AQUANEWS

Sustainable Aquaculture for a Secure Future

POND DYNAMICS/AQUACULTURE COLLABORATIVE RESEARCH SUPPORT PROGRAM NEWSLETTER

Volume 13, Number 2/Spring 1998 Oregon State University ISSN 1062-4996

Sustainable Aquaculture in the Peruvian Amazon

by Marcos J. De Jesus, Christopher C. Kohler, and Susan T. Kohler

The Amazon River Basin in South America provides a substantial food resource for the continuously growing human populations that live along its shores. As the river system descends from its Andean origins into the lowland forests of Peru, the local inhabitants' dependency on fish as a main source of protein increases. Fish consumption has become a lifestyle in the Peruvian forests, and demand for commercial species has increased, along with the burgeoning human population. Data from the Peruvian Ministry of Fisheries show a steady increase in the commercial fish harvest over the last ten years in the region of Iquitos. Iquitos is a city of about 300,000 residents. On average nearly half of the daily animal protein intake of the inhabitants of Iquitos comes from fish. Demand for fish is consequently high and increasing in the region. Political instability in the last six years did not allow for prioritization of fisheries resource management schemes to prevent depletion of this important resource. However, now the Peruvian Ministry of Fisheries is working to establish restrictions and regulations for commercial harvest in the region.

Development of aquaculture programs is a valuable complementary strategy that will aid fishery conservation efforts in Peru. Production of important species for human consumption could make fish available year-round (the wild fishery catch plummets during the rainy season when the Amazon water level rises over ten meters). There is also potential to initiate stocking programs to conserve wild fish populations. There is, undoubtedly, an important role for aquaculture in the Peruvian Amazon.

CHRISTOPHER KOHLER

PD/A CRSP Principal Investigator Fernando Alcantara Bocanegra holding Colossoma macropomum

The PD/A CRSP has been active in Peru for the past year and a half. During this time much has been accomplished, including site renovations and experimental work. Dr. Gonzalo Llosa (Project Leader) and Dr. Fernando Alcantara Bocanegra (Principal Investigator) from the Instituto de Investigaciones de la Amazonia Peruana (IIAP) have led the way under the coordination of Drs. Christopher C. Kohler and Susan T. Kohler, and with the assistance of graduate student/researcher Marcos J. De Jesus from Southern Illinois University at Carbondale. Llosa and Alcantara have worked hard to assure the participation of many academic volunteers in these projects. All the participants have either earned a college degree, or are in the process of such, or have a substantial amount of experience in the field of aquaculture or fisheries biology, and want to learn more through this experience. These participants include college professors, researchers, college students, and fish farmers. Capacity strengthening is a significant aspect of this project.

In November 1996 Alcantara, using internal funds, undertook renovations

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The PD/A CRSPs Peru project is a collaborative venture between Instituto de Investigaciones de la Amazonia Peruana (IIAP), Southern Illinois University at Carbondale (SIUC), and Universidad Nacional de la Amazonia Peruana (UNAP). Project participants include: Fernando Alcantara Bocanegra (IIAP), Marcos J. De Jesus (SIUC), Enrique Rios Isern (UNAP), Christopher C. Kohler and Susan T. Kohler (SIUC), Gonzalo Llosa (IIAP), and Karen Vincent (SIUC).

PD/A CRSP Plans for Regionalization

by Deb Burke

The CRSP has prime sites projects in Central America, South America, East Africa, and Southeast Asia. With the award of the PD/A CRSPs Continuation Plan 1996-2001, the CRSP has sought to further expand its sphere of relevance and to conduct activities on a broadened regional scale. To achieve this aim regional plans were conceptualized and developed to create a shared vision among CRSP participants and institutions involved with aquaculture development and to ensure the integration of CRSP research efforts and research support activities. This year at the 16th Annual Meeting, held in Las Vegas, Nevada, PD/A CRSP researchers discussed their regionalization strategies for the upcoming year.

With some regional variations in emphasis, PD/A CRSP regionalization efforts will include:

- Enhancement and establishment of contacts and institutional collaboration;
- Identification of CRSP companion sites;
- Publication of literature relevant to the applied technological aspects of aquaculture;
- Organization of trainings and workshops; and
- Provision of support for students and technicians to acquire education and training in the field of aquaculture.

Networking and the establishment of contacts will be taking place across all CRSP sites. CRSP researchers at the Central America prime site in Honduras have established primary contacts with Nicaragua and Costa Rica and are planning the start-up of collaborative activities. There is also discussion of unifying efforts with PRADEPESCA, a regional support program for fisheries development in Central America based in Panama. PRADEPESCA consists of capture fisheries and aquaculture components. The CRSP hopes to collaborate with PRADEPESCA in achieving its various objectives, including the transfer and validation of fish culture technologies, economic evaluation of artemia production, aquatic animal health regulations, water quality monitoring in major estuaries, and information dissemination.

From Peru, the South America prime site, there are plans to develop a network of aquaculturists from Peru, Brazil, Argentina, and Chile. Additionally, CRSP researchers are working to formalize Brazil as a companion site in South America and will establish a Memorandum of Understanding (MOU) with the government of Brazil.

Researchers at the CRSPs prime site in Africa, the Sagana Fish Farm, have begun developing a contact list that will extend to Uganda, Tanzania, and Malawi. Companion site selection is also underway with Malawi, Ghana, and Tanzania being potential prospects.

Previously, the Philippines had acted as a companion site to the Thailand prime site for Southeast Asia; however, the Philippines now has prime site status. Consequently, CRSP researchers are making continued collaboration between Thailand and the Philippines a priority. It is hoped that the genetics work accomplished

CRSP Graduate Student Profile: Deb Burke

by Matt Niles

Deb Burke has been a technical editor at the PD/A CRSPs headquarters at Oregon State University since beginning her Master's program at OSU in the fall of 1995. She is currently putting the finishing touches on her MA degree in Anthropology (specifically, cultural anthropology) with a concentration in natural resources and community values. She is particularly interested in the way different cultures view their natural resources and how their values affect their management of these resources.

SAYEA JENABZADEH

PD/A CRSP Graduate Student Deb Burke

In late March, Deb traveled to the CRSPs project site at the Sagana Fish Farm in Kenya, where she will be doing her thesis research. She'll be in Sagana for nine weeks, and she hopes to find out what effect the CRSPs presence and the fish farm in general have had on the people that work there.

Deb's research will consist of semi-structured interviews with employees of the Sagana Fish Farm, through which she hopes to learn not only of the effects of the CRSPs presence, but also that of other projects that have passed through the farm over the years. She hopes to interview all of the roughly 75 employees on the farm. Interviews will consist of questions relating to why they came to work at the farm, how employees have been affected by the farm, how farm practices at the Sagana farm differ from those at other places they have worked, how Westerners are viewed, and what the differences might be between a Western-run project and a Kenyan-run project at the farm.

The results of Deb's research will have several important applications. "With international development programs, it's a really good idea to know what the people are about socially and culturally, how they view the world, and what their value systems are," says Deb. Knowing that, better plans can be made for development projects that are more meaningful to the groups of people the projects are working with.√

in the Philippines and the feeds and fertilizers research done in Thailand will be tested across sites. CRSP researchers are also considering the implementation of a comparative brackish water study that would involve both the Thailand and Philippines sites. The environmental effects of cage culture, which has become popular within recent years, is another potential research area that both the Philippines and Thailand sites may be undertaking.

Workshops and trainings are planned for the Honduras, Kenya, and Thailand CRSP prime sites. In Honduras, arrangements will be made to host a training course focused on the intensive analysis of financial management of shrimp and tilapia farms. Carole Engle, a CRSP researcher from the University of Arkansas, Pine Bluff, will visit Honduras later this year to conduct this training.

The Africa project is also coordinating a workshop to familiarize other regional aquaculture players with the scope and goals of the CRSP, to establish needs and priorities, and to create linkages for collaboration on research and extension activities. The Director of Fisheries in Kenya and the CRSP Host Country Project Leader, Fred Pertet, will be attending a director's meeting of the Kenya Department of Fisheries to facilitate regional participation for the planning and design of this workshop.

A water quality training program for researchers from all CRSP sites will be held at the Asian Institute of Technology in Thailand in addition to a workshop that will be conducted for fisheries officers from Cambodia, Laos, and Vietnam. There are several possible dates for the water quality training at AIT—August 1998, December 1998, and April 1999—and the workshop for fisheries officers is slated for either 1999 or 2000.

Publications that focus on the applied and technological aspects of aquaculture are included in both the Central America and Southeast Asia projects' regionalization strategies. Central American CRSP researchers will be designing a pamphlet, written in Spanish, about the safe handling of methyltestosterone (MT).

CRSP researchers from Southeast Asia will work with the Information Management and Networking Component at Oregon State University to produce brochures, posters, and other public information material on topics such as green water, cage systems, and staged feeding systems. These items will be reviewed to determine how they could be produced in the native language.

Educational support is another aspect of regionalization that CRSP projects will be pursuing within the next year. The Central America project plans to send a student to the US to obtain her/his master's degree and the project in South America will be sending a technician to the water quality training that CRSP researchers are organizing in Thailand. √

A New Report From PD/A CRSP

Lessons Learned from On-Farm Trials: The PD/A CRSP Experience

This 83-page report contains five case studies of PD/A CRSP on-farm trials in Honduras, Thailand, the Philippines, and Rwanda. The lessons learned are based not only upon scientific results, but also on challenges involved in the process of implementing new aquaculture technologies in farm-based trials. It is hoped that the lessons will be of practical use to program researchers and others wishing to implement on-farm aquaculture trials.

Contents:

- Lessons learned from on-farm trials: the PD/A CRSP Experience
- On-farm testing of PD/A CRSP fish production systems in Honduras (reprinted)
- Field testing of least intensive aquaculture techniques on small-scale farms in Thailand (reprinted)
- The co-culture of *Clarias* and tilapia in Thailand
- On-farm research in Rwanda
- Impacts of the PD/A CRSP in Central Luzon, Philippines

Copies can be requested from:

Publications
Pond Dynamics/Aquaculture CRSP
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Corvallis, OR 97331-1641

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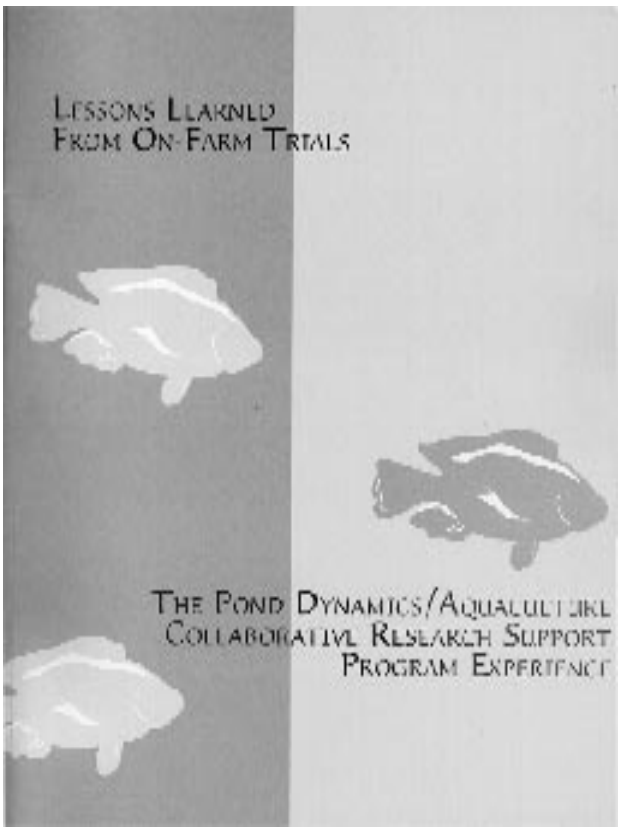

To Shrimp Farm or not to Shrimp Farm: Is that the Question?

Due to its environmental and social impacts, shrimp farming is one of the more controversial areas of aquaculture. The CRSPs goals to remove constraints to warmwater aquaculture production have direct bearing on the issues surrounding shrimp aquaculture. At this year's American Association for the Advancement of Science meeting in Philadelphia in February, a symposium addressing the impacts of shrimp farming, organized by CRSP Principal Investigator Joe Molnar, provided a meeting of researchers, producers, and environmental advocates. CRSP participants Claude Boyd, Hector Corrales, and Kwei Lin gave presentations at the symposium.

Shrimp Symposium at AAAS

by Joseph J. Molnar

Mangroves are plants that live between the sea and the land, characterized by an ability to thrive in saltwater. Mangrove forests offer a significant and unique habitat to birds, mammals, crustaceans, and fish populations. In addition to improving water quality by filtering and assimilating pollutants, mangroves stabilize bottom sediments and protect shorelines from erosion. Water quality may suffer when aquaculture ponds are located in or near mangrove areas.

The three-hour symposium, "Global Shrimp Farming, Mangroves, and People: Finding a Sustainable Path," was held February 13 at the 1998 Annual Meeting of the American Association for the Advancement of Science, Philadelphia, Pennsylvania. Participants addressed the interactions between shrimp farming and the social and biological environment associated with mangrove and other coastal ecosystems affected by shrimp farming's rapid growth. Questions raised included the extent of global mangrove loss and how much of this is due to shrimp farming. Government and business institution of meaningful programs to protect coastal ecosystems was also considered. The symposium examined these issues in the context of shrimp aquaculture in Ecuador, Honduras, and Thailand. It considered the ecological evidence and understanding of the impacts of shrimp aquaculture as well as the socioeconomic consequences of the industry's growth in rural areas.

For years, mangroves throughout the world have been harvested by local residents for firewood, building materials, and charcoal production. They used these items for their own households and to sell as a source of income. Urban markets for the commodities as well as local population growth, largely through landless people migrating to coastal areas, have increased pressure on mangrove areas. Shrimp farming is also responsible for mangrove losses when coastal areas are converted to aquaculture ponds. C. Kwei Lin, from the Asian Institute of Technology, noted that the numerous small shrimp farms in parts of Asia often had negative individual and cumulative effects on local ecosystems. Larger farms were often better able to implement research recommendations and better management practices. New construction on small operations tended to be less well-capitalized or technically informed, and hence more environmentally damaging.

Auburn University's Claude Boyd related many egregious shrimp construction and water management practices from around the world. Using in part PD/A CRSP research results, he made a number of technical recommendations for shrimp production that shrimp farmer associations are beginning to disseminate to their memberships. Much of the damage to date is associated with ignorance of and insensitivity to environmental consequences of pond construction. Knowledge and awareness of environmental issues have increased among shrimp farmers. The economic realities of mangrove clearing are a major disincentive to pond construction in these areas. In addition, the acid sulfate mangrove soils tend to be poor substrates for shrimp ponds. Most mangrove destruction is now linked to the usually minor impacts of canal

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JIM SZYPER

Harvesting shrimp from 20-hectare pond in Honduras

The FAO and Sustainable Shrimp Aquaculture

The United Nations Food and Agricultural Organization (FAO) convened a technical consultation on policies for sustainable shrimp aquaculture in Bangkok, Thailand, from December 8-11 [1997]. The meeting was attended by representatives from 10 countries, six intergovernmental and multilateral organizations, seven shrimp industry organizations, and seven nongovernmental organizations. In addition, there were nearly a dozen individual resource people that were invited to attend.

The objective of the consultation was to contribute to the preparation of guidelines containing policy options and methodologies for government officials as well as to develop an appropriate incentive structure and regulatory and decisionmaking framework for the development of sustainable shrimp aquaculture. In particular, the group was to discuss and, upon agreement, recommend for shrimp aquaculture:

- A legal and institutional framework for planning, regulating, monitoring, and enforcement.
- Planning and regulatory methods.
- Policies that would affect the distribution of net benefits from the industry.
- Siting and best management practices.
- Measures to achieve consensus and resolve conflicts among the different coastal resource users.

After considerable discussion and debate concerning whether shrimp aquaculture is sustainable, is not sustainable, or can be sustainable, the group decided to acknowledge that there probably were sustainable shrimp operations to be found, but it would make no comment about how common they are. Similarly, the group argued about the impact of shrimp aquaculture on the environment, what constitutes fragile ecosystems, and what the implications of net loss are for the environment. Finally, all present agreed that there should be no further loss of fragile ecosystems as a result of shrimp aquaculture.

Still, the group found that there were a number of areas upon which there was already considerable agreement. A draft report of the policies and principles prepared and endorsed by the group is available from the FAO. With the exception of Greenpeace (which objected, in particular, to the lack of NGO participation), all those groups adopted the final draft as an excellent first step. The group recommended that two additional technical groups be convened by the FAO. The first would be to develop further the legislative and regulatory frameworks necessary for countries to oversee shrimp aquaculture. The second would be to develop a specific set of guidelines for siting shrimp ponds and recommendations for best management practices.

The final draft of the policies recommended by the group build upon the FAO's Code of Conduct on Responsible Fisheries. The draft policies and principles provide a good starting point for further discussions on what would be required to ensure sustainable shrimp aquaculture production and will certainly have an impact on the numerous discussions that are being convened on the topic by dozens of organizations around the world.

Source: *Intercoast Network No. 30, Winter 1998.*

Shrimp Aquaculture Viewed

Shrimp aquaculture can be a significant contributor to the economic well being of many developing nations and government policies should be encouraging its growth, the Global Aquaculture Alliance (GAA) told an FAO technical conference in Bangkok, Thailand, in early December, 1997.

"Trade in seafood products now generates $50 billion annually and will grow with steadily increasing demand for such high quality products as shrimp favored by consumers throughout the world," said Lee J. Weddig, speaking for the Global Aquaculture Alliance.

In the United States, as an example, shrimp accounts for about 25 percent of the fresh and frozen seafood consumed. It is extremely popular in Japan and Western Europe as well, he said. A growing middle class in many developing nations is also increasing consumption.

About 20 percent of today's international seafood trade is in shrimp products, said the GAA. Pointing out that population growth alone will generate a two to three percent increase in demand each year, the GAA spokesperson said reasonable aquaculture will be the primary source for additional supplies since catch from the oceans' resources have generally plateaued in most areas of the world. "This situation offers an ideal economic opportunity for nations with undeveloped coastal areas," Weddig said.

Farmed raised shrimp now makes up nearly one-third of the total shrimp supply and can be expected to provide more with effective government policies and regulations which encourage development in a manner that provides for suitable environmental safeguards and efficient production.

"The benefits of shrimp farming can be immense. Billions of dollars in critical foreign exchange can flow to developing nations now facing economic uncertainty. Shrimp farm employment now totals at least one million, most often in areas

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to the hatchery facilities at IIAP. Laboratory and pond cleaning, and the addition of a new solids removal system (sand filter) were necessary to prepare the hatchery for future projects. The acquisition of equipment to measure physical and chemical properties of water in the culture ponds was also a major part of the facility renovations. With CRSP funding Alcantara acquired an oxygen meter, digital pH meter, spectrometer, minimum-maximum thermometers, water quality chemistry sets, a feed pelleter, and human chorionic gonadotropin (HCG) for the preparation of upcoming fish rearing projects.

In November 1996 HCG was utilized for the first time in Peru in an attempt to induce spawning of *Colossoma macropomum* (gamitana). The gamitana, known in the United States as black-belly pacu, is a large seed-eating characin which grows up to a meter in length and 30 kg in weight. This fish has proven to be an excellent aquaculture candidate in much of Latin America. It is one of the most popular food fish in Peru, and plays a major role in the ecology of the flooded forests of the Amazon by disseminating seeds. De Jesus' master's research on the commercial fisheries in the Peruvian Amazon found a steady increase in the harvest of many fish species, including gamitana. These harvest levels are now a cause for concern.

Unfortunately gamitana production in 1996 was poor. A very dry season and late rains affected the broodstock's biological timing, and spawning was unsuccessful in most hatcheries around Peru, including IIAP. Hence, the gamitana larvae required for our planned rearing trials were unavailable. As an alternative, in April 1997, Alcantara and biologist Palmira Padilla began a study of stocking density using *Piaractus brachypomus* (paco) fingerlings instead of the proposed gamitana.

Paco, known in the US as red-belly pacu, is another large seed-eating characin that biologically resembles gamitana. Previous culture studies indicate almost identical performances for these species. Alcantara stocked six ponds with three replicates of two different densities (3,000 and 4,000 fish per hectare). Alcantara and Mr. Del Aguila prepared the fish diet, and the fish were fed twice daily. Pond water physical properties were monitored twice daily, and water quality was monitored weekly. The fish were sampled every two weeks to record lengths and weights. The experimental trial lasted from 29 April 1997 to 12 October 1997. The fish exhibited incredible growth rates—growing from 27.5 g at stocking to mean weights of over 460 g in some ponds after five months. In addition to the experimental trial, fish in two ponds were fed until February 1998 and reached approximately one kg in weight (over two pounds in ten months!).

This year Llosa and Alcantara are preparing for another study of stocking density scheduled to start in April. Future goals for the Peru project include additional experiments, further site renovations, running training programs, and publication of research work. In addition, the Peru project will integrate more fully with the PD/A CRSPs crosscutting research. In June 1998 Drs. Wes Wood and Joe Molnar, Auburn University, will visit Iquitos to initiate soil/water quality and sociological studies, respectively. As the project progresses, we intend to communicate and regionalize our findings via various pathways throughout South America. √

Shrimp Aquaculture Viewed

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desperately needing jobs," said Weddig. "The prospects for future benefits from shrimp farming are outstanding, provided technical and other problems are solved by cooperative efforts of governments, scientists, and industry."

"Basic and applied science and technology are providing solutions to environmental concerns associated with rapid growth and early technology," he said, "Government policy and regulations must encourage technology and operational practice now known to assure productivity with minimal environmental impact."

The GAA pointed out that preservation of ecologically sensitive mangrove areas is strongly encouraged by the shrimp farming (industry), and new husbandry techniques call for less use of fresh water and better control of discharge effluent. Disease resistant strains of shrimp have been developed and more and more stock is coming from the many new hatcheries being constructed. "All of these advances are contributing to long term sustainable, efficient operations," Weddig said, "And are consistent with the history of development of other animal husbandry industries."

Discussions on sustainable shrimp culture took place at a consultation of technical experts from shrimp producing nations sponsored by the Food and Agriculture Organization of the United Nations. Held in Bangkok Dec. 8-11, 1997, the consultation produced a report outlining recommended provisions for legislation and regulation which should be considered by governments as they set the stage for continued development of environmentally compatible shrimp aquaculture. The report noted that sustainable shrimp culture is being practiced and that this is an achievable and desirable goal for all operations. The report also pointed out that shrimp culture offered important benefits of food production, employment, and foreign exchange to producing nations.

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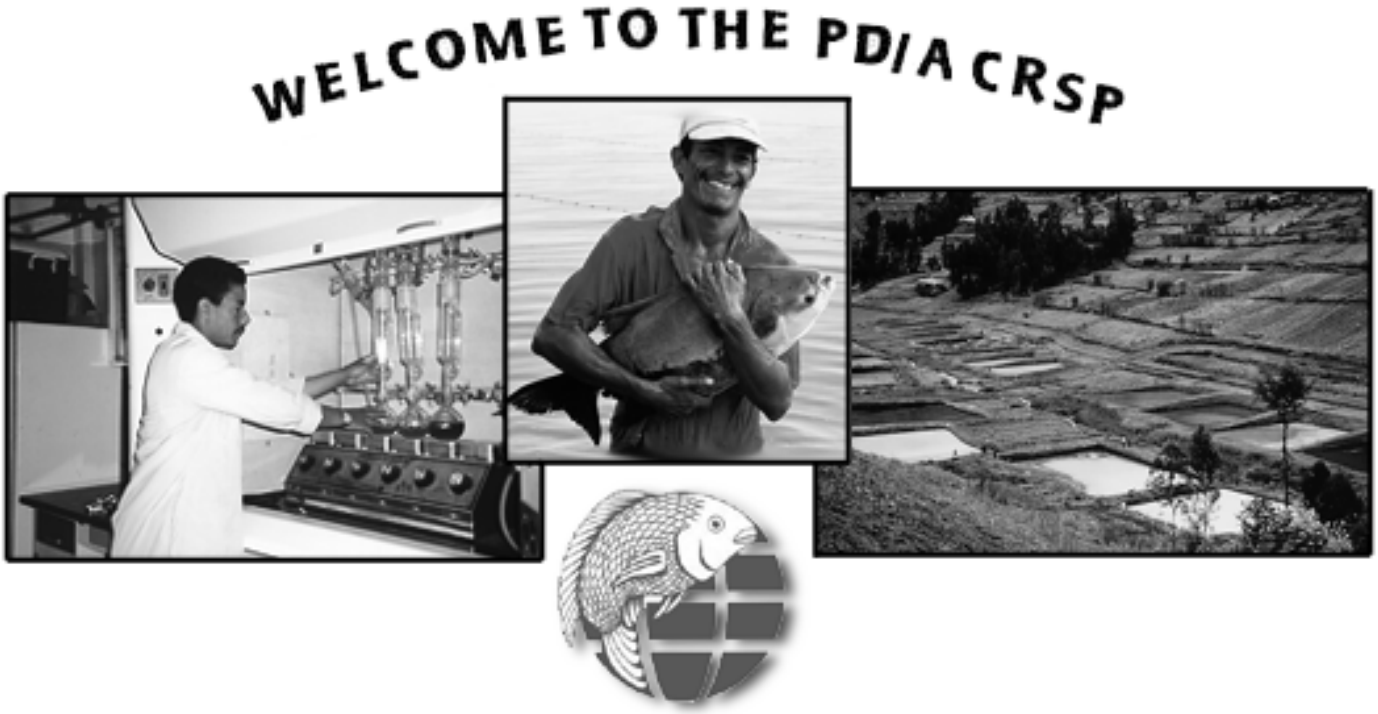
What's New on the PD/A CRSP Web Site?

by R. Ingvar Elle



The CRSPs homepage address is www.orst.edu/Dept/crsp/homepage.html

The publications page of the PD/A CRSP Web Site at www.orst.edu/Dept/crsp/pubs/publications.html is a valuable source of CRSP programmatic and research material. Publications available include Aquanews, Annual Administrative and Technical Reports, the Research Report Series, and Global Experiment literature. Most documents are available in both HTML and Acrobat formats.

The section has recently undergone significant changes aimed at improving access to both online and hard copy publications, enhancing navigation between the individual articles, optimizing the speed of document loading, and ensuring that the site is compatible with a range of web browsers and operating systems.

The main publications page itself has been updated to include a more readable layout, more thorough document descriptions, and links to the PD/A CRSP Central Database data.

While the primary purpose of the CRSP web site's publication section is to make documents available for direct downloading, visitors often require publications in hard copy format. Recent updates to the hard copy order page include the addition of links from each publication list down to the order form and the addition of a short Javascript to help ensure that users successfully filled out the order form. The page was subjected to testing by most members of the PD/A CRSP Program Management Office.

Browsing between articles in the publication section has also been enhanced. Within any publication, whether it is an administrative report, technical report, or the research report, are links to the next and previous section or article, and to the table of contents of the parent publication. In addition, report abstracts contain links to the full reports and full reports contain links back to the abstracts.

Because the site is regularly accessed by international as well as domestic visitors, rapid document loading is critical. Toward this end, the abstracts of the CRSP Research Reports have been divided into smaller sections. Also, technical report figures, which, because they appear as graphics, can be quite large, have been placed separately from the articles they relate to, so that users have the option of downloading the figures via a hypertext link if they wish to view them. Furthermore, all tables, whenever possible, are placed in the documents in HTML format, which makes them significantly smaller than if they appeared as images.

In order to provide access for the widest range of web users and to ensure optimum readability of our online publications, special care is now given to make the web site compatible with the latest versions of the most popular graphical and non-graphical browsers. In addition, most pages are tested on both Macintoshes and PCs.

The PD/A CRSP web site is maintained by CRSP Systems Administrator Ingvar Elle and student workers Pemechay Sinouvong and Rene Sanchez . √

Fishellaneous Items

Faster Website

In response to the growing demand from regular visitors to the Internet website of Fish Info Service (FIS), a new format has been launched to present data in a faster and more user-friendly way.

"The site has witnessed a massive increase in traffic over the last six months, with daily visitor numbers averaging well over 8000 from all the major fisheries areas in the world," FIS's commercial manager James Sandford told FFI.

"Particular growth has been recorded in the South and Central America region, with the larger companies from these areas taking advantage of the three-language presentation."

The new presentation loads at three times the speed of the old version. The waiting time for the data has been drastically reduced, and new search facilities enable the visitor to find data faster and more easily.

"There is a new section specifically designated to aquaculture, that brings all the relevant data on farmed fish species onto one site as well as well-established favorites from the old system—Hot News, Market Reports, Market Prices & Trading Market," said Sandford.

"The site now offers a comprehensive search facility to speed up access to data."

The FIS website is www.sea-world.com

Source: *Fish Farming International Vol. 25, No. 1, January 1998.*

Intensive Aquaculture Systems

California Sea Grant project leader Raul Piedrahita of UC Davis and his trainees, William Brinkop and Steven Thomas, have successfully developed a tool for modeling a variety of intensive aquaculture systems using different types of water treatment operations as well as different fish species and husbandry practices.

Their automated system, AquaMod, can model water quality, oxygen use, feed consumption, and fish growth. It was created using "blocks," each of which simulates a separate operation, such as biofiltration, aeration, or solids removal. Once created, the blocks are stored in a library and can be used to create a model for a given production system.

The models can be used to simulate water quality changes and fish biomass production, and to account for feed and oxygen consumption in an aquaculture system. Distribution of beta copies of the model will be shortly underway.

Source: *The Aquaculture News, Vol. 6, No. 5, March 1998.*

Netcage culture of tilapia in reservoirs

AQD [Aquaculture Department of the Southeast Asian Fisheries Development Center] continues to intensify its technology verification and dissemination program. Just recently, AQD in collaboration with the Local Government Unit (LGU) of Bingawan, Iloilo, and the Bingawan Multipurpose Cooperative (BMPC) started a project on netcage culture of tilapia in a small freshwater reservoir in Bingawan.

Fish stocking commenced last October 21, 1997. The project will end after one cropping period. If found successful, the LGU of Bingawan and the BMPC plan to replicate the project in more than 50 freshwater reservoirs in the municipality. The beneficiaries are the people of Bingawan who will have a profitable livelihood to improve their living condition.

The project was designed by AQD's Dan Baliao who wrote the "Methodology for Technology Verification Study No. 4: Culture of Tilapia, *Oreochromis* spp., in Freshwater Ponds/Reservoirs." Baliao's paper covers: (1) pond culture including site and pond specifications, life support system and pond preparation; (2) net cage culture in natural or man-made reservoirs including site specifications, floating and stationary netcage specifications; (3) stocking of tilapia; (4) feeding; (5) water management; (6) monitoring schemes; and (7) harvesting. Cost and return analyses are also provided.

Total cost of investment, annual net income after 35% tax, and payback period for pond, floating netcage and stationary cage culture are estimated at P291,000, 91,540 and 88,220 per year; P183,787.50, 58,961.50 and 61,119.50 per year, and 1.58, 1.55 and 1.44 years, respectively.

Source: *SEAFDEC Asian Aquaculture Vol. XIX No.5 December 1997.*

Agri-aqua farming in Thailand

Integrated agriculture-aquaculture systems have been in existence in Thailand for centuries. In fact, rice-fish farming started in the country more than 200 years ago. Perhaps Thailand has the most varied integrated farming operations in southeast Asia. Pig, cattle, buffalo, chicken, duck, vegetable, aquatic plant, rice and orchard in combination with fish are practiced. Chinese kale, yard long bean, cucumber, hot pepper, eggplant, tomato, banana, mango, coconut and papaya are the vegetables and orchard plants cultivated. Leaves of these plants and that of rice are composted, serving as pond fertilizer. On the other hand, aquatic plants grown on septage and pond effluent are used as fish feed ingredients (like the water hyacinth *Ceratophylum demersum*) or as direct feed to fish (*Azolla* and duckweed).

The Nile tilapia *Oreochromis niloticus* is the most popular fish used because it breeds readily and produces high yields. Other species widely raised are the common carp *Cyprinus carpio*; the Chinese carps *Hypophthalmichthys molitrix, Ctenopharyngodon idella*, and *Aristichthys nobilis*; the silver striped catfish *Pangasius sutchi*; the silver barb *Puntius gonionotus*; and gouramies *Trichogaster pectoralis* and *Osphronemus goramy*.

Wild fishes which occasionally invade culture ponds during the rainy season such as the snakehead *Channa striata*, the catfish *Clarias* spp. and the climbing perch *Anabas testudineus* increase profits because of their high market value.

BRIGITTE GOETZE

Goat pens and tilapia ponds at AIT

Why rice-fish farming?

The northeast region is the largest in Thailand but its farmers are the poorest. Inferior soil condition makes the agricultural land less productive than its neighbours. Rice, fish and vegetables are the basic diet of the people. Fish, the most important and cheapest source of protein, has become scarcer in natural waters because of overexploitation by the rapidly increasing population. Malnutrition due to insufficient dietary protein has become a problem especially among pre-school children, pregnant and lactating women. This situation makes the northeast region of Thailand the center for development of integrated farming for more than a decade.

In 1984-1987, the government's Ubon Farming Systems Research and Development Unit carried out rice-fish farming trials in the province of Ubonrachathani. Results of the tests indicated that benefits are higher in rice-fish culture than rice monoculture; the 2-3 cm tilapia fingerlings previously reared in separate nursery ponds grow more rapidly than those stocked directly in rice-fish ponds; and the yields of rice can be attained in gently sloping areas.

An effective system of promoting acceptance of rice-fish culture among farmers was developed by the Appropriate Technology Association based on its experiences in the region from 1984-87. Known as horizontal transfer of technology, the system encourages prospective farmers to visit and observe successful rice-fish culturists who improved technologies based on their local environment.

The Asian Institute of Technology—in collaboration with the Thai Department of Fisheries and the USAID Pond Dynamics/Aquaculture Collaborative Research Support Program—began its outreach project in 1988. Among the successful technologies developed were (1) nursing of fingerlings to predator-free size in netcages prior to stocking in ponds to avoid wild fish predation and (2) supplementation of buffalo manure with urea to increase pond productivity. The outreach project is being extended to other areas.

Another on-going integrated farming project is that of the Bank for Agriculture and Agricultural Cooperatives and the Belgian Administration for Development. The project aims to increase land and labor productivity of small and medium scale farms. The project covers 28 districts in six provinces and started four years ago. Unlike the previous extension programs, participating farmers in the project are provided with loans.

Excerpted from: *SEAFDEC Asian Aquaculture Vol. XIX No.5 December 1997.*

Shrimp Symposium at AAAS

...from p. 4

construction, and the potentially much greater effects of disrupted water flows or isolation of mangrove areas.

The share of mangrove losses attributable to shrimp farming is an empirical question that Domingo Omar Oyuela from the Escuela Nacional de Ciencias Forestales, Honduras, began to answer with longitudinal forest inventory data from the Pacific coast of Honduras. Mangrove forest area had declined slightly, but the losses attributable to shrimp farming *per se* were not estimated. Salt flats were the land use type that had declined most dramatically during the period examined. Tanneries, which reportedly create a heavy demand for the bark of a certain type of mangrove tree, were associated with wasteful and often illegal harvesting practices.

Shrimp farming affects social ecology as well. When mangrove forests are denuded, coastal ecosystems are altered in ways that can have significant impacts on local populations. Food fish supplies may change, and access to former fishing grounds may be limited. On the other hand, shrimp farming and processing operations often generate waged jobs where few or no employment opportunities existed before. Many of the processing plant jobs are held by women. The impacts of new income streams on local living standards, community structure, and family patterns must be considered in tandem with disruptions to traditional livelihoods connected to mangroves. Conner Bailey, Auburn University, addressed this issue in terms of the frequent lack of community involvement in making decisions regarding coastal resources. The expansion of shrimp farming can entail more than the destruction of mangrove forests. Saline intrusion into freshwater aquifers and surrounding farmlands also has serious consequences for coastal residents. The potential for intimidation by powerful elites and manipulation by local authorities remains a concern.

Rodrigo Laniado Romera, son of the founder of the oldest shrimp farm in the Western hemisphere, reported on the progress that Ecuador's farmers have been making in identifying environmentally destructive practices, noting the strong interest farmers themselves have in protecting water quality. As to whether the business of shrimp farming has matured into a sustainable enterprise, Hector Corrales, Granjas Marinas San Bernardo, Honduras, related the cooperative water quality management program that shrimp and tilapia farmers have organized with the assistance of the PD/A CRSP Honduras project. These efforts have made a demonstrable difference in the quality of waters flowing into the Gulf of Fonseca.

Symposium Participants

Joseph J. Molnar, Auburn University, Department of Agricultural Economics and Rural Sociology
Symposium Organizer and Chair.

C. Kwei Lin, Food and Agricultural Engineering, Asian Institute of Technology, Bangkok, Thailand
Presentation: Management Strategies and Approaches for Water Quality Improvement in Shrimp Farming.

Claude E. Boyd, Auburn University, Department of Fisheries and Allied Aquacultures Auburn University
Presentation: Shrimp Farming and the Environment.

Conner Bailey, Auburn University, Department of Agricultural Economics and Rural Sociology
Presentation: Shrimp Farming and Community Development.

Domingo Omar Oyuela, Escuela Nacional de Ciencias Forestales [ESNACIFOR]), Honduras
Presentation: Mangroves: Factors Causing Changes in the Honduras Inventory.

Rodrigo Laniado Romera, Camera National de Aquacultura, Equador
Presentation: Environmental Considerations in Shrimp Farm Development: The Producer Perspective.

Hector Corrales, Granjas Marinas San Bernardo, Honduras
Presentation: Sustainable Shrimp Aquaculture: The Producer's Responsibility.

Rebecca Goldburg, Environmental Defense Fund
Presentation: Environmental and Socioeconomic Criteria for Sustainable Shrimp Aquaculture.

Jason W. Clay, World Wildlife Fund
Presentation: Shrimp Aquaculture: Getting to Sustainability.

The Environmental Defense Fund's Rebecca Goldburg reported findings from a larger study of the environmental impacts of aquaculture. She raised continuing concerns about the water management practices of existing shrimp farms and the effects of new construction on mangroves throughout the world. Guidelines for appropriate management of shrimp ponds were proposed.

Jason W. Clay, World Wildlife Fund, disputed the contention that little new damage was being caused by the expansion of shrimp farming and expressed continuing concerns regarding the adverse impacts of shrimp farming on water quality and endorsed the proposal that shrimp farming be conducted away from mangrove areas.

The symposium demonstrated the broad nature of threats to coastal ecosystems, including mangroves as well as to the people who rely on them. It noted ways shrimp farming has damaged parts of this critical ecosystem, and the measures that shrimp farmers themselves are undertaking with the assistance of PD/A CRSP research results to ameliorate problems and guide shrimp aquaculture's overall role in coastal development. √

PD/A CRSP Advisory Bodies

At the CRSPs 16th Annual Meeting (Las Vegas, February 1998) Doug Ernst, Kevin Fitzsimmons, and Marion McNamara were elected, and Shree Nath and Bill Shelton were re-elected to the Technical Committee. John Bolte and Jim Szyper stepped down after completion of their terms of office on the Work Plan and Budgets and the Materials and Methods Subcommittees, respectively. (Since the Annual Meeting, Peter Edwards has resigned from his seat on the Technical Progress Subcommittee due to conflicting time commitments.)

Current membership on the CRSPs three advisory bodies is shown below.

Board of Directors

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Research Support At-large member
Marion McNamara, Oregon State University

Notices of Publication

CRSP Research Report 97-119

PD/A CRSP Central Database: A standardized information resource for pond aquaculture

Douglas H. Ernst
John P. Bolte
Duncan Lowes
Shree S. Nath
Department of Bioresource Engineering
Oregon State University
Corvallis, OR 97331 USA

The Pond Dynamics/Aquaculture Collaborative Research Support Program (PD/A CRSP) supports applied research and outreach programs for pond-based food-fish production, with funding under the U.S. Agency for International Development (USAID). Since its inception in 1982, the PD/A CRSP has accomplished a wealth of collaborative, multi-national, multi-institutional aquaculture projects, including facilities, investigators, and user-groups in Egypt, Honduras, Indonesia, Kenya, Panama, Peru, Philippines, Rwanda, Thailand, and the USA.

The PD/A CRSP Central Database is a centralized data storage and retrieval system for PD/A CRSP research and for other aquaculture research programs with compatible objectives and standardized methodology. The Database currently contains over 80 aquaculture production studies and represents the world's largest inventory of standardized aquaculture data. The majority of studies currently in the Database are for production of Nile tilapia (*Oreochromis niloticus*) in sub-tropical and tropical, solar algae ponds, receiving inputs of plant materials, inorganic/organic fertilizers, and/or prepared feeds. Studies of other pond fishes and penaeid shrimp, under monoculture and polyculture management, are also available.

The PD/A CRSP Database can be accessed free of cost by aquaculture researchers, educators, outreach and extension agents, and producers. Data may be searched and extracted according to geographical site, calendar year, fish species, and fish production methods. Weather, water quality, fish performance, and fish culture management regimes may be viewed in raw or summary forms and in graphical or tabular formats. All extracted datasets include references to research investigators, physical descriptions of research facilities, and related publications. An interface to the Database is provided at its Internet Web Site, located at http://biosys.bre.orst.edu/crspDB/. This publication mechanism provides immediate and comprehensive access to the Database worldwide.

The PD/A CRSP Database provides a model for standardized design and reporting of pond-based aquaculture research, and it provides a publication mechanism that leverages the usefulness of such research to the greater aquaculture community. Full reporting of weather, water quality, fish performance, and fish management regimes provides a sound empirical foundation for planning, design, management, and analysis of aquaculture enterprises.

This abstract was excerpted from the original paper, which was published in *Tilapia Aquaculture. Proceedings from the Fourth International Symposium on Tilapia in Aquaculture,* November 9-12, 1997, Orlando, Florida. NRAES-106: 683-700.

Notices of Publication (cont.)

CRSP Research Report 97-120

Secchi disk visibility and chlorophyll *a* relationship in aquaculture ponds

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The application of Secchi disk visibility measurements (SDV) in modeling phytoplankton productivity and management in aquaculture ponds requires a quantitative treatment of the relationship between SDV measurements and chlorophyll *a* (chla) concentrations. Almazan and Boyd (1978) produced one such relationship for aquaculture ponds where phytoplankton was the major source of turbidity. However, in aquaculture ponds, organic matter, color of humic substances and inorganic materials like suspended clay may also be significant sources of turbidity. A majority of aquaculture ponds receive high inputs of organic matter in the form of food or organic fertilizers (Edwards, 1987; Schroeder et al., 1991; Chien, 1992). In such systems, non phytoplankton sources of turbidity can be significant and the Almazan and Boyd (1978) relationship may be inappropriate. Nath (1996) modified the Almazan and Boyd (1978) relationship to allow its applicability in waters with high algal turbidity by including a non algal turbidity parameter.

A method for estimating chla from SDV and for partitioning SDV has been proposed for natural freshwater systems (Bannister, 1974; Megard et al., 1980; Lorenzen, 1980). The linear relationship between the overall light extinction coefficient (k_w), the light extinction due to chla ($k_c c$, where k_c is the light extinction coefficient due to chla and c is the chla concentration) and the light extinction due to non-phytoplankton particulate and dissolved material (k_t) was expressed as (Bannister, 1974; Megard et al., 1980):

$$k_t = k_w + k_c c \qquad (1)$$

where k_t and k_w have units of m^{-1} and k_c has units $m^{-1}(mg.m^{-3})^{-1}$. The general applicability of this method to aquaculture has not been evaluated. The aim of this study was to evaluate the applicability of Bannister's approach (1974) to aquaculture ponds by partitioning sources of turbidity and determining the relative importance of phytoplankton and non phytoplankton turbidity.

This abstract was excerpted from the original paper, which was published in *Advances in Aquaculture Engineering, Proceedings form the Aquacultural Engineering Society (AES) Technical Sessions at the Fourth International Symposium on Tilapia in Aquaculture,* November 9-12, 1997, Orlando, Florida. NRAES-105:159-162.

CRSP Research Report 97-121

Masculinization of Nile tilapia (*Oreochromis niloticus*) by single immersion in 17α-methyldihydrotestosterone and trenbolone acetate

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The production of single sex populations offers several advantages in tilapia aquaculture, including enhanced growth and prevention of unwanted reproduction. A number of androgens have been shown to masculinize various tilapia species, including 17α-methyltestosterone (MT; summarized by Pandian and Varadaraj 1990 for *Oreochromis mossambicus*); mibolerone (Torrans et al. 1988 with *O. aureus*); fluoxymesterone (Phelps et al. 1992 with *O. niloticus*); norethisterone acetate (Varadaraj 1990 with *O. mossambicus*); 17α-ethynyltestosterone (Shelton et al. 1981 with *O. aureus*); 17α-methylandrostendiol (Varadaraj and Pandian 1987 with *O. mossambicus*), and trenbolone acetate (Galvez et al. 1996 with *O. niloticus*).

Aquaculturists usually administer hormones to fish through the diet, but this method is prone to inefficiencies such as uneven exposure to steroid due to the establishment of feeding hierarchies or the availability of supplemental feed from pond primary productivity. Immersion of tilapia fry in steroid solutions may be one way to achieve masculinization and avoid these inefficiencies. This technique is well-developed in salmonid aquaculture (Piferrer and Donaldson 1989; Feist et al. 1995); however, it remains largely experimental in tilapia culture. Most of the reported studies immersed tilapia fry in androgens for periods of over 1 week to 5 weeks (Varadaraj and Pandian 1987; Torrans et al. 1988). Recently, Gale et al. (1995) demonstrated that immersion for just three hours in 17α-methyldihydrotestosterone (MDHT) on two days resulted in masculinization of Nile tilapia. The study described below was undertaken to determine if these findings could be extended through examination of the effects of 1) rearing density on efficacy of MDHT immersion, 2) a single immersion in MDHT, and 3) immersion in another masculinizing androgen, trenbolone acetate (TBA).

This abstract was excerpted from the original paper, which was published in *Tilapia Aquaculture. Proceedings from the Fourth International Symposium on Tilapia in Aquaculture,* November 9-12, 1997, Orlando, Florida. NRAES-106:783-790.

Notices of Publication (cont.)

CRSP Research Report 97-122

A strategic assessment of the potential for freshwater fish farming in Latin America

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Marine and many inland fishery resources are heavily exploited or overexploited, and although there is potential for increasing production from inland fisheries through intensification, development of aquaculture holds the most promise in the long term for improving food security through increasing the supply of fish. Currently, inland aquaculture production in Latin America is insignificant compared with the output from inland and marine fisheries.

Lack of good planning at the national level has been identified as a serious impediment to the development of aquaculture. Estimates of potential are scarce that are both comprehensive and comparable over large geographic areas. Accordingly, the objective of this study was to estimate the potential for warm-water and temperate-water fish farming in the fresh waters of Latin America in order to stimulate improved planning for aquaculture development at national levels, and at the same time to provide a tool to plan comprehensively for technical assistance activities by FAO and other national and international organizations.

The present study is patterned on an estimate of warm-water fish farming potential made for Africa. However, a number of refinements have been made, one of which is a fourfold increase in resolution (i.e., to 5 arc-minutes, equivalent to 9 km x 9 km grids at the equator), thereby making the results much more usable for assessing fish farming potential at the national level. Another refinement is that, for the first time, a bio-energetics model has been incorporated into a geographical information system (GIS) to predict fish yields over large geographic areas. A gridded water temperature data set was used as input to the bioenergetics model to predict numbers of crops per year for four species: Nile tilapia (*Oreochromis niloticus*), tambaqui *(Colossoma macropomum)*, pacu (*Piaractus mesopotamicus*) and carp (*Cyprinus carpio*). By varying input levels and sizes at harvest, opportunities for two levels of commercial fish farming and for small-scale fish farming were identified.

In addition to the suitability of each 9 x 9 km grid cell for the production of the above-mentioned species, each grid cell was evaluated for a number of other factors important for fish-farm development and operation. These included urban market potential based on travel time proximity and population size of urban centres, potential for farm-gate sales based on population density, engineering and terrain suitability for pond construction using a variety of soil attributes, water loss from ponds due to evaporation and seepage, and availability of agricultural by-products as feed inputs based on crop potential. Commercial and small-scale aquaculture models were developed by weighting these factors using a multiple criteria evaluation procedure. Areas unavailable for inland fish farming development were identified by incorporating protected areas and large inland water bodies as constraints. Finally, the yield potential of each grid cell for each of the four species was analysed using the growth model together with the other factors in the commercial and small-scale models to show the coincidence of each class of suitability with each range of yield potential.

Potential for inland fish farming is high in continental Latin America. From 8% to 60% of the continental area scores from suitable to very suitable for small-scale farming of Nile tilapia and carp, respectively. In the same areas, from 0.9 to 1.7 crops/y of Nile tilapia and from 0.9 to 1.8 crops/y of carp can be realized by harvesting at modest weights.

The most important factor for commercial fish farming—urban market potential—scores high across more than one-half of the continent. For Nile tilapia and carp, from 19% to 44% of Latin America rates from suitable to very suitable for commercial farming. From 1.2 to 2.4 crops/y of Nile tilapia and from 1.2 to 2.3 crops/y of carp can be realized on the same areas by feeding at 75% satiation and harvesting at a moderate weight. Tambaqui and pacu occupy an intermediate position in terms of the surface area that is suitable or very suitable for commercial farming. From 0.7 to 1.4 crops/y for tambaqui and from 1.0 to 2.0 crops/y for pacu can be achieved from areas that are suitable or very suitable for commercial farming by feeding at 75% satiation and harvesting at a moderate weight.

From a country viewpoint, at least 18 of the continental countries have some area with potential that rates suitable or very suitable for farming of Nile tilapia and pacu, while there are 19 in the same category for tambaqui. Finally, there are opportunities for carp farming in all 21 countries.

This abstract was excerpted from the original paper, A strategic assessment of the potential for freshwater fish farming in Latin America. COEPSCAL *Technical Paper.* No. 10. Rome, FAO. 1997. 128p.

Notices of Publication (cont.)

CRSP Research Report 97-123

EXPERIMENTAL AND COMMERCIAL CULTURE OF TILAPIA IN HONDURAS

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In 1983 the USAID-funded Pond Dynamics/Aquaculture Collaborative Research Support Program (PD/A CRSP) was initiated in Central America, focusing on increasing natural productivity and fish yields of static water ponds by developing new input regimes without using mechanical aeration. Forty-one semi-intensive tilapia pond management systems were developed and evaluated in Honduras. Ponds were managed semi-intensively; Nile tilapia *(Oreochromis niloticus)* stocking rates did not exceed 3/m^2. Nutrient inputs used were inorganic phosphorus, various levels of organic fertilization, combinations of organic and inorganic fertilization, and combinations of fertilizers and feeds. All tilapia production systems were evaluated in terms of income above variable costs and net returns to land and management from enterprise budgets for 150-day growing cycles.

Incomes above variable costs were positive for all systems except where phosphorus was the sole input, and in one instance where chemical fertilizer was the sole input. Negative returns to land and management were demonstrated for systems based only on inorganic fertilization or on weekly chicken litter inputs less than 1000 kg/ha when fish were stocked at 1/m^2. In general, profitability was higher when the stocking density was 2/m^2, indicating available resources were not being used by fish at low stocking density. Positive returns to land and management in fed systems were obtained only at stocking rates of 2/m^2. Fertilization was more profitable than feeding at low fish stocking rates. Greatest tilapia yields (5300 kg/ha for 150 days) were obtained with feeds, but a combination of chicken litter and nitrogen yielding 3700 kg/ha proved to be at least as profitable. Feed use was more profitable if feed requirements were reduced by substitution with chicken litter. If a large fish (> 300 gram) is required by the market, then feed will probably have to be used as a finisher. Production of 600-900 gram fish for the export market requires high quality feeds. Current practices in commercial intensive tilapia production practices in Honduras are described.

This abstract is excerpted from the original journal article which was published in Tilapia Aquaculture in the Americas, Vol. 1. World Aquaculture Society, Baton Rouge, Louisiana, B.A. Costa-Pierce and J.E. Rakocy (editors), 1997:142-162.

Shrimp Aquaculture Viewed

...from p. 6

As a non-government organization participating in the consultation, the GAA provided a technical paper which outlined techniques and new technology now being employed in the industry to minimize any environmental impact of shrimp farming. The GAA is also developing a Code of Good Practice to assist shrimp culture operators in their desire to establish environmentally sustainable operations.

The Global Aquaculture Alliance is made up of aquaculture businesses committed to growth of environmentally and socially responsible aquaculture to meet world food needs. The recently formed Alliance now includes Founding members from North, South, and Central America as well as Spain. It is recognized by the FAO as an international non-government organization entitled to participate in such United Nations sponsored conferences as the recent consultation in Bangkok.

Producers of aquaculture products, associations of such producers, processors and marketers of aquaculture products, and allied supplying companies such as feed companies are invited to become Founding Members of the GAA to provide a unified international voice for the industry. The group's first regular annual meeting is scheduled to be held at the 1998 World Aquaculture Society conference in Las Vegas, Nevada, in mid-February.

Source: *The Aquaculture News Vol. 6, No. 3, January 1998.*

Upcoming Conferences and Expositions

Date	Topic/Title	Event Location	Contact Information
May 5-8	Cairo International Food, Food Processing, & Agricultural Trade Fair	Cairo, Egypt	Tel (49 6221)-45650; Fax (49 6221)-456525
May 14-15	AquaVision '98, Second Nutreco Business Conference	Stavanger, Norway	Nutreco Aquaculture/Skretting, PO Box 319, N-4001 Stavanger, Norway; Tel +47-51-88-5950; Fax +47-51-58-4368
May 25-30	International Symposium on Agro-Environmental Issues and Future Strategies	Faisalabad, Pakistan	Dr. Jehangir Khan Sial, University of Agriculture, Faisalabad, Pakistan; Tel 0092-41-30281-89/ext 434; email iqrar@ptccuaf.fsd.brain.com.pk
May 31-June 3	Aquaculture Association of Canada, Aquaculture Canada '98	St. Johns, Canada	Dr. J. Parsons, Memorial University, PO Box 4920, St. John's, Newfoundland A1C 5R3. Tel 709 778-0307; Fax 709 778-0535; email jparsons@gill.ifmt.nf.ca
June 17-20	Atlantic Aquaculture Exposition & Conference	St. Andrews, New Brunswick, Canada	Sydney Jane Brittain. Tel 506-658-0018; Fax 506-658-0750; email show@nbnet.nb.ca
July 8-11	International Institute of Fisheries Economics & Trade, IIFET Tromso '98	Tromso, Norway	IIFET Secretariat, Oregon State University, Dept. of Agricultural and Resource Economics, Corvallis, OR 97331-3601, USA
July 16-19	2nd International Conference on Recirculating Aquaculture Systems	Roanoke, VA, USA	Dr. George Libey, Virginia Tech, Mail Code 0321, Blacksburg, VA 24061; Tel (540) 231-6400; email fishfarm@vt.edu; home page www.conted.vt.edu/aquaculture/index.htm
Aug 23-26	Seafood Africa '98	Johannesburg, South Africa	Tel (27 3)-3354-1890; Fax (27 3)-3354-1962
Aug 30-Sept 3	3rd International Symposium on Aquatic Animal Health	Baltimore, MD, USA	Division of Comparative Medicine, Johns Hopkins University School of Medicine, 720 Rutland Ave, Baltimore, MD 21205, USA; Tel 410-955-3273; Fax 410-550-5068; email wellfish@welchlink.welch.Jhu.edu
Sept 2-4	FishEco '98, International Symposium on Fisheries and Ecology	Trabzon, Turkey	Dr. A C Dincer, Faculty of Marine Science, Karadeniz Technical University, 61530 Camburnu, Trabzon, Turkey; Fax +90-462-752-2158; email fisheco@risc01.bim.ktu.edu.tr
Sept 30-Oct 3	16th Lowell Wakefield Fisheries Symposium & 1998 Joint Meeting of AFS Western Division, Alaska Chapter & N. Pacific Intl. Chapter	Fairbanks, AK, USA	Brenda Baxter, Coordinator, Alaska Sea Grant College Program, University of Alaska Fairbanks, PO Box 755040, Fairbanks, AK 99775-5040 USA.Tel 907-474-6702; Fax 907-474-6285
Oct 1-3	II Simposio Internacional de Acuicultura	Mazatlan, Sinaloa, Mexico	Tel 52-(67)-17-27-20/21; Fax (67)-14-08-85
Oct 6-10	1st Latin American Shrimp Culture Congress and Exhibition	Panama City, Republic of Panama	Grupo de Ferias, Congresos y Eventos, S.A. P.O. Box 7277, Panama 5, Rep. de Panama. Tel (507) 269-3995/264-7227. Fax (507) 264-6983; email gfce@sinfo.net; www.expoferia.com/camaron
Oct 7-10	Aquaculture Europe '98	Bordeaux, France	Aquaculture Europe '98 Secretariat, EAS, Slijkensesteenweg4, B-8400 Oostende, Belgium. Fax 32 59 32 10 05; email eas@unicall.be
Oct 7-10	Bordeaux Aquaculture 5th Biennial Conference, Workshop & Exhibition	Bordeaux, France	BCS, Palais de Congrès, 33300 Bordeaux Lac, France; Fax +33-5-56-43-17-76
Oct 8-11	Agritech '98 & Fisheries '98	Surabaya, Indonesia	Tel (852)-2851-8603; Fax (852)-2851-8637
Oct 15-17	Fish Expo Boston	Boston, MA, USA	Diversified Expositions; Tel 207-842-5508
Nov 2-7	I Congreso Sul Americano de Aquicultura; X Simpósio Brasileiro de Aquicultura; V Simpósio Brasileiro sobre Cultivo de Camarão; Feria Internacional de Aquicultura	Pernambuco, Recife, Brasil	Tel (55-81)-445-2200
Nov 11-14	5th Asian Fisheries Forum	Chiangmai, Thailand	Dr. Padermsak Jarayabhand, Chulalongkorn University, Bangkok 10330, Thailand; Tel 66-2-2188160-62; Fax 66-2-2544259; email ardic@chulkn.car.chula.ac.th
Nov 13	Asian Fisheries Society, Symposium on Women in Asian Fisheries	Chiangmai, Thailand	Asian Fisheries Society, MC PO Box 2631, 0718 Makati, Metro Manila, Philippines; Tel 63-2-818-9283; Fax 63-2-816-3183; email e.tech@cgnet.com
Nov 16-18	IV Simposium Internacional de Nutrición Acuícola	La Paz, Baja California, México	Tel (8)-352-63-80; Fax (69)-88-01-57/58
Nov 19-21	Fish Expo Seattle	Seattle, WA, USA	Diversified Expositions. Tel 207-842-5508
Dec 2-5	ExpoPESCA '98, Latin America's Total Fish Show	Santiago, Chile	Sue Hill, Emap Heighway, Meed House, 21 John St., London WC1N 2BP, England; Tel 44-171-470-6340/6302; email sueh@meed.emap.co.uk

Workshops and Short Courses

Date	Title/Topic/Site	Contacts
Year-round	Work Experience in Hatcheries Techniques/ Asian Institute of Technology, Thailand	Aquaculture Short Course Unit, Ag & Aquatic Systems, School of Env, Resources & Development, GPO Box 2754, Bangkok 10501 Thailand; Fax 66-2-524-5484; email somchai@ait.ac.th
Year-round	Training & Research in Fisheries & Stock Mgmt/Wageningen Agricultural University, the Netherlands	G. van Eck, Dept of Fish Culture & Fisheries, PO Box 338, 6700 AH Wageningen, The Netherlands; Tel 31-8370-8330; Fax 31-8370-83937; email gerrie.van.eck@alg.venv.wau.nl
Year-round	Tropical Aquaculture Advanced Training in a Third Country/Escuela Agricola Panamericana (EAP), Honduras, and Asian Institute for Technology, Thailand	Zentralstelle fuer Ernahrung und Landwirtschaft (ZEL) Feldafing/Zschortau, Deutsche Stiftung fuer Internationale Entwicklung (DSE), D-82336 Feldafing, Germany; Tel ++49/8157/38-0; Fax ++49/81 57/38-227
Apr 20-June 12, 1998	Auburn University Aquaculture Training Course–Practical Warmwater Aquaculture in Earthen Ponds/Auburn University, AL, USA	Dr. Len Vining, Intl Ctr for Aquaculture and Aquatic Environments, Auburn University, AL 36849-5419, USA; Tel 334-844-4786; Fax 334-844-9208; home page www.acesag.auburn.edu/dept/faa; email lvining@acesag.auburn.edu
June 23-28, 1998	Aquaculture Water Reuse Systems Short Course, Cornell University, NY, USA	Brenda Snowberger; Tel (607) 255-2495.
July 27-August 7, 1998	10th Annual intensive Short Course on Shrimp Diseases: Disease Diagnosis and Control in Marine Shrimp Culture, Tucson, AZ, USA	Wanda Mc Cormack or Dr. Donald Lightner, University of Arizona, Dept. of Veterinary Science and Microbiology, Vet. Science/ Microbiology Bldg, Room 202, Tucson, AZ 85721 Tel (520) 621-8414; Fax (520) 621-4899; email aquapath@vetsci.microvet.arizona.edu

AQUANEWS

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Aquanews is published by the Information Management and Networking Component of the Pond Dynamics/Aquaculture Collaborative Research Support Program, Oregon State University, 400 Snell Hall, Corvallis OR 97331-1641.

The Pond Dynamics/Aquaculture Collaborative Research Support Program is funded in part by the US Agency for International Development under CRSP Grant No. LAG-G-00-96-90015-00 and by participating US and Host Country Institutions.

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