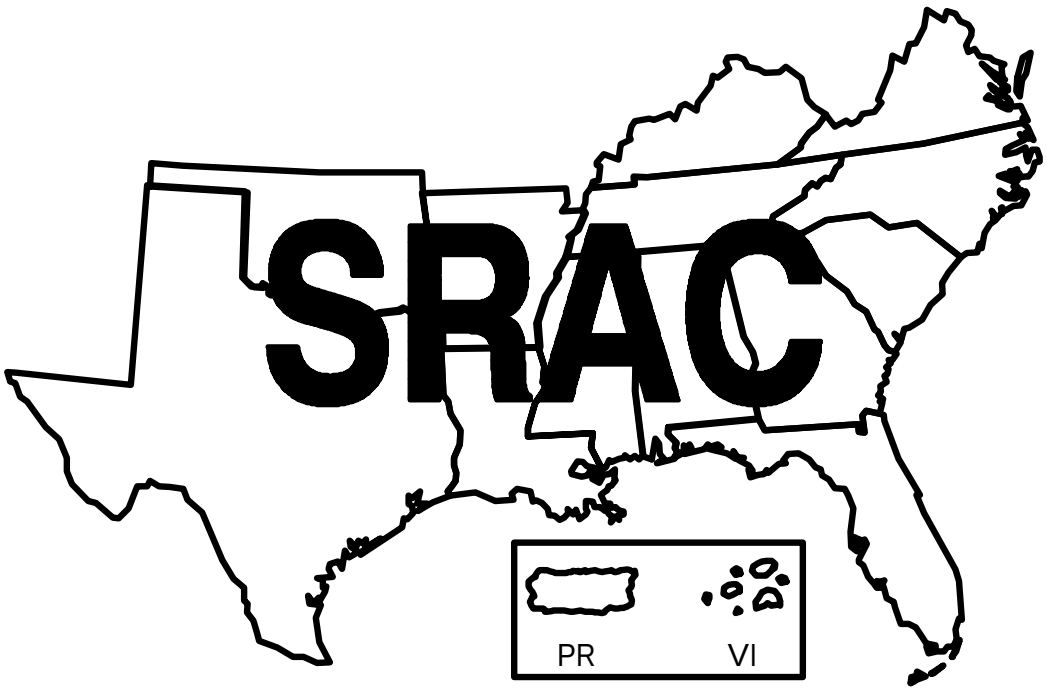
SOUTHERN REGIONAL AQUACULTURE CENTER



NINTH ANNUAL PROGRESS REPORT

DECEMBER, 1996

Work summarized in this report was supported in part by Grant Nos. 90-38500-5099, 91-38500-5909, 92-38500-7110, 93-38500-8393, 94-38500-0045, 95-38500-1411 and 96-38500-2630 from the United States Department of Agriculture sponsored by the Cooperative State Research, Education, and Extension Service.

NINTH ANNUAL PROGRESS REPORT

December, 1996

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TABLE OF CONTENTS

PREFACE

Title XIV of the Agriculture and Food Act of 1980 and the Food Security Act of 1985 authorized establishment of aquacultural research, development, and demonstration centers in the United States (Subtitle L, Sec. 1475[d]) in association with colleges and universities, State Departments of Agriculture, federal facilities, and non-profit private research institutions.

The Regional Aquaculture Centers encourage cooperative and collaborative research and extension educational programs in aquaculture having regional or national application. Center programs complement and strengthen existing research and extension educational programs provided by the Department of Agriculture and other public institutions.

The mission of the Centers is to support aquaculture research, development, demonstration, and extension education to enhance viable and profitable U.S. aquaculture production which will benefit consumers, producers, service industries, and the American economy. Projects that are developed and funded by the Regional Centers are based on industry needs and are designed to directly impact commercial aquaculture development in all states and territories. The Centers are organized to take advantage of the best aquaculture science, education skills, and facilities in the United States. Center programs insure effective coordination and a region-wide, team approach to projects jointly conducted by research, extension, government, and industry personnel. Inter-agency collaboration and shared funding are strongly encouraged.

Beginning with the first projects funded by SRAC, the interest among aquaculture research and extension scientists in the SRAC activities has been excellent. We are very 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 Principal Investigators for the projects. We believe this broad-based representation has resulted in strong, cooperative research which will be of long-lasting benefit to aquaculture producers and consumers, and to the growth of the aquaculture industry in the United States.

ACKNOWLEDGMENTS

SRAC would like to acknowledge the contributions of the Principal Investigators and Participating Scientists involved in the projects reported in this Ninth Annual Progress Report. All 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 our Board, IAC and TC, and those serving as Administrative Advisors for our projects.

I. INTRODUCTION

This Ninth Annual Progress Report of the Southern Regional Aquaculture Center (SRAC) covers the period from September 1, 1995, to August 31, 1996. Section IV includes Progress Reports on the five multi-year research and extension projects supported by SRAC during this reporting period.

Progress Reports are included in Section IV for the following on-going research and extension projects:

Aquaculture Food Safety: Residues

Improving Production Efficiency of Warmwater Aquaculture Species Through Nutrition

Delineation and Evaluation of Catfish and Baitfish Pond Culture Practices

Publications, Videos and Computer Software

Management of Environmentally-Derived Off-Flavors in Warmwater Fish Ponds

Three additional projects proposals have been completed and approved by the SRAC Board of Directors and will be initiated after final approval of USDA/CSREES has been granted.

Verification of Recommended Management Practices for Major Aquatic Species

Optimizing Nutrient Utilization and Waste Control Through Diet Composition and Feeding Strategies

National Aquaculture Extension Conference

The objectives of the project **Verification of Recommended Management Practices for Major Aquatic Species** include:

1. Develop and implement verification programs of recommended management practices for catfish, baitfish, trout and crawfish production systems in participating states.

2. Publish guidelines for infrastructure development, program implementation and assessing results/benefits of aquaculture management verification.

3. Publish recommended management plans and results of Objective 1.

The Administrative Advisor and Steering Committee for this project are:

Administrative Advisor:

Dr. Billy G. Hicks, Dean
Tennessee Agricultural Extension Service
University of Tennessee
Knoxville, TN

Steering Committee -- Research/Extension:

Carole Engle, Chair, AR
Jack Whetstone, SC
R. M. Durborow, KY
Chris Hyde, AL
G. W. Lewis, GA
M. W. Brunson, MS
Andy Lazur, FL
J. L. Avery, LA

Steering Committee -- Producer/Industry:

Jerry Williamson, AR

The objectives of the project **Optimizing Nutrient Utilization and Waste Control Through Diet Composition and Feeding Strategies** include:

1. Determine the effects of manipulating diet composition on fish production, nutrient

utilization, and consequently production of organic and nitrogenous wastes.

2. Assess the effects of various feeding strategies and techniques on fish production, nutrient utilization, and waste production.

3. Develop publications to effectively extend information derived from this project to feed manufacturers and fish producers.

The Administrative Advisor and Steering Committee for this project are:

Administrative Advisor:

Dr. W. H. Brown, Associate Director
Louisiana Agricultural Experiment Station
Louisiana State University
Baton Rouge, LA

Steering Committee -- Research/Extension:

Ken Davis, Chair, TN
Ray McClain, LA
R. C. Reigh, LA
T. A. McCaskey, AL
Rebecca Lochmann, AR
E. H. Robinson, MS
Y. W. Huang, GA
J. M. Hinshaw, NC
Delbert Gatlin, TX

Steering Committee -- Producer/Industry:

Lester Myers, MS
W. T. Kyser, AL

The **National Aquaculture Extension Conference** will be held April 9-12, 1997, in Annapolis, Maryland. This proposed national conference builds on the National Aquaculture Extension Workshop held in 1992 in Arkansas and on the regional collaboration that has resulted from the networks of extension professionals who have been involved directly with the RACs as members of the Technical Committees or have contributed to and/or benefited from the development of RAC extension products.

The 1992 workshop was the first interregional project funded by the RACs. The role of extension education within the Regional Aquaculture Center program is evidenced by the realization of the need for an effective extension component in most if not all RAC-funded projects. The national extension network has an important role in furthering U.S. aquaculture development. With the advent of new technologies of computer systems, distance education satellite programs and a movement towards sharing expertise and talents across state and regional boundaries, there are increasing opportunities for meaningful multi-state collaborative efforts that raise standards for excellence and service. Because of declining state-level budgets and staff resources there is a more pressing need to leverage existing resources in cases of mutual interest and need relating to aquaculture.

The changes in technologies, issues, people and challenges since the last National Aquaculture Extension Workshop warrant an updated approach to seeking solutions and advancing collaborative strategies to move private industry development forward in an economically and environmentally sustainable manner that is acceptable by today's society.

Objectives of the conference are:

1. Learn successful approaches to problem-solving through case studies that can be replicated in other states.

2. Demonstrate and conduct hands-on experience with state-of-the-art computer applications for improving delivery of extension programs.

3. Identify national extension priorities and critical issues with development of corresponding action plans for implementation.

4. Identify potential interregional extension projects, such as curriculum development of national decision-support databases.

5. Share educational materials and programs in addition to expertise.

6. Strengthen regional and national communication networks to improve services to customers.

7. Examine successful extension components and outcomes to RAC research projects and develop approaches to improve integration across RACs nationwide.

8. Develop a collective strategy to define extension's role in measuring impacts of RAC projects and collaboration with others in academia and the private sector.

9. Strengthen communication networks to leverage resources and talent-sharing.

10. Improve business management skills related to aquaculture and enhance knowledge concerning marketing aspects of aquatic products.

11. Develop a method to evaluate the impact and accomplishments associated with the conference after one year (1998).

II. ORGANIZATIONAL STRUCTURE

The Agriculture Acts of 1980 and 1985 authorized the establishment of aquaculture research, development and demonstration centers in the United States. With appropriations provided by Congress for the 1987 and 1988 FY's, 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.

The Board of Directors, the policy-making body for SRAC, utilizes recommendations from an Industry Advisory Council (IAC) and a Technical Committee (TC) to determine priorities for new and continuing aquaculture research and extension projects for the Southern Region. IAC membership represents different segments of the aquaculture industry throughout the Region and provides valuable inputs for identifying priorities from an industry perspective. The TC is composed of research and extension scientists from essentially all states within the region and identifies priorities from a technical perspective. These groups provide valuable inputs into the SRAC program by identifying and developing priority research and extension needs in aquaculture. Using recommendations from these two groups, the SRAC Board of Directors selects priority categories for project development and funding.

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.

A. 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 of Directors, Industry Advisory Council, Technical Committee, Steering Committees and project Work Groups are provided by the Administrative Center. This includes monitoring the status and progress of projects, preparing and executing Letters of Agreement, tracking administrative and project expenditures, reviewing progress reports and assisting Principal Investigators and participating institutional Grants Office personnel as needed.

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

B. BOARD OF DIRECTORS

The Board of Directors is the policy-making body for SRAC. Membership of the Board provides an appropriate balance among representatives from State Agricultural Experiment Stations, Cooperative Extension Services, 1890 Institutions, and the Council of Administrative Heads of Agriculture (CAHA).

The structure of the Board is as follows:

Three members of the 1862 Southern Extension Service Directors Association
Three members of the 1862 Southern Experiment Station Directors Association

One member of the 1890 Association of Research Administrators
One member of the 1890 Association of Extension Administrators
One CAHA administrator from the host institution

Members of the Board are:

Jack Bagent, Louisiana Cooperative Extension Service
Harold R. Benson, Kentucky State University
William H. Brown, Louisiana State University
W. S. Clarke, Virginia State University
Dan Ezell, Clemson University Cooperative Extension Service
R. Rodney Foil, Mississippi State University (Chairman)
David E. Foster, Arkansas Cooperative Extension Service
David H. Teem, Auburn University
Greg Weidemann, University of Arkansas

Ex-officio Board members are:

Lester Myers, Chairman, Industry Advisory Council
James T. Davis, Co-chairman, Technical Committee
J. Larry Wilson, Co-chairman, Technical Committee
Craig S. Tucker, Director, SRAC

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 Technical Committee and Industry Advisory Council 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.

C. INDUSTRY ADVISORY COUNCIL

The IAC, which meets at least annually, 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 as deemed appropriate by the Board of Directors.

The IAC provides an open forum wherein maximum input from private and public sectors can be gained and incorporated into annual and on-going plans for SRAC. The chairman serves for two years and is elected by IAC members.

Members of the IAC are:

Steve Abernathy, Producer, LA
J. Neal Anderson, Producer, AR
James A. Battle, Jr., Producer, SC
Randy Deshotel, Producer, LA
Lane Gregory, Producer, NC
Austin Jones, Producer, MS
Lester Myers, Feed Mill/Service, MS (Chairman)
Rick Perry, Commissioner of Agriculture, TX
Kenneth Semmens, Producer, GA
George Smelley, Processing/Marketing, AL
D. B. Strickland, Financial Institution, NC
Marty Tanner, Producer, FL
Jerry Williamson, Other, AR

IAC members serve up to three-year appointments having staggered terms with options for reappointment.

The IAC (1) recommends to the Board research and extension needs and priorities from an industry perspective; (2) reviews project proposals and accomplishment and termination reports; and (3) recommends to the Board, jointly

with the Technical Committee, actions regarding new and continuing proposals, proposal modifications and terminations.

D. TECHNICAL COMMITTEE

The TC is composed of representatives from participating research institutions and state extension services, other state or territorial public agencies as appropriate, and non-profit private institutions. Membership of the TC includes research and extension scientists representing essentially all states in the region. The TC meets as needed, but at least annually, and has a co-chairman for research and a co-chairman for extension. Co-chairmen serve for two years and are elected by TC members.

Members of the TC for research are:

Dallas Alston, PR
Gary Burtle, GA
Donald Campton, FL
J. A. Collier, SC
Harry Daniels, NC
Carole Engle, AR
Delbert Gatlin, TX
John Hargreaves, MS
Leonard Lovshin, AL
Ray McClain, LA
Stephen Smith, VA
Jim Tidwell, KY
J. L. Wilson, TN (Co-chair)

Members of the TC for Extension are:

Jimmy Avery, LA
Martin W. Brunson, MS
Charles "Bo" Collins, AR
James T. Davis, TX (Co-chair)
Robert Durborow, KY
G. J. Flick, Jr., VA
Tom Hill, TN
Conrad Kleinholz, OK
Andy Lazur, FL
G. W. Lewis, GA
Tom Losordo, NC
Mike Masser, AL
Jack Whetstone, SC

Technical Committee members serve up to three-year appointments having staggered terms with options for reappointment.

The TC (1) recommends to the Board research and extension needs and priorities from a scientific perspective; (2) develops problem statements for research and extension areas under consideration; (3) plans, develops, and implements regional proposals; (4) reviews proposals and accomplishment and termination reports; and (5) recommends to the Board, jointly with the IAC, actions regarding new and continuing proposals, proposal modifications and terminations.

E. PROJECT CRITERIA

Projects developed within SRAC should meet the following criteria:

- involves participation by two or more states in the Southern Region;
- requires more scientific manpower, equipment, and facilities than generally available at one location;
- approach is adaptable and particularly suitable for inter-institutional cooperation, resulting in better use of limited resources and a saving of funds;
- will complement and enhance ongoing extension and research activities by participants, as well as offer potential for expanding these programs;
- is likely to attract additional support for the work which is not likely to occur through other programs and mechanisms;
- is sufficiently specific to promise significant accomplishments in a reasonable period of time (usually up to 3 years);
- can provide the solution to a problem of fundamental importance or fill an information gap;
- can be organized and conducted on a regional level, assuring coordinated and complementary contributions by all participants.

F. PROJECT DEVELOPMENT PROCEDURES

Research and extension priorities and statements of problems defining priority areas are jointly developed and recommended to the Board by the IAC and TC. Using their recommendations as guidelines, the Board selects specific problem areas to be funded and appoints a Steering Committee (comprised of research, extension and industry representatives from the IAC, TC and other agencies) and an Administrative Advisor. The Steering Committee has full responsibility for developing a definitive research and extension Problem Statement, recommending levels of funding for each year of the proposed work, and preparation of the subsequent project proposal.

An Administrative Advisor is appointed by the Board for each active project area, and serves as the coordinator for activities related to the project, providing continuous linkage between the Work Group, Steering Committee and SRAC. Responsibilities of Administrative Advisors are outlined in the SRAC Operations Manual.

Following review of the Problem Statement by the IAC and TC, and review and approval by the Board, announcements to convene an *ad hoc* Work Group are made regionally to (1) institutions and individuals identified by the Steering Committee; (2) extension and research directors of 1862 and 1890 Land Grant Universities within the Southern Region; and (3) other institutions, agencies and organizations within the Southern Region having demonstrated capabilities in the area under consideration.

All *ad hoc* Work Group participants desiring to participate in a proposed research and extension activity must submit a "Commitment to Participate" form. Participants will also have an opportunity to make appropriate comments and suggestions relative to the development of the proposal and their interest and capability in participating. This information is used by the Steering Committee to draft a proposal, recommending the best qualified participants, as well as tentative funding allocations, to address objectives outlined in the Problem Statement.

Project proposals are reviewed by the Steering Committee, IAC, TC, all proposed participants and designated peer reviewers from within the region and from outside the region. The SRAC Director submits the project proposal and peer reviews to the Board of Directors for review and approval. Proposals not approved by the Board are returned for revision or eliminated from consideration.

Final selection of projects and levels of funding are determined by the Board. Most projects have an expected duration of three years. Following final approval by the Board of Directors and CSREES, work described in the research and extension project is implemented. Participating scientists, along with the Steering Committee, comprise the permanent Work Group for the research and extension effort and are responsible for implementation and conduct of the proposed work.

Separate allocations are made for research and extension to ensure strong programs in each of these areas. All funds allocated for extension activities are administered through the respective State Cooperative Extension Services.

III. ADMINISTRATIVE ACTIVITIES

The SRAC administrative staff consists of the Center Director and Administrative Assistant. A wide variety of support functions for the various SRAC components, including the Board, TC, IAC, Steering Committees and project Work Groups are provided including:

-- Center Director serves as an ex-officio member of the Board, TC, and IAC.

-- Monitor research and extension activities sponsored by SRAC.

-- Provide documentation for, attend and assist with meetings of the Board, TC and IAC; prepare minutes of meetings of the Board.

-- Attend and participate in meetings of producers, industry representatives, scientists, and others involved in the aquaculture industry in the Southern Region and nationally.

-- Solicit and receive nominations for memberships on the Technical Committee and the Industry Advisory Council.

-- Coordinate and participate in testimony before the House Agriculture, Rural Development, and Related Agencies Subcommittee on Appropriations regarding RAC support.

-- Work with members of the House and Senate Appropriations Committees, as well as other members of Congress from the Southern Region, in support of the RACs.

-- The Director of SRAC serves as a member of the National Coordinating Council for Aquaculture which consists of the Directors of the five Regional Centers and appropriate USDA/CSREES National Program staff.

-- Prepare and submit the Grant Application entering into funding agreement with USDA/CSREES for each fiscal year.

-- Prepare and submit Annual Plans of Work and Amendments to USDA/CSREES.

-- Develop and execute appropriate Letters of Agreement with participating institutions in each funded proposal for the purpose of transferring funds and coordinating and implementing projects approved under each of the grants.

-- Serve as fiscal agent to distribute funds as approved under the grants and as set forth in the Letters of Agreement.

-- Approve and process invoices received from participating institutions for reimbursement of expenditures.

-- Track status of reimbursement of expenditures to each participating institution for all funded projects.

-- Monitor budgetary status and progress of participating institutions for all funded projects.

-- Prepare budgets for the Administrative Center, track administrative expenditures, and obtain USDA/CSREES approval for project and budget revisions.

-- Prepare budget reports for the Board of Directors, tracking expenditures and status of funded projects and the Administrative Center.

-- Assist personnel from participating institutions in establishing procedures for invoicing for expenditures and obtaining reimbursements.

-- Assist Steering Committees and Work Groups with preparation and revision of proposals for technical and scientific merit, feasibility and applicability to priority problem areas.

-- Assist Administrative Advisors and Work Group chairmen as needed.

-- Solicit and coordinate national reviews of project proposals.

-- Review project progress reports, publications and videos.

-- Distribute extension fact sheets, research publications and videos to research and extension contacts throughout the Southern Region, other RACs, USDA personnel, and the Aquaculture Information Center.

-- Produce and distribute the "SRAC Annual Progress Report," which includes editing and proofreading the project reports, designing and, using desktop publishing, producing camera-ready copy. Approximately 400 copies of this report are distributed by the Administrative Center each year.

-- Produce and distribute "SRAC Publications and Videos" which lists extension publications and videos developed through SRAC projects, and the "SRAC Summary of Projects." This involves editing, designing and, using desktop publishing, producing camera-ready copy. Numerous requests are received for these reports each year, and they are widely distributed throughout the Region.

-- Maintain mailing lists for solicitation of proposals and announcements of *Ad Hoc* Work Group meetings and distribution of fact sheets and other SRAC publications.

-- Prepare and distribute Work Group announcements and Requests for Proposals to research and extension directors and other interested parties throughout the Southern Region.

-- Prepare and distribute interim reports on SRAC activities to provide information regarding on-going projects.

-- Respond to numerous requests from aquaculture producers, the public and research and extension personnel for copies of fact sheets, research publications and videos produced by SRAC and the other Centers, as well as requests for general aquaculture-related information.

IV. PROGRESS REPORTS

A. AQUACULTURE FOOD SAFETY: RESIDUES

Progress Report
For the Period
September 11, 1992 to August 31, 1996

FUNDING LEVEL:

Year 1	$100,000
Year 2	$155,000
Year 3	$101,000
Total	$356,000

PARTICIPANTS:

The University of Georgia (Lead Institution) - George Lewis, James Shelton, P. Bush, C.R. Santerre (formerly at The University of Georgia, now at Silliker Laboratories, Inc.)

University of Florida - Cheng I. Wei

Mississippi State University - Earl G. Alley, L. G. Lane

Auburn University - W. Rodgers, Dehai Xu

Louisiana State University - Robert M. Grodner

Texas A&M University - Delbert Gatlin, James T. Davis

ADMINISTRATIVE ADVISOR:

Dr. Neal Thompson, Professor
University of Florida
Gainesville, Florida

PROJECT OBJECTIVES:

Objective 1: Information on residues is available for many food products and some is available for specific aquaculture products. Various state and federal agencies and private companies have collected data on chemical residues in channel catfish. The quality and quantity of these data is unknown. For instance, distinctions between farm-raised channel catfish and "wild" channel catfish are often overlooked. The exposure of "wild" channel catfish to hazardous compounds is often greater due to point source environmental contamination and data collected from "wild" catfish may not be representative of aquaculture products. In the development of an appropriate data base, related publications and educational programs, distinctions will be made between farm-raised channel catfish and "wild" channel catfish.

Survey and review of data bases for pesticides, PCB and metal residues in farm-raised catfish, crawfish and rainbow trout.

Objective 2: Protocols and guidelines are to be developed and disseminated for a residue monitoring program.

Objective 3: All research scientists participating in the study are to be contacted and requested to send reports and/or any information that they have that could be used in the development of Extension-type fact sheets or brochures. The information received will be catalogued as reference sources so that outlines and fact sheets can be written with this new data. Also, a library search will be conducted for additional information that may be applicable in writing the publications mentioned above.

Objective 4: The University of Georgia will develop a chemical application record system for producers.

Objective 5: The steady growth in per capita consumption of fish and seafood products has caused increased attention to product safety. There is always a potential for problems due to

contamination of foods by pesticides, heavy metals, and pharmaceutical compounds either from direct or indirect sources. These potential problems can occur on the farm, during processing, or at wholesale/retail levels. There is a need to minimize potential problems during and following production by determining the influence of processing on residues. The aim of the study is to determine the fate of residues from the farm to the processing plant and finally to a product which would be prepared by the consumer.

Objective 6: The aim of this project is to attempt to improve the available information on residues in farm-raised channel catfish, crawfish and rainbow trout so that consumers can more realistically assess issues related to consumer safety from scientific data.

ANTICIPATED BENEFITS:

Objective 1: The aquaculture industry will have scientifically-generated residue data base to support its contention that aquaculture products are safe for consumption.

Objective 2: Residues will be monitored by producers to increase consumer confidence in the safety of aquaculture products.

Objective 3: Educational programs are invaluable to preventing residue problems in the industry.

Objective 4: Proper record-keeping will also help to insure that pesticides and animal drugs have been used in a safe manner.

Objective 5: The benefits of food processing and preparation for reducing residue levels in edible tissue will be determined.

Objective 6: Pesticide and heavy metal residue data will be made available for selected aquaculture products. Preliminary indications are that the fish sampled in this study are free from residues or have much lower residues than wild fishes.

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:

Objective 1: Data included in this report on fish and seafood products were retrieved from FOODCONTAM, a national database consisting of state generated information on pesticide and other toxic chemical residues in human foods. Data are generated by state agriculture, food, and health protection agencies responsible for assuring the quality and safety of foods grown or imparted into their states. The data are presented in four separate computer-generated packets for FY 1986-1989, FY 1990-1992, FY 1993, FY 1994 and FY 1995.

Objective 2: Protocols and guidelines were developed and disseminated for a residue monitoring program. These protocols were used in collecting and analyzing residue data.

Objective 3: Development of educational materials were redirected to the SRAC Publications Work Group.

Objective 4: A chemical application record system was developed in the third year of this project.

Objective 5: After appropriate dosing of pesticides and pharmaceuticals, channel catfish were processed by researchers at the University of Georgia into four consumer-ready products in order to determine the effects of different processing conditions on the residues. Catfish were stunned, beheaded, eviscerated, skinned, filleted and washed. Both fillets from each fish were frozen for subsequent residue analyses either before or after cooking. One of the frozen complimentary fillets was thawed then either: (1) breaded and fried in vegetable oil at 190°C; (2) breaded and baked at 190°C in a conventional oven; (3) injected with a mixture of polyphosphates and citric acid, then frozen for four weeks, thawed, breaded and fried in vegetable oil at 190°C; or (4) brined and smoked in a temperature- and humidity-controlled smoke house to achieve an internal temperature of 71°C

for 30 min. Raw and cooked fillets were homogenized following processing into a table-ready item and stored at -80°C until analyses.

Pesticide and pharmaceutical residues were determined in fillets from duplicate fish for each treatment using standard procedures (FDA, PAM-1 Methods, AOAC Methods, etc.). Results of a study to determine oxytetracycline, sulfadimethoxine and ormetoprim residues in catfish using HPLC were reported in the 1995 Progress Report. This work was also published in the Journal of Food Science 60: 1220-1224, and presented at the 1995 annual meeting of the Institute of Food Technologists. The study of oxytetracycline residues in raw and cooked catfish fillets is summarized below.

Channel catfish (average weight = 0.87 kg; SD = 0.05) were held in concrete tanks at 24°C, and fed feeds containing 1.88, 3.75, or 7.50 g oxytetracycline hydrochloride per kg feed. Fish were provided medicated feeds at 2% body weight daily for 10 days. If all the feed was consumed, fish would receive 37.5, 75.0, or 150.0 mg oxytetracycline per kg of fish daily. At 18 hours after the last feeding, fish were stunned with a hammer, beheaded using a band saw, skinned and eviscerated. Both fillets from each fish were collected: one matched fillet was analyzed raw and the other was cooked and analyzed. Fillets from each fish were wrapped in aluminum foil, placed in zip-lock plastic bags, kept under ice, and transported to the University of Georgia, Athens, where they were stored at -23°C prior to further processing. Fillets were prepared by each of the four cooking methods. All cooked samples were labeled, wrapped in aluminum foil, placed in zip-lock plastic bags, and frozen at -23°C until analyzed. Moisture contents of catfish fillets were determined by an AOAC (1990) oven method 950.46. Oxytetracyline in the cooked and uncooked fillets was determined by high performance liquid chromatography.

The moisture content of raw fillets ranged from 70.7 to 78.1%. Cooking the fish muscle caused a significant ($P < 0.05$) reduction in moisture content to 68.6%. Fried fillets had a significantly higher moisture content than baked and smoked sampled. The smoked fillets had the lowest moisture content. The HPLC detection limits for oxytetracycline were 3.5 ng for a standard solution (50 ng/mL, 70-L injection volume) and 0.05 ppm for catfish extracts. Oxytetracycline exhibited a linear response over the range of 0.05 to 1.0 ppm in spiked catfish muscle ($R^2 > 0.999$). The recovery rate of oxytetracycline from spiked catfish was 92.5% over the concentrations of 0.05 - 1.0 ppm.

Oxytetracycline residues were detected in raw catfish 18 hr after oral administration of 37.5, 75.0 or 150.0 mg oxytetracycline/kg of fish for 10 days. Most of the residues exceeded the 0.1 ppm tolerance level, which might be expected since fish were purposely harvested only 18 hr after ending the medicated feed regimen in order to maintain oxytetracycline residues in raw fillets. No corrections for recovery loss were made with these data. Catfish receiving higher doses of oxytetracycline tended to have higher tissue residue levels. Those receiving 150 mg oxytetracycline/kg for 10 days had a higher residue level (0.27 ± 0.26 ppm) ($P < 0.05$) than those receiving 37.5 mg/kg (0.12 ± 0.10 ppm). Those receiving 75.0 mg oxytetracycline/kg had a residue level of 0.24 ± 0.29 ppm.

Pairwise comparisons between the raw and cooked fillets for each cooking method and at each feeding level showed that cooking of catfish caused a reduction in oxytetracycline residues. In general, the cooked fillets of the 150 mg/kg group had a higher residue content than that of the 37.5 or 75 mg/kg group. Baking and smoking were, in general, more effective than frying in reducing oxytetracycline in fillets. The longer cooking time used for baking and smoking apparently contributed to the greater loss of oxytetracycline in cooked fillets. Although a temperature of 190°C was used to fry the fillets, the internal temperature was only 71°C. Therefore, frying of catfish fillets at this temperature for only 7-10 min was not as effective

as baking or smoking in reducing oxytetracycline residues. Thus, the results confirmed that ordinary cooking procedures by frying, baking, and smoking at 190°C could not completely eliminate high levels of oxytetracycline residues in catfish fillets. The most effective approach to minimize oxytetracycline residues in cooked fillets would be adherence to the FDA's guidelines for oxytetracycline use. Under such feeding protocol, oxytetracycline residues in catfish fillets, if it occurs, will not exceed the legal tolerance level of 0.1 ppm and such low levels may then be destroyed by regular cooking procedures.

Objective 6: Progress for the first three years included: development of standard operating procedures for sample collection, sample preparation, pesticide analysis, metal analysis, and quality assurance; producers' and processors' samples were submitted to the University of Georgia for sample preparation; analysis of samples was completed at the University of Georgia and Mississippi State University. Residue data will be provided to cooperators in the eight states. Farm-raised channel catfish, rainbow trout and red swamp crawfish were collected from commercial ponds and processing sites at intervals for the two-year period. Locations for sample collection are as follows:

Location	Catfish Processors	Catfish Pond Sites	Rainbow Trout Pond Sites	Crawfish Production Sites
Mississippi	3	4	--	--
Alabama	2	3	--	--
Georgia	--	4	2	--
Louisiana	2	3	--	3
Tennessee	--	3	3	--
Florida	2	4	--	--
Texas	2	4	--	2
N. Carolina	--	--	20*	--
TOTAL	11	25	25	5

*Samples were only submitted following a single collection from this location.

Pond sites for channel catfish, rainbow trout and red swamp crawfish were selected to obtain diverse and representative sampling sites from each state. Catfish and rainbow trout were harvested from ponds within each state; fillets, including bellyflap, were collected and frozen. Crawfish were harvested; raw tail flesh was obtained and frozen. In addition, catfish, rainbow trout and crawfish feed were collected for analyses when fish with elevated residues are found. Catfish fillets obtained from commercial processing facilities were collected and frozen. Frozen samples were shipped to the University of Georgia where a composite sample was coded, homogenized, frozen and distributed to analytical facilities. Samples are being maintained below 0°C for five years for future retesting or additional residue analyses. Analyses for the following chemicals have been conducted:

Organochlorines

PCB's (1242, 1248, 1254, 1260)
Chlordane's
BHC's (Lindane, etc.)
Heptachlor
Heptachlor Epoxide
Dieldrin
Endosulfan I & II
Endosulfan sulfate
Endrin
o,p'- and p,p'-DDD, DDE, DDT
Methoxychlor
Toxaphene
Hexachlorobenzene
Mirex

Organophosphates

Chlorpyrifos
Diazinon
Malathion
methyl-Parathion
ethyl-Parathion

Pyrethroids

Cypermethrin
Fenvalerate

Metals

Copper
Cadmium
Lead
Mercury
Arsenic
Selenium
Chromium
Barium
Silver

Since pharmaceutical compounds are approved for use during production, samples of catfish are being maintained below 0°C until such time as the methods have been satisfactorily developed and additional funds become available. Multiples of all samples collected during this study will be maintained below 0°C for five years from collection date for subsequent residue determinations which may be of interest to the industry.

Quality assurance was conducted by the University of Georgia in a facility which is independent of sample analyses. Standard Operating Procedures (SOP) have been developed to ensure the validity of the data generated during this study.

IMPACTS:

Objective 5: Regulatory agencies are currently evaluating animal drugs for use in aquaculture systems. A major impact of this study will be to determine the fate of antibiotics from production through processing. It is not known whether prophylactic treatment with antibiotics will increase the residues in harvested catfish which have or have not been held for prescribed withdrawal times before harvest.

One of the important educational aspects which will result from this study will be a better understanding of the fate of antibiotics used in production. The information generated during this study will be communicated to production and processing segments of the industry to help avoid problems which may occur involving resistant organisms and residues in the processed fish.

Objective 6: The results generated during this objective are likely to have a major positive impact on the aquaculture industry. The data are expected to follow trends from other limited sampling experiments which demonstrate much lower residues in farm-raised products than in wild caught fish. The results from this study will be used to find potential problems relating to elevated residues and solve these problems with the help of the producer or processor. Furthermore, this study will serve as a pilot study for the industry to develop a quality assurance program to routinely monitor for residues in aquaculture products.

Educational opportunities are also expected as a result of this project. First, producers and processors will be made more aware of the importance in reducing residues in aquaculture products. Second, there will be many analytical methods developed from this study which will be useful for people to conduct future testing. Third, undergraduate and graduate students as well as faculty participants will become more aware of aquacultural products and practices and be better able to serve the industry.

PUBLICATIONS, MANUSCRIPTS OR PAPERS PRESENTED:

PUBLICATIONS

Du, Wen-Xian. (1994) Determination of oxytetracycline, sulfadimethoxine, and ormetoprim residues in catfish using high performance liquid chromatography. Master thesis. University of Florida, Gainesville.

Du, W.X., M.R. Marshall, W.B. Wheeler, M. Mathews, D. Gatlin, S.D. Rawles, D.-H Xu, W.A. Rodgers, and C.I. Wei. (1995) Oxytetracycline, sulfadimethoxine, and ormetoprim residues in catfish by HPLC. J. Food Sci. 60:1220-1224.

PUBLICATIONS SUBMITTED

Du, W.X., M.R. Marshall, D.-H. XU, C.R. Santerre, and C.I. Wei. (1996) Effect of cooking on oxytetracycline residues in catfish fillets. J. Food Sci. (submitted).

Xu, D., J.M. Grizzle, W.A. Rogers, and C.R. Santerre. In press. Effect of cooking on residues of ormetoprim and sulfadimethoxine in the muscle of channel catfish. Food Research International 30: in press.

PUBLICATIONS IN PREPARATION

Rawles, S.D., A. Kocabas, C.I. Wei (others from Dr. Wei's lab) and Delbert M. Gatlin III (In preparation) Dietary supplementation of Terramycin and Romet-30 does not enhance growth of channel catfish but does influence tissue residues. Journal of the World Aquaculture Society.

Khanna, N., C.R. Santerre, Dehai Xu and Y.W. Huang. 1996. Influence of Processing of Residues of Dieldrin and p,p'-DDE in Channel Catfish. Journal of Food Protection (in preparation).

Wei, C, et al. 1996. Determination of Oxytetracycline, Sulfadimethoxine and Ormetoprim Residues in Catfish Using HPLC. (in preparation)

Wei C. et al. 1995. Processing Affects on Oxytetracycline, Sulfadimethoxine and Ormetoprim residues in Catfish. (in preparation).

PAPERS PRESENTED

Du, W.X., M.R. Marshall, W.B. Wheeler and C.I. Wei. (1995) Determination of oxytetracycline, sulfadimethoxine, and ormetoprim residues in catfish using high performance liquid chromatography. Presented at the Institute of Food Technologists annual meeting at Anaheim, CA (Abstract 54E-13).

Du, W.X., M.R. Marshall, D.-H Xu, C. R. Santerre, and C.I. Wei. (1996) Effect of cooking on oxytetracycline residues in catfish. Presented at the American Chemical Society 212th annual meeting at Orlando, Florida in August (AGFD Abstract 48).

SUPPORT:

Additional support ($95,048 over two years) has been received by the University of Georgia from the National Biological Survey under a project entitled, "Use of Immune Factors in Fish as Indicators of Environmental Contamination" with R. Reinert as the PI and C. Santerre as CoPI and V. Blazer as the agency coordinator. Results from this research are demonstrating the relationship between residue levels of pesticides in fish and exposure through the diet.

YEAR	SRAC FUNDING	OTHER SUPPORT					TOTAL SRAC+ OTHER SUPPORT
		UNIVERSITY	INDUSTRY	OTHER FEDERAL	OTHER	TOTAL OTHER SUPPORT	
1	100,000	29,978				29,978	129,978
2	155,000	60,785		95,048		155,833	310,833
3	101,000	48,651				48,651	149,651
Total	356,000	139,414		95,048		234,462	590,462

B. IMPROVING PRODUCTION EFFICIENCY OF WARMWATER AQUACULTURE SPECIES THROUGH NUTRITION

Progress Report
for the period
January 1, 1994 to August 31, 1996

FUNDING LEVEL:

Year 1	$280,310
Year 2	$249,485
Year 3	$234,705
Total	$764,500

PARTICIPANTS:

Texas A&M University - Delbert M. Gatlin (Institutional leader), W.H. Neill, James T. Davis, L.V. DiMichele and J.B. Cotner

Mississippi State University - E.H. Robinson (Institutional leader), H.R. Robinette and R.P. Wilson

Auburn University - R.T. Lovell (Institutional leader) and U. Hatch

University of Arkansas at Pine Bluff - Rebecca T. Lochmann

Louisiana State University - R.C. Reigh

Kentucky State University - Carl D. Webster (Institutional leader) and James H. Tidwell

East Carolina University - Marjorie L. Gallagher

University of Georgia - G.J. Burtle (Institutional leader) and G.L. Newton

University of Memphis - Kenneth B. Davis (Institutional leader) and B.A. Simco

ADMINISTRATIVE ADVISOR:

Dr. Greg Weidemann
Associate Dean/Director
Arkansas Agricultural Experiment Station
Fayetteville, Arkansas

PROJECT OBJECTIVES:

1. Determine minimum effective levels of vitamin and protein/amino acid supplementation to maximize feed efficiency in commercial-scale channel catfish production.

2. Evaluate feeding strategies and their effects on commercial-scale channel catfish production. Of particular concern will be the effects of feeding time, frequency, and rate (satiation or restricted) on production efficiency. Feeding regimes to achieve maintenance of body weight and compensatory growth also will be addressed.

3. Investigate nutritional aspects that are most limiting production of baitfish and hybrid striped bass. This will include determining digestible energy and availability of amino acids in practical feedstuffs for hybrid striped bass and the relative contribution of natural foods and prepared feeds to growth of baitfish under conditions of commercial production.

ANTICIPATED BENEFITS:

Based on results of the project to date, some modifications in diet formulations and feeding schedules for channel catfish can be made which will improve production efficiency and cost effectiveness of diet formulations. Advancements in these areas will significantly improve production economics by reducing diet costs and increasing the efficiency of feed utilization. The benefits obtained from these advancements will be substantial because over one-half of the variable production costs associated with channel catfish aquaculture relate to diets and feeding. The efficiency and profitability of baitfish production also should be improved by integrating

information obtained in this project on nutritional requirements of these fish with pond management and feeding strategies to meet those requirements most economically. Additional information concerning nutritional requirements of hybrid striped bass and their utilization of feedstuffs also will facilitate the development of optimized formulations that will reduce diet costs and improve production efficiency of these fish.

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:

Objective 1: Several feeding trials in aquaria and experimental ponds have been completed and others are in progress to evaluate vitamin and protein/amino acid supplementation of practical diets for channel catfish. At the Mississippi State University Delta Research and Extension Center, two pond feeding trials (1994 and 1995) have been conducted to evaluate the need to supplement typical commercial catfish feeds with vitamin C, thiamin, riboflavin, niacin, pantothenic acid, and pyridoxine. Weight gain, feed conversion, feed consumption, survival, and hematocrit data indicated that supplemental thiamin, riboflavin, niacin, pantothenic acid, and pyridoxine may not be necessary in commercial catfish diets. Data from fish fed vitamin C test diets also indicated that the requirement appears to be less than 15 mg/kg which is much less than previously reported. Based on production data and liver vitamin analyses completed to date, it appears that supplemental riboflavin and pyridoxine are not needed in typical commercial catfish feeds used for growout. There also appears to be enough endogenous niacin in commercial catfish feeds to meet the requirement of channel catfish. Stress responses of catfish fed diets with various vitamin supplements were measured by associates at the University of Memphis. Data on plasma chloride, osmotic pressure, and cortisol levels during confinement did not indicate any consistent difference due to reduced dietary vitamin levels. The stability of several B-complex vitamins in extruded catfish feeds also were determined. These vitamins are fairly to very stable during the extrusion process with relative retention of 65% for thiamin, 100% for riboflavin, 96% for niacin, 100% for pantothenic acid, and 70% for pyridoxine.

In 1996, additional evaluations of vitamin supplementation are continuing with the control diet being the same as used in 1994 and 1995. Diets without individual supplements of thiamin, riboflavin, niacin, pantothenic acid, or pyridoxine, or with 500 mg supplemental choline are being evaluated. The fish were stocked in May 1996 and have been fed the experimental diets once daily to satiation. Samples of 200 fish from each pond will be taken in October/November 1996 to evaluate treatment effects. Fish will be overwintered in the ponds and harvested in February 1997.

A similar investigation concerning vitamin E supplementation of diets for channel catfish was conducted in ponds at Texas A&M University in 1994-95. A typical commercial diet formulation (with approximately 10 mg vitamin E/kg provided endogenously) was supplemented with vitamin E acetate at either 0, 30, 60 or 240 mg/kg diet. No differences in growth, feed efficiency and survival were observed over the 1-year trial; however, plasma tocopherol was directly correlated with vitamin E supplementation in the diet. Differences in liver tocopherol also were observed in fish fed the various diets with those fed the highest level of supplemental vitamin E having the highest liver tocopherol concentrations. Based on the lack of overt or histological signs of vitamin E deficiency in fish fed the basal diet, it appears that vitamin E supplementation of practical diets for growout of channel catfish can be reduced considerably.

In the Department of Biochemistry at Mississippi State University, laboratory experiments on the dietary riboflavin and niacin requirements of fingerling channel catfish have been completed. Fish were fed purified diets containing graded levels of dietary riboflavin or niacin for 8 and 12 weeks, respectively. The

dietary riboflavin requirement of channel catfish for optimal growth was determined to be 6 mg/kg diet which is lower than the previously accepted value of 9 mg/kg diet. A riboflavin level of 4 mg/kg diet was sufficient to prevent the appearance of gross deficiency signs in the fish. The dietary niacin requirement for rapidly growing channel catfish was estimated to be 7.4 mg/kg diet which is about half the previously reported value of 14 mg/kg diet. In a separate experiment, it has been confirmed through direct evidence that dietary tryptophan does not serve as an efficient precursor of niacin in channel catfish. Based on the results of two previous niacin studies, a catfish liver NAD bioassay was developed to determine the bioavailability of niacin from feed ingredients commonly used in commercial catfish feeds. Menhaden fish meal (MFM), meat and bone/blood meal (MBM), wheat middlings (WML), cooked corn (CCO), uncooked corn (UCO), cottonseed meal (CSM) and soybean meal (SBM) were found to contain 105.3, 50.5, 153.3, 21.9, 12.8, 22.5 and 20.3 mg available niacin/kg, respectively. When compared to the total niacin content of each feed ingredient, niacin in animal feed ingredients (MFM, MBM) was found to be completely available to channel catfish. The availability of niacin in the cereals and cereal byproduct, WML, CCO and UCO, was 60, 44 and 28%, respectively. Niacin availability in the two oilseeds, CSM and SBM, was found to be 58 and 57%, respectively. It was concluded that supplementation of niacin may not be needed or can be significantly lowered in typical commercial catfish feeds because of the relatively high amount of available niacin found in the feed ingredients. Studies on the nutritional availability of vitamin E from the feed ingredients are currently being conducted.

An investigation to optimize dietary protein/amino acid supplementation of all-plant-protein diets for channel catfish is nearing completion at Louisiana State University. Channel catfish have been produced continuously in sixteen, 0.08 ha (0.2 acre) ponds at the Aquaculture Research Facility, Baton Rouge, since the spring of 1994. Ponds have been top-harvested multiple times and restocked with fingerlings after top-harvests to maintain a density of 25,000 fish/hectare. Fish have been fed one of two, custom-formulated, 32% crude protein, extruded diets: one containing animal and plant protein (control) and one containing only plant protein (primarily from cottonseed and soybean meal with supplemental lysine). Each diet has been fed to fish in eight randomly selected ponds, once per day. Diet allotments have been adjusted daily to provide as much food as the fish will eat. Since initiation of the experiment, 3,493 kg of fish have been harvested from ponds assigned the cottonseed/soybean (C/S) diet and 3,214 kg from ponds assigned the control diet. Live weights have averaged 0.7 kg and dressing percentages have averaged 59% for fish harvested to date in both treatment groups. Visceral fat content has averaged 1.5% in C/S-fed fish and 1.7% in the control group. A final (batch) harvest will occur in October-November 1996, at which time all ponds will be drained. Data analysis and report preparation will be completed in the spring of 1997.

At the University of Georgia, a study was conducted to evaluate replacement of menhaden fish meal in channel catfish diets with alcohol-extracted soy protein concentrate. Two experimental diets were formulated to contain either 8 or 16% soy protein concentrate to totally replace menhaden fish meal and some soybean meal which were included in the control diet at 8 and 43%, respectively. Dietary protein, energy, lysine, methionine, and phosphorus were the same among the three diets. Channel catfish in three size classes were stocked at 25,000 fingerlings/ha into 0.10-ha ponds. Partial harvests were made during the growing season of catfish that had reached market size for Georgia, $\geq$ 0.2 kg/fish. After stocking in May, five partial harvests were completed and a final complete harvest was made in November when all remaining catfish were counted and weighed. Catfish production and conversion efficiency were similar for all three diets and resulted in total production of between 5,736 and 7,390 kg/ha for all ponds.

Catfish survival ranged between 73% and 97% because of bird depredation and disease-related mortalities but was not significantly different among treatments. Thus, soy protein concentrate used in an all-plant-protein diet allowed the omission of fish meal without negative effects on catfish production.

Objective 2: Several studies to investigate various feeding strategies in channel catfish production have been conducted and others are currently in progress. Laboratory experiments have been completed at Texas A&M University in which effects of feed restriction and dissolved oxygen concentration on growth of channel catfish were investigated. Fish maintained at two levels of dissolved oxygen (60 and 92% of air saturation) were either not fed or fed at 1.5 or 3% of body weight per day for one month after which they were all fed to satiation for another month. Weight gain and feed efficiency of fish subjected to low dissolved oxygen were significantly reduced compared to those of fish maintained at the higher dissolved oxygen concentration. Compensatory gain of fish that were not fed or fed at the restricted rate for the first 4 weeks was limited. Another study is ongoing with channel catfish in ponds to evaluate restricted feeding regimes that may illicit compensatory growth responses. Catfish of two size classes were stocked at commercial densities and are either being fed to satiation every day, fed to satiation every third day, or not fed at all for a 3-week period, alternated with another 3-week period during which fish in all treatments are fed to satiation each day. The effects of these feeding regimes on growth, feed efficiency and body composition will be evaluated over a 6-month period.

At Auburn University, channel catfish of two sizes, year-1 (43 g) and year-2 (660 g), were stocked separately in 0.04-ha ponds in mid-November of 1994 and subjected to three overwinter management regimes: no feed, restricted feeding and continuous feeding. Fish were challenged with *Edwardsiella ictaluri* the following spring. Among year-1 fish, those not fed during the 5-month overwintering period showed significantly higher mortality from *E. ictaluri* than fish fed continuously or restricted (not fed during December, January and February). However, among year-2 fish, those not fed showed significantly lower mortality than fish fed continuously or restricted. In the spring of 1995, year-1 fish not fed during the previous winter (November 1 - April 20) lost 12% of their weight while year-1 fish fed during winter increased their weight by 99%. Year-2 fish not fed during the winter lost 7% of body weight while year-2 fish that were fed increased their weight by 38%. During the following summer growing season all fish in both size groups were fed to satiation. During the first 10 weeks of the summer period, specific growth rate and feed consumption of fish not fed during winter in both age groups were greater than those of fish fed during the previous winter. Feed conversion was the same among treatments in both age groups. At the end of the summer, there was no difference in body weight between the year-1 fish that had been fed during winter and year-1 fish that had not been fed during winter; however, the year-2 fish not fed the previous winter did not reach a similar weight as year-2 fish fed the previous winter. These data indicate that year-1 channel catfish can completely compensate and year-2 fish can partially compensate for previous winter feed deprivation if fed to satiety during the summer growing season.

In the Department of Wildlife and Fisheries at Mississippi State University, a study of the effects of size-class distribution and dietary protein level on protein utilization and feed conversion of channel catfish has been conducted. Fish averaging either 24.1 g or 392.1 g were stocked in earthen ponds as separate size classes and in a 50:50 ratio in June 1994, and fed either a 28 or 32% protein diet daily to satiation. After 125 days, there were no significant differences in average harvest weight, weight gain, survival, feed conversion, or proximate composition of whole body and fillets from fish fed either diet or stocked with only the same size versus mixed sizes. However, large fish stocked with small fish had higher percentage fillet, carcass

and fat dressout (32.2, 51.5, and 2.3, respectively) than large fish stocked alone (29.7, 48.3, and 1.6, respectively). Small fish stocked alone had higher percentage carcass dressout (50.3) than small fish stocked with large fish (47.6). Additionally, small fish stocked in mixed-size ponds displayed significantly less average weight gain (148 g) than small fish stocked alone (264 g). In December 1994, 26 g fingerlings were stocked with non-market size fish (remaining from the fall harvest of year-1 fish) to bring fish density to 24,719/ha in each of the 18 ponds used in year 1. Thus, the experimental design from year 1 (three fish size groups each fed 28 and 32% protein feeds) was continued into year 2 of the study. However, the treatment consisting of only large fish in year 1 became only small fish in year 2 because all fish reached market size in year 1. The two remaining size treatments were mixed size group ratios of large fish: small fish of approximately 1:2 (mixed-1) and 1:5 (mixed-2). Market size fish were removed by partial harvest in April, July, and October, 1995. Total number and weight of fish in each pond were determined by total harvest in November 1995. Average survival rate in mixed-1 ponds (74.5%) was significantly higher than in mixed-2 ponds (65.9%) or in small-only ponds (63.8%). The differential survival rate may influence interpretation of the following results. There was no interaction among the three size groups and two dietary protein levels, and there were no significant differences between diets for average market-size and total production. However, across size groups at final harvest, small fish stocked alone (market size at harvest) displayed significantly greater average visceral fat (2.01%) than fish stocked as mixed-1 (1.4%) or mixed-2 (1.4%) groups. The small-only fish also had significantly greater average fillet yield (29.9%) when compared to fish in the mixed-1 treatment (28.6%).

Objective 3: Several studies have been completed or are in progress with baitfish and hybrid striped bass to investigate various aspects of their nutrition and feeding. Investigators at the University of Arkansas at Pine Bluff (UAPB) have completed the following:

(1) The dietary protein requirement (29%) and optimal dietary energy:protein ratio (9.7 kcal/g) of golden shiners and goldfish in aquaria were established.

(2) A series of stable carbon isotope ratio studies has been completed with golden shiners. Isotope analysis of fish and plankton has been used to estimate the relative assimilation of natural and prepared feeds by golden shiners in ponds. Under the conditions of this study, fish obtained approximately 40-83% of their nourishment from the plankton, and the remainder from the prepared feeds. The percentage of plankton consumed by golden shiners was inversely related to the assimilation of the diets which varied with diet composition.

(3) A pond feeding trial performed jointly at UAPB and Texas A&M University was conducted to study the effect of different stocking densities (660,000 fish/ha at UAPB vs. 330,000/ha at TAMU) on the relative intake of natural and prepared feeds by golden shiners. Stable carbon isotopic analysis has been completed on samples from each site and final analysis of the data is in progress.

(4) Aquarium studies of the dietary lipid requirement of golden shiners and goldfish were completed. Golden shiners performed well when fed diets containing a wide range of lipid (7-19%), but performance showed a peak when the diet contained around 12% lipid. Goldfish fed diets containing 4.5-7.0% lipid had the highest weight gain. However, survival of goldfish fed the diet with 4.5% lipid was significantly lower than that of fish fed diets containing 7.0-13.3% lipid.

(5) A pond trial comparing performance of golden shiners fed diets containing similar energy:protein ratios (10.3 kcal/g) and either high (31%) or low (24%) protein levels is in

progress. Ponds will be harvested and final data will be obtained later this fall.

At East Carolina University, feeding trials have been completed to determine organic matter digestibility coefficients for dextrin, wheat starch, wheat flour, wheat middlings, potato starch and corn starch in diets fed to original cross hybrid striped (palmetto) bass of two sizes (6 g) and (95 g). Digestibility coefficients for all carbohydrates were generally high (90.5-100%), indicating that simple and complex carbohydrates can be digested by these fish. However, potato starch was not well digested (66.0%) in either small or larger fish. Digestibility determinations also have been conducted at Texas A&M University with reciprocal cross hybrid striped (sunshine) bass. Apparent protein and organic matter digestibility coefficients have been determined for menhaden fish meal, anchovy meal, meat and bone meal, poultry byproduct meal, soybean meal and cottonseed meal.

At Kentucky State University, experiments were conducted with hybrid striped bass to evaluate the effects of diet formulations on growth, body composition and organoleptic qualities. In one experiment, sunshine bass in floating cages were determined to require a diet with 41% protein and a protein to energy ratio greater than 99 mg protein/kcal when fish meal comprised 56% of the dietary protein. In another experiment, juvenile (20 g) palmetto bass in cages were shown to require some fish meal in the diet to provide good growth; however, fish meal inclusion at 15% of diet produced similar growth as diets with higher levels of fish meal. Another study was conducted to determine frozen storage stability, fatty acid composition, and textural quality of sunshine bass. The n-3 fatty acids composed one-third of the total fatty acids in muscle, with eicosapentaenoic acid, 20:3(n-3), and docosahexaenoic acid, 22:6(n-3), being the most prevalent n-3 highly unsaturated fatty acids. Storage of muscle at -20°C for 6 months did not cause increases in lipid oxidation for skin-on fillets; however, skinless fillets exhibited marked increases from month 4 to 6. There was no charge in textural quality during 6 months of frozen storage. Flavor quality of sunshine bass fillets stored frozen (-10°C) with skin on for 0, 9, and 18 months also was evaluated by a trained taste-test panel. Diet had little effect on flavor quality, even after 18 months of frozen storage, except for a diet that had 35% fish meal and 10% menhaden fish oil which produced a "fishy" flavor. Frozen storage of sunshine bass fillets for up to 18 months did not greatly affect flavor quality.

WORK PLANNED:

All project activities are proceeding as planned.

IMPACTS:

Considerable benefits to the aquaculture industry already have emerged from this project. Based on research to date, it appears that dietary supplementation of several vitamins may be reduced substantially, resulting in a reduction in feed costs which represents a considerable savings to the industry. Research concerning various feeding strategies also has identified means of improving health and increasing production efficiency of channel catfish. Significant advancements also have been made in obtaining specific information on the nutritional requirements of baitfish and hybrid striped bass, and how to meet those requirements most economically. Additional benefits to the industry are anticipated as several studies in the project near completion.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED:

PUBLICATIONS IN PRINT

Keembiyehetty, C.N. 1995. Amino acid nutrition of sunshine bass (*Morone chrysops* x *M. saxatilis*). Ph.D. Dissertation, Texas A&M University, College Station, TX, 84 pp.

Kim, M.K., and R.T. Lovell. 1995. Effect of overwintering feeding regimen on body weight, body composition and resistance to *Edwardsiella ictaluri* in channel catfish. Aquaculture 134:237-246.

Kim, M.K., and R.T. Lovell. 1995. Effect of restricted feeding regimens on compensatory weight gain and body tissue changes in channel catfish *Ictalurus punctatus* in ponds. Aquaculture 135:285-293.

Li, M.H., J.B. Rushing, and E.H. Robinson. 1996. Stabilities of B-complex vitamins in extruded catfish feeds. Journal of Applied Aquaculture 6(2):67-71.

Lochmann, R.T., and H. Phillips. 1994. Dietary protein requirement of juvenile golden shiners (*Notemigonus crysoleucas*) and goldfish (*Carassius auratus*) in aquaria. Aquaculture 128:277-285.

Lochmann, R.T., and H. Phillips 1995. Stable isotopic evaluation of the relative assimilation of natural and artificial foods by golden shiners *Notemigonus crysoleucas* in ponds. Journal of the World Aquaculture Society 27:168-177.

Serrini, G., Z. Zhang, and R.P. Wilson. 1996. Dietary riboflavin requirement of fingerling channel catfish (*Ictalurus punctatus*). Aquaculture 139: 285-290.

Webster, C.D., L.G. Tiu, J.H. Tidwell, P. Van Wyk, and R.D. Howerton. 1995. Effects of dietary protein and energy levels on growth and body composition of sunshine bass (*Morone chrysops* x *M. saxatilis*) reared in cages. Aquaculture 131:291-301.

Xiong, Y.L., E.A. Decker, S.P. Blanchard, A.D. Crum, N.C. Shantha, C.D. Webster, L.G. Tiu, and J.H. Tidwell. 1996. Dietary protein level has minimal effect on flesh quality of frozen stored sunshine bass (*Morone chrysops* x *M. saxatilis*). Journal of Applied Aquaculture 6(1):47-63.

MANUSCRIPTS

Brett, K.L., P.B. Johnsen, C.D. Webster, L.G. Tiu, Y.L. Xiong, and E.A. Decker. In preparation. Sensory evaluation and lipids oxidation of sunshine bass (*Morone chrysops* x *M. saxatilis*) fillets frozen for various periods of time. Aquaculture.

Lochmann, R. T., and H. Phillips. In review. Dietary lipid requirement of juvenile golden shiners (*Notemigonus crysoleucas*) fed diets differing in protein level in aquaria. Aquaculture.

Lochmann, R.T., and H. Phillips. In preparation. Optimal dietary carbohydrate:lipid ratios of juvenile golden shiners (*Notemigonus crysoleucas*) and goldfish (*Carassius auratus*) in aquaria.

Ng, W.K., G. Serrini, Z. Zhang, and R.P. Wilson. In press. Niacin requirement and inability of tryptophan to act as a precursor of NAD in channel catfish, *Ictalurus punctatus*. Aquaculture.

Ng, W.K., C. Keembiyehetty, and R.P. Wilson. In review. Bioavailability of niacin from feed ingredients commonly used for channel catfish, *Ictalurus punctatus*. Aquaculture: Proceedings of the VII International Symposium on Nutrition and Feeding of Fish, College Station, TX, Aug. 11-15, 1996.

Rawles, S.D., T.G. Gaylord, and D.M. Gatlin III. In preparation. Vitamin E supplementation of practical diets for channel catfish. Aquaculture.

Stahl, C.J., T.G. Gaylord, and D.M. Gatlin III. In preparation. Influence of feeding time and dissolved oxygen on growth performance and body composition of channel catfish. Fish Physiology and Biochemistry.

Webster, C.D., L.G. Tiu, and J.H. Tidwell. In press. Effects of replacing fish meal in diets on growth and body composition of palmetto bass (*Morone saxatilis*) x *M. chrysops*) raised in cages. Journal of Applied Aquaculture 7(1).

Gallagher, M.L. In preparation. Apparent digestibility coefficients for carbohydrates in diets for hybrid striped bass. Journal of the World Aquaculture Society.

Xiong, Y. L., E. A. Decker, S. P. Blanchard, A. D. Crum, N. C. Shantha, C. D. Webster, L. G. Tiu and J. H. Tidwell. In press. Dietary protein level has minimal effect on flesh quality of frozen stored sunshine bass, *Morone chrysops* X *M. saxatilis*. Journal of Applied Aquaculture.

PAPERS PRESENTED

Gatlin, D.M., III. An overview of fish nutrition research supported by the Southern Regional Aquaculture Center. Aquaculture America, February 1996 (abstract).

Ng, W.K., C. Keembiyehetty, and R.P. Wilson. Bioavailability of niacin from feed ingredients commonly used for channel catfish, *Ictalurus punctatus*. VII International Symposium on Nutrition and Feeding of Fish, August 1996 (abstract).

Okwoche, V.O., and R.T. Lovell. Effects of winter feeding regimen on resistance to *Edwardsiella ictaluri* challenge by channel catfish, *Ictalurus punctatus*. VII International Symposium on Nutrition and Feeding of Fish, August 1996 (abstract).

Serrini, G., Z. Zhang, and R.P. Wilson. Dietary riboflavin requirements and lack of conversion of tryptophan to niacin in channel catfish. 24th Fish Feed and Nutrition Workshop, October 1995.

Stahl, C.J., W.H. Neill, and D.M. Gatlin, III. Influence of feeding time and dissolved oxygen on the growth performance of fingerling channel catfish (*Ictalurus punctatus*). Aquaculture America, February 1996 (abstract).

Unprasert, P., and H.R. Robinette. Influence of channel catfish, *Ictalurus punctatus*, size-class distribution on protein utilization and feed conversion. Aquaculture America, February 1996 (abstract).

Webster, C.D., L.G. Tiu, and J.H. Tidwell. Effect of dietary regimen and frozen storage on lipid oxidation and textural quality of hybrid striped bass muscle. Aquaculture America, February 1996 (abstract).

Webster, C.D., L.G. Tiu and J.H. Tidwell. Effect of dietary regimen and frozen storage on lipid oxidation and textural quality of hybrid striped bass (*Morone chrysops* x *M. saxatilis*) muscle. Annual Meeting of the World Aquaculture Society, Bangkok, Thailand, January 1996 (abstract).

SUPPORT:

YEAR	SRAC FUNDING	OTHER SUPPORT					TOTAL SRAC+ OTHER SUPPORT
		UNIVERSITY	INDUSTRY	OTHER FEDERAL	OTHER	TOTAL OTHER SUPPORT	
1	280,310	290,009	19,000			309,009	589,319
2	249,485	251,522				251,522	501,007
3	234,705	221,510				221,510	456,215
Total	764,500	763,041	19,000			782,041	1,546,541

C. DELINEATION AND EVALUATION OF CATFISH AND BAITFISH POND CULTURE PRACTICES

Progress Report
For the Period
April 1, 1994 to August 31, 1996

FUNDING LEVEL:

Year 1	$147,500
Year 2	$152,000
Year 3	$150,500
Total	$450,000

PARTICIPANTS:

Auburn University - Jerry Crews, Leonard Lovshin, John Jensen, Michael Masser, Chris Hyde, Greg Whitis, David Cline, Claude Reeves

LSU Agricultural Center (Cooperative Extension Service) - C. Greg Lutz

Texas A & M University (Texas Agricultural Extension Service) - Greg Clary, Joe Lock

University of Arkansas at Pine Bluff - Carole Engle, Nathan Stone, David Heikes, Steve Killian

University of Georgia - Ronnie Gilbert

ADMINISTRATIVE ADVISOR:

Dr. David Foster, Associate Vice President for Agriculture-Extension
University of Arkansas
Little Rock, Arkansas

PROJECT OBJECTIVES:

1. Develop catfish and baitfish standardized production and financial performance analysis (SPFPA-CC and SPFPA-BF) guidelines which include measures for evaluating the performance of commercial catfish and baitfish production systems.

2. Delineate and evaluate current commercial catfish and baitfish production practices (i.e., stocking, feeding, aeration, water exchange, pond size and configuration, harvesting, etc.) utilizing SPFPA-CC and SPFPA-BF guidelines.

3. Identify relationships between measures of production and financial performance as calculated according to SPFPA-CC and SPFPA-BF guidelines.

4. Develop management tools to assist commercial catfish and baitfish producers, lenders, aquaculture specialists and others in determining the efficacy of selected production practices.

ANTICIPATED BENEFITS:

Narrow margins between production costs and revenues result in challenges for managers of commercial catfish and baitfish production systems. Decisions must be made regarding resource allocation, optimal production alternatives, reinvestment, marketing strategies, use of credit and many other issues. A standardized system to measure production and financial performance is necessary to monitor the impact that decisions have on the productivity, financial performance of entire farms, and more specifically on commercial catfish and baitfish enterprises. Standardization lends itself to comparing performance of farms with different locations, management levels, production strategies, sizes and other characteristics. This project proposes to delineate and evaluate current commercial practices by developing a standardized system of production and financial performance measures for catfish and baitfish operations independent of size, production methods, or marketing strategies. This standardized system will then be used to make an integrated evaluation of biological and financial risk, and the consequences of management decisions on productivity and profitability with a group of cooperating producers in five southeastern states. The results will only be indicative of the cooperators and not necessarily

the entire industry but should begin to elucidate best management practices. At the conclusion of the project the standardized system that has been developed will be available for producers to utilize throughout the nation.

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:

CATFISH

Objective 1: The Performance Evaluation Standards for Commercial Catfish Operations (PESCAT) is complete and is available for use by anyone interested in implementing the analysis. These guidelines establish standards for production and financial performance analysis of commercial catfish production systems. Producers have been heavily involved with the development of these guidelines. The guidelines are divided into two publications: one for fingerling production enterprises and one for food fish production enterprises. Standardized Production and Financial Performance Guidelines drafted previously are incorporated into all products described under Objective 4.

Objective 2: Paper forms and software are available for use in collecting data to accomplish this objective. These analysis tools request the necessary data to describe commercial catfish production practices and farm characteristics for comparisons. Investigators are in the process of identifying cooperators and collecting data as they are available.

Objective 3: Relationships between production practices and measures of productivity and financial performance will be evaluated on an aggregate basis as soon as sufficient data are available. At this point, cooperators in each state have been identified and data collection is under way.

Objective 4: Significant efforts to date have been directed at accomplishing this objective. A PESCAT Handbook is available for fingerling and food fish operations. It contains 13 fact sheets which are detailed discussions on topics that needed further discussion beyond that contained in the Guidelines. It also contains sample reports, input forms for collecting necessary data, inventory maintenance forms and software to facilitate calculating performance measures with a computer. Handbooks have been distributed to all participating faculty. An abbreviated version of the Handbook, called the PESCAT Toolkit, is being distributed as a promotional tool to generate interest in the program. It contains the vital fact sheets, input forms, sample reports and software necessary to get started gathering data for analysis.

BAITFISH

Standard Production and Financial Performance Analysis (SPFPA) guidelines and data forms have been developed, reviewed, and finalized for the four principal species of baitfish: golden shiner, goldfish, fathead minnows, and rosy red minnows. A codebook, database structure and analysis worksheets have been developed and reviewed for data entry and analysis. The SPFPA-Golden Shiner guidelines, data forms, database structure, and worksheet analysis formulae were pilot tested in 1995 with a cooperating farmer and modifications made accordingly. The modified SPFPA guidelines and data forms were pilot tested this past year for goldfish, fathead minnows, and rosy red minnows, as well as with additional golden shiner cooperators. Cooperators for all these species were identified and interviewed to explain expectations and benefits of participation in the project. Enterprise budgets have been finalized for all species. However, we will wait to analyze another year's data to make further adjustments to the budget before publishing them.

WORK PLANNED - 1996-97:

CATFISH

Objective 1: Work basically is complete. Minor changes in guidelines might be required once program has been revisited following several analyses.

Objective 2: As much data as possible will be collected throughout this year so summary reports can be developed that delineate and evaluate current production practices. The implementation phase of this project has been the most difficult, something that was expected in most states.

Objective 3: As this is the final year of this project, considerable effort will be directed towards data collection, analysis and reporting. Additional fact sheets will be authored as the need is identified. Summary reports chacterising the data and identifying important relationships will be published.

Objective 4: At the present time it appears that this objective is successfully completed. Additional products could still be deemed necessary and would then be developed. However, all items initially planned for in the original project objectives are published and available.

BAITFISH

Data collection on all species will be continued for another year. At this point, the numbers of observations for some of the species are too low to publish any summary analyses. In this coming year, we will increase the number of observations and add an additional year of data. With this, we will begin to conduct analyses, develop summaries of the data, and publish the enterprise budgets.

IMPACTS:

No quantitative measures have been made that allow for any conclusions about the economic impact of programs to this point. It is hoped that as participants analyze their individual farm production and financial information from year to year, that a more direct determination of increased profits, decreased costs, improved productivity, etc. will be available. PESCAT programs are designed to document production and financial relationships in commercial catfish operations which is consistent with tracking the economic impact of the project. Those reviewing project products to this point agree that completing a PESCAT analysis should provide extremely valuable information to managers as they make decisions about their operations.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED:

The following three products are available from state faculty or from Greg Clary, P.O. Box 38, Overton, TX 75684; (903)834-6191; fax (903)834-7140; g-clary@tamu.edu

1. PESCAT Handbook (Fingerlings, Food Fish or Combination) containing the following fact sheets:

- What PESCAT Is and Is Not (Clary)
- What You Need to Get Started and Who Can Help (Clary and Hnatt)
- Errors in Estimating Fingerling Numbers and Value: The Black Hole Begins on Paper (Lutz and Hymel)
- Inventory and Other Data Worksheets for Financial Statement Accrual Adjustments (Clary)
- Depreciation of Broodfish for Tax Reporting - When and When Not to Depreciate (Hnatt and Clary)
- Developing, Reviewing and Using the Depreciation Schedule (McGrann, Lovell and Ewing)
- Performance Based Borrowing (Klinefelter)
- Change in Owner's Equity (McGrann)
- Doing the Right Thing: Decision Making for Agricultural Families (Doye)
- Performance Evaluation Standards for Commercial Catfish Operations - Summary Analysis Worksheets (Foodfish/Fingerlings) (Hnatt and Clary)

- Suggested Methods for Allocating Overhead Costs (Clary)

- Chart of Accounts for Commercial Catfish Financial Records (Clary)

- Inventory Assessment Methods for Catfish Ponds (Van Wyk, Masser, Heikes, and Killian) {in preparation}.

2. The PESCAT Toolkit contains selected fact sheets, input forms, sample reports, and a brochure describing the program and ordering additional resources.

3. PESCAT software is a program written in Access and compiled so anyone with at least Windows 3.1 can run it. It contains user-friendly forms for inputing data and reporting results. Considerable help is included within the program so the user can find information about PESCAT guidelines without referring to the Handbook. All data sheets and summary analysis forms are also available on Lotus(TM) spreadsheets.

All materials, including software which comes on four small high density diskettes, is complementary as long as project funding is available to cover materials, reproduction and mailing costs.

The following four products are available from the University of Arkansas at Pine Bluff Extension faculty at 1200 N. University Drive (or P.O. Box 4912), Pine Bluff, AR 71611; (501) 543-8537.

1. Standardized Production and Financial Performance Analysis - Golden Shiners (SPFPA-GS), published by project participants, UAPB, February 1995.

2. Standardized Production and Financial Performance Analysis - Fathead Minnows (SPFPA-FM), published by project participants, UAPB, February 1995.

3. Standardized Production and Financial Performance Analysis - Goldfish (SPFPA-GF), published by project participants, UAPB, February 1995.

4. Standardized Production and Financial Performance Analysis - Rosy Red Minnows (SPFPA-RR), published by project participants, UAPB, February 1995.

Two papers were presented at the Aquaculture '96 meeting of the U.S. Chapter of the World Aquaculture Society in Arlington, TX; February 1996:

Common Errors in Estimating Catfish Fingerling Numbers and Value: The Black Hole Begins on Paper, by G. Lutz and T. Hymel.

A Cost Analysis of Forced-Air Incubation of Catfish Eggs, by G. Lutz and T. Tiersch.

SUPPORT:

The Alabama Cooperative Extension Service (ACES) at Auburn University has provided an additional $7,000 to support this project. No other additional support is noted at this time other than in-kind support from each participating institution.

YEAR	SRAC FUNDING	OTHER SUPPORT					TOTAL SRAC+ OTHER SUPPORT
		UNIVERSITY	INDUSTRY	OTHER FEDERAL	OTHER	TOTAL OTHER SUPPORT	
1	147,500	178,024				178,024	325,524
2	152,000	176,746				176,746	328,746
3	150,500	180,605				180,605	331,105
Total	450,000	535,375				535,375	985,375

D. PUBLICATIONS, VIDEOS AND COMPUTER SOFTWARE

Progress Report
For the Period
April 1, 1995 to August 31, 1996

FUNDING LEVEL:

Year 1 ..... $50,000
Year 2 ..... $61,000
Total $111,000

PARTICIPANTS:

Mississippi Cooperative Extension Service - Martin Brunson

Mississippi State University - Louis R. D'Abramo

Georgia Cooperative Extension Service - George Lewis

University of Georgia - Ronnie Gilbert, James Shelton, Tim R. Murphy

Kentucky Cooperative Extension Service - Robert Durborow

Arkansas Cooperative Extension Service - Nathan Stone, Eric Park, Debbie Archer

Louisiana State University - J. David Bankston, Jr.

Louisiana Cooperative Extension Service - Sandra Malone, Wendell Lorio, Fred Eugene Baker

Florida Cooperative Extension Service - Charles Cichra, Andrew Lazur

Alabama Cooperative Extension System - Michael Masser

Texas Agricultural Extension Service - Katheleen F. Ladewig, Michelle Morat, Russell Miget, Kim Jefferson, J. T. Davis

ADMINISTRATIVE ADVISOR:

Dr. Dan Ezell
Interim Director
Clemson Cooperative Extension Service
Clemson, SC

PROJECT OBJECTIVES:

1 Review and revise, as necessary, all SRAC Extension printed and video publications.

2 Establish an ongoing project location to develop and distribute new SRAC educational publications and videos for Southern Region aquaculture industries. This project will be responsible for preparation, peer review, editing, reproduction and distribution of all Extension and popular-type publications for all SRAC projects.

3. Place current, revised and new publications in electronic format (eg. Internet or compact disc) for more efficient use, duplication and distribution.

ANTICIPATED BENEFITS:

The most direct benefit from this project to the aquaculture industry is the widespread and ready availability of detailed information on production and marketing constraints and ways to alleviate or manage those constraints. Such information is of particular assistance to those making decisions about entering the aquaculture business. Economics information is used by lending agencies as well as current producers in day-to-day decision making. Information on the use of therapeutants, pesticides, methods of calculating treatment rates, and possible alternative crops and marketing strategies is in constant demand by practicing aquaculturists. Videos that demonstrate techniques are a ready source of “how-to” information. Educational institutions at the elementary and high school level have recently started using extension materials to make students aware of aquaculture production and associated trades as a way of life

for many people. Placing the information on the Internet and compact discs makes access easier, facilitates searching for needed information, and reduces storage space requirements for printed documents.

Producers will also benefit indirectly from the materials intended for use by consumers who buy the products, as well as from those materials that furnish background information on aquaculture. This information also helps in awareness and decision-making when citizens are involved in regulating the industry. This is particularly important with the increased emphasis on possible environmental contamination resulting from agricultural practices. Information to date indicates a relatively minor impact (often of a positive nature) of aquaculture on the surrounding areas.

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:

Production of new and revised fact sheets is an ongoing process. Since the last annual report seven fact sheets have been completed and distributed. Fourteen fact sheets are in the writing and editing stage. The shooting script for the baitfish video was approved and completion is expected within the calendar year. Footage for the revised channel catfish video has been taken and the shooting script should be approved within the next 60 days. The new publications are the result of work conducted under other projects. As projects have been completed Extension-type publications are prepared.

Work on placing all fact sheets into electronic format is progressing steadily. Problems with computer software and hardware have been overcome and distribution of compact discs is planned for early September. These are being made available through normal SRAC channels and state Extension contacts in the region.

WORK PLANNED:

Fact sheets on marine shrimp are in the review stage. Revisions of the eleven fact sheets projected for this year are proceeding well and should be in the editing cycle by the end of the calendar year. At least four publications based on the food safety projects and the nutrition project are scheduled for completion during the year.

IMPACTS:

The impacts of this project are significant. Fact sheets and videos are requested and used by clientele in all 50 states on a regular basis. Within the Southern Region, more than 60 fact sheets and 4 videos are distributed on request daily. Fact sheets generated within the Southern Region are also widely distributed by RACs and extension personnel in other regions. It has been reported that, on average, from 5 to 20 SRAC fact sheets and 3 videos are distributed daily from each of the other four regions. This means that about 20,000 fact sheets and 3200 videos per year are used by interested producers or consumers. Though there has been no attempt to quantify the impact financially, one Extension agent has estimated that using this information to help prospective producers make the correct decision about entering the aquaculture business results in savings of at least $100,000 per contact. For producers already in the business, the savings from enhanced production efficiency are probably on the order of $5,000 per producer using the service per year.

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 indicates 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, although it has

not been quantified. 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 the 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.

PUBLICATIONS, MANUSCRIPTS OR PAPERS PRESENTED:

PUBLICATIONS PRINTED AND DISTRIBUTED

Bankston, J. David, Jr. and Fred Eugene Baker. SRAC#372. Selecting the Proper Pump.

Bankston, J. David, Jr. and Fred Eugene Baker. SRAC#373. Piping Systems.

Bankston, J. David, Jr. and Fred Eugene Baker. SRAC#374. Open Channel Flow in Aquaculture.

Bankston, J. David, Jr. and Fred Eugene Baker. SRAC#375. Powering Aquaculture Equipment.

Cichra, Charles E., Michael P. Masser and Ronnie J. Gilbert. SRAC#479. Fee Fishing, An Introduction.

Cichra, Charles E., Michael P. Masser and Ronnie J. Gilbert. SRAC#482. Fee Fishing, Location, Site Development and Other Considerations.

D'Abramo, Louis R. and Martin W. Brunson. SRAC #483. Biology and Life History of Freshwater Prawns.

D'Abramo, Louis R. and Martin W. Brunson. SRAC #484. Production of Freshwater Prawns in Ponds.

Hargreaves, John and Martin Brunson. SRAC#468. Carbon Dioxide in Fish Ponds.

Ladewig, Katheleen F. and Michelle Morat. SRAC#224. Rainbow Trout.

Lorio, Wendell J. and Sandra Malone. SRAC#432. The Cultivation of American Oyster Crassostrea virginica.

Lorio, Wendell J. and Sandra Malone. SRAC#433. Biology and Culture of the Northern Quahog Clam.

Murphy, Tim R. and James L. Shelton. SRAC#361. Aquatic Weed Managment, Herbicides (Revised).

Perkins, Brian E. SRAC#434. Aquacultured Oyster Products.

Perkins, Brian E. SRAC#491. Micro-biological Rinse Technique: Basis for a New QualityControl Program

Rottmann, R.W., R. Francis-Floyd, P.A. Reed, and R. Durborow. SRAC#473. Use of Medicated Feed in Food Fish (Revised).

VIDEOS COMPLETED

Ladewig, Katheleen F. Get Hooked on Rainbow Trout

Miget, Russell J. Shrimp Farming

MANUSCRIPTS

Baitfish Production - Video- shooting script completed.

PAPERS PRESENTED

Davis, James T. and Kim Jefferson, Using Adobe Capture for Electronic Formatting of Publications, Texas Chapter of the American Fisheries Society, September 1995.

Davis, James T., Regional Aquaculture Centers: Research Dissemination. Aquaculture 96, World Aquaculture Society Annual Meeting, Arlington, Texas, February 1996.

Davis, James T., The Use of Electronic Media in Aquaculture. Aquaculture 96, World Aquaculture Society Annual Meeting, Arlington, Texas, February 1996.

Davis, James T., Aquatic Exotics: the Good, the Bad, and the Ugly, Plants. 8th National Extension Wildlife and Fisheries Specialists Workshop, Bellingham, Washington, June 1996.

SUPPORT:

YEAR	SRAC FUNDING	UNIVERSITY	OTHER SUPPORT				TOTAL SRAC+ OTHER SUPPORT
			INDUSTRY	OTHER FEDERAL	OTHER	TOTAL OTHER SUPPORT	
1	50,000	43,950				43,950	93,950
2	61,000	30,737				30,737	91,737
Total	111,000	74,687				74,687	185,687

E. MANAGEMENT OF ENVIRONMENTALLY-DERIVED OFF-FLAVORS IN WARMWATER FISH PONDS

Progress Report
For the Period
June 1, 1996 to August 31, 1996

FUNDING LEVEL:

Year 1	$261,000
Year 2 (projected)	$251,000
Year 3 (projected)	$171,000
Year 4 (projected)	$36,000
Year 5 (projected)	$41,000
Total	$760,000

PARTICIPANTS:

University of Tennessee (Lead Institution) - Thomas K. Hill, Project Leader

University of Arkansas, Pine Bluff - Peter Perschbacher

Auburn University - C. E. Boyd, R.T. Lovell

Louisiana State University - Douglas L. Park

Louisiana Tech University - H. Lynn Walker

University of Memphis - King-Thom Chung, Edward Stevens, Tit-Yee Wong

University of Mississippi - Daniel K. Schlenk

Mississippi State University - David J. Wise, Edwin H. Robinson

Texas A&M University - Delbert M. Gatlin, James B. Cottner

ADMINISTRATIVE ADVISOR:

Dr. Don Richardson
University of Tennessee
Tennessee Agricultural Experiment Station
Knoxville, TN 37901

PROJECT OBJECTIVES:

1. Evaluate the feasibility of decreasing the incidence of fish off-flavors by reducing the amount of phosphorus available to support phytoplankton growth.

a. Evaluate methods of reducing phosphorus input by diet modification by determining the minimum phosphorus requirement for food-sized channel catfish and quantifying the reduction in waste phosphorus generation by food-sized catfish fed low-phosphorus feeds relative to presently available feeds

b. Evaluate methods of removing phosphorus from pond water by studying methods of enhancing rates of phosphorus removal from pond waters by pond bottom soils and determining the feasibility of precipitating phosphorus from pond waters as sparingly soluble aluminum or calcium salts.

2. Evaluate the feasibility of reducing the incidence of fish off-flavors by manipulating pond phytoplankton biomass and taxonomic composition using biological and chemical control measures.

a. Evaluate the effect of filter-feeding fishes on water quality and reduction or elimination of off-flavor in pond-raised channel catfish.

b. Develop microbial pathogens to control blue-green algal abundance.

c. Determine whether plant phenolics (tannins) can control growth of microorganisms that produce odorous compounds in warmwater fish ponds.

d. Evaluate the effect of routine, low-level treatments of ponds with copper sulfate on phytoplankton communities, off-flavor incidence, and water quality in channel catfish ponds.

3. Determine the feasibility of managing fish of-flavors by reducing rates of MIB uptake

by fish and/or enhancing rates of MIB elimination from fish.

4. Develop statistical models describing the within-pond variation in the degree of off-flavor in fish populations under various conditions.

5. Develop analytical techniques for assessing flavor qualities in fish.

6. Develop publications to educate producers and processors on the ecology of environmentally derived off-flavors, off-flavor management, and the results of this project.

ANTICIPATED BENEFITS:

Certain blue-green algae that are common in summertime plankton communities of warmwater fish ponds can produce earthy-smelling secondary metabolites. Those metabolites may be absorbed by fish, thereby conferring an earthy-musty flavor to the flesh. Off-flavored fish are not marketable and holding fish in inventory until flavor quality improves is a significant economic burden. It has been estimated that development of off-flavors in pond-raised channel catfish increases the per pound cost of production by 5 to 15%. This project proposes to evaluate practical management practices that may lessen the economic impact of environment-derived off-flavors. Two additional objectives of this proposal are to study the variability of the degree of off-flavor within a population of pond-reared fish and develop quantitative tools for determining the degree of off-flavor in fish. Information obtained from those studies may allow development of more effective sampling protocols to quantify the incidence and severity of off-flavor in pond-raised fish.

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:

This project has a nominal starting date of June 1, 1996. As of the ending date of the reporting period for this report (August 31, 1996), the project has not been approved by USDA/CSREES. As such, no progress can be reported.

V. SRAC RESEARCH AND EXTENSION PROJECTS

Project	Duration	Funding	Grant No.
*__Analysis of Regional and National Markets for Aquacultural Products__ Produced for Food in the Southern __Region.__ Dr. J. G. Dillard, Mississippi State University, Principal Investigator	04/01/88-06/30/90 **Project Total**	**$346,038**	87-CRSR-2-3218
*__Preparation of Southern Regional Aquaculture Publications.__ Dr. J. T. Davis, Texas A&M University, Principal Investigator	01/01/88-12/31/90 **Project Total**	**$150,000**	87-CRSR-2-3218
*__Performance of Aeration Systems for Channel Catfish, Crawfish, and Rainbow Trout Production.__ Dr. C. E. Boyd, Auburn University, Principal Investigator	03/01/88-10/31/90 **Project Total**	**$124,990**	87-CRSR-2-3218
*__Develop a Statistical Data Collection System for Farm-Raised Catfish and Other Aquaculture Products in the Southern Region.__ Dr. J. E. Waldrop, Mississippi State University, Principal Investigator	06/01/89-11/30/90 **Project Total**	**$13,771**	88-38500-4028
***Immunization of Channel Catfish**. Dr. J. A. Plumb, Auburn University, Principal Investigator	Yr. 1-05/02/89-04/30/90 Yr. 2-05/01/90-04/30/91 **Project Total**	$50,000 49,789 **$99,789**	88-38500-4028 89-38500-4516
*__Enhancement of the Immune Response to *Edwardsiella ictaluri* in Channel Catfish.__ Dr. J. R. Tomasso, Clemson University, Principal Investigator	Yr. 1-05/02/89-04/30/90 Yr. 2-05/01/90-10/31/91 **Project Total**	$46,559 51,804 **$98,363**	88-38500-4028 89-38500-4516
*__Effect of Nutrition on Body Composition and Subsequent Storage Quality of Farm-Raised Channel Catfish__. Dr. R. T. Lovell, Auburn University, Principal Investigator	Yr. 1-05/02/89-04/30/90 Yr. 2-05/01/90-04/30/91 Yr. 3-05/01/91-12/31/92 **Project Total**	$274,651 274,720 273,472 **$822,843**	88-38500-4028 89-38500-4516 90-38500-5099

*Project Completed

SRAC RESEARCH AND EXTENSION PROJECTS (CONTINUED)

Project	Duration	Funding	Grant No.
***Harvesting, Loading and Grading Systems for Cultured Freshwater Finfishes and Crustaceans**. Dr. R. P. Romaire, Louisiana State University, Principal Investigator	Yr. 1-05/02/89-04/30/90	$124,201	88-38500-4028
	Yr. 2-05/01/90-04/30/91	124,976	89-38500-4516
	Yr. 3-05/01/91-04/30/93	124,775	90-38500-5099
	Project Total	**$373,952**	
***Preparation of Extension Publications on Avian Predator Control in Aquaculture Facilities**. Dr. James T. Davis, Texas A&M University, Principal Investigator	05/01/90-12/31/92		
	Project Total	**$15,000**	89-38500-4516
***National Extension Aquaculture Workshop**. Dr. Carole Engle, University of Arkansas at Pine Bluff, Principal Investigator	10/01/91-09/30/92		
	Project Total	**$3,005**	89-38500-4516
***Educational Materials for Aquaculturists and Consumers**. Dr. J. T. Davis, Texas A&M University, Principal Investigator	Yr. 1-05/01/91-04/30/92	$3,971	87-CRSR-2-3218
		35,671	88-38500-4028
	Total Yr. 1	$39,642	
	Yr. 2-06/01/92-05/31/93	$59,000	91-38500-5909
	Yr. 3-06/01/93-12/31/94	34,500	92-38500-7110
	Project Total	**$133,142**	
***Characterization of Finfish and Shellfish Aquacultural Effluents**. Dr. J. V. Shireman, University of Florida, Principal Investigator	Yr. 1-05/01/91-04/30/92	$ 13,081	88-38500-4028
		82,747	89-38500-4516
		49,172	90-38500-5099
	Total Yr. 1	$145,000	
	Yr. 2-06/01/92-05/31/93	$168,105	91-38500-5909
	Yr. 3-06/01/93-12/31/94	$128,936	92-38500-7110
	Project Total	**$442,041**	
Food Safety and Sanitation for Aquacultural Products: Microbial. Dr. J. L. Wilson, University of Tennessee, Principal Investigator	Yr. 1-04/01/92-03/30/93	$12,649	89-38500-4516
		71,608	90-38500-5099
	Total Yr. 1	$84,257	
	Yr. 2-06/01/93-05/31/94	$213,106	92-38500-7110
	Yr. 3-06/01/94-05/31/95	$237,975	93-38500-8393
	Project Total	**$535,338**	

*Project Completed

SRAC RESEARCH AND EXTENSION PROJECTS (CONTINUED)

Project	Duration	Funding	Grant No.
Aquaculture Food Safety: Residues. Dr. George Lewis, University of Georgia, Principal Investigator	Yr. 1-09/11/92-09/30/93	$99,393	91-38500-5909
	Yr. 2-10/01/93-09/30/94	$44,631	90-38500-5099
		107,050	91-38500-5909
	Total Yr. 2	$151,681	
	Yr. 3 - 10/01/94-09/30/95	$89,463	93-38500-8393
	Yr. 4 - 10/01/95-09/30/96	$13,992	93-38500-8393
	Project Total	**$354,529**	
*__National Coordination for Aquaculture Investigational New Animal Drug (INAD) Applications__. (In cooperation with other Regional Aquaculture Centers and USDA)	Yr. 1-09/01/93-08/31/94		
	Project Total	**$2,000**	90-38500-5099
Improving Production Efficiency of Warmwater Aquaculture Species Through Nutrition. Dr. Delbert Gatlin, Texas A&M University, Principal Investigator	Yr. 1-01/01/94-12/31/94	$ 28,148	90-38500-5099
		123,705	91-38500-5909
		128,444	92-38500-7110
	Total Yr. 1	$280,297	
	Yr. 2-01/01/95-12/31/95	$ 38,059	92-38500-7110
		176,047	93-38500-8393
		32,403	94-38500-0045
	Total Yr. 2	$249,509	
	Yr. 3-01/01/96-12/31/96	$23,907	93-38500-8393
		210,798	94-38500-0045
	Total Yr. 3	$234,705	
	Project Total	**$761,511**	
Delineation and Evaluation of Catfish and Baitfish Pond Culture Practices. Dr. Michael Masser, Auburn University, Principal Investigator	Yr. 1-04/01/94-03/31/95	$75,530	92-38500-7110
		44,652	93-38500-8393
	Total Yr. 1	$120,182	
	Yr. 2-04/01/95-03/31/96	$152,000	94-38500-0045
	Yr. 3-04/01/96-03/31/97	$25,320	93-38500-8393
		125,180	94-38500-0045
	Total Yr. 3	$150,500	
	Project Total	**$422,682**	
Publications, Videos and Computer Software. Dr. James T. Davis, Texas A&M University, Principal Investigator (Continuing project)	Yr. 1-04/01/95-03/31/96	$50,000	94-38500-0045
	Yr. 2-04/01/96-03/31/97	$13,405	93-38500-8393
		47,595	94-38500-0045
	Total Yr. 2	$61,000	
	Project Total	**$111,000**	

SRAC RESEARCH AND EXTENSION PROJECTS (CONTINUED)

Project	Duration	Funding	Grant No.
Management of Environmentally-Derived Off-Flavors in Warmwater Fish Ponds. Dr. Tom Hill, University of Tennessee, Principal Investigator	Yr.1-06/01/96-05/31/97	$29,349	93-38500-8393
		18,858	94-38500-0045
		202,993	95-38500-1411
	Total Yr. 1	$251,200	
	Yr. 2 - Projected	$250,900	
	Yr. 3 - Projected	$180,900	
	Yr. 4 - Projected	$30,900	
	Yr. 5 - Projected	$31,100	
	Project Total	**$745,000**	
Optimizing Nutrient Utilization and Waste Control through Diet Composition and Feeding Strategies. Dr. Kenneth Davis, University of Memphis, Principal Investigator	Yr. 1 - Projected	$246,715	95-38500-1411
	Yr. 2 - Projected	$258,370	
	Yr. 3 - Projected	$234,915	
	Project Total	**$740,000**	
National Aquaculture Extension Conference (In cooperation with other Regional Aquaculture Centers)	01/01/97-12/31/97	$2,432	93-38500-8393
		1,268	95-38500-1411
	Project Total	**$3,700**	
Verification of Recommended Management Practices for Major Aquatic Species. Dr. Carole Engle, University of Arkansas at Pine Bluff, Principal Investigator	Yr. 1 - Projected	$31,410	
	Yr. 2 - Projected	$65,525	
	Yr. 3 - Projected	$66,925	
	Project Total	**$163,860**	