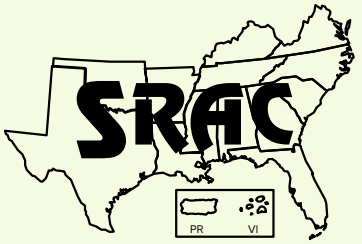

Nearly 70% of the $1 billion dollar domestic aquaculture industry is located in the southeastern United States. One of the most important programs supporting this critical sector of southern agriculture is the USDA-CSREES Southern Regional Aquaculture Center (SRAC). The Center is the only research-funding program 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.

SOUTHERN REGIONAL AQUACULTURE CENTER

ARKANSAS LOUISIANA MISSISSIPPI KENTUCKY VIRGINIA OKLAHOMA TEXAS ALABAMA GEORGIA NORTH CAROLINA SOUTH CAROLINA VIRGIN ISLANDS FLORIDA TENNESSEE PUERTO RICO

SUMMARY OF PROJECTS

WHAT IS SRAC? . . . SRAC is one of five Regional Centers established by Congress and administered through the USDA Cooperative State Research, Education, and Extension Service. The thirteen states and two territories included in the Southern Region are listed in the masthead, above. Mississippi State University serves as the Host Institution for SRAC, and the Administrative Center is located at the Thad Cochran National Warmwater Aquaculture Center, Stoneville, Mississippi.

In the simplest sense, SRAC provides an efficient means for identifying and solving problems. Priority research and education needs for the Southern Region are identified by the Industry Advisory Council, which consists of aquaculture industry representatives from throughout the region, and the Technical Committee, which is composed of research and extension scientists. These two groups recommend project areas to the SRAC Board of Directors, which then selects priority categories for project development and funding. The best scientific talent in the region is then brought together to address the problem.

IMPACT . . . Hundreds of high-quality, peer-reviewed scientific articles, graduate theses, and technical papers have been published since program inception in 1987. Through the activities of the SRAC "Publications" project, much of this work is summarized in the 170 fact sheets and reports available at the SRAC web site (see footnote).

SRAC research has lead to many technologies adopted by the aquaculture industry, and two examples are presented in this summary. A new seine developed at Mississippi State University as part of the "Harvesting" project allows catfish ponds to be harvested faster and with greater capture efficiency than traditional seine designs. And a mechanical fish grader, developed at the University of Arkansas at Pine Bluff, is so superior to conventional technologies that it may revolutionize catfish harvest technology.

This report summarizes these projects and others currently funded by SRAC. ❖

Project Summaries . . .

For further information on the Southern Regional Aquaculture Center and detailed reports of the results of SRAC projects, visit the SRAC web site at http://www.msstate.edu/dept/srac

December, 2002

Publications, Videos and Computer Software

THE CHALLENGE . . .

Aquaculture currently produces about 25% of the world's seafood supply, and is one of the most rapidly expanding agricultural industries in the world. Domestic aquaculture production is centered in the southeast region, where more than 100 species of fish, shellfish, aquatic reptiles, and plants are cultured for food or ornamental purposes. The total economic value of southeastern aquaculture is over five billion dollars. Aquaculture is a young, unique, and rapidly expanding industry, and the need for information to sustain growth and development has increased dramatically over the past 20 years.

YOUR RESPONSE . . .

Extension and research scientists in the southeastern United States initiated this project to produce research-based fact sheets, videos, and other educational materials to support regional aquaculture production and marketing. The SRAC publication project uses a region-wide pool of experts to develop materials for distribution through the nationwide network of Extension Specialists and County Agents. This process makes efficient use of personnel and funds at the State level, and results in timely, high-quality educational materials. Each publication contains understandable, factual information that provides guidance for producers, processors, consumers, or investors. Subject matter includes biology and life history of specific culture species, culture techniques and systems, nutrition, water quality and waste management, disease treatment, off-flavor management, consumer education, marketing, and much more.

PRINCIPAL ACCOMPLISHMENTS . . .

The Southern Regional Aquaculture Center has now published 154 fact sheets, 16 research summaries, and 19 videos. These publications provide essential information for aquaculture producers, lending agencies, and consumers of aquaculture products. Educators in high schools and colleges use SRAC publications in classrooms throughout the United States and the world.

Eleven publications were printed this year, with 15 fact sheets, a video, and a compilation CD in progress. These publications were developed by 21 scientists associated with the following institutions and agencies:

- Auburn University
- Clemson University
- Louisiana State University
- Mississippi State University
- North Carolina State University
- Texas A&M University
- Texas A&M University - Sea Grant College
- South Carolina Department of Natural Resources
- University of Arkansas at Pine Bluff
- University of Florida
- University of North Carolina at Wilmington

Fact sheets are available at http://www.msstate.edu/dept/srac on the Internet. ❖

Management of Aquacultural Effluents from Ponds

THE CHALLENGE . . .

Aquaculture operations in the United States have recently come under increased scrutiny because of potential or perceived environmental degradation caused by the discharge of water from production facilities. Aquaculture is now under consideration by the Environmental Protection Agency (EPA) as a candidate industry for new regulatory activity. Therefore, regulation of pond aquaculture effluents in the southeastern United States within the next few years is a distinct possibility. Regulatory requirements to operate ponds without discharge could drastically alter the way pond aquaculture facilities have traditionally been managed. Additionally, these requirements would impose additional financial burdens on existing operations and restrict further development of the regional aquaculture industry.

OUR RESPONSE . . .

The aquaculture industry has an opportunity to participate in the process of formulating regulations, because the approach and framework for the regulatory process have not yet been decided. Through this regional research project, the research community can provide information required by permit writers for the development of rational regulatory mechanisms. This project will provide important information on the character of effluents from aquaculture ponds and explore management methods for reducing the volume and improving the quality of pond effluents. This information will be used to develop a set of best-available pond water management practices which will be evaluated for environmental risks and economic performance.

Fourteen research scientists and extension agents are collaborating on a three-year project initiated on April 1, 1999. The following institutions are involved:

- Auburn University
- University of Arkansas at Pine Bluff
- Louisiana State University
- Mississippi State University
- North Carolina State University
- Virginia Polytechnic Institute and State University
- South Carolina Department of Natural Resources - Waddell Mariculture Center

PRINCIPAL ACCOMPLISHMENTS . . .

Solids in pond overflow from rainfall and in most of the water discharged during intentional drawdown of ponds are very difficult to settle because most particles are small and organic. Between 51-82% of the suspended solids in effluent from catfish ponds in Alabama and Mississippi, hybrid striped bass ponds in North Carolina, and baitfish ponds in Arkanasas were less than 5 micrometers in diameter.

In watershed ponds for catfish culture and in marine shrimp ponds, effluent quality deteriorates during the final 20% of water volume discharged. This effluent can be settled with sedimentation basins designed with a hydraulic retention time of 8 hours, although a settling time of 1 to 4 hours is sufficient to reduce total suspended solids in effluents to 75 to 90% of original concentrations. Solids removal is associated with settling of the mineral fraction, with little change in organic solids concentrations in effluents.

Project research indicates that drainage ditches can be used to settle the heaviest solids that are discharged with the initial flush of effluent from ponds with internal drains and during discharge of the last 10 to 20% of effluent volume. Water quality improvement has been demonstrated by passing effluent from catfish ponds in Mississippi, baitfish ponds in Arkansas, crawfish ponds in Louisiana, and

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Control of Blue-Green Algae in Aquaculture Ponds

THE CHALLENGE . . .

The occurrence of both noxious and toxic blue-green algal blooms in fish aquaculture is a worldwide problem. Excessive abundance of blue-greens in aquaculture ponds, especially when combined with their habit of growing in surface scums, can cause low dissolved oxygen concentrations and other water quality aberrations that affect fish growth and health. Several species of blue-green algae also produce compounds that are highly toxic to aquatic animals. The ability to control the composition of these algal blooms could result in better fish growth and lower costs for aeration and other water quality management procedures The annual economic loss associated with blue-green algal blooms in southeastern aquaculture ponds exceeds $50 million; therefore, any management practice demonstrated to be effective in controlling these algae has considerable potential for enhancing profits and would of tremendous benefit to the aquaculture industry.

OUR RESPONSE . . .

The overall goal of this project is to identify methods of controlling or eliminating blue-green algae from aquaculture ponds. Treatments being evaluated include the use of natural chemicals as algicides, nutrient manipulations, water circulation techniques, biocontrol using planktivorous fishes, and a modified pond culture system called the Partitioned Aquaculture System, or PAS.

Twenty-one research and extension scientists representing the following institutions and agencies are participating in the 3-year project which began on 1 January 1999:

- University of Arkansas at Pine Bluff
- Auburn University
- Clemson University
- University of Georgia
- Louisiana State University
- University of Mississippi
- Mississippi State University
- North Carolina State University
- University of Tennessee
- USDA/ARS, Natural Products Utilization Research Unit
- USDA/ARS, Southern Regional Research Center

PRINCIPAL ACCOMPLISHMENTS . . .

Chemicals in certain plants algae may have the ability to control blue-green algae that bloom in aquaculture ponds. Research has been completed at two institutions to identify these natural chemicals that prevent the establishment of noxious blue-green algal communities. This project examined over 4,000 extracts from a large number of marine algae, wetland plants, and a biogenetically diverse repository of tropical rainforest plant extracts from over 170 plant families. Extracts that showed non-specific antimicrobial activity or cytotoxicity were excluded from further study. Some plant and algal extracts evaluated in this study showed strong, selective activity against blue-green algae. One derivative from a compound found in certain plants is undergoing patent application for use as a selective algicide to help prevent musty off-flavor in cultured catfish. Extracts from the roots and stems of a Peruvian collection of *Dulacia candida* (family Olacaceae) showed extremely potent activity against blue-green algae, approaching the parts per billion range. The substances responsible for this activity are currently under investigation.

Researchers at six institutions evaluated nutrient manipulations to promote more desirable phytoplankton communities by eliminating blue-green algae. Methods being evaluated include manipulating the ratio of nitrogen-to-phosphorus in the water, reducing the availability of phosphorus from

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Control of Blue-Green Algae in Aquaculture Ponds (continued from page 4)

bottom muds, enhancing the availability of inorganic carbon, increasing levels of salinity and potassium, and manipulating trace metal availability. Studies indicated that various manipulations of waterborne plant nutrients have little promise for controlling phytoplankton community composition in catfish ponds with high feeding rates.

Phosphorus-only fertilization was as effective as nitrogen plus phosphorus fertilization in bait minnow ponds. Phosphorus-only fertilization is less expensive, it conserves nitrogen, and it lessens the possibility for nitrogen pollution of natural waters by pond effluents. Removal of soft sediment from old (25 years or more) bait minnow ponds should improve bottom soil quality, but the usual method of pond renovation had little effect on subsequent levels of soluble reactive phosphorus in baitfish pond waters or on average concentrations of phosphorus in bottom sediments. A possible explanation for these results is that pond bottom soils are used to rebuild levees during renovation and not removed from ponds.

The research in baitfish ponds has raised the possibility that hydrogen sulfide may possibly contribute to declining production levels, as several baitfish species are known to be sensitive to low concentrations of this compound. If additional research indicates that hydrogen sulfide is problematic in baitfish ponds, sodium nitrate might be a possible treatment to temporarily suppress sulfide formation.

The effects of water circulation on phytoplankton communities is under investigation at five institutions. Research in Mississippi suggests that some threshold level of turbulent mixing is necessary to overcome light limitation of phytoplankton production and shift phytoplankton community composition from dominance by blue-green algae. Application of turbulent mixing should attempt to develop a uniform flow field to avoid areas of concentrated turbulence that can suspend pond soils.

In Louisiana, three water management practices were evaluated, each at two levels to determine their effects on blue-green algal community composition and water quality in experimental mesocosms managed to simulate commercial catfish production practices. A continuously operating pump mixed water in these ponds. Suspension of sediments in the water column from vertical mixing increased total nitrogen, total phosphorus, nitrate, and pH but had no discernible effect on the phytoplankton community.

In North Carolina, hybrid striped bass research production ponds exhibited no differences among circulated and non-circulated treatments in fish production or in any of the measured water quality parameters. Non-circulated ponds had higher numbers of diatoms, but there were no differences among treatments in incidence of blue-green algae or in overall phytoplankton abundance. This study showed no benefits resulting from water circulation in hybrid striped bass ponds.

Using plankton-feeding fish to control blue-green algae is being investigated at three institutions. In Georgia, stocking 600 adult threadfin shad per acre of catfish pond in the winter or spring reduced blue-green algal abundance. In replicated experimental ponds at Auburn University, stocking threadfin shad with fingerling channel catfish resulted in improved water quality conditions later in the growing season. This apparently produced improved culture conditions for channel catfish, leading to greater survival of catfish in the presence of shad. Stocking threadfin shad in Alabama commercial catfish ponds also resulted in significant improvements in water quality. In Louisiana, the presence of shad did not reduce the percentage of blue-green algae in the phytoplankton community, but did significantly reduce total algal

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Development of Improved Harvesting, Grading and Transport Technology for Finfish Aquaculture

THE CHALLENGE . . .

Inefficient harvesting, improper sizing, and stresses related to handling and hauling of fish are seriously affecting profitability of the finfish aquaculture industry. Market-size fish that escape harvest continue to grow and create additional inefficiencies resulting from higher feed conversion ratios and carry-over of large fish that are unacceptable to processing plants. In addition, if the stress is sub-lethal, incidence of disease increases and growth rate, fecundity, and product quality may be lessened. Losses during transport can result in even greater overall reductions in farm profits, particularly since losses at this stage are generally market-size fish that represent investment of full production costs.

OUR RESPONSE . . .

Twelve research scientists have teamed in a three-year project that began on January 1, 2001, to investigate methods to improve harvest efficiency, grading selectivity, and transport of finfish, and thus improve profitability of finfish aquaculture. The scientists represent these institutions:

- Mississippi State University
- University of Tennessee
- North Carolina State University
- University of Memphis
- University of Florida
- University of Arkansas at Pine Bluff

Several possible solutions to this problem are under investigation:

- developing new gear and methods or modifying existing methods to improve harvest efficiency and fish grading selectivity as well as reducing fish stress associated with these activities;

- evaluating methods used for loading and transporting of fish to reduce fish mortalities and the negative effects of stress on product quality; and

- comparing new technology and current technology for harvesting, grading, and loading fish for efficiency and profitability.

PRINCIPAL ACCOMPLISHMENTS . . .

Work during years 1 and 2 of the project indicated that braided polyethylene mesh is a good choice for use in constructing seines and socks for harvesting and grading catfish. Also, mesh sizes of the braided material that retain fish of a certain size have been determined. In addition, a new seine design that appears to be more efficient than conventional seine designs has been commercialized.

Another result from this work, is that a horizontal floating platform grader with adjustable spacing can be effectively integrated into current harvest procedures to grade catfish in ponds. Tests with the grader have shown that 5 to 11% more weight of sub-harvestable size fish can be grader compare to current technology. This resulted in a 12.5% increase in average weight of fish available for processing. With certain modifications, the grader appears to be adaptable to other species such as striped bass. Though testing continues, several commercial catfish producers and one striped bass producer have adopted this technology.

Work on ammonia excretion rates of golden shiners has provided a basis for calculating filter size for use in hauling live baitfish. ❖

Management of Aquacultural Effluents from Ponds (continued from page 3)

shrimp ponds in South Carolina through drainage ditches prior to release to receiving waters.

Effluent volume from catfish ponds can be reduced by increasing pond depth by 1 foot to increase rainwater storage capacity and linking the deeper combined storage/production pond to one or three adjacent conventional ponds. Effluent volume was reduced by approximately 50% and groundwater consumption was reduced by more than 40% compared to conventionally managed ponds. Linking ponds and reusing stored water has not affected fish growth, occurrence of diseases, or water quality.

Effluent volume from baitfish pond can be reduced if water can be reused. Research in Arkansas has demonstrated that water from baitfish ponds can be reused if it is filtered to remove zooplankton predators of newly stocked baitfish fry.

Economic analysis indicates that construction of settling basins or combined storage/production ponds requires a large investment of financial resources and result in a reduction in revenue. The results of this analysis suggest that using existing ponds as sedimentation basins is more economical than building new sedimentation basins.

Project scientists have been active participants in the Federal Joint Subcommittee on Aquaculture - Aquaculture Effluents Task Force. They have assembled and provided the Task Force and EPA with general information on the aquaculture sectors in the Southern region, the characteristics of pond effluents, and the effectiveness of various effluent management options and best management practices. Best management practices formulated by project participants will be used as the basis for regulation in Alabama and Louisiana. ❖

Control of Blue-Green Algae in Aquaculture Ponds (continued from page 5)

biomass and, most importantly, nearly eliminated species of blue-green algae known to cause off-flavor in catfish.

Researchers at Clemson University have demonstrated that current industry pond fish production can be more than tripled through the use of an innovative new technique, the Partitioned Aquaculture System (PAS). High catfish yield, with no water discharge, combined with control of algal density and community composition has been demonstrated in PAS units since 1996. This system couples high-density raceway culture of fish with paddlewheel driven high rate algal growth basins for treatment of ammonia and organic wastes allowing 100% reuse of culture water in self-contained, self-oxygenating culture units. A detailed economic analysis projects system production costs to be 15 to 17 cents/lb less than conventional pond aquaculture. ❖

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