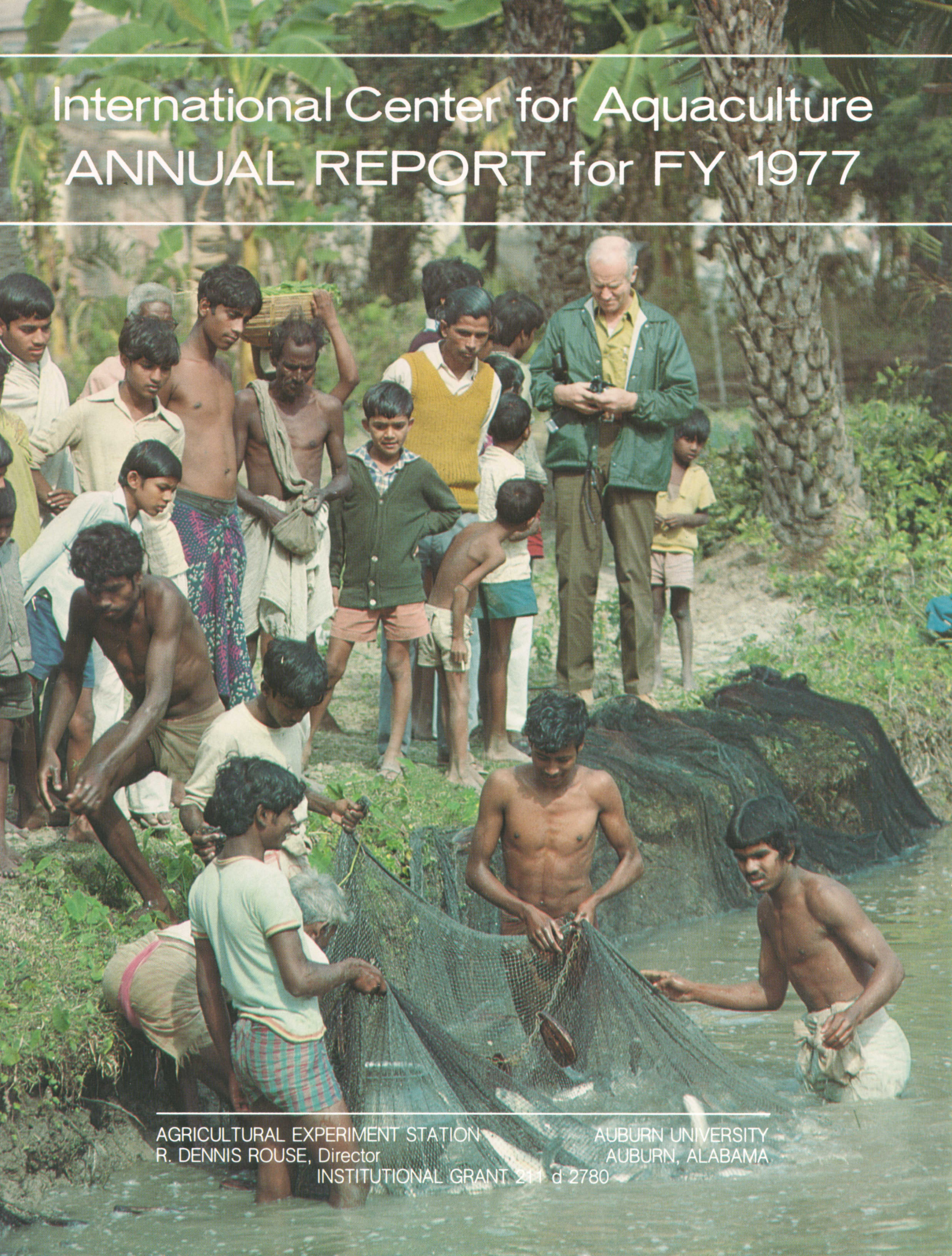
International Center for Aquaculture
ANNUAL REPORT for FY 1977



AGRICULTURAL EXPERIMENT STATION
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AUBURN UNIVERSITY
AUBURN, ALABAMA
INSTITUTIONAL GRANT 211 d 2780

CONTENTS

Published 10/77-1M

The International Center for Aquaculture ANNUAL REPORT FOR FY 1977

E. W. SHELL*

INTRODUCTION

THIS REPORT SUMMARIZES the activities of the International Center for Aquaculture during the fiscal year 1977 (July 1, 1976-June 30, 1977), particularly as related to support received from the U. S. Agency for International Development (AID) institutional grant AID/csd 2780. Highlights for the year included providing 94 man-months of long-term overseas service by center staff. Country projects were operational in the Philippines, Brazil, Indonesia, Nigeria, Jamaica, Colombia, and El Salvador. Additionally, 20 special requests for international development assistance were serviced during the year. In total, 744 students (517 American and 227 foreign) were enrolled in 41 academic courses taught during the year. The second 5-month special Aquaculture Training Program for foreign biologists was also in progress.

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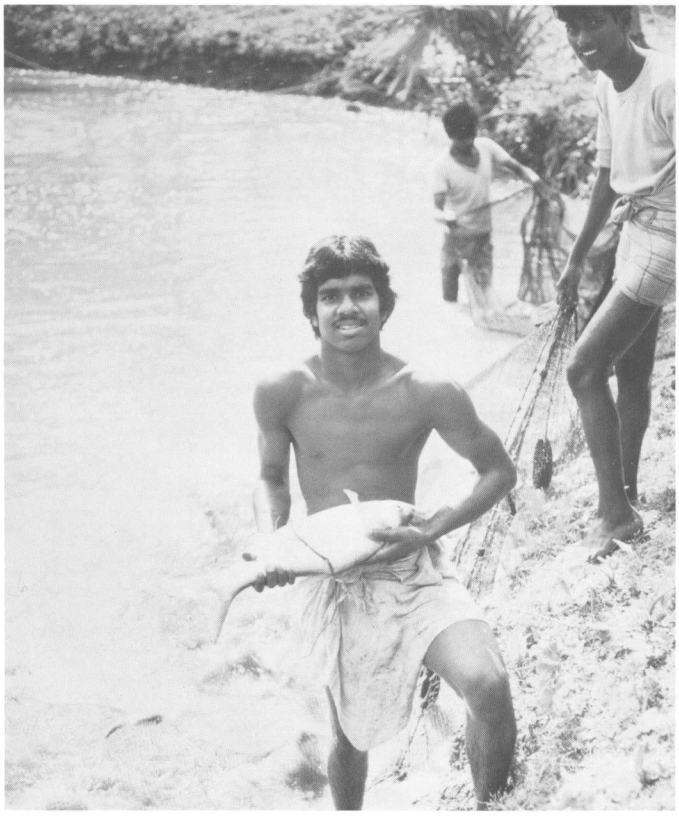


A young fish farmer begins to see results of his efforts.

Aquaculture is becoming increasingly important in developing countries as a means of providing larger quantities of the protein needed for adequate diets and as an increasing contribution to economic growth. It utilizes infertile lands and runoff waters, plus agricultural wastes and surpluses, to intensively grow crops of high quality proteins in the form of fish and other aquatic animals, thus increasing the ability of each country to supply the protein needed by its own people. Aquaculture permits local production of high quality protein where it is most needed, thus reducing the cost of transportation, processing, and refrigeration. It also provides additional income and employment for farmers. Local food production saves foreign money reserves otherwise lost because of importation costs.

Auburn University has received worldwide recognition for its leadership in warmwater fisheries generally and aquaculture specifically. The University has committed itself to assist developing nations increase their supplies of high quality protein and improve their economic well-being through improved methods of aquaculture. No other American university has the experience or program orientation to provide comparable support services to overseas development.

The AID grant was awarded to Auburn University to strengthen its research, teaching, and extension capabilities and to improve service capabilities in aquaculture. As a consequence, more significant contributions can now be made by the University in assisting with aquaculture in developing countries. In addition, the grant can be used to develop methods and procedures for making the University's competence in aquaculture more readily available for those who need it. The initial grant for $800,000 covered a 5-year period, 1970-75. A 2-year extension for the grant, along with revised objectives and a modified scale of operation, was approved covering the period 1976-78 with additional funds amounting to $578,000. This report covers the second year of the 2-year extension period. A 6-month extension of the grant has been requested to facilitate transition to some other form of institutional support. A comprehensive report will be prepared at the conclusion of the grant relationship.

GRANT OBJECTIVES

The program funded by the grant revision and extension has five primary objectives:

1. To provide education and training opportunities in inland fisheries and aquaculture related to international development.
2. To continue to develop and improve the knowledge base of Auburn University, including the development of a capability in production economics as related to aquaculture.
3. To develop a more effective capability for advisory services and actively promote its utilization.
4. To continue to collect, analyze, publish, and disseminate information.
5. To develop a strong professional network of linkages between Auburn and LDC institutions, international development agencies, and U.S. institutions.

Specific work plans to achieve each of these objectives were developed at the beginning of the grant extension. These plans outline the activities of each principle person supported under the AID grant.

PERSONNEL OF THE PROJECT

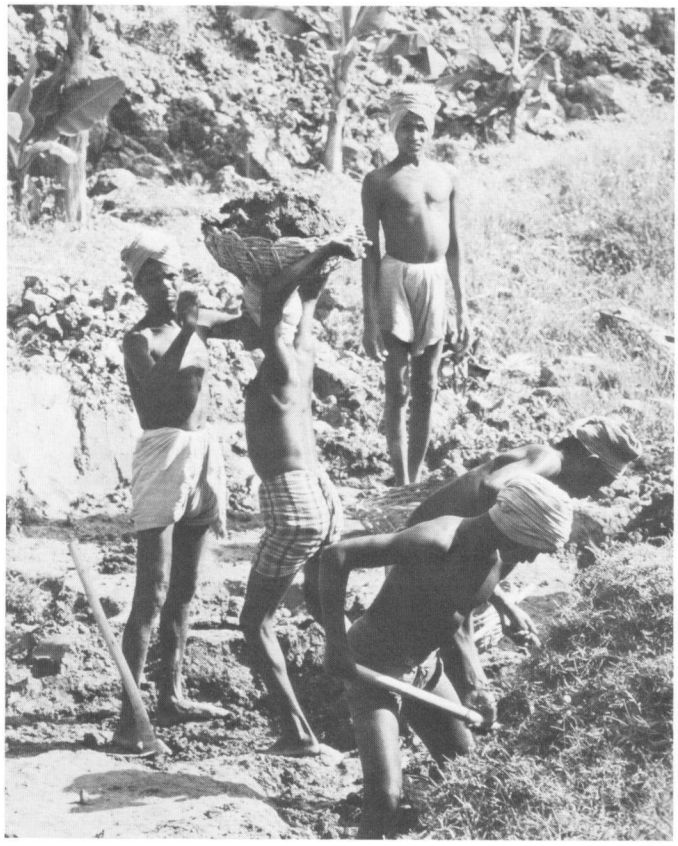
Following is a list of personnel who received grant funds as part of their salary during the year:

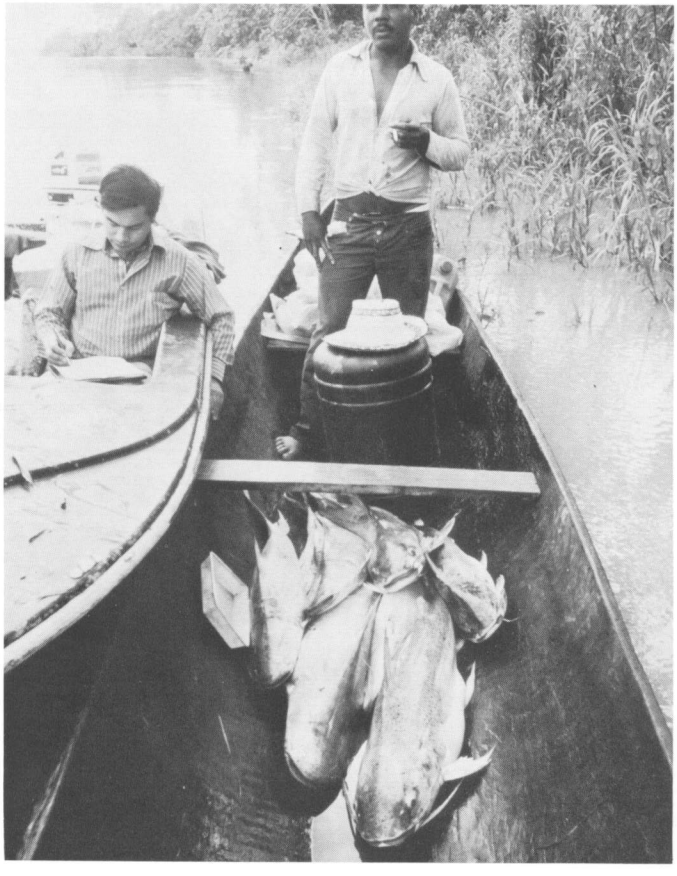
Name	*Position*	*Support months*
Dr. E. W. Shell	Director	2.2
Dr. D. D. Moss	Assistant Director	0.5
Dr. R. T. Lovell	Professor	2.9
Dr. Ray Allison	Associate Professor	0.7
Dr. C. E. Boyd	Associate Professor	2.4
Dr. E. W. McCoy	Associate Professor	9.0
Dr. M. M. Pamatmat	Associate Professor	8.7
Dr. H. R. Schmittou	Associate Professor	12.0
Dr. R. O. Smitherman	Associate Professor	8.0
J. R. Snow	Associate Professor	7.4
Dr. J. H. Grover	Assistant Professor	5.7
K. W. Crawford	Research Associate	9.8
Randell K. Goodman	Research Associate	4.9
Margarita L. Hopkins	Research Associate	12.0
David G. Hughes	Research Associate	3.0
Ellen W. Johnston	Research Associate	7.4
Christine B. Sherrer	Administrative Secretary	3.6
Evelyn C. Talley	Staff Secretary	3.8
Kathy D. Dowling	Secretary	2.6
Deborah A. Morgan	Secretary	4.8
Carl E. Anderson	Graduate Research Assistant*	2.5
Leslie L. Behrends	Graduate Research Assistant*	2.0
Mark J. Brooks	Graduate Research Assistant*	2.0
Robert L. Busch	Graduate Research Assistant*	2.5
Jesse A. Chappell	Graduate Research Assistant*	4.0
John A. Davis	Graduate Research Assistant*	3.8
David R. Dunseth	Graduate Research Assistant*	3.0
John W. Jensen	Graduate Research Assistant*	4.0
Paul C. Lauenstein	Graduate Research Assistant*	2.0
Chhorn Lim	Graduate Research Assistant*	2.0
Robert G. Nelson	Graduate Research Assistant*	2.0
Edwin H. Robinson	Graduate Research Assistant*	4.0
John W. Sowles	Graduate Research Assistant*	2.0
Craig S. Tucker	Graduate Research Assistant*	4.0

*All graduate research assistants are generally expected to spend 1/3 time on activities related to their stipend and under normal circumstances do not contribute more than 4.0 man-months to a project in a year.

ACCOMPLISHMENTS

At the beginning of the grant extension, work plans were submitted for outputs in five general areas: education and





TOP: Pond construction and operation can be labor intensive. BOTTOM: Management of natural stocks can help increase yield for open waters.

Group of foreign biologists at time of graduation from the second Aquaculture Training Program.

training, extended knowledge base, advisory capacity, information capacity, and linkages and networks. The accomplishments in each of these areas will be discussed in reference to the work plans as submitted.

Education and Training

Four activities were programmed in this category: develop new courses, provide practical training, develop special visitor training, and support graduate training. New courses to be developed were in fish seed production, economics of aquaculture, and fish genetics and breeding. These courses have been developed and will become part of the curriculum in the 1977-78 academic year. New courses include Hatchery Management of Food Fish (5 credits, summer quarter), Fish Breeding (3 credits, fall quarter), Economics of Aquaculture (5 credits, winter quarter), and Aquaculture Extension (5 credits, spring quarter).

A special 5-month Aquaculture Training Program for biologists from the international community, divided into two 2 1/2-month sessions, was offered March-August 1976 and is being repeated in 1977. There are 11 trainees enrolled in the second session of this program — 3 from India, 2 from the Philippines, and 1 each from Ghana, Nigeria, Jamaica, Dominican Republic, Syria, and Sierra Leone.

During the report period, 91 visitors from 19 foreign countries were received at the center, 80 percent more than in the previous year. The names and addresses of these visitors are listed in Appendix A. Many of these visitors were provided with special tours of the ponds, laboratories, and other facilities. Meetings with appropriate University administrators or scientific staff were arranged according to the interest and intent of the visitors and, in selected cases, additional tours to fish farms or other facilities around the country were arranged. In addition, a Fulbright exchange scientist, Thomas T. George from the Sudan, spent most of the summer quarter in residence with the Department. More visitors were received during fiscal year 1977 than in any previous year since the International Center was established, as shown below:

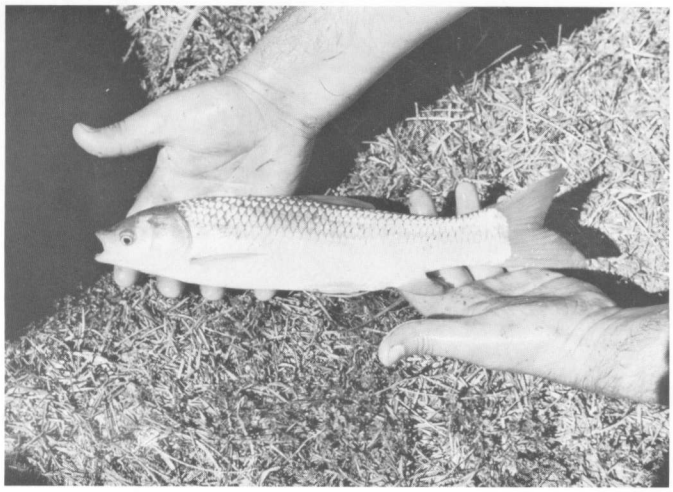
Year	*Number of visitors*
1970-71 (FY 1971)	[1]
1971-72 (FY 1972)	41
1972-73 (FY 1973)	30
1973-74 (FY 1974)	58
1974-75 (FY 1975)	58
1975-76 (FY 1976)	51
1976-77 (FY 1977)	91

[1]Records not kept for fiscal year 1971.

Fourteen graduate students with an interest in international development were provided some financial support from grant funds during the year. Graduate student enrollment during the year in fisheries academic courses averaged 85, of which 25 were foreign students. This is the largest number of graduate students the Department has ever enrolled and is up 16 percent from the previous year. Much of the increase in enrollment can be attributed to interest in the international program. Fifty-two of the graduate students (22 foreign) had major professors and advisors who received some grant support. Graduate student enrollment in FY 1977 is listed below by school quarter:

Quarter	*U.S.*	*Foreign*	*Total*
Summer	66	19	75
Fall	64	23	87
Winter	62	26	88
Spring	60	30	90

The foreign students represented 15 different countries: Philippines (8), Colombia (6), Thailand (6), Taiwan (5), Malaysia (3), Nepal (2), Kuwait (2), Cambodia (1), Panama (1),



LEFT: Rio Grande strain of channel catfish used in fish breeding and genetics studies. RIGHT: Grass carp produced at Auburn for use in pond weed control.

Indonesia (1), Honduras (1), Dominican Republic (1), Jamaica (1), India (1), and Belgium (1). Of these, 20 were sponsored by USAID missions, 9 by their home governments, 5 by personal resources, 4 by International Development Research Centre (Canada), and 2 by FAO. The subject matter specialities for the foreign graduate students were in five fields: fish feeding and nutrition (9), fish diseases and health (8), aquaculture (13), ecology and fish biology (6), and aquacultural economics (4).

Twenty-three graduate degrees were awarded during the year, 5 Ph.D. (3 to foreign students) and 18 M.S. (5 to foreign students). Seven of the 8 foreign degree recipients have returned to foreign countries and employment in the fisheries sector. The eighth married an American before coming to Auburn and is now working for a university in the United States. Of the 15 American graduates, 5 are teaching at the college level, 5 are working for private firms, 4 are employed by government, and 1 is pursuing a Ph.D. degree.

Extend Knowledge Base

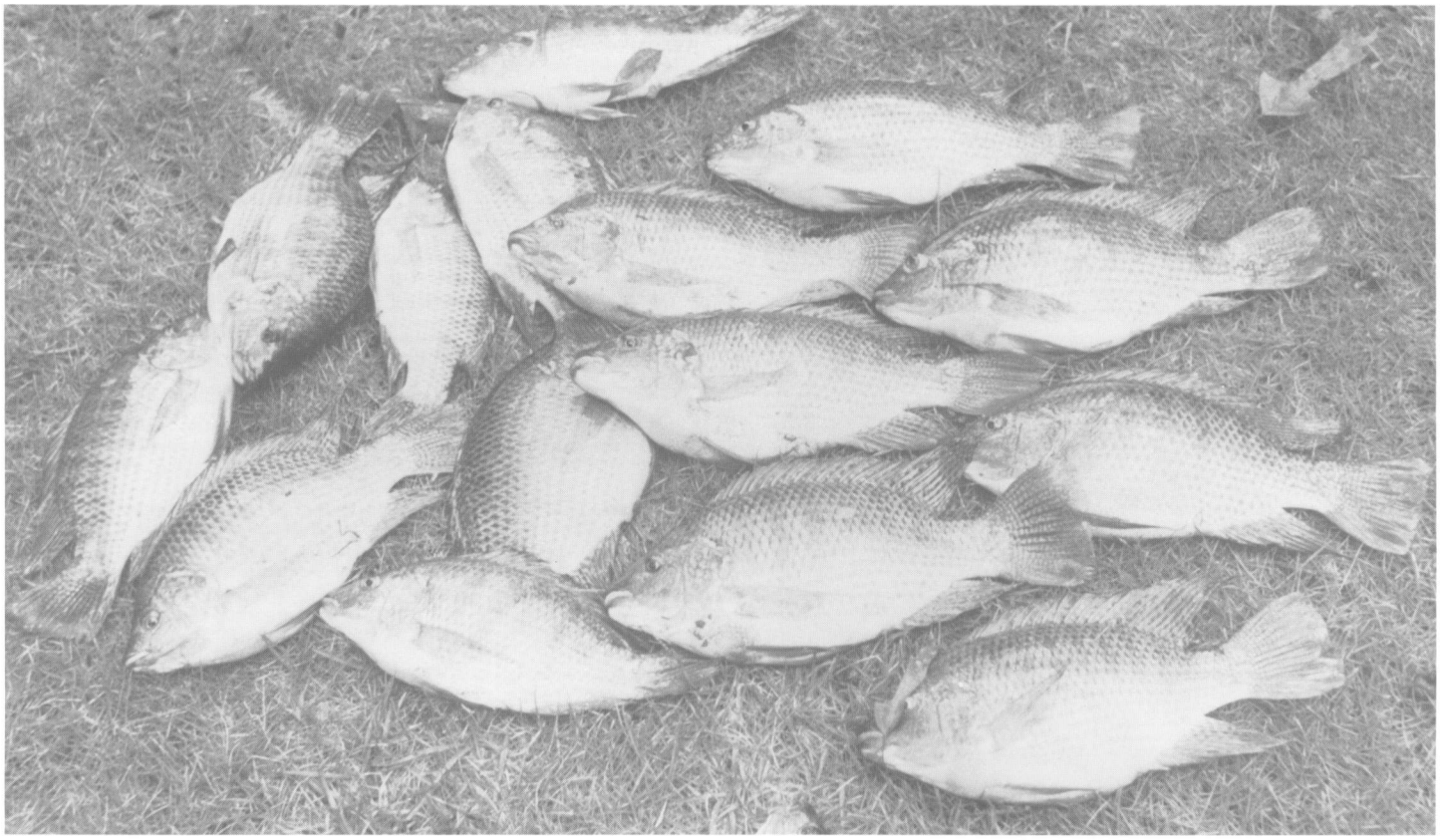
The outputs targeted in this activity include continuation of ongoing research and preparation of state-of-the-art reports on the subjects of aquaculture, aquacultural economics, minimum input aquaculture, and knowledge transfer technology. The extent and nature of ongoing research is illustrated by the list of graduate student research topics given in Appendix B. A list of staff research publications during the year is presented in Appendix C. Additional manuscripts in press include reports on pond polyculture production, algae management with copper herbicides, energy flows in benthic organisms, and fish nutrition. During the year a new experimental fish hatchery building and two water storage ponds were added to the Experiment Station field facilities. These new facilities were constructed with University funds and reflect the continuing support provided by the University for the Center.

A state-of-the-art report giving examples of aquaculture in different countries, input levels, and technology transfer has been drafted. The report is now being discussed and improved before publication. Another manuscript, The State-of-the-Art of Aquacultural Economics — 1977, has been completed. This is supported with an annotated bibliography on aquaculture economics, an open-ended computer-format bibliography, that is a comprehensive search of the literature on this topic. The finalization of these reports will complete the state-of-the-art review activity planned at this time.

Research interests, research projects, and publications of grant-funded staff are listed below:

Name	*Research interests*	*No. of research projects*	*No. of publications*[1]
Dr. E. W. Shell	aquaculture	1	0
Dr. D. D. Moss	aquaculture	0	0
Dr. R. T. Lovell	fish nutrition and fish processing and technology	2	13
Dr. Ray Allison	aquaculture	2	0
Dr. C. E. Boyd	water quality and ecology	6	8
Dr. E. W. McCoy	aquaculture economics	3	2
Dr. M. M. Pamatmat	pond ecology	3	2
Dr. H. R. Schmittou	aquaculture	0	0
Dr. R. O. Smitherman	aquaculture	8	4
J. R. Snow	aquaculture and fish reproduction	4	6
Dr. J. H. Grover	aquaculture international training and development	0	3
K. W. Crawford	aquaculture economics	3	3
Randall K. Goodman	hatchery management	0	0
Margarita L. Hopkins	aquaculture economics	2	2
David Hughes	aquaculture	1	0
Ellen W. Johnston	algal taxonomy and ecology	3	0
Carl E. Anderson	tilapia production aquaculture (with Smitherman)	1	0
Leslie L. Behrends	polyculture and water quality (with Smitherman)	1	1
Mark J. Brooks	aquaculture (with Smitherman)	4	0
Robert L. Busch	induced spawning of fish (with Shelton)	1	0
Jesse Chappell	quantitative inheritance in fish (with Smitherman)	5	0
John Davis	elemental composition of fish (with Boyd)	1	0
David Dunseth	polyculture of fish (with Smitherman)	1	1
John Jensen	pond economics (with McCoy)	1	0
Paul C. Lauenstein	aquaculture (with Smitherman)	1	0
Chhorn Lim	nutrient requirements of fish (with Lovell)	1	1
Robert Nelson	pond culture of fish (with Dendy)	1	1
Edwin H. Robinson	nutrient requirements of cultured fish (with Lovell)	1	0
John Sowles	water quality (with Boyd)	1	1
Craig Tucker	prevention of oxygen depletion following plankton die-offs (with Boyd)	2	1

[1]Titles of publications given in appendix, credit given to each joint author; includes thesis or dissertations that were completed.



Tropical tilapia raised in ponds at Auburn.

Advisory Capacity

This activity was to provide functional training to Center staff, develop a list of talent for work in aquaculture with international development, and to provide pre-departure orientation for Auburn staff being sent overseas. In July 1976, Dr. John Grover was sent as observer to the AID Program Review at the University of Rhode Island International Center for Marine Resources Development. Dr. Donovan D. Moss attended a special conference sponsored by the Southern Regional Conference on Training of International Students in Agriculture in Lexington, Kentucky, May 11-13, 1977. A list of potential consultants and overseas workers for aquaculture has been developed from an inquiry letter that was circulated the previous year. The Center is frequently asked to suggest people who might help with various overseas project activities. A 1-day seminar was held in January 1977 to provide an exchange of information between staff that had returned from overseas assignments and staff scheduled for overseas assignment. A total of 8.2 man-months predeparture orientation was held for staff members. Center staff also provided 22.7 man-months of coordination services for the seven overseas projects operational during the year.

Information Capacity

This activity was for publishing useful results of grant activities during the year. Three new titles were added to the Center's Research and Development Series during the report period:

Marketing As a Factor in Fishculture Development in El Salvador (Parkman and McCoy) 8 pp.

Fish Marketing in El Salvador (Parkman and McCoy) 19 pp.

Marketing of Fisheries Products by Municipal Fishermen in Panguil Bay, Philippines (Hopkins and McCoy) 11 pp.

Two additional titles are in press:

Progress Report on Fisheries Development in El Salvador (August 1974-May 1976.).

Progress Report on Fisheries Development in Northeast Brazil (July 1975-December 1976).

Linkages and Networks

Little new in the way of linkages developed during the report year. The Center continues to play an active role with a variety of international groups. For example, Dr. R. T. Lovell has been working for the U.S. Feed Grains Council in Poland reviewing fish nutrituional work with the hope of finding outlets for American grain. The campus academic program continues to accept foreign students sponsored by a variety of international agencies and governments as indicated earlier in the report. Center staff participate on project development or consulting teams with people from a variety of institutions.

IMPACT OF GRANT-SUPPORTED ACTIVITIES IN ACHIEVING GRANT PURPOSES

The purpose of the grant is to strengthen the International Center for Aquaculture for greater service to developing countries. It is evident from the discussion of accomplishments that reasonable progress is being made to realize this purpose. The International Center has been strengthened and the resulting capability for service is being maintained and enhanced. Furthermore, the increased capacity is being effectively utilized.

Center staff provide technical advice about design for hatchery system.

Grant funds were utilized during the year to purchase 150.7 man-months of personnel services. These services contributed significantly to the capability of the Center in the areas of education and training, extending the knowledge base, advisory capacity, information capacity, and linkages and networks. Funds were also used to increase library holdings, to support the activities of the Center staff, and to provide materials, supplies, and minor items of equipment utilized in graduate training. Approximately 140 new titles or periodical subscriptions were purchased for the library during the year.

The major contribution of the grant was to provide for the purchase of approximately 59.5 man-months of senior-level (assistant professor and above) staff time. These personnel are key elements in the strengthening of the International Center. They are primarily responsible for the training, extension of the knowledge base, advisory services, and other activities necessary for a viable program.

Virtually all of the grant-funded staff participated in the expansion of the knowledge base through research and development. Results of their activities were published as research papers in recognized scientific journals, as chapters in monographs or books, as parts of symposia, and as reports prepared for various USAID Missions and International Development Agencies (see Appendix C).

Man-months of personnel services purchased with grant funds since the beginning of the project are given in the following table:

Year	*Category of personnel*			
	Academic and research	*Technical and secretarial*	*Graduate research assistants*	*Field and student labor*
1970-71 (FY 1971)	47.8	12.0	15.2	17.6
1971-72 (FY 1972)	38.0	22.3	25.6	74.9
1972-73 (FY 1973)	45.2	16.1	16.3	65.6
1973-74 (FY 1974)	48.4	29.0	22.4	47.9
1974-75 (FY 1975)	44.2	30.6	19.5	26.8
1975-76 (FY 1976)	93.6	21.8	40.8	113.8
1976-77 (FY 1977)	96.6	14.8	39.3	23.8

Research conducted by foreign students represents one of the significant ways in which grant-funded activity aids in the expansion of the knowledge base. Not only did the students contribute new information to various fields of aquaculture and inland fisheries, but they also learned something of the use of the scientific method for solving practical problems. A total of eight foreign students received graduate degrees during the year. Each student was required to submit a thesis or dissertation based on original research. Although foreign students were not supported directly on grant funds, all of the students utilized equipment and supplies, benefited from the availability of field labor, or received guidance and assistance from staff which was provided with grant funds. Names, country of origin, and title of thesis or dissertation for each foreign student are:

Name	*Thesis or dissertation title*
Cabrero, Jose Eduardo, Jr. (El Salvador)	Production of Channel Catfish, *Ictalurus punctatus* (Rafinesque), in a Closed System with Circulation, Aeration, and Filtration (Ph.D. — Allison)
Cuenco, Michael (Philippines)	Application of Lime in Ponds, Its Penetration in Muds, and Effect on Water Hardness (M.S. — Boyd)
Lim, Chhorn (Cambodia)	Dietary Ascorbic Acid (vitamin C) Requirements of Channel Catfish in Ponds and in a Controlled Environment (Ph.D. — Lovell)
Liu, Chi-Yuan (Taiwan)	Aspects of Reproduction and Progeny Testing in *Sarotherodon aureus* (Steindachner) (M.S. — Shelton)
Manandhar, Hridaya (Nepal)	Digestibility of Phytoplankton by Silver Carp (*Hypohthalmichthys molitrix*) and Three Tilapias (*Sarotherodon* spp.) in Polyculture with Channel Catfish (*Ictalurus punctatus*) (M.S. — Smitherman)
Pretto, Richard (Panama)	Polyculture Systems with Channel Catfish as the Principal Species (Ph.D. — Smitherman)
Shrestha, Sundar (Nepal)	The Parasites of Different Strains and Species of Catfishes (*Ictalurus* sp.) (M.S. — Rogers)
Sun, Peter Lin (Taiwan)	Effects of Increasing or Decreasing the Protein Percentage in Isocaloric Rations for Pond-raised Catfish during the Summer Growing Period (M.S. — Lovell)

Because of availability of the staff funded from the grant, the Department has been able to attract a number of research grants and contracts that it could not otherwise have handled. The grant-funded staff were involved in a number of research projects supported by State appropriated university funds. Several of these research projects will result in information that will have direct transferability to developing countries.

Grant-funded staff taught 13 courses during the year. The University paid most of the costs for teaching the courses, but the use of grant funds resulted in more specialists in different disciplines being available for teaching these courses. Nine courses per 12-month academic year would be approximately a full-time teaching load for one professor if he were supported entirely by university teaching funds. Obviously, a single individual could not adequately teach the wide variety of courses offered in the Department.

The number of publications produced by grant-funded staff each year since the beginning of the grant is shown below:

Year	*Number*
1970-71 (FY 1971)	6
1971-72 (FY 1972)	8
1972-73 (FY 1973)	12
1973-74 (FY 1974)	13
1974-75 (FY 1975)	37[1]
1975-76 (FY 1976)	35
1976-77 (FY 1977)	50

[1]Beginning in FY 1975, formal reports prepared as a result of USAID contracts are included in the number of publications.

A summary of courses taught and student enrollment is presented below:

Quarter	No. of courses	Number of students enrolled[1]	
		American	Foreign
Summer 1976	8	109	37
Fall 1976	12	164	73
Winter 1977	11	147	61
Spring 1977	10	97	56
TOTAL	41	517	227

[1]Students normally take more than one course each quarter. The total number of students enrolled increased approximately 13 percent over the previous year. Foreign student enrollment increased 49 percent.

The average number of graduate students enrolled during the year was 85, up 16 percent over the previous year. A summary of graduate enrollment during the past 6 years follows:

Year	Number of graduate students enrolled in each quarter			
	Summer	Fall	Winter	Spring
1970-71 (FY 1971)	24	23	31	28
1971-72 (FY 1972)	29	34	43	46
1972-73 (FY 1973)	43	48	50	51
1973-74 (FY 1974)	48	57	54	53
1974-75 (FY 1975)	50	57	65	69
1975-76 (FY 1976)	60	73	79	79
1976-77 (FY 1977)	75	87	88	90

Foreign graduate student enrollment has been relatively stable for the past 5 years, as shown by the following:

Year	Number of foreign graduate students enrolled in each quarter			
	Summer	Fall	Winter	Spring
1970-71 (FY 1971)	7	5	5	7
1971-72 (FY 1972)	5	5	13	15
1972-73 (FY 1973)	16	16	19	22
1973-74 (FY 1974)	22	27	26	26
1974-75 (FY 1975)	24	22	19	21
1975-76 (FY 1976)	20	20	22	22
1976-77 (FY 1977)	19	23	26	30

A total of 23 advance degrees was awarded during the year (18 M.S. and 5 Ph.D.). Eight of these were awarded to foreign students. Information on the total number of advance degrees awarded and the number awarded to foreign students is presented below:

Year	Graduates	
	M.S.	Ph.D.
1970-71 (FY 1971)	4 (0)[1]	4 (2)
1971-72 (FY 1972)	10 (4)	4 (1)
1972-73 (FY 1973)	18 (8)	4 (0)
1973-74 (FY 1974)	20 (9)	5 (3)
1974-75 (FY 1975)	24 (12)	3 (2)
1975-76 (FY 1976)	17 (7)	3 (1)
1976-77 (FY 1977)	18 (5)	5 (3)
TOTAL	111 (45)	28 (12)

[1]Number of foreign student graduates indicated in parentheses.

OTHER RESOURCES FOR GRANT-RELATED ACTIVITIES

All funds received by the Department and International Center strengthen and support the Center. Information on the various sources of funds received by the Center is presented in the following table:

Source of funds	Amount
State of Alabama appropriated funds	
For teaching	$ 183,622.00
For research	185,678.00
Sales funds	
From sale of food fish and fingerlings	45,000.00
Federal appropriated funds for research	
USDA — Land-Grant College funds	107,731.00
Research grants from other state governments	128,000.00
Research grants from Federal agencies	61,150.00
Research grants from private enterprise	70,000.00
Sub-total	781,181.00
All USAID support — grant and country projects	570,204.00
TOTAL	$1,351,385.00

As the information indicates, the Department and Center receive funds from a wide variety of sources; however USAID is the largest single source of funds. Appropriated funds from the State of Alabama to Auburn University for teaching and research represent the second largest source of funds. A number of separate research and development contracts provide the third largest source.

Interpreting the term "grant-related activities" in its broadest sense, virtually all funds received contribute directly or indirectly to achieving the purpose of the grant. Even industrial research grants contribute supplies, equipment, and personnel that are used to some extent in graduate training. By having this type of work going on in the same Department, foreign graduate students are able to better comprehend the complexity of problems they must fact in the future when attempting to balance food and industrial production needs with the need for environmental protection.

UTILIZATION OF INSTITUTIONAL RESPONSE CAPABILITIES IN DEVELOPMENT

Much information about service activities by the International Center for Aquaculture has already been presented. A total of 20 requests for assistance was responded to during the year. Additional requests, mostly from private industry wishing to acquire staff services on a personal services contract (consulting) basis, were received, but this type of arrangement is generally discouraged by the Center.

The international service activities for the year can be divided into four categories. The different categories with the number of man-months of each were as follows:

Category	Man-months
Activities by grant staff utilizing 211 (d) funds	0.9
Activities by other staff utilizing 211 (d) funds	0.1
Activities by grant staff utilizing other funds	4.7
Activities by other staff utilizing other funds	2.7
TOTAL	8.4

The specific people and the activities involved by each category were:

Professor	Activity and dates
Grant staff utilizing 211 (d) funds	
David Hughes	Attended conference in Costa Rica and visited Honduras relative to project development, January 7-14, 1977.
H. R. Schmittou	Participated in conference in Costa Rica, January 9-15, 1977.
R. T. Lovell	Visited research laboratories in Italy and Israel, March 28-April 3, 1977.
Other staff utilizing 211 (d) funds	
C. C. Carroll	Visited Honduras to confer with officials of the government regarding fisheries development, January 4-6, 1977.

Grant staff utilizing other funds

E. W. Shell	Visited Brazil to provide consulting services and explore regionalization of project, September 27-October 4, 1976.
J. R. Snow	Visited Philippines to assist in design of fish hatchery, August 3-31, 1976 Advised in Honduras, relative to hatchery plans, June 27-July 2, 1977.
R. O. Smitherman	Visited Greece and FAO, Rome, in response to request about fish culture development, September 2-16, 1976.
Mario Pamatmat	Presented a paper in Scotland, September 14-24, 1976.
H. R. Schmittou	Assisted with fisheries assessment team in Sierra Leone, September 21-October 2, 1976. Advised relative to aquaculture extension efforts in Philippines, October 5-21, 1976. Participated in project review of Oceanic Foundation in Hawaii, February 28-March 5, 1977.
John Grover	Assisted AID fisheries sector review in Egypt, November 14-December 17, 1976.
R. T. Lovell	Helped develop fish rations and research programs in Poland for U.S. Feed Grains Council, April 4-10, 1977.
E. W. McCoy	Conducted aquaculture economics training in the Philippines for USAID, April 12-23, 1977.

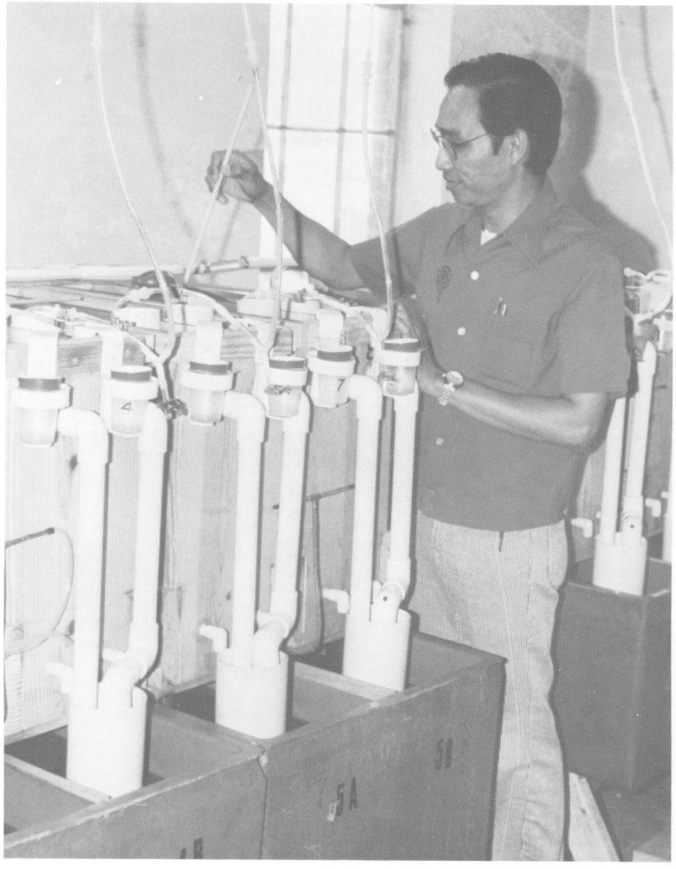
Other staff utilizing other funds

W. D. Davies	Reviewed for USAID the lake fisheries in Zaire and Burundi, October 13-28, 1976. Advised fisheries program in Colombia, March 25-April 6, 1977.
K. N. Randolph	Visited Jamaica relative to project development, October 18-November 13, 1976.
Ronald Phelps	Visited Colombia relative to project design, October 19-November 9, 1976.
L. L. Lovshin	Invited consultations about tilapia culture in El Salvador and conference in Costa Rica, January 5-15, 1977. Provided advisory assistance to USAID in Paraguay, June 12-17, 1977.

In addition to the international service activities discussed above, the Center has provided 94 man-months of technical assistance to seven international development projects overseas. Twelve different Center staff were assigned to these projects full time. In addition, 15.1 man-months of technical coordination and support plus 7.6 man-months of secretarial support services were provided by the Center on campus. Funds for these came from the individual projects and were utilized in the support of five different staff members. These projects were: (1) USAID-supported aquaculture development project in Northeast Brazil (AID/la BOA 1152 T. O. 2), (2) USAID-supported aquaculture production project in freshwater, brackishwater, and extension fisheries work in the Philippines (AID/ea 180 ICA), (3) freshwater aquaculture development project in Mid-Western State, Nigeria, supported by the Nigerian Government, (4) brackishwater intensification project in Indonesia sponsored by USAID (AID/ASIA-C-1177), (5) USAID-sponsored pond development project in Jamaica (AID/la-C-1166), (6) USAID-sponsored aquaculture and fisheries development project in Colombia (AID/la-C-1176), and (7) government-sponsored aquaculture project in Honduras.

Man-months of overseas activities by grant-funded staff since its inception are given in the following table:

Year	*Man-months*
1970-71 (FY 1971)	9.8
1971-72 (FY 1972)	8.0
1972-73 (FY 1973)	3.0
1973-74 (FY 1974)	4.5
1974-75 (FY 1975)	7.7
1975-76 (FY 1976)	9.3
1976-77 (FY 1977)	5.6



Filipino doing research on hatchery design to improve fish survival.

NEXT YEAR'S PLAN

The Center is fast approaching the state of development intended with the purpose of the AID grant. It should be clear that Auburn University has a strong commitment and sizable program for participation in international aquacultural development. In spite of this commitment by the University, it is also clear that the Center needs substantial core support from outside sources if the program is to sustain its workload.

It is expected that the current grant will be extended for a few months until new contractual arrangements can be developed between AID and the University. Activities called for under the present work plans will be continued in the meantime.

Title XII programs are a possible means to obtain core operating support for the Center. The Center plans to submit proposals and work with the Title XII programs as they develop. A special university services contract has also been proposed between AID and the Center. Both of these approaches have good potential, but neither appears far enough along administratively to become effective in time to meet the Center's immediate support needs. For this purpose a continuation of the current grant has been requested until such time as other arrangements are in force. Meanwhile, it is expected that overseas service, international training, and relevant research activities will continue with the same dynamic interest as in the past.

INVOLVEMENT OF MINORITY PERSONNEL AND WOMEN

The budgeted academic and non-academic personnel receiving support under the grant during the report year are classified below according to race and sex:

	Men	*Women*
Blacks	0	3
Spanish American	0	0
American Indians	0	0
American Orientals	2	1
Other	29	3
TOTAL	31	7

Student employment was provided to three foreign nationals, two female orientals and one oriental male, which enabled them to continue their studies. A special seminar was presented to three black male students from Alabama A&M University, who were employed by the School of Agriculture during the summer, to make them aware of available opportunites in graduate education in aquaculture.

Auburn University has an "affirmative action program" for the involvement of minority personnel and women and for recruiting students for training. The provisions of the program are followed closely by the Center in recruiting staff and in recruiting students for graduate training.

There are excellent opportunities for involving minority personnel and women in international development work and for significant contributions to Center activities. Unfortunately, few of either group are interested in careers in fisheries and aquaculture and even fewer are interested in international service in these areas of work.

APPENDIX A

Visitors Seeking Information on International Development

Name	*Date*
Dr. Jean Nyan Ngatchou, Director Research Institute of Agriculture and Forestry Research ONAREST Yaounde, Cameroon	July 2, 1976
Ms. Patricia T. Arroyo Assistant Professor Department of Fisheries and Technology College of Fisheries University of the Philippines Diliman, Quezon City Philippines 3004	July 8, 1976
President and Mrs. Amado C. Campos Central Luzon State University Munoz, N. E. 2320 Philippines	July 8, 1976
Mr. James Kapetsky Apartado AEREO 2458 Cartagena Bolivar Colombia	July 8-9, 1976
Chief Justice T. Mabandla Chief of the Bhele Tribe Cape Province, South Africa	July 12, 1976
Mr. George Crowell Department of State Washington, D.C.	July 12, 1976
Mr. J. Weihl Mr. I. Tzhak Mr. J. Levi Israeli Farmers Israel	July 14, 1976
Mr. E. Heckman Mr. M. Harvey Mr. Patterson Sudan Consultants Khartoum, Sudan	July 14, 1976
Mr. K. Sheets Mr. G. Weishbart Colorado Fish Farmers Colorado	July 14, 1976
Mr. John Hartzog Henry County, Alabama	August 10, 1976
Dr. Tapan Benergee Program Director (Fisheries) U.S. Peace Corps c/o U.S. Embassy Manila, Philippines	August 23-25, 1976
Mr. Emmitt Parrish P.O. Box 1155 Pensacola, Florida	August 27, 1976
Mr. C. E. White Mr. William Reeves Mr. Gerald Hooper Game and Fish Division Alabama Department of Conservation and Natural Resources 64 N. Union Street Montgomery, Alabama	September, 1976
Mr. Kermit Sneed Thompson Anderson Enterprises Thornton, Mississippi	September 1, 1976
Mr. Tirso Jamandre Fish Farmer and FAO Consultant Iloilo City, Philippines	September 1, 1976
Mr. Varadi Laszlo 5541 Szarvas Fish Culture Research Institute P.f. 47 Hungary	September 2-14, 1976
Mr. John Hester Mr. Bruce Bell U.S. Fish and Wildlife Service Box 836 Decatur, Alabama	September 9, 1976
Mr. Ken Corson Methodist Mission Casilla 356 La Paz,Bolivia, S.A.	September 23, 1976
Legislative Aides, U.S. House of Representatives Mrs. Thomas S. Joley, Chairman — Agriculture Mr. Yourman Ms. Ermann Mr. T. Adams Dr. Jim Halpin	September 27-28, 1976
Dr. Ralph Jones, Jr. Southern Union State Junior College 1414 Davis Drive Roanoke, Alabama	October 4, 1976
Mr. George Holmes Honalde 404 Maxwell Hall Syracuse University Syracuse, New York	October 5-6, 1976
Mr. Earl B. Terwillinger Chief, Production Programs Branch International Training Foreign Development Division U.S. Department of Agriculture Washington, D.C.	October 7-8, 1976
Hon. John Breaux (D-LA) U.S. House of Representatives Washington, D.C.	October 8, 1976

Mr. James Williams — October 11-12, 1976
Caribe King Shrimp Co.
Box 432
Cabo Rojo, Puerto Rico

Mr. and Mrs. Michael Sipe — October 12, 1976
Natural Systems
Rt. 1, Box 363
Palmetta, Florida

Mr. Abd Al-Rahman Selin — October 13, 1976
Political International Affairs
Writer for Saudi Daily
Box 4676 Jidda
Kingdom of Saudi Arabia

Dr. Q. F. Miravite — October 15, 1976
Aquaculture Department
Southeast Asian Fisheries Development Center
Tigbauan, Iloilo, Philippines

Ing. Joaquin Guevara Moran — October 19-20, 1976
General Director of Natural Resources
Ministry of Agriculture
El Salvador

Dr. Jay Huner — October 21-22, 1976
Southern University
Baton Rouge, Louisiana

Mr. Bill Myers — October 29, 1976
Action-Recruitment Resources
Room P-302
1735 I. Street, N.W.
Washington, D.C.

Ms. Sophia L. Basa — November 3-December 17, 1976
Senior Forestry Biologist
Department of Natural Resources
Bureau of Fisheries and Aquatic Resources
P.O. Box 623
Manila, Philippines

Mr. Geoffrey Parker — January 6, 1977
Route No. 2
Milton, Wisconsin

Mr. Doug Jones — January 24, 1977
USAID/Washington
Office of Agriculture, (TAB)
Washington, D.C.

Mr. Milton Bedard — January 24-25, 1977
Apartado 7-2740
San Jose, Costa Rica

Mr. Paul Bedard — January 24-28, 1977
864 Chattahooche Drive
C.P.O. Box 10547
Gainesville, Georgia

Mr. Dan Thomaston — February 1, 1977
Mr. Dan Self
Mr. Frank Ellis
Department of Natural Resources
Georgia

Dr. Donald F. Amend, Director of Research — February 4, 1977
Tavolek, Inc.
2779-152 Avenue N.E.
Redmond, Washington

Dr. Ward Falkner — February 11, 1977
Mr. Jack Mathias
Mr. Burton Ayles
Freshwater Institute
Department of Fisheries and Environment
Winnipeg, Canada

Mr. Fleming — February 16, 1977
Mr. Rasmusn
Mr. Arne
Mr. Anderson
Danish Farmer Group

Mr. Philip Irwin — March 24, 1977
Voice of America
United States Information Agency
Washington, D.C.

Mr. Alfonse Catchy — March 25-27, 1977
Director of Fisheries
Central African Empire
Africa

Mr. Bob Thoesen — April 4, 1977
U.S. Fish and Wildlife Service
Atlanta, Georgia

Mr. Bruce G. Barclay, Jr., M.P. — April 4, 1977
U.S. Fish and Wildlife Service
Atlanta, Georgia

Mr. Emil R. Knutti — April 20, 1977
U.S. Peace Corps Regional Representative
Atlanta, Georgia

Mr. L. C. Berth — April 20, 1977
Research Specialist
L. D. Schreiber Cheese Co., Inc.
1601 Main Street
P. O. Box 610
Green Bay, Wisconsin

Dr. Jim Jones — April 25, 1977
Director of Mississippi-
Alabama Sea Grant Consortium
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

Mr. Sherman Reed — April 27, 1977
Mr. Mitch Olszewski
Engineering Technical Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Mr. Sam Suffern — April 27, 1977
Mr. Jack Griffith
Environmental Science Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Dr. Vasile Jurwbesco — April 28-29, 1977
Ministry of Agriculture and Food Industry
Technical Direction
Buchark, Romania

Prof. Ivan B. Tokin — April 28-29, 1977
Institute of Marine Biology
Academic of Sciences of USSR
Deline Zelentzy, 184531
Murmanskaya obl, USSR

Ms. Valarie Anderson Gillen — May 2, 1977
NOAA, Office of Public Affairs
6010 Executive Blvd.
Rockville, Maryland

Mr. Mustafa Bezikoglu — May 9, 1977
Dr. Fethullah Koc.
Mr. Kamal Orue
Mr. Orpah Ozbaysal
Mr. Necmettia Alpturk
Dr. Adnan Oaturk
Turkish Government Fisheries Personnel

Mr. D. Kloen — May 27, 1977
Otto van Gehreweg 35
Wageningen
Holland

Mr. Rick Goodier — June 4, 1977
Rt. 2, Box 3P
Richmond, Texas

Mr. Chris Nugent — June 8-10, 1977
Mr. Jim Miller
FAO Country Program
Central African Empire
Bangui, CAE

Mr. Joseph P. Senft — June 20, 1977
Mr. Andrew Merkowsky
Mr. James Fritch
Rodale Press Reservoirs Division
576 North Street
Emmaeus, Pennsylvania

Dr. Dale Toetz — June 28, 1977
Southeast Water Laboratory
EPA
Athens, Georgia

APPENDIX B

Graduate Student Research Topics and Advisors

Almazan, Guadiosa*	Relationship between Alkalinity, Phosphorus, and Algae Growth (Boyd)
Alston, Dallas	Microinvertebrate Study of Three Experimental Channels to Determine the Effects of Thermal Enrichment on Fish Food Organisms (Dendy)
Anderson, Carl E.	Comparison of Tilapia aurea, *T. nilotica,* and hybrid *(T. nilotica x T. hornorum)* in Polyculture Systems (Smitherman)
Behrends, Leslie	Comparison of Water Quality in Polyculture Systems (Smitherman)
Boonyaratpalin, Mali*	Energy Requirement of Channel Catfish (Lovell)
Boonyaratpalin, Sitdhi*	Pathogenesis and Control of Bass Tapeworm (Rogers)
Bowman, James	Culture of Larval Fishes (Snow)
Bowser, Paul	Studies on Vertical Transmission of Channel Catfish Virus Disease (Plumb)
Braid, Malcolm	Intensive Culture of Striped Bass Fry (Shell)
Bright, David	Stream Ecology-Insects (Dendy)
Brooks, Mark	Effects of Initial Weight on Final Weight in Genetically Distinct Populations of Channel Catfish (Smitherman)
Burtle, Gary	Diets for Golden Shiners (Lovell)
Busch, Robert	Induced Spawning of Channel Catfish Using Clomiphene Citrate (Shelton)
Cabrero, Jose*	Recirculation in Intensive Culture (Allison)
Campbell, Terry	Study of Primary Productivity in West Point Reservoir (Bayne)
Canlas, Joel*	Bacterial and Parasitic Loads of Cultured Channel Catfish in Farm Ponds (Plumb)
Carreon, Jose*	Feed and Feeding of Striped Bass Fry (Shell)
Chappell, Jesse	Heterosis in Pond-reared, Crossbred Strains of Channel Catfish (Smitherman)
Chitwood, Brian	Growth and Production of Largemouth Bass with Forage Species and in Combination with Bluegill and Redear (Davies)
Chuapoehuk, Wiang*	Nutritional Contribution of Natural Pond Organisms to Channel Catfish Growth in Ponds (Lovell)
Clay, Larry	Pathology Associated with Healing After Surgery of Fish (Plumb)
Cook, Stanley	Larval Fishes of Jones Bluff Reservoir (Davies)
Cox, Kenneth	Dynamics of the Black Crappie Population in Lee County Public Fishing Lake (Davies)
Cuenco, Michael*	Crayfish Culture with Channel Catfish (Dendy)
Cuevas, Hugo*	Special Problems in Larval Fish Culture (Snow)
Davis, John	Phytoplankton Related Fish Kills (Boyd)
Dobbins, Daniel	Effects of Phosphorus and Potassium Fertilization on Sunfish Production (Boyd)
Dunseth, David	Production of *Tilapia aurea* (Steindachner) in Combination with the Predator *Chichlasoma manaquense* (Meeks) at Different Stocking Rates (Bayne)
Dureza, Virgilio*	Use of Recirculation and Aeration in the Culture of Channel Catfish (Allison)
Dutta, Omeo*	Sex Identification of Cichlids and Chinese Carp by Cytological Techniques (Shelton)
Felts, Shawn	Winter Management of Channel Catfish (Lovell)
Foote, Karen	Studies of Some of the Possible Effects of Overturns in Fish Ponds (Boyd)
Fong, Sunchio*	Dynamics of Bass-bluegill Population in Farm Ponds (Davies)
Grizzle, John	Histological and Ultrastructural Changes in Gills of Channel Catfish Treated with Malachite Green (Rogers)
Hardin, Scott	Electrophoretic Determination of Sex in *Tilapia aurea* (Smitherman)
Hemstreet, William	Studies of the Parasites of Year-class Largemouth Bass in West Point Reservoir (Rogers)
Hopkins, Kevin	Sex Reversal of *Tilapia aurea* with Synthetic Estrogens (Shelton)
Inko-Tariah, McKenzie*	Production of *Tilapia aurea* in Polyculture Using Largemouth Bass and Monosex Male as Population Controls (Smitherman)
Jensen, Gary	Sex Reversal of *Tilapia aurea* with Three Naturally Occurring Estrogens (Shelton)
Jensen, John	Alternative Production Systems for Hill Pond Culture (McCoy)
Jones, Walter	Observations on Biology of *Macrobrachium ohione* (Smitherman)
King, Terry A.	Population Dynamics of Largemouth Bass in West Point Reservoir-Georgia-Alabama (Davies)
Kubaryk, John	Protein-energy Requirements of Tilapia (Lovell)
Landesman, Louis	Tilapia Culture in Combination with a Recirculating Hydroponic System (Smitherman)
Lauenstein, Paul	Culture of Tilapia in Tanks with Supplemental Species (Allison)
Lawson, Curtis	Dynamics of the Largemouth Bass Population in Lee County Public Fishing Lake (Davies)
Lee, Jen-Chyuan*	Production of Hybrid Tilapia (Smitherman)
Li, Yen-Pin*	Vitamin D_3 Requirements of Channel Catfish (Lovell)
Lichtkoppler, Frank	Comparison of 20-10-5 and 20-20-5 Fertilization in Sunfish Ponds (Boyd)
Lim, Chhorn*	Vitamin C Requirements of Channel Catfish (Lovell)
Lim, Ricardo*	Common Carp Population in the West Point Reservoir (Shelton)
Liu, Chi-Yuan*	Progeny Testing of Sex Reversed *Tilapia aurea* (Shelton)
Malvestuto, Stephen	Harvest of Largemouth Bass in a Newly Impounded Reservoir (Davies)
Manandar, Hridaya*	Digestibility of Phytoplankton by Silver Carp and Tilapia in Channel Catfish Ponds (Smitherman)
McGinty, Andrew	Effects of Initial Weight on Final Weight in Catfish Breeding Systems (Smitherman)
McGinty, Paul	Management of Aquatic Plants in Farm Ponds (Boyd)
Mezainis, Valdis	The Metabolic Activity of a Pond Ecosystem under Intensive Catfish Cultivation (Pamatmat)
Minton, Vernon	Effect of Dietary Protein and Energy Levels on Voluntary Food Consumption of Channel Catfish in Ponds (Lovell)
Mitchell, Andrew	Susceptibility of Homogenetic and Heterogenetic Strains of Channel Catfish (*Ictalurus punctatus to Chondrococcus columnaris)* (Plumb)
Mohead, Malcolm	Comparison of Three Trap-harvest Systems for Channel Catfish (Smitherman)
Moon, Charles*	Phytoplankton Abundance in Three Fish Ponds (Boyd)
Moreira, Paulo*	Effects of Lead and Source of Energy and Carbohydrates on Growth and Body Composition of Channel Catfish (Lovell)
Neils, Kenneth	The Grazing Effects of Phytophagous Fish in Polyculture Ponds (Dendy)
Nelson, Robert	Crayfish Culture Related to Cover "Hides" (Dendy)
Newman, Michael	A Comparison of Second-year Growth and Catchability Between the Northern and Florida Subspecies of Largemouth Bass (Davies)
Osborn, Maury	Intensive Culture of Channel Catfish in Earthen Ponds (Allison)
Pestrak, James	Larvae Fishes in the Alabama River (Ramsey)
Popma, Thomas	Digestibility of Nutrients in Natural and Artificial Foods by Tilapia (Lovell)
Pradhan, Bhola*	Age, Growth, and Reproduction of the Bowfin in West Point Reservoir (Davies)
Pretto, Richard*	Polyculture Systems with Channel Catfish, Tilapia, Buffalofish, and Israeli Carp (Smitherman)
Romaire, Robert	A Dissolved Oxygen Model for a Catfish Pond (Boyd)
Saad, Cheroos*	Evaluation of Full-fat Roasted Soybeans in Catfish Diets (Lovell)

*Foreign students

Santiago, Alfredo*	Diets for Brood Channel Catfish (Lovell)
Santiago, Corazon*	Nutritional Factors of Commercial Fish Production (Lovell)
Schachte, John	Immunity in Channel Catfish to *Aeromonas hydrophila* and *Chondrococcus columnaris* (Rogers)
Scott, Alan	Stress Related Disease Development in Waters of Different Quality (Rogers)
Sconell, Darrell	Economical Factors in Aquaculture (McCoy)
Scully, Richard	Catch and Effort Assessment of the Fishery Resources on the Upper Meta River System (Davies)
Seesock, Wendy	The Life History and Ecology of the Cold Water Darter (Ramsey)
Shaffer, Karl	Growth Reproduction of the Redear x Green Sunfish Hybrid in Farm Ponds (Davies)
Shaw, Cynthia	Dehydrogenase Activity of Various Anaerobic Metabolic Types of Bacteria in Sediments (Pamatmat)
Sherriff, Timothy	Effects of a Fall Drawdown on the Benthic Population of Lee County Lake (Pamatmat)
Shrestha, Sunder*	Parasitic Load on Different Strains of Catfishes and its Mode of Transmission from Brood to Offspring (Rogers)
Steeby, James	Effects of Aeration on Channel Catfish and Water Quality in a Large Pond (Lovell)
Sowles, John	Effects of Nitrogen Fertilization on Plankton Production in Fish Ponds (Boyd)
Sullivan, Joseph	Parasites of Basses of the Southeastern United States (Rogers)
Sun, Peter*	Effects of Increasing or Decreasing the Protein Percentage in Rations of Pond Raised Catfish During the Grow-out Period (Lovell)
Tapp, Ronnie	Size Selection of Largemouth Bass and Bluegill by Sport Fishermen (Davies)
Tave, Douglas	Production of Hybrid Blue x Channel Catfish (Smitherman)
Tayamen, Melchor*	Androgen and Estrogen Sex Reversal of *Tilapia nilotica* (Shelton)
Taylor, Peter	Amoeba Incidences, Pathogenicity, and Potential Control in Fishes (Rogers)
Thune, Ronald	Methods of Vaccinating Fish Against Bacterial Diseases (Plumb)
Timmons, Thomas	Year-class Mortality of the Largemouth Bass in West Point Reservoir (Shelton)
Tsao, Yi-Te*	Use of Catfish Processing Wastes in Pet Foods (Lovell)
Tucker, Luther	Early Food Habits of Striped Bass Larvae (Snow)
Vandemaele, Katerine*	Tilapia Culture in Tanks with Filtration (Allison)
Vanhoose, Mark	Behavioral Characteristics Between the Northern and Florida Subspecies of Largemouth Bass (Davies)
Wallace, Richard	Systematics of Pimelodid Catfishes (Ramsey)
Walters, Gerald	Influence of Environmental Stress on Susceptibility to Bacterial Infections in Fish (Plumb)

APPENDIX C

Publications of Grant-supported Staff

APOLINARIO, K. AND R. T. LOVELL. 1976. Yield and Quality of Mechanically Deboned Flesh from Farm-raised Channel Catfish, Tilapia, and Buffalofish. Proc. of Tropical and Subtropical Fish Technology Conf., April, 1976, pp. 41-44.

BEHRENDS, LESLIE. Effects of Three Tilapias (*Sarotherodon* spp.) and Silver Carp *(Hypophthalmichthys molitrix)* on Phytoplankton Communities and Water Quality in Ponds with Channel Catfish *(Ictalurus punctatus).* MS. thesis, Auburn Univ.

BOONYARATPALIN, M. AND R. T. LOVELL. 1976. Flaked Diets for Aquarium Fishes. Aquaculture, Vol. 10. (Accepted for publication, 1976.)

BOUTWELL, J. L. AND E. W. MCCOY. 1977. Simplified Programming as a Farm Management Tool. Auburn Univ. (Ala.) Agr. Exp. Sta. Cir. 232.

BOYD, C. E. 1976. Chemical and Textural Properties of Muds from Different Depths in Ponds. Hydrobiologia 48: 141-144.

BOYD, C. E. 1976. Accumulation of Dry Matter, Nitrogen, and Phosphorus by Cultivated Water Hyacinths. Econ. Bot. 30: 51-56.

BOYD, C. E. 1976. Nitrogen Fertilizer Effects on Production of *Tilapia* in Ponds Fertilized with Phosphorus and Potassium. Aquaculture 7: 385-390.

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BOYD, C. E. 1977. Organic Matter Concentrations and Textural Properties of Muds from Different Depths in Four Fish Ponds. Hydrobiologia. (In press.)

CRAWFORD, K. W. 1976. Factors Affecting Catfish Production in West-Central Alabama. Auburn Univ. (Ala.) Agr. Exp. Sta. Highlights of Agricultural Research, Vol. 23, No. 2.

CRAWFORD, K. W. 1976. Economic Comparisons of Single Cropped and Multiple Cropped Catfish Production Systems. Auburn Univ. (Ala.) Agr. Exp. Sta. Highlights of Agricultural Research, Vol. 23, No. 3.

CRAWFORD, K. W., R. O. SMITHERMAN, AND D. R. DUNSETH. 1977. Consumer Response to Market-size Tilapia and Silver Carp Grown in Combination with Channel Catfish. Proc. of Sixth Annual Meeting, Inland Commercial Fisheries Workshop. Little Rock, Ark.

DOBBINS, D. A. AND C. E. BOYD. 1976. Phosphorus and Potassium Fertilization of Sunfish Ponds. Trans. Amer. Fish. Soc. 105; 536-540.

GROVER, J. H. AND R. O. JULIANO. 1976. Length-weight Relationship of Pond-raised Milkfish in the Philippines. Aquaculture. 7: 339-346.

GROVER, J. H., R. D. RECOMETA, AND V. A. DUREZA. 1976. Production and Growth of Milkfish, Common Carp, and Catfish in Fertilized Freshwater Ponds. Kalikasan, Philipp. J. Biol. 5: 193-206.

HOPKINS, M. L. AND E. W. MCCOY. 1976. Methods to Evaluate Investments in Alternative Farm Enterprises. Auburn Univ. (Ala.) Agr. Exp. Sta. Highlights of Agricultural Research, Vol. 23, No. 4.

LOVELL, R. T. 1976. Developing Marine Resources. Debate Issues, 9(3): 9.

LOVELL, R. T. AND R. R. STICKNEY. 1976. Nutrition and Feeding of Channel Catfish. Sou. Coop. Ser. Bull. 218. Accepted for publication, 1976.

LOVELL, R. T. 1976. Nutritional Diseases in Warmwater Fishes. Midwest Fish Disease Workshop. June 1976, Carbondale, Ill. (In press.)

LOVELL, R. T. 1976. Factors Affecting Food Consumption of Channel Catfish. Fish Nutrition Workshop V. November 1976, Portland, Ore. (In press.)

LOVELL, R. T. 1976. Flavor Problems in Intensively Cultured Fish. Proc. of Tropical and Subtropical Fish Technology Conf. April 1976, pp. 45-47.

LOVELL, R. T. 1976. Formulating Fish Feeds. Commercial Fish Farmer 2(2): 42.

LOVELL, R. T. 1976. Nutritional Diseases in Fish. Commercial Fish Farmer 2(3): 26.

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LOVELL, R. T. 1976. Least Cost Fish Rations. Commercial Fish Farmer 2(5): 26.

LOVELL, R. T. 1976. Energy and Protein Conversion by Fish as Compared with Livestock and Poultry. Commercial Fish Farmer 3(1): 49.

MCCOY, E. W., J. L. BOUTWELL, AND C. M. JOLLY. 1976. Reducing Uses of Energy in Aquaculture. Auburn Univ. (Ala.) Agr. Exp. Sta. Highlights of Agricultural Research, Vol. 23, No. 3.

MCCOY, E. W. AND M. L. HOPKINS. 1977. Establishing a Market for Exotic Fish Species. Auburn Univ. (Ala.) Agr. Exp. Sta. Highlights of Agricultural Research, Vol. 24. No. 1.

MCCOY, E. W. AND J. L. BOUTWELL. 1977. Preparation of Financial Budgets for Fish Production. Auburn Univ. (Ala.) Agr. Exp. Sta. Cir. 232.

NELSON, ROBERT. Experiments on the Reproduction and Survival of the Louisiana Red Swamp Crayfish, *Procambarus clarkii* (Girard) in Intensive Culture Conditions. M.S. thesis, Auburn Univ.

PAMATMAT, M. M. The Metabolic Activity of a Salt Marsh. *In:* J. P. Stout and M. M. Pamatmat, Monetary Values of Alabama Coastal Marshes: An Interim Report. Submitted to the Alabama Development Office and Alabama Coastal Area Board, August 1976.

PAMATMAT, M. M. 1977. Benthic Community Metabolism: A Review and Assessment of Present Status and Outlook. *In:* B. C. Coull, ed., Ecology of Marine Benthos, pp. 89-111. Univ. South Carolina Press, Columbia, S.C.

PRETTO, R. AND R. O. SMITHERMAN. 1976. Polyculture Systems with Channel Catfish as the Principal Species. Proc. of National Fish Culture Symposium (Fish Culture Section of the American Fisheries Society). Abstract No. 8. p. 8.

SNOW, J. R. AND C. F. WRIGHT. 1976. Rearing Largemouth Bass Fingerlings in Cages. Proc. of Ann. Conf. Southeast Game and Fish Comm. 29: 74-81.
SNOW, J. R. 1977. Increasing the Yield of Channel Catfish by Periodic Division of the Stock. Proc. Ann. Conf. Southeast Game and Fish Comm. (In press.)
SNOW, J. R. 1976. Recommendation for Development of a Freshwater Fish Hatchery Center in Central Luzon, Philippines. Dept. of Fisheries and Allied Aquacultures, Auburn Univ. (Ala.) Agr. Exp. Sta.
SNOW, J. R. 1976. Honduras Aquaculture Project Advisory Service Report. Department of Fisheries and Allied Aquacultures, Auburn Univ. (Ala.) Agr. Exp. Sta.
SNOW, J. R. 1977. A Technique for Controlling Weeds in Striped Bass Rearing Ponds. Proc. of Ann. Conf. Southeast Game and Fish Comm. (In press.)
SOWLES, JOHN WHEELER. The Effect of Ammonium Nitrate on Primary Production in Fish Ponds. M.S. Thesis, Auburn Univ.
UNDERWOOD, J. R., JR., AND J. H. GROVER. 1977. Tadpole Nests in Libya. Geol. Soc. Amer. Abstracts with Programs. 9(1): 79.
WILLIAMSON, J. AND R. O. SMITHERMAN. 1976. Food Habits of Hybrid Buffalofish, Tilapia, Israeli Carp, and Channel Catfish in Polyculture. Proc. 29th Ann. Conf. Southeast Game and Fish Comm. 29: 86-91.
YANT, D. R., R. O. SMITHERMAN, AND O. L. GREEN. 1976. Production of Hybrid (Blue x Channel) Catfish and Channel Catfish in Ponds. Proc. 29th Ann. Conf. Southeast Game and Fish Comm. 29:82-86.