

Gregory Bohach, Mississippi State University
Phil Elzer, Louisiana State University
Steve Lommel, North Carolina State University
Wondi Mersi, Virginia State University
Joe Street, Mississippi State University Extension Service
Tony Windham, University of Arkansas Cooperative Extension Service
Wes Burger, Mississippi State University

Industry Advisory Council

The IAC is composed of representatives of state and regional aquaculture associations, federal, territorial and state agencies, aquaculture producers, aquaculture marketing and processing firms, financial institutions, and other interests or organizations. The IAC provides an open forum wherein maximum input from private and public sectors can be gained and incorporated into annual and ongoing plans for SRAC.

The IAC 1) identifies research and extension needs; 2) works with the TC to prioritize research and extension needs; 3) works with the TC to develop problem statements and recommend funding levels for projects addressing priority research and extension needs; 4) reviews project proposals, progress reports, and termination reports; and 5) recommends to the Board, jointly with the TC, actions regarding new and continuing proposals, proposal modifications, and terminations.

Members of the IAC for the reporting period were:

J. Neal Anderson, AR
Robert Mayer, KY
Ben Pentecost, MS
Martha Campbell, FL
Rob Ellis, NC
Marty Tanner, FL
Butch Wilson, AL
Townsend Kyser, AL
Ralph Babin, TX
Lynn Blackwood, VA
Kim Edge, GA
Stephen Sagrera, LA
Shorty Jones, MS
Chase Holub, TX
Bill Livingston, SC
Joey Lowery, AR
Jenny Davis Fagan, TN
Wes Hardin, OK

Technical Committee

The TC consists of representatives from participating research institutions and state Extension services, other state or territorial public agencies as appropriate, and private institutions. Membership of the TC includes research and Extension scientists representing essentially all states in the region. The TC 1) works with the IAC to prioritize research and extension needs; 2) works with the IAC to develop problem statements and recommend funding levels for projects addressing priority research and extension needs; 3) reviews proposals, progress reports, and termination reports; and 4) recommends to the Board, jointly with the IAC, actions regarding new and continuing proposals, proposal modifications and terminations.

Members of the TC for research for the reporting period were:

Brian Bosworth, USDA-ARS Warmwater Aquaculture Research Center
Harry Daniels, North Carolina State University
Jim Tidwell, Kentucky State University
Allen Davis, Auburn University
Carole Engle, University of Arkansas at Pine Bluff
Delbert Gatlin, Texas A&M University
Terry Tiersch, Louisiana State University
Cortney Ohs, University of Florida
Don Bailey, University of the Virgin Islands
Bill Shelton, University of Oklahoma
Patricia Duncan, Fort Valley State University
Dan Kauffman, Virginia Tech University
Mike Denson, South Carolina Department of Natural Resources
Brian Alford, University of Tennessee

Members of the TC for Extension for the reporting period were:

Jack Whetstone, Clemson University
Mike Frinsko, North Carolina State University
Ron Blair, University of Tennessee
Gary Burtle, University of Georgia
Jesse Chappell, Auburn University
Todd Sink, Texas A&M University
Greg Lutz, Louisiana State University
Michael Schwarz, Virginia Tech University
Craig Watson, University of Florida
Forrest Wynne, Kentucky State University
Anita Kelly, University of Arkansas at Pine Bluff
Mark Peterman, Mississippi State University
Marley Beem, Oklahoma State University

PROGRESS REPORTS

PUBLICATIONS, VIDEOS, AND COMPUTER SOFTWARE

Reporting Period: March 1, 1995 – August 31, 2014
Length of Project: Ongoing
Current Project Year: 18
Total Funds Committed: $45,774
Principal Investigator: Todd Sink, *Texas A&M University*

Relevance: When this project was initiated, fewer than half the states had educational materials covering the major aquacultural species in their state. The concept of using the SRAC program to produce timely, high-quality educational materials is based upon the benefits of centralizing the production process while using a region-wide pool of expertise to develop materials. Distribution is then decentralized through the nationwide network of Extension Specialists and County Agents including the National eXtension Initiative. This process assures an efficient publication process that makes use of the best available talent in specific subject areas.

Response: A committee of Extension Specialists and researchers solicit input on publication and digital product needs from their counterparts across the region. These suggestions are prioritized during an annual meeting of the committee based on need and available funding. The best talent from within and outside the region are then recruited to submit proposals to develop these products.

Results: The result is widespread availability of high-quality educational materials for scientists, educators, producers, students, and the general public.

Outreach Overview: SRAC fact sheets and videos are distributed by direct request and via Extension Specialists, County Extension Agents, and other RACs. These products are used regularly by clientele in all 50 states as well as internationally in 205 countries and territories. Fact sheets, videos, and web presentations are accessed daily from the SRAC Publications website and YouTube by people searching for technical information.

Targeted Audiences: The target audiences for this project are educators, consumers, producers, potential investors, students, and the general public.

Outputs: Sixteen new fact sheets and two web presentations were completed for this reporting year. The SRAC Publications and AquaPlant websites were also updated with new materials. All publications have been distributed electronically throughout the Southern Region and to interested Extension Specialists in other regions.

Outcomes/Impacts: Publications and videos produced by SRAC are increasingly used in educating high school and college students about aquaculture. These programs heavily utilize SRAC publications and videos for educational purposes but usage is impossible to measure because access to the information is gained from many different Internet sites, through file sharing, and digital downloads of PDFs.

Another important impact is the education of local, state, and federal regulators about the aquaculture industry. This impact is difficult to measure but feedback from personnel in two states have indicated that the fact sheets are recommended reading for all new employees dealing with aquaculture, water quality, exotic species, and other permitting duties. This should be a positive influence toward making aquaculturists better understood and the development of more enlightened regulations.

The impact on consumers of aquaculture products is also likely significant. Consumers are primarily interested in a wholesome, safe, and inexpensive product, and it has been reported that the consumer-oriented fact sheets and videos developed within SRAC have generated more interest than the producer-directed materials. The fact sheets are in demand in both the English and Spanish versions and, as more information becomes available, extension materials on food safety will be in increased demand by health conscious consumers.

The Southern Regional Aquaculture Center commenced the Publications, Videos, and Computer Software Project in order to provide these materials in a timely and relevant manner. Since that time, more than 235 technical fact sheets and numerous update revisions, 7 web presentations, and 30 videos have been produced through the SRAC PVCS Project. In the current year alone, 148,493* visitors from 168 countries/territories used the SRAC Publications website, https://srac.tamu.edu/, to access SRAC publications 498,415* times. SRAC videos from several sources were viewed on YouTube 330,211 times during the current reporting period. The AquaPant website, created with funding from the SRAC PVCS Project, had 285,122 visitors that accessed 1,224,410 pages during the reporting period. These visitors came from 209 countries/territories.

*Web-based analytical tracking and reporting methods have dramatically improved in the current project year.

Using National Retail Databases to Determine Market Trends for Southern Aquaculture Products

Reporting Period: June 1, 2009 – August 31, 2014
Length of Project: 4 years
Current Project Year: 4
Total Funds Committed: $398,397
Principal Investigators: Madan Dey, Carole Engle, *University of Arkansas at Pine Bluff*; Benaissa Chidimi, *Texas Tech University*; Terry Hanson, *Auburn University*; Sherry Larkin, Charles Adams, *University of Florida*

Relevance: Though the demand for fresh and chilled/frozen seafood has been increasing over time in the U.S., the market size and share of U.S. farm-raised catfish are declining. Increased understanding of demand structure of sales of seafood and fish over season and space could help the U.S. aquaculture industry refine marketing strategies and targets.

Response: The study found that the catfish industry needs to develop market specific strategies in order to gain further market share in the U.S. Results show that the responsiveness of catfish demand to changes in its own and substitute products prices vary over seasons and U.S. census divisions. Researchers have conveyed to stakeholders (catfish farmers, processors, policy makers) that understanding the consumer demand behavior across seasons and over space is essential as (i) fish demand varies over species, season and space; and (ii) not only does the degree of competition among finfish products vary considerably over space, but substituting products themselves change.

Results: Based on these findings, several catfish farmers and processors have expressed intention to develop market specific strategies for catfish marketing. The industry has invited the UAPB Aquaculture/Fisheries Center to further assist them with designing their marketing plans. The Catfish Institute, an industry managed organization responsible to raise consumer awareness of the positive qualities of U.S. farm-raised catfish, has requested the UAPB Aquaculture/Fisheries Center to help them in organizing region-specific advertisement messages for the industry.

Outreach Overview: Results have been shared with stakeholders through presentations, workshops, meetings, and field-day events organized by the UAPB Aquaculture/Fisheries Center. Summaries of market trends in 52 cities across the U.S. for the past 5 years have been sent to 19 catfish processing companies, and detailed customized reports have been sent to 6 catfish processing companies at their request.

Targeted Audiences: The targeted audiences are catfish farmers, catfish processors, other fish famers, other fish processors, and The Catfish Institute.

Outputs: There were 14 stakeholders' workshops during 2012-2013 (six in 2013) across the country. Summaries of market trends analysis were presented to 19 catfish processing companies while detailed customized reports were presented to six catfish processing companies. Detailed customized reports were provided to six catfish processing companies.

Outcomes/Impacts: The Project procured three data sets of scanner data on frozen/chilled seafood sales from A.C. Nielsen. These include (i) market-level weekly scanner data for 52 markets of the U.S. covering the period of July 2005 to July 2012, (ii) market-level scanner data on frozen/chilled seafood and another animal protein products, aggregated at four-week intervals, for the period from January 2009 to November 2013 for 10 markets with Walmart stores, and (iii) household-level data covering five markets, namely Chicago, Houston, Miami, Memphis and New Orleans-Mobile, for a five year period from 2007-08 to 2009-10. The UAPB research team analyzed market trends and estimated demand and hedonic models for various seafood products. The results have been communicated among existing and potential fish famers throughout the country.

Partnerships Developed: The National Aquaculture Association is a national commodity association that jointly organized and implemented stakeholders' workshops.

Improving Catfish Broodstock Management by Manipulating Diet, Stocking Densities, and Sex Ratios

Reporting Period: January 1, 2011 – August 31, 2014
Length of Project: 3 years
Current Project Year: 3
Total Funds Committed: $388,352
Principal Investigators: Rebecca Lochmann, Carole Engle, Alf Haukenes, *University of Arkansas at Pine Bluff*; Delbert M. Gatlin, III, Camilo Pohlenz, *Texas A&M University*; Brian Bosworth, Sylvie Quiniou, Geoff Waldbieser, *USDA-ARS Warmwater Aquaculture Research Unit*

Relevance: Industry wide, only 30 to 40% of female catfish spawn each year. The reasons for the low spawning rates are unclear. Producers maintain an excess of broodstock to meet egg production goals, which is inefficient. This project aims to identify the most cost-effective method of increasing catfish fry production efficiency through manipulation of broodfish diets, gender ratios, and stocking densities.

Response: Diets with different proteins, lipids and supplements were tested for efficacy in improving fry production. Different ratios of males to females and stocking rates were tested for their ability to improve fry production. The effects of early (July) versus late (January) consolidation of broodfish on spawning success the following spring were determined. Economic analysis of fry production efficiency was conducted.

Results: Most of the information has not been disseminated yet. The researchers have used the economic results to adjust their research strategies aimed at improving fry production efficiency.

Outreach Overview: Results from this project will be disseminated through presentations at scientific and producer meetings, through trade publications, and publications in peer-reviewed journal articles. There is enough information synthesized to increase outreach efforts in early 2015.

Targeted Audiences: The targeted audience includes catfish producers, feed mills, research scientists, and interested laypersons.

Outputs: Economic models and undergraduate student trainees.

Outcomes/Impacts: Diet modification so far has had few clear effects on fry production efficiency, which might allow the use of lower-cost diets with more plant ingredients. Use of a 1:1 ratio of male to female broodfish significantly increased reproductive efficiency of channel catfish compared to standard commercial practices. A higher percentage of females spawned at the higher stocking density. Late (January) consolidation of broodstock showed a slight advantage on subsequent spawning success

compared to early (July) consolidation. Other potential benefits of early consolidation were not considered and should be addressed in other studies. Economic models have been developed to clarify the cost-effectiveness of the different feeding and management strategies. The higher broodstock spawning density resulted in cost per million fry produced that was 2.5 times lower than the cost per million fry produced at the low density broodstock spawning density.

Performance Evaluation of Intensive, Pond-Based Culture Systems for Catfish Production

Reporting Period: October 1, 2012 – August 31, 2014
Length of Project: 3 years
Current Project Year: 2
Total Funds Committed: $300,000
Participants: Les Torrans, Travis Brown, Craig Tucker, *USDA-ARS Warmwater Aquaculture Research Unit*; Luke Roy, Jesse Chappell, Terry Hanson, Claude Boyd, *Auburn University*; David Wise, Terry Greenway, Matt Griffin, *Mississippi State University*; Carole Engle, Yushun Chen, Matt Recsetar, *University of Arkansas at Pine Bluff*

Relevance: Many farmers feel that intensifying fish production will reduce production costs. They are currently using three production systems to do this; smaller conventional earthen ponds with increased aeration rates, split-pond systems, and in-pond raceways. Intensified production systems will likely continue to draw the interest of catfish farmers in the future but without a thorough economic analysis there can be no definitive recommendations.

Response: This study will evaluate the production efficiencies of these new production systems on commercial catfish farms. Based on these findings, a complete economic analysis will be performed and will provide the necessary guidance to make recommendations to farmers. In addition, detailed physical descriptions of each culture system will be thoroughly investigated and the most efficient and practical designs will be recommended to farmers. Data will be used to identify fish health related risk factors associated with each type of production system. Information will be used to develop disease management programs to complement specific production parameters.

Results: Two commercial catfish farms in Mississippi have been enlisted as cooperators on this project. Additionally, six-commercial-sized ponds at the MSU Delta Research and Extension Center are being used in this study. Electric monitors have been installed on all equipment, production facilities have been stocked with either hybrid or channel catfish, and management inputs are being monitored. Harvesting of the first year's production has begun. Three commercial catfish farms in Arkansas have been enlisted as cooperators on this project. Production facilities have been stocked with either hybrid or triploid (on three occasions) hybrid catfish, and management inputs are being monitored. Harvesting

of the first year's production has begun. The framework for the economic analysis of split pond and intensively-aerated ponds has been developed and preliminary analyses are underway.

Outreach Overview: Results from this project will be disseminated through presentations at scientific and producer meetings, through trade publications, and publications in peer-reviewed journal articles. Outreach efforts have increased dramatically in 2014 as more data has been collected. There should be enough information synthesized in 2015 to reach valuable conclusions and largely complete outreach efforts.

Targeted Audiences: Catfish producers and the aquaculture scientific community.

Outputs: Thus far there have been four refereed journal publications and six extension/trade publications. More important, there have been 31 presentations (most with published abstracts) to scientific and industry groups, with many more planned for this winter. The research participants are not waiting for final publication in research journals before informing the industry of results to date. These industry presentations also stimulate further discussion among the researchers and farmers interested in the new technologies.

Outcomes/Impacts: The final impact of this project cannot be determined at this point as the data is incomplete. However, the comprehensive database that is emerging from this project will be a valuable guide for farmers considering investing in the new systems. The intensive monitoring of this project has documented extremely high fish production but also high variability. In most cases net production exceeded 12,000 lbs/acre with FCRs better than 2.0:1, with production up to 17,000-19,000 lbs/acre in the best cases. This dataset provides a more complete picture of the comparative production and economic benefits of these systems than has previously been available, and enables extension personnel to better assist farmers to make informed decisions related to adoption of these new technologies.

Partnerships. Formal partnerships were established between the research collaborators and eight commercial farms in Arkansas, Mississippi, and Alabama. Without the support and cooperation of these farmers this on-farm economic study obviously would not have happened. Their partnerships have greatly strengthened the working relationship between research and industry in these states.

Identification and Removal of Adhesive Proteins from Goldfish and Baitfish Eggs and Egg Masses

Reporting Period: January 1, 2014 – August 31, 2014
Length of Project: 1 year
Current Project Year: 1
Total Funds Committed: $45,000
Principal Investigators: Chris Green, Louisiana State University; Cortney Ohs, *University of Florida*; Anita Kelly, *University of Arkansas at Pine Bluff*

Relevance: Goldfish and ballyhoo readily deposit their eggs on artificial substrates in captivity. Their eggs are naturally adhesive which requires an additional labor investment for removal from spawning substrates and may result in decreased hatch rate. This project is a continuation of SRAC funded research directed at identification of proteins associated with egg adhesion. Previous work from this collaborative team was unsuccessful in protein identification and it was believed that difficulties in protein extraction could be accomplished within a brief period of time.

Response: This project has tested over 20 different compounds for their potential ability to remove koi eggs from spawning mats. These compounds included various concentrations of the following compounds: sodium sulfite, tannic acid, urea, fresh squeezed pineapple juice, bromelain, papaya, papain 4M urea, lithium chloride, cadavarine, lysozyme, acetone, sodium hydroxide, ammonium chloride, ethylene glycol mono-butyl ether, propolyene glycol n-butyl ether, citric acid, and alcalase.

Isolation of glycoproteins from newly fertilized koi eggs was first attempted using a protocol derived from Mansour et al. (2009). A new protocol was also developed from Scapigliati et al. (1995). In the spring of 2014, two new protocols for the solubilization of eggshell proteins using egg samples from our two target species were investigated. The two protocols were described in Oppen-bernsten et al. (1990) for Cod (*Gadus morhua*) and Chiou et al. (2004) for Malabar grouper (*Epinephelus malabaricus*). Consultation with the LSU AgCenter's Biotechnology Laboratory on these protocols yielded a protocol similar to Choiu et al. (2004).

Results: A large survey of compounds (>20) were investigated in an attempt to remove adhesive eggs from recently spawned egg mats. None of these treatments were successful in removing large numbers of koi or ballyhoo eggs from spawning mats.

The Mansour protocol produced four weakly detected protein bands at the highest concentration of 20 µL of sample. The Scapigliati protocol resulted in greater amounts of eggshell proteins when compared to the Mansour method and as a result we continued protein extractions with the Scapigliati protocol.

Mass Spectrocopy determined that that the first band in our gel had an 84% similarity to vitellogenin, a yolk precursor protein from *Fundulus heterclitus*. This indicates that our first protein band was contaminated from the yolk or embryo and not a protein that originates in the chorion. These results indicate that the protocol still yields contamination of embryonic tissue within the eggshell sample.

New protocols developed from modified procedures reported in Oppen-bernsten et al. (1990) for Cod (*Gadus morhua*) and Chiou et al. (2004) for Malabar grouper produced products that were identified in gels representing both koi and ballyhoo samples using a more sensitive silver staining as compared to coomassie staining. Although the concentration of these products were low, silver stained bands were used as a marker location for isolation from other replicate gels.

Outreach Overview: This project has not yet yielded results that could be delivered to the public as outreach.

Targeted Audiences: Hatchery professionals, researchers, and other individuals producing eggs that need to be removed from a spawning substrate would greatly benefit.

Outputs: Tangible outputs that can be disseminated to a target audience have not been completed to date.

Outcomes/Impacts: This project has tested the ability for 20 different compounds to remove koi eggs from spawning mats. Sodium sulfite and trypsin at varying concentrations have also been applied to ballyhoo egg in an effort to remove adhesion with no success.

Previously published reports on the characterization of eggshell proteins (Mansour et al 2009) appear to present a protocol that yielded a high degree of contamination from the contents of the egg itself. As a result, new protocols have been created for the processing and solubilization of eggshell proteins for Mass Spectroscopy analysis. Many difficulties have been encountered in this project, however, the value of our approach is in the development of new protocols that address the problems we have encountered.

Partnerships: This is a very unique project and, as a result, many important partnerships have been created in order broaden the expertise needed to address the objectives.

Fabirzio Donnarumma is a Post-Doctoral Research within the Department of Chemistry at Louisiana State University and has contributed in the analysis and refinement of protein extraction protocols.
Dr. Ted Gauthier (Director) and **Tamara Chouljenko** (Research Scientist) of the Louisiana State University H.D. Wilson Laboratories Protein Center have been instrumental in providing research support and laboratory space to conduct protein extraction and analysis.
Dr. Hongjin Huang, Research Scientist at Applied Biomics Inc in Hayward, California was consulted for the initial glycoprotein-profiling analysis on two-dimensional DIGE gels.
Dr. Jeonghoon Lee from the Louisiana State University Department of Chemistry has provided expertise for protein purification and analysis using Mass Spectroscopy.

Split-Pond Aquaculture Systems: Design Refinements for Catfish Production and Evaluation for Culturing Other Species

Reporting Period: February 1, 2014 – August 31, 2014
Length of Project: 3 years
Current Project Year: 1
Total Funds Committed: $465,000
Principal Investigators: Craig Tucker, Travis Brown, Les Torrans, *USDA-ARS, Warmwater Aquaculture Research Unit*; Charles Mischke, *Mississippi State University*; Greg Whitis, Claude Boyd, *Auburn University*; Kevin Schrader, *USDA-ARS Natural Products Utilization Research Unit*; Jeonghwan Park, Nathan Stone, *University of Arkansas at Pine Bluff*

Relevance: In an effort to remain competitive in the face of adverse economic conditions, some catfish farmers have started using intensive, outdoor culture systems called split-ponds. Despite widespread adoption, optimum split-pond design is unknown and commercial systems vary widely in pump type, water exchange rate, and management of the two basins. Further, the apparent success of split-ponds for growing catfish has generated interest in the possibility of culturing other species, especially baitfish.

Response: Nine scientists at five institutions are collaborating to improve split-pond design for warmwater aquaculture. The project is evaluating important design or management options for producing catfish, including pumping systems and oxygen management, and will develop engineering design criteria for baitfish aquaculture.

Results: Four, 7-acre earthen ponds at the National Warmwater Aquaculture Center at Stoneville, Mississippi have been modified into split-ponds. Four pumping systems were installed: a) slow-turning paddlewheel, b) fast-turning paddlewheel, c) high-speed screw-type pump, and d) high-speed axial flow turbine. Pump performance data will be obtained in fall, 2014, and ponds will be stocked with hybrid catfish for production studies in spring, 2015. A commercial catfish farm in Alabama is cooperating to determine benefits of aeration in the waste-treatment section of split-ponds. Water quality and fish flavor data collection was initiated in late July, 2014 and will continue for three years. Work in Arkansas focuses on modifying split ponds for baitfish production. Pump-performance data for paddlewheel pumps has been collected and paddlewheel pumps based on the engineering models have been installed in ponds for engineering and production studies. Experimental split-ponds were constructed to assess the possibility of golden shiner production. Young-of-the-year fish were stocked on July 9, 2014, and will be harvested in October, 2014. A prototype rotary screen fish barrier was designed to address the problem of fish escape when small fish are grown in split ponds. The fish barrier will be installed at a cooperating baitfish farm and construction will be completed by May, 2015. Finally, a 6-week study indicated that the contribution of natural foods to golden shiner growth in split ponds is less than that in traditional ponds.

Outreach Overview: This is a new project and initial studies have not been completed. Results of these initial studies will be disseminated in late 2014 and 2015 through presentations at scientific and producer meetings, through trade publications, and publications in peer-reviewed journal articles.

Targeted Audiences: Catfish and baitfish producers and the aquaculture scientific community.

Outputs: None to date.

Outcomes/Impacts: The impact of this project cannot be measured because initial studies in this new project have not been completed.

IMPLEMENTATION OF COLLECTIVE ACTION ALTERNATIVES IDENTIFIED FOR THE U.S. CATFISH INDUSTRY

Reporting Period: March 1, 2014 – August 31, 2014
Length of Project: 1 years
Current Project Year: 1
Total Funds Committed: $125,000
Principal Investigators: Carole Engle, Madan Dey, *University of Arkansas at Pine Bluff;* Terry Hanson, *Auburn University*; Richard Sexton, *University of California at Davis*; Michael Cook, *University of Missouri*

Relevance: The U.S. catfish industry has struggled to pass production cost increases through to end consumers within a market affected by high volumes of low-priced imports of *Pangasius* spp. A project funded by the Southern Regional Aquaculture Center brought together a group of economists to examine changing market conditions and to identify alternative forms of collective action that might benefit the U.S. catfish industry.

Response: The final approval for this project was received in March, 2014. Thus, this report reflects accomplishments for the first six months of the project.

The University of California at Davis is working to identify how the ownership and control of processing/packing functions in the catfish industry differ across organizational structures. Contract models being utilized in related industries are under review. The applicability of alternative models to the catfish industry are being assessed.

The University of Missouri is working on research on the history, structure, growth, opportunities and challenges of the catfish cooperative, Delta Pride. The purpose is to prepare a mini case study to inform development of alternative contractual models.

UAPB has developed the baseline model to assess the effects of alternative contract frameworks on market demand and industry costs has been developed. Results of the assessments from Objective 2 will be used to complete this objective.

Work is underway to prepare the relevant packets of information on the expected benefits of the federal marketing order, cooperative structure, and closer vertical integration. Once these are completed, efforts to disseminate the materials at a variety of venues will be initiated.

Results: Given that this project is only in its first 6 months, results have not yet been finalized.

Outreach Overview: There have been a series of meetings with Board members of the Catfish Farmers of America to develop a

strategy to move forward to implement a federal marketing order and an appropriate cooperative structure. Committees composed of industry representatives of various farm sizes and states have been formed to move the initiative forwarded.

Targeted Audiences: Primarily catfish farmers and processors.

Outputs: There have been three presentations to date from this project.

Outcomes/Impacts: Outcomes and impacts will come at the end of the project.

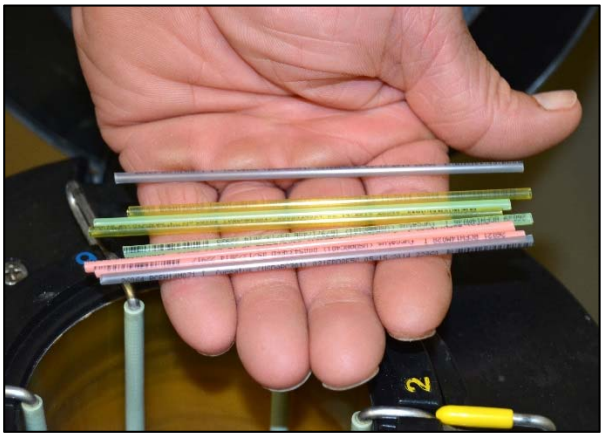
Partnerships: Participants in this project are working closely with Catfish Farmers of America as this project moves forward.

IMPROVEMENT OF BLUE CATFISH GERMPLASM FOR HYBRID CATFISH PRODUCTION

Reporting Period: April 1, 2014 – August 31, 2014
Length of Project: 3 years
Current Project Year: 1
Total Funds Committed: $45,000
Principal Investigators: Brian Bosworth, *USDA-ARS Warmwater Aquaculture Center;* Terry Tiersch, E Hu, *Louisiana State University*

Relevance: Many U.S. catfish farmers have started to raise hybrid catfish (channel catfish x blue catfish) instead of the traditionally farmed channel catfish because hybrids have faster growth, better survival and higher meat yield. Hybrid catfish fry are typically produced by hormone-induced ovulation of channel catfish females and manual fertilization of eggs with blue catfish sperm. Blue catfish males are killed and their testes removed to obtain sufficient fresh sperm for hybrid fry production. The reliance on fresh sperm, which has a useful life of 2 to 4 days, is a barrier to genetic improvement of economically important traits of hybrids.

Response: The objectives of this project are to develop a repository of cryopreserved sperm from diverse blue catfish populations to initiate genetic improvement of hybrid catfish, and to develop a database for efficient storage and retrieval of cryopreserved blue catfish sperm and associated information.



Results: At the end of the reporting period, this project was less than 6 months along. Therefore, participants were not asked to provide summary results/outcomes.

Targeted Audiences: Primarily hybrid catfish fry/fingerling producers.

STUDIES TO IMPROVE THE CONTROL OF VIRULENT *AEROMONAS HYDROPHILA* AND EVALUATE THE IMPACT OF ENVIRONMENTAL FACTORS ON ITS ABUNDANCE IN CATFISH AQUACULTURE PONDS

Reporting Period: June 1, 2014 – August 31, 2014
Length of Project: 2 years
Current Project Year: 1
Total Funds Committed: $374,374
Principal Investigators: Mark Liles, Cova Arias, Jeffery Terhune, Joseph Newton, *Auburn University;* Matt Griffin, Henry Wan, Larry Hanson, Charles Mischke, *Mississippi State University;* Fred Cunningham, *USDA-National Wildlife Research Center*

Relevance: A highly virulent and clonal population of *Aeromonas hydrophila* is the causative agent of an ongoing epidemic of motile Aeromonas septicemia in farmed catfish. Originally with an epicenter in western Alabama, this disease epidemic has now spread to Mississippi and Arkansas. This research will help identify the environmental and human factors that contribute to its spread, develop effective disinfection and management practices that can result in improved biosecurity, and develop control measures for farms afflicted with this epidemic.

Response: The project will seek to:
1) Determine the environmental factor(s) and animal vector(s) that are correlated with epidemic *A. hydrophila* abundance and dissemination.
2) Determine the disinfection method(s) that will allow removal of *A. hydrophila* from seines.
3) Determine the efficacy of vaccine and/or probiotics delivered orally in preventing mortality due to *A. hydrophila* in farmed catfish.

Results: At the end of the reporting period, this project was less than 6 months along. Therefore, participants were not asked to provide summary results/outcomes.

Targeted Audiences: Primarily catfish farmers and fish health professionals.

Products Developed and Students Supported

Journal Articles

Bott, L.B., T.R. Hanson, L.A. Roy, J.A. Chappell, and G.N. Whitis. Research verification of production practices at an intensively aerated hybrid catfish operation in west Alabama (in preparation).

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

Brown, T.W. and C.S. Tucker. 2014. Pumping performance of a commercial modified paddlewheel aerator for split- pond aquaculture systems. North American Journal of Aquaculture 76:72-78.

Brown, T.W., T.R. Hanson, J.A. Chappell, C.E. Boyd, and D.S. Wilson. 2014. Economic feasibility of an in-pond raceway system for commercial catfish production in west Alabama. North American Journal of Aquaculture 76:79-89.

Chidmi, B., T. Hanson, and G. Nguyen. Effect of promotional activities on substitution pattern and market share for aquaculture products. Journal of the Food Distribution Research Society (in review).

Chidmi, B., T. Hanson, and G. Nguyen. Substitutions between U.S. and imported fish and seafood products at the national retail level. Marine Resource Economics (in review).

Dey, M.M., A.G. Rabbani, K. Singh, and C.R. Engle. 2014. Determinants of retail price and sales volume of catfish products in the United States: an application of retail scanner data. Aquaculture Economic and Management 18(2):120-148.

Park, J., D. Heikes, M.S. Recsetar, and L.A. Roy. 2014. Performance evaluation and engineering considerations for a modular - and culvert-based paddlewheel circulator for split-pond systems. Aquacultural Engineering 61:1-8.

Singh, K., M.M. Dey, and P. Surathkal. 2014. Seasonal and spatial variations in demand for and elasticities of fish products in the United States: an analysis based on market-level scanner. Canadian Journal of Agricultural Economics 63:343-363.

Extension/Outreach Publications

Avery, J. and C. Mischke. 2013. Farm-raised channel catfish. SRAC Publication No. 7304. Southern Regional Aquaculture Center, Stoneville MS.

Beem, M. 2014. Aquaculture: realities and potentials when getting started. SRAC Publication No. 441 (Revision). Southern Regional Aquaculture Center, Stoneville MS.

Bott, L.B., T.W. Brown, L.A. Roy, and T.R. Hanson. 2014. Chemical treatment costs reduced with in-pond raceway systems. Global Aquaculture Advocate 17(4):62-64.

Brown, T., W. Powe, and L. Roy. 2014. A trap panel to capture escaped catfish for in-pond raceways. The Catfish Journal 27(7):21-23.

Brown, T.W. and C.S. Tucker. 2014. Effects of fish barrier screening material on water flow in split-pond aquaculture systems. National Warmwater Aquaculture Center Newsletter 12(1):10-11.

Brown, T.W. and C.S. Tucker. 2014. Pumping performance of a slow-rotating paddlewheel for split-ponds. National Warmwater Aquaculture Center Newsletter 12(1):6-7.

Caporelli, A. and A.M. Lazur. 2014. Small-scale, on-farm fish processing. SRAC Publication No. 442 (Revision). Southern Regional Aquaculture Center, Stoneville MS.

Dasgupta, S. and K.R. Thompson. 2013. Comparison of costs of different hybrid striped bass production systems in ponds. SRAC Publication No. 3000 (Revision). Southern Regional Aquaculture Center, Stoneville MS.

Engle, C.R. and N. Stone. 2014. Costs of small-scale catfish production for direct sales. SRAC Publication No. 1800 (Revision). Southern Regional Aquaculture Center, Stoneville MS.

Gettys, L.A. 2014. Aquatic weed management: control methods. SRAC Publication No. 360. Southern Regional Aquaculture Center, Stoneville MS.

Green, C. 2013. Intensive (non-pond) culture of gulf killifish. SRAC Publication No. 1202. Southern Regional Aquaculture Center, Stoneville MS.

Kelly, A. and B. Baumhoer. 2014. Species profile: hybrid crappie. SRAC Publication No. 7212. Southern Regional Aquaculture Center, Stoneville MS.

Malone, R. 2013. Recirculating aquaculture tank production systems: a review of current design practice. SRAC Publication No. 453 (Revision). Southern Regional Aquaculture Center, Stoneville MS.

Mischke, C. and J. Avery. 2013. Toxicities of agricultural pesticides to selected aquatic organisms. SRAC Publication No. 4600 (Revision). Southern Regional Aquaculture Center, Stoneville MS.

Recsetar, M. 2014. Update on split pond catfish production. Cooperative Extension Program Publication. Arkansas Aquafarming 31: 6.

Stone, N. 2014. An indoor hatching and intensive rearing method for fathead minnows. SRAC Publication No. 1203. Southern Regional Aquaculture Center, Stoneville MS.

Supan, J. 2014. High-density rearing of oyster larvae in flow-through systems. SRAC Publication No. 4311. Southern Regional Aquaculture Center, Stoneville MS.

Tucker, C.S., D.E. Brune, and E.L. Torrans. 2014. Partitioned pond aquaculture systems. World Aquaculture 45(2): 9-17.

Veal, M.W., K.R. Caffrey, M.S. Chinn, and A.M. Grunden. 2013. Algae for biofuels – economic and environmental costs. SRAC Publication No. 4310. Southern Regional Aquaculture Center, Stoneville MS.

Veal, M.W., M.S. Chinn, A.M. Grunden, and K.R. Caffrey. 2013. Algae for biofuels – production and conversion. SRAC Publication No. 4309. Southern Regional Aquaculture Center, Stoneville MS.

Walton, W.C., J.E. Davis, and J.E. Supan. 2013. Off-bottom culture of oysters in the Gulf of Mexico. SRAC Publication No. 4308. Southern Regional Aquaculture Center, Stoneville MS.

Yanong, R.P.E. 2013. Biosecurity in aquaculture, Part 3: Ponds. SRAC Publication No. 4712. Southern Regional Aquaculture Center, Stoneville MS.

Oral Presentations

Bott, L.B, T.W. Brown, L.A. Roy, and T.R. Hanson. 2015. Chemical treatment costs for in-pond raceway systems. Abstract submitted to the Annual Meeting of the U.S. Aquaculture Society, New Orleans, Louisiana. Feb. 19-25.

Bott, L.B., Hanson, T.R., Roy, L.A., and Chappell, J.A. 2014. Production and economics of hybrid catfish *Ictalurus punctatus* x *Ictalurus furcatus* raised in an in-pond raceway system in west Alabama. Abstract and Presentation, Aquaculture America 2014 meeting, Seattle, Washington. February 9-12.

Bott, L.B., L.A. Roy, T.R. Hanson, G.N. Whitis, and J.A. Chappell. 2014. Yield verification of production methods for an intensively aerated (10hp/acre) hybrid catfish operation in west Alabama. Presented at the 30th Annual Meeting of the Alabama Fisheries Association, Eufaula, Alabama. February 19-21.

Bott, L.B., Roy, L.A. Hanson, T.R., Whitis, G.N., and Chappell, J.A. 2014. The use of a yield verification program to evaluate production methods on a hybrid catfish production operation that uses intensive aeration (10 hp/acre) in west Alabama. Abstract and Presentation, Aquaculture America 2014 meeting, Seattle, Washington. February 9-12.

Bott, L.B., T.R. Hanson, L.A. Roy, W. Powe, and J.A. Chappell. 2015. Production and economics of an in-pond raceway system for supplying niche markets with catfish. Abstract submitted to the Annual Meeting of the U.S. Aquaculture Society, New Orleans, Louisiana. Feb. 19-25.

Brown, T.W., E.L. Torrans, and C.S. Tucker. 2015. Performance evaluation of intensive, pond-based culture systems for catfish production in Mississippi. Abstract submitted to Aquaculture America 2015, New Orleans, LA, Feb. 19-22, and CFA Catfish Research Workshop, Natchez, MS, Feb. 27.

Dey, M.M. 2013. Market trends for fish/seafood products: global and U.S. city-level analysis. Presented at Aquaculture Business Management and Marketing Workshop, Charleston, South Carolina. May 22.

Dey, M.M. 2013. Market Trends for fish/seafood products: global and U.S. city-level analysis. Presented at Aquaculture Business Management and Marketing Workshop, University of Hawaii at Manoa Campus, Hawaii. July 29.

Dey, M.M. 2013. Market trends for fish/seafood products: global and U.S. city-level analysis. Presented at Aquaculture Business Management and Marketing Workshop, Hilo, Hawaii. July 30.

Dey, M.M. 2013. Market trends for fish/seafood products: global and U.S. city-level analysis. Presented at Aquaculture Business Management and Marketing Workshop, New Bern, North Carolina. August 14.

Dey, M.M. 2013. Market trends for fish/seafood products: global and U.S. city-level analysis. Presented at Aquaculture Business Management and Marketing Workshop, University of Southern Illinois, Carbondale, Illinois. September 24.

Dey, M.M. 2013. Market trends for fish/seafood products: global and U.S. city-level analysis. Presented at Aquaculture Business Management and Marketing Workshop, Galloway, New Jersey. October 17.

Dey, M.M, K. Singh, and P. Surathkal. 2013. Seasonal and spatial variation in demand for and elasticity of fish products in the United States: an analysis of market-level scanner data. Paper presented at the World Aquaculture Society Conference, Aquaculture 2013, Nashville, Tennessee. February 21-25.

Engle, C.R. 2014. Can a US catfish marketing order and bargaining cooperative stabilize prices? Annual Meeting of the Catfish Farmers of Arkansas, Hot Springs, Arkansas.

Farrelly, J.C., Y. Chen, and S. Shrestha. 2014. Effects of commercial catfish production systems (traditional, intensively aerated, and split) on pond water quality in Arkansas. Abstracts Book of American Fisheries Society Arkansas Chapter Meeting, Rogers, Arkansas. February 26-28.

Farrelly, J.C., Y. Chen, and S. Shrestha. 2014. Water quality in split, intensively aerated, and traditional earthen ponds in southeast Arkansas. Abstracts Book of Aquaculture America 2014, Seattle, Washington. February 10-12.

Hanson, T.R. and C.A. Courtwright. 2014. A farm management approach to control off-flavor in processed catfish. Abstract and Presentation, Aquaculture America 2014 meeting, Seattle, Washington. February 9-12.

Hanson, T.R. and C.A. Courtwright. 2014. A farm management approach to control yellow fillet in processed catfish. Abstract and Presentation, Aquaculture America 2014 meeting, Seattle, Washington. February 9-12.

Hanson, T.R. and C.A. Courtwright. 2014. Production and economic efficiency: developing regression models predicting total production and farm profitability in the U.S. catfish industry. Abstract and Presentation, Aquaculture America 2014 meeting. Seattle, Washington. February 9-12.

Hanson, T.R., L.A. Roy, L. Bott, G.N. Whitis, and J.A. Chappell. 2014. Alabama yield verification program – catfish cost of production. Abstract and Presentation, Aquaculture America 2014 meeting, Seattle, Washington. February 9-12.

Kumar, G. 2014. Economic comparison of split-ponds and intensively aerated ponds. Annual Meeting of the Catfish Farmers of Arkansas, Hot Springs, Arkansas. January 16-17.

Kumar, G., and C. Engle. 2014. Economic and investment analyses of alternate catfish farming technologies. Abstract, Annual Meeting of the U.S. Aquaculture Society, Seattle, Washington. February 9-12.

Park, J. 2014. Engineering fundamentals of split pond system. Aquaculture Field Day, University of Arkansas at Pine Bluff, Pine Bluff, Arkansas. October 2.

Recsetar, M. 2014. Split pond production systems. Missouri Aquaculture Association Winter Meeting, Jefferson City, Missouri. January 11.

Recsetar, M. 2014. Production results from a 2-year verification program of catfish ponds using intensive aeration (> 11.7 kwh/ha; 6.4 hp/ac). World Aquaculture Society meeting, Seattle, Washington. February 9-14.

Recsetar, M. 2014. Split-ponds and intensively aerated ponds: production and water quality. Catfish Farmers of Arkansas meeting. Hot Springs, Arkansas. January 16-17.

Stone, N. 2014. Split-ponds for golden shiners? Aquaculture Field Day, University of Arkansas at Pine Bluff, Pine Bluff, Arkansas. October 2.

Surathkal, P., M. Dey, and K. Singh. 2013. Consumer demand for frozen seafood products in the United States: an analysis using market-level retail scanner panel data. Paper presented at the North American Association of Fisheries Economists Forum 2013, St. Petersburg, Florida. May 21-24.

Torrans, L. and B. Ott. 2015. Intensive production of hybrid catfish – 14 tons per acre in earthen ponds. Abstract submitted to Aquaculture America 2015, New Orleans, Louisiana, February 19-22 and CFA Catfish Research Workshop, Natchez, Mississippi, February 27.

Whitis, G., T. Hanson, L. Roy, J. Chappell, and L. Bott. 2014. Using graded fingerlings in intensive commercial catfish production: reality, myth, and does it really matter? Abstract and Presentation, Aquaculture America 2014 meeting. Seattle, Washington. February 9-12.

Whitis, G., T. Hanson, L. Roy, J. Chappell, and L. Bott. 2014. Field validation of the FISHY Software program for catfish production using three years of production data from an Alabama pond verification trial. Abstract and Presentation, Aquaculture America 2014 meeting, Seattle, Washington. , February 9-12.

Poster Presentations

Brown, R., R. Lochmann, C. Engle, and A. Haukenes. 2014. Improving channel catfish *Ictalurus punctatus* broodstock performance by manipulating the lipid and protein contents of the diet. Poster presentation and abstract, 58th Annual Rural Life Conference, Pine Bluff, Arkansas. February 28.

Engle, C., M. Dey, R. Sexton, T. Saitone, T. Hanson, and M. Cook. 2014. Can collective action make the U.S. catfish industry more competitive in a global market? Poster presented at the 2014 Arkansas Aquaculture Field Day, Pine Bluff, Arkansas.

Kaimal, S., and N. Stone. 2014. Evaluation of the use of natural foods in traditional and split-pond systems for raising golden shiners (*Notemigonus crysoleucas*). Poster presented at the Aquaculture Field Day, University of Arkansas at Pine Bluff. Pine Bluff, Arkansas.

McCoy, K., S. Kaimal, M. A. Smith, and N. Stone. 2014. Summer production of golden shiners in split- and traditional earthen ponds. Poster presented at the Aquaculture Field Day, University of Arkansas at Pine Bluff. Pine Bluff, Arkansas.

Sexton, R. 2014. Creation of a Federal Marketing Order for U.S. farm-raised catfish. Poster presented at the 2014 Arkansas Aquaculture Field Day, Pine Bluff, Arkansas.

Smith, M. A., and N. Stone. 2014. Winter production of golden shiners (*Notemigonus crysoleucas*) in split- and traditional earthen ponds. Poster presented at the Aquaculture Field Day, University of Arkansas at Pine Bluff. Pine Bluff, Arkansas.

Digital Products

SRAC Publications website - https://srac.tamu.edu/

AquaPlant website - http://aquaplant.tamu.edu/

Cline, D. 2014. Aquaculture in the classroom. SRAC Presentation No. 006. Southern Regional Aquaculture Center, Stoneville MS.

Cline, D. 2014. Advanced aquaculture systems – split ponds. SRAC Presentation No. 007. Southern Regional Aquaculture Center, Stoneville MS.

Students Supported

Alichia Wilson, University of Arkansas at Pine Bluff, B.S. Fisheries Biology, graduated May, 2014. No thesis (undergraduate).

Lisa Bott, Auburn University, M.S. (May 2015), *Comparison of Production and Economic Aspects of Intensive Catfish Production Systems.*

Yilin Li, Auburn University, Ph.D. (August 2015), *Evaluation of Commercial Bacterial Amendments for improving Water and Sediment Quality in Alabama Catfish Ponds*.

Siriat Chatvijukul, Auburn University, Ph.D. (August 2015), *Elemental Composition of Aquaculture Feeds*.

Appendix 1. List of Completed SRAC Projects to Date

Effects of Mosquito Abatement Pesticides on Various Life Stages of Commercially Important Shellfish Aquaculture Species in the South
Duration: 2011-2012 Funding level: $39,973
Participants: Coll. Of Charleston, Sanibel-Captiva Conservation Foundation Marine Laboratory

Development of Baitfish, Goldfish and Ornamental Fish Hatchery Methods
Duration: 2011-2012 Funding level: $59,957
Participants: UAPB, LSU, UF

Reproduction and Larval Rearing of Freshwater Ornamental and Marine Bait Fish
Duration 2011-2014 Funding level: $499,400
Participants: UF, LSU, MSU

Potential Marketing Structures for the Catfish Industry
Duration: 2011-2013 Funding level: $244,591
Participants: UAPB, AU, KSU, UCDavis, UMo

Evaluation of Impacts of Potential "Cap and Trade" Carbon Emission Policies on Catfish, Baitfish, and Crawfish Farming
Duration: 2011-2013 Funding level: $119,952
Participants: AU, UAPB, LSU

Development and Evaluation of Cool-Water Crawfish Baits
Duration: 2011-2014 Funding level: $124,326
Participants: LSU, TAMU, AU

Identifying Determinants for Development of Live-Market Grading Standards for Crawfish
Duration: 2011-2012 Funding level: $49,952
Participants: LSU, UAPB

Improving Reproductive Efficiency of Cultured Finfish
Duration: 2009-2011 Funding level: $493,973
Participants: USDA/ARS/CGRU, TAMU-CC, TAMU, AU, UF, UT, UAPB, USDA/ARS NRAC

Economic Forecasting and Policy Analysis Models for Catfish and Trout
Duration: 2007-2009 Funding level: $148,335
Participants: UAPB, LSU, MSU, NCSU, UF, AU

Improving Reproductive Efficiency to Produce Channel x Blue Hybrid Catfish Fry
Duration: 2004-2008 Funding level: $460,000
Participants: AU, LSU, MSU, UMem, USDA/ARS CGRU

Development and Evaluation of Pond Inventory Methods
Duration: 2007-2009 Funding level: $294,976
Participants: UAPB, LSU, MSU, UF, UMiss

Feed Formulation and Feeding Strategies for Bait and Ornamental Fish
Duration: 2005-2008 Funding level: $335, 063
Participants: UAPB, TAMU, UF, UG

Innovative Technologies for Commercial-Scale Aquaculture
Duration: 2004-2008 Funding level: $935,726
Participants: AU, CU, LSU, MSU, UAPB, USDA/ARS CGRU, USDA/ARS NARC

Identification, Characterization, and Evaluation of Mechanisms for Control of Bolbophorus Trematodes and Columnaris-Like Bacteria Causing Disease in Warm Water Fish
Duration: 2003-2006 Funding level: $598,947
Participants: USDA-APHIS-WS, USDA-ARS SNARC, AU, CU, LSU, MSU, NCSU, UAPB, UT

National Aquaculture Extension Conference
Duration: 2002 Funding level: $4,500
Participants: University of Arizona

Development of Improved Harvesting, Grading and Transport Technology for Finfish Aquaculture
Duration: 2001-2003 Funding level: $750,000
Participants: UMem, MSU, NCSU, UAPB, UF, UT

Control of Blue-green Algae in Aquaculture Ponds
Duration: 1999-2001 Funding level: $836,247
Participants: AU, CU, LSU, MSU, NCSU, UAPB, UG, UMiss, UT

Management of Aquacultural Effluents from Ponds
Duration: 1999-2002 Funding level: $555,353
Participants: AU, LSU, MSU, NCSU, UAPB, Waddell MC

National Aquaculture Extension Conference
Duration: 1997 Funding level: $3,700
Participants: Univ. of Maryland

Verification of Recommended Management Practices for Major Aquatic Species
Duration: 1997-2000 Funding level: $160,305
Participants: AU, LSU, NCSU, UAPB

Optimizing Nutrient Utilization through Diet Composition and Feeding Strategies
Duration: 1996-1999 Funding level: $732,804
Participants: AU, LSU, UMem, MSU, NCSU, LSU, TAMU, UAPB, UG

Management of Environmentally-Derived Off-Flavors in Warmwater Fish Ponds
Duration: 1996-1999 Funding level: $866,281
Participants: AU, LSU, LaTech, UMem, MSU, TAMU, UAPB, UMiss, UT

Publications, Videos and Computer Software (Years 1-12)
Duration: 1995-2008 Funding level: $826,000
Participants: TAMU

Improving Production Efficiency of Warmwater Aquaculture Species through Nutrition
Duration: 1994-1996 Funding level: $760,466
Participants: AU, ECU, KSU, LSU, UMem, MSU, TAMU, UAPB, UG

Delineation and Evaluation of Catfish and Baitfish Pond Culture Practices
Duration: 1994-1997 Funding level: $332,993
Participants: AU, LSU, MSU, TAMU, UAPB, UG

Aquaculture Food Safety: Residues
Duration: 1992-1995 Funding level: $351,929
Participants: AU, LSU, MSU, TAMU, TennTech, UF, UG

National Coordination for Aquaculture Investigational New Animal Drug (INAD) Applications
Duration: 1992 Funding level: $2,000
Participants: North Central Regional Aquaculture Center

National Extension Aquaculture Workshop
Duration: 1991 Funding level: $3,005
Participants: UAPB, ACES, TAMU

Educational Materials for Aquaculturists and Consumers
Duration: 1991-1992 Funding level: $133,142
Participants: AU, KSU, LSU, MSU, NCSU, OSU, TAMU, UF, UG, UVI

Characterization of Finfish and Shellfish Aquacultural Effluents
Duration: 1991-1994 Funding level: $442,041
Participants: AU, CU, LSU, MSU, NCSU, TAMU, UAPB, UF, UG, VSU, Waddell MC

Food Safety and Sanitation for Aquacultural Products: Microbial
Duration: 1991-1995 Funding level: $535,338
Participants: UT, AU, LSU, UF, UG

Preparation of Extension Publications on Avian Predator Control in Aquaculture Facilities
Duration: 1990-1992 Funding level: $15,000
Participants: TAMU, MSU, UG, USDA/APHIS/ADC (MS, AR, LA, and S&T Field Station)

Effect of Nutrition on Body Composition and Subsequent Storage Quality of Farm-Raised Catfish
Duration: 1990-1992 Funding level: $822,843
Participants: AU, KSU, LSU, MSU, TAMU, UG

Harvesting, Loading, and Grading Systems for Cultured Freshwater Finfishes and Crustaceans
Duration: 1990-1993 Funding level: $373,952
Participants: LSU, AU, CU, UMem, MSU, UG, USL

Immunization of Channel Catfish
Duration: 1990-1991 Funding level: $99,789
Participants: AU, LSU, UG

Enhancement of the Immune Response to *Edwardsiella ictaluri* in Channel Catfish
Duration: 1990-1991 Funding level: $98,363
Participants: CU, TAMU, UG

Develop a Statistical Data Collection System for Farm-raised Catfish and Other Aquaculture Products in the Southern Region
Duration: 1989-1990 Funding level: $13,771
Participants: MSU, LSU, AU, UA, TAMU, UG, LU, CU, UF, UT, VTU, USDA/NASS

Performance of Aeration Systems for Channel Catfish, Crawfish, and Rainbow Trout Production
Duration: 1988-1990 Funding level: $124,990
Participants: AU, LSU, MSU, NCSU, TAMU

Analysis of Regional and National Markets for Aquacultural Products Produced for Food in the Southern Region
Duration: 1988-1990 Funding level: $346,038
Participants: AU, CU, LSU, MSU, TAMU

Preparation of Southern Regional Aquaculture Publications
Duration: 1988-1990 Funding level: $150,000
Participants: AU, UA, UF, UG, KSU, LSU, MSU, NCSU, UPR, USC, TAMU, UVI