

# AQUANEWS



*Sustainable Aquaculture  
for a Secure Future*

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## Spotlight on Latin America

*This issue of Aquanews highlights CRSP activities in Latin America, with contributions from almost every CRSP project in the region. For additional information, or to contact any of the CRSP principal investigators whose work is of interest to you, please see p. 10.*

### Water Supply Development for Tilapia in Honduras

*by Ernest W. Tollner, University of Georgia, Athens*

The Alabama-Georgia PD/A CRSP project is applying a comprehensive systems research approach to assess and foster the development of small to intermediate-sized tilapia production enterprises in Honduras and other Central American countries. Development of reliable and sustainable water supplies is a key ingredient in any inland aquacultural enterprise. In this article, we review the progress toward water supply development in Honduras.

Honduras is a Central American country of approximately 11 million hectares with both Atlantic and Pacific coasts. Mountains may be as high as 2,600 meters. Rainfall varies from 600 mm to 3,400 mm annually, with the highest precipitation generally associated with higher elevations. Temperatures above 1,300 meters are usually too cool for tilapia production. Rainfall is unevenly distributed in the elevations where tilapia would most likely be produced, which requires innovative schemes for water supply development.

The current state-of-the-art approach for supplying small to medium-sized communities with water for a variety of uses (including

ponds) is the water tube-spring. PVC or polyethylene pipe (12 mm to 25 mm in diameter) is run down slope from a naturally occurring spring to a site, which may be a kilometer or more from the spring. Springs are prevalent in mountainous areas at altitudes below 1,300 meters. The excavated levee pond is currently the most popular containment for fish production. The watershed pond is not widely used because the steep valleys do not readily enable suitable diversion spillways for adequate handling of high runoff rates during rainy seasons.

Several assumptions were made at the project outset. First, we assumed that interested nongovernmental organization (NGO) staffers would be willing to devote time to learning how to evaluate topography and soils for pond suitability. Second, we assumed that these NGO staffers would be able to obtain and load EXCEL<sup>®</sup>-based software onto their computers. Experience with workshops conducted to date suggests that both assumptions are realistic.

The modeling effort was separated into water supply feasibility and economics phases. EXCEL<sup>®</sup>-based models were developed for evaluating feasibility and costs of levee ponds and hillside ponds. The difference between the levee pond and the hillside pond in this report is

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## Upcoming Request for Proposals

CRSPs typically have 5-year life spans as funded by the United States Agency for International Development (though funding is provided only annually).

During the current grant, our CRSP sought and received a 2-year extension, making for a 7-year program. The summer of 2003 will mark the end of those seven years.

A proposal for a new 5-year grant (2003–2008) is under development and will be submitted to USAID in early 2003.

The PD/A CRSP will be seeking proposals in the field of aquaculture research.

A Request for Proposals (RFP) will be issued on 1 August 2002. Successful proposals to the PD/A CRSP will form part of the CRSPs overall grant proposal package to USAID. The RFP will contain complete details on programmatic and technical considerations for award of a PD/A CRSP project.

The PD/A CRSP anticipates funding a number of proposals that comprise multiple investigations, disciplines, researchers, and institutions and that focus on a specific region.

Broad participation by eligible institutions and researchers not previously engaged in collaboration with the PD/A CRSP is encouraged.

The RFP will be available at our website.

For more information, call Steve Sempier at 541-737-6423 or email <sempiers@onid.orst.edu>.

## Marketing Research in Latin America

by Carole R. Engle and Ivano Neira, Aquaculture/Fisheries Center, University of Arkansas at Pine Bluff

Several studies were funded under the Tenth Work Plan to extend the results of the marketing surveys that were carried out in Honduras and in Nicaragua as part of the Ninth Work Plan.

Discrete choice logit models are under development with data from each of the six Ninth Work Plan surveys to identify the effects of consumer attitudes and sociodemographic characteristics on binary choice variables related to either sales of tilapia or willingness to add tilapia to the product or menu line. For example, the logit analysis of the Nicaraguan restaurant survey data evaluated the factors that affect the probability that a given restaurant was selling tilapia as well as the probability that a restaurant that was not selling tilapia would add it to its menu.

From this analysis, the most promising restaurant markets for tilapia farmers appear to be older restaurants that offer a variety of different types of food on the menu and those that served steaks. Larger restaurants that considered tilapia to be a high-quality product and that offered ceviche on the menu were those that tended to sell tilapia. Restaurateurs' experiences with off-flavor and poor quality tilapia were cited as reasons for not selling tilapia.

Those variables that emerge as most significant across the surveys will be



ALDO GUERRERO

University of Arkansas at Pine Bluff graduate student Ivano Neira interviews a restaurant owner in León city, Nicaragua.

## The Oregon–Mexico Connection

by Carl B. Schreck and Guillermo R. Giannico, Oregon State University, and Wilfrido Contreras-Sánchez, Gabriel Márquez-Couturier and Mario Fernández Pérez, Universidad Juárez Autónoma de Tabasco, Mexico

This OSU/UJAT collaborative project addresses some of the major problems that small farmers face in Southeastern Mexico. Three areas are critical for restructuring and supporting sustainable aquaculture in Mexico and Central America: 1) implementing masculinizing systems for tilapia and native fish species that are safe for the fish culturist and the environment; 2) producing a new line of tilapia for broodstock replacement; and 3) diversifying aquacultural practices

WILFRIDO CONTRERAS-SÁNCHEZ



Yara Rivera Márquez and Alejandro Mcdonal Vera stock hapas with tilapia fry for masculinization treatment.

used to design a short, rapid market assessment tool. This tool will be tested in Mexico and in Peru. Raymundo Sury, under the supervision of Wilfrido Contreras-Sánchez of the Universidad Juárez Autónoma de Tabasco, Mexico, will carry out the testing in Mexico while the work in Peru will be done in collaboration with Fernando Alcántara, host country

IVANO NEIRA



Guapote, *Cichlasoma managuense*, a freshwater cichlid native to Nicaragua that is a popular finfish; some restaurants substitute guapote with tilapia.

principal investigator for Peru based at the Instituto de Investigaciones de la Amazonia Peruana.

## Aquaculture Facilities at UJAT

The laboratory comprises an area of 1972 m<sup>2</sup>. Site facilities include 2 wet rooms, 2 offices, a chemistry lab, a sampling room, an ecophysiology lab, a constant temperature room, a small library and a kitchen. There are 3 concrete ponds with an area of 50 m<sup>2</sup> each and one earthen pond with an area of 200 m<sup>2</sup> that are used for reproduction and grow-out. One circular tank (240 m<sup>3</sup>) is used for tilapia juvenile grow-out. Three 8 m<sup>3</sup> tanks are used for studies on masculinization of tilapia fry, 5 circular 6 m<sup>3</sup>-tanks are used for native cichlids reproduction, and two 16 m<sup>3</sup>-tanks are used for tilapia broodstock selection. Many experiments are run in recirculating systems. The facility has 6 systems composed of twelve 20-l buckets each and one with 27 buckets. Studies on fry growth and sex differentiation are conducted in a system with 9 tanks with 1,000 l capacity each. Two outdoor recirculating systems have a total of 72 tanks with a capacity for 120 l.

using native species. We have brought together a very strong group of twenty students, sixteen of whom are supported by the PD/A CRSP—12 undergraduate and 4 graduate students—all of them working in the UJAT laboratory on their own theses projects.

We have implemented an intensive masculinizing system equipped with an activated-charcoal filter and tested different amounts of charcoal (0, 2.5, and 5.0 k) to capture excess methyltestosterone (MT) present in the

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## Peru Project: Broodstock Diets and Spawning of *Colossoma macropomum* and/or *Piaractus brachypomus* Research Update

by Rebecca Lochmann, University of Arkansas at Pine Bluff

One of the objectives of this Tenth Work Plan project is to determine the effect of improved broodstock nutrition on maturation and spawning performance of *Colossoma macropomum* and/or *Piaractus brachypomus*, species native to the Peruvian Amazon and locally known as tambaqui and pacu. Ideally, optimal broodstock diets will be formulated using nutrient sources that are cost effective and readily available in the Amazon region.

Assessment of the diets used previously for Characid broodstock revealed that they contain very low levels of xanthophyll (about 17 mg/kg) but no other carotenoids. Carotenoids are known to influence reproduction in some fish (red sea bream, yellowtail, Atlantic salmon).

Furthermore, the natural diets of Characids are rich in carotenoids. Pijuayo (*Bactris gasipaes*) is a locally available fruit with a deep orange-red color. The fruit is similar to corn in its percentages of protein and lipids, but pijuayo contains mostly beta-carotene and corn contains xanthophyll. Previous research (Mori-Pinedo et al., 1999) has shown that pijuayo and corn could be used interchangeably for growth and body composition in tambaqui fingerlings. In addition, pijuayo is being used in diets for ornamental fishes at Fondepes, a government fish production facility in Peruvian Amazon city of Iquitos.

Assuming pijuayo has no negative effects on pacu growth, health, or survival, it should be safe to include in broodstock diets

to determine the effects of carotenoid enhancement on spawning success. Therefore, we conducted a small feeding trial with juvenile pacu to determine whether or not pijuayo and corn can be used interchangeably to support normal growth without producing negative effects. Whole ripe pijuayo (including the seed, skin, and flesh) fruits were finely minced and dried in an oven at 40°C overnight at the CRSP's Peru research site, the Instituto de Investigaciones de la Amazonia Peruana, in Iquitos, Peru. The drying step destroys the trypsin inhibitor in pijuayo and makes it suitable for grinding to a flour. The flour was used in a feeding trial with pacu in a recirculating system at the University of Arkansas at Pine Bluff (UAPB). There were two diets that contained 20% fish meal, 34% soybean meal, 24% wheat flour, 2% vitamin/mineral mix, 4% soybean oil, and 16% either corn or pijuayo. Fish in triplicate 110-L tanks per treatment were fed to satiation three times daily for six weeks. Survival was 100%, and there were no significant differences in growth between treatments.

Therefore, pijuayo can be substituted for corn at 16% of the diet without sacrificing growth or health of pacu. Mori-Pinedo et al. (1999) showed that pijuayo or corn could be used up to 55% of the diet for comparable growth and body composition in tambaqui fingerlings. The next step is to determine whether substitution of corn with pijuayo confers any benefits to broodstock Characids in terms of spawning success.

Other work in progress at UAPB indicates additional changes to consider for pacu (broodstock and fingerling) diets. Apparent digestible energy coefficients determined recently for common feed-stuffs in pacu indicate that the available energy content of wheat bran is about half that of fish meal, soybean meal, or corn (Fernandes and Lochmann, unpublished). Apparent protein and lipid digestibility coefficients are also being determined for these feedstuffs in pacu.

REBECCA LOCHMANN



Pijuayo and other produce at the mercado in Iquitos, Peru.

### PERUVIAN CEVICHE DE PESCADO

Serves 6 to 8

2 lbs seabass filet  
 1 cup lime juice  
 1 clove of garlic, crushed  
 Hot pepper sauce  
 Salt and pepper  
 Large onion, finely chopped  
 2 red peppers, cut into strips  
 2 stalks of celery, finely chopped  
 Cilantro, finely chopped  
 2 ears of corn, cooked, and cut into 2-inch pieces  
 2 sweet potatoes, cooked, peeled, and sliced

1. Wash the fish and cut into small cubes. Add lime juice, garlic, pepper sauce, salt, and pepper. Cure for one hour.

2. Add the onion, red peppers, celery, and cilantro. Continue curing for one hour more.

3. Serve with the corn on the cob and sweet potato.

## Ohio State and UJAT/ Mexico: Evaluating the Potency of Phytochemicals to Sex-Reverse Tilapia

by Konrad Dabrowski, Mary Ann G. Abiado, Gustavo Rodriguez Montes de Oca, The Ohio State University, and Wilfrido Contreras Sánchez, Universidad Juárez Autónoma de Tabasco, Mexico

July 1, 2001, marked the beginning of a new CRSP project on “Studies on Fate of Methyl–testosterone and its Metabolites in Tilapia and on the Use of Phytochemicals as an Alternative Method to Produce a Monosex Population of Tilapia.”

Collaborators are Konrad Dabrowski and Mary Ann G. Abiado of The Ohio State University (OhSU), Columbus, Ohio, and Wilfrido Contreras-Sánchez and Gabriel Márquez-Couturier of Universidad Juárez Autónoma de Tabasco (UJAT), Tabasco, Mexico. The research aims to determine the concentration of methyltestosterone (MT) derivatives in tilapia and in water using radioimmunoassay (RIA) and high-performance liquid chromatography (HPLC) and to evaluate the potential action of phytochemicals on sex differentiation in tilapia. Three students from Mexico are working on the project—Gustavo Rodriguez Montes de Oca, a Ph.D. student at Ohio State, and Maria de Jesus Contreras Garcia and Guadalupe Morales Lara, undergraduate students in biology at UJAT.

An initial study, “Phytochemical (quercetin) and Vitamin C role in Tilapia Nutrition and Sex Determination,” was conducted at OhSU and UJAT. The study sought to determine the effect of quercetin alone and with ascorbic acid on sex differentiation and growth in tilapia. Four diets—control, quercetin 1%, vitamin C (1000 ppm) and quercetin plus vitamin C (1000 ppm)—were used to feed tilapia

larvae for 8 and 17 weeks at UJAT and OhSU, respectively. Mixed-sex tilapia larvae were used at UJAT while first-feeding larvae of genetically all-male tilapia (GMT, Til-Tech Aquafarm, Robert, Louisiana) were used (see experimental facility, below) at OhSU.

Results from both locations showed that the incorporation of 1% quercetin in the diet does not affect sex determination in tilapia. However, the addition of 1% quercetin and 1000 ppm vitamin C in the diet shows potential for promoting growth in tilapia. Further studies are recommended to evaluate higher percentage of quercetin in the diet.

This study demonstrated that the phytochemical quercetin has no feminizing effect on tilapia. The next step is to evaluate its masculinizing effect in a separate study using either all-female populations from FishGen Ltd, based at Swansea University, United Kingdom, or from mixed-sex populations available from fish vendors in the United States. Contreras-Sánchez will be visiting OhSU during the course of the investigation to train Rodriguez in analyzing concentrations of MT in the water and diet by RIA and HPLC. Contreras-Sánchez’ Ph.D. research at Oregon State University involved the use of these techniques for analyzing levels of MT in water and pond sediments. 



Rodriguez, a Ph.D. student advised by Dabrowski at OhSU, catches tilapia for weekly sampling. The feeding study involves twelve experimental tanks provided with recirculated water under controlled temperature (27–29°C).

## Honduras Project: Update on WIDeST—Web-based Information Delivery System for Tilapia

by Brahm Verma and Jennifer Maldonado

Countries with predominantly small and medium-scale farms, poor infrastructure for transportation and communication, and limited material resources typically have large populations with marginal economic income.

Development efforts in these countries have tended to focus on the provision of technical assistance to enhance agricultural productivity, sometimes at the cost of exploiting natural resources to unsustainable levels. Lack of access to information that can lead to creative alternatives for economic development is a great impediment in making informed decisions.

The primary purpose of this CRSP project is to develop an integrated framework in Honduras that supports a systematic method of creating partnerships and communication among stakeholders and to build decision-making capacity locally. The target group is small- and medium-scale farmers.

Project team members from the University of Georgia, Athens, the Escuela Agrícola Panamericana, Auburn University, the Red de Desarrollo Sostenible–Honduras (RDS–HN) are developing the user-friendly Web-based Information Delivery System for Tilapia (WIDeST) and using it to bring Zamorano, local NGOs and extension agents, and the US universities together in partnership. WIDeST is a central feature of workshop sessions for training host country trainers who will then train small and medium-scale farmers.

In user-friendly websites for decision-making, users can be immersed in critical thinking and decision-making without the distraction of unneeded pages. The current WIDeST site

<[www.acuacultura-ca.org.hn](http://www.acuacultura-ca.org.hn)>

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## Honduras Project: Status Report on Fisheries and Aquaculture

by Daniel Meyer and Suyapa Triminio, Escuela Agrícola Panamericana El Zamorano

Commercial aquaculture has developed in Honduras during the past 20 years. Today Honduras has two dynamic industries based on the cultivation of marine shrimp (*Litopenaeus vannamei*) and tilapia (*Oreochromis niloticus*).

Initial efforts in this country to culture fish go back to the 1960s when personnel from the United Fruit Company (UFC) imported channel catfish fingerlings from the US for culture along the north coast of Honduras. During Hurricane Fifi (September of 1974), the UFC fish farm was flooded, and approximately 250,000 adult catfish were lost to local rivers. There are now channel catfish in several natural bodies of water in the northern part of Honduras. With the intent of improving sport fishing, UFC also introduced largemouth bass to the largest freshwater lake in Honduras. Bass are presently found in many water bodies locally.

During the 1970s and 80s the United States Agency for International Development (USAID) supported several important development programs aimed at increasing agricultural production in Honduras. USAID efforts included fish culture as one alternative for increasing animal protein in the diets of the rural poor. The US Peace Corps has also promoted fish culture and the use of improved agricultural practices with local farmers since the early 1960s in this country. Many non-governmental organizations have included fish culture in their rural development programs.

In addition, government agencies and private companies and organizations have introduced a variety of aquatic species to Honduras for use in aquaculture. These

introductions (Table 1) have definitely impacted many the aquatic habitats in Honduras and presented new opportunities to local residents.

This list of introductions is not meant to be complete but does illustrate the frequency and variety of animal species that have been introduced with the intention of developing aquaculture locally, both at the commercial and subsistence levels. Many species were introduced on multiple dates by several different agencies. The list could easily be expanded by adding species of mollusks, ornamental fish, and aquatic plants.

It is now apparent that several of these exotic "aquaculture" species have escaped from farms and become established in the natural waters of Honduras. We have conversed with fishermen from several towns in northern Honduras who are fishing successfully for common carp, grass carp, tilapia, and Malaysian river prawns. The fishermen generate income from these species through sales locally.

We were informed that any carp fingerlings caught by these fishermen are released back into the river for further growth. It is not clear if the grass carp have been able to successfully reproduce locally without exogenous hormone-induced maturation of the fish. Successful spawning of channel catfish has occurred under local conditions in Honduras.

In Honduras, mixed-sex grass carp fingerlings were available for distribution from the El Carao National Fish Culture Station, in Comayagua, during most of the 1980s. To our knowledge, since about 1990, no grass carp have been spawned successfully on any station in this country.

This interesting situation of aquaculture species providing opportunities to local fishermen should motivate us to look into the potential economic benefits, and the possible environmental impacts, related to the presence of these exotic species in rivers and lakes in Honduras.



Group of artisan fishermen in El Progreso, Honduras, with (left to right) grass carp, grass carp, tilapia, grass carp, common carp and grass carp, caught locally along the north coast of Honduras.

Table 1. Partial list of introductions of aquatic species to Honduras.

Common name	(scientific name)	Date	Introduced by
Large mouth bass	( <i>Micropterus salmoides</i> )	1950s	United Fruit Company
Common carp	( <i>Cyprinus carpio</i> )	1954	FAO, United Nations
Java tilapia	( <i>Oreochromis mossambicus</i> )	1954	FAO, United Nations
Channel catfish	( <i>Ictalurus punctatus</i> )	1960s	United Fruit Company
Malaysian river prawn	( <i>Macrobrachium rosenbergii</i> )	1974	General Mills Corp
Nile tilapia	( <i>Oreochromis niloticus</i> )	1979	USAID, Ministry of Agriculture
Hornorum tilapia	( <i>O. urolepis hornorum</i> )	1980s	USAID, Ministry of Agriculture
Grass carp	( <i>Ctenopharyngodon idella</i> )	1980s	Ministry of Agriculture, Zamorano
Silver carp	( <i>Hypophthalmichthys molitrix</i> )	1980s	Ministry of Agriculture
Bighead carp	( <i>Aristichthys nobilis</i> )	1980s	Ministry of Agriculture
Tambaquí	( <i>Colossoma macropomum</i> )	1980s	Ministry of Agriculture
Red tilapia	( <i>Oreochromis sp.</i> )	1990	Federation of Ag Exporters (FPX)
Red claw	( <i>Cherax quadricarinatus</i> )	1996	Zamorano
Bull frog	( <i>Rana catesbiana</i> )	2001	Private farmer



Small child with exotic fish (grass carp and common carp) ready for sale in El Progreso, Honduras.

## Peru Project's International Training Course in Aquaculture of Amazon Species for Extensionists and Producers

by William Camargo, Southern Illinois University, Carbondale

The first international training course titled "Aquaculture of Amazon Species for Extensionists and Producers," sponsored by CRSP-SIUC-USAID, was held at the Instituto de Investigaciones de la Amazonia Peruana (IIAP) Quistococha facility from 25-30 April 2002.

The course, the first of a proposed series of training courses, offered basic tools to initiate small but productive aquaculture ventures to aid in facilitating food security and additional income to farmers and indigenous communities (Quichua, Shipibo and Cocama) of the Amazon region. To ensure sustainability, various native Amazonian plant products (fruits, foliage and agriculture byproducts) were promoted as sources of food for plant-eating fishes (e.g., Colossomids). The next training course will be held at the same location (IIAP-Quistococha) from 25-30 August 2002. 🐟

## Oregon-Mexico Connection

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water. A preliminary trial run with an initial number of 7,000 fry yielded more than 3,000 masculinized fry (of which more than 99 % were males) in all units. In a second trial that started with approximately 21,000 fry, we obtained more than 9,000 fry in the units containing 2.5 and 5.0 k of charcoal, while only about 4,000 were present in the unit containing no charcoal.

The fish are in a growout pond and the efficacy of MT feeding will be assessed shortly for this trial. We have been monitoring nitrates, nitrites, and ammonia concentrations in water; high concentrations may be responsible for high mortalities in the preliminary trial. Water and charcoal samples have been collected and kept frozen to be analyzed at Oregon State

FERNANDO ALCANTARA



Standing from right to left: Gustavo Malaverly Gayas, Julio Tananta Vásquez, Oswaldo Pinedo del Aguila, Salvador Tello, Peru), Lorgio Clever Guerra Amaral, Juan Aricari Yahuarcani, Simith Grández Panduro, Lucila Melita Chota Mozombite, Juan Zevallos Lozano, Paulo José Santos, Manuel Fasabi Mozombite. Below from right to left: José Machoa Santi, Marcelino López Córdova, William Camargo Navarro, Fernando Alcántara Bocanegra, and Luís Cardozo Sanda. Not in picture: Clara Dos Santos Barbosa, Martín Luís Vela Morales, Luciano Rodríguez, Carlos Chavez, and Lamberto Arevalo.

University for MT concentrations. We are currently running another trial using 18,000 fry in each experimental unit.

In another set of experiments we are evaluating the administration of bioencapsulated trenbolone acetate (TA) for masculinization of tropical gar and mojarra castarrica fry and estradiol (E2) for feminization of tropical gar fry, using *Artemia nauplii* as a vehicle. We have validated the incorporation of both steroids in the *A. nauplii*. After two hours of treatment, we detected more than 6,000 picograms (pg) of E2 and more than 6,500 pg of TA per gram of *A. nauplii*. Concentrations of both steroids

remained elevated after 24 hours. Fish were fed with enriched *A. nauplii* and are currently in growout recirculating systems, until they reach sampling size.

At the Mariano Matamoros tilapia farm we are finishing the selection of the first line of Nile tilapia juveniles that will be tested as broodstock. This selection has been conducted using weight and standard length as the main response variables.

The establishment of good quality broodstock treatments, their distribution to local hatcheries, and the implementation of intensive masculinization programs are basic steps for sustainable aquaculture. These actions can improve significantly the production of good quality fingerlings and have a favorable impact on more than 5,000 subsistence farmers and medium-scale producers.

Tabasco is considered among the States of Mexico with the highest potential for both intensive and extensive aquacultural development. Moreover, fish consumption constitutes an important part of the rural lifestyle in the State of Tabasco. Therefore, research efforts underway are logical initial steps toward developing sustainable aquaculture in the region. 🐟

WILFRIDO CONTRERAS-SÁNCHEZ



Rocío Chan Rodríguez and Maria de Jesús Contreras García work on a recirculating system used for growing out tropical gar juveniles. This experiment was performed to determine sex inversion can be performed on gars because females grow larger than males.

## Honduras Water Supply

...from p. 1

that the levee pond must be supplied by pipe while the hillside pond may capture runoff from surrounding areas. The hillside pond is intended to supply water for a variety of uses including fish production. The levee pond is the primary containment for fish production. Levee and hillside ponds are of similar construction.

The feasibility of a levee pond size in a given area was evaluated by determining the peak, average, and minimum monthly water balance (see Figure 1). The model predicts the supply flowrate required to

small fraction of the runoff during the rainy season (see Figure 2). Water in this pond may be used for a variety of uses including fishpond supply. The EXCEL®-based model performs a water balance (see Figure 3) as with the levee pond with the addition of runoff prediction from the watershed above the pond.

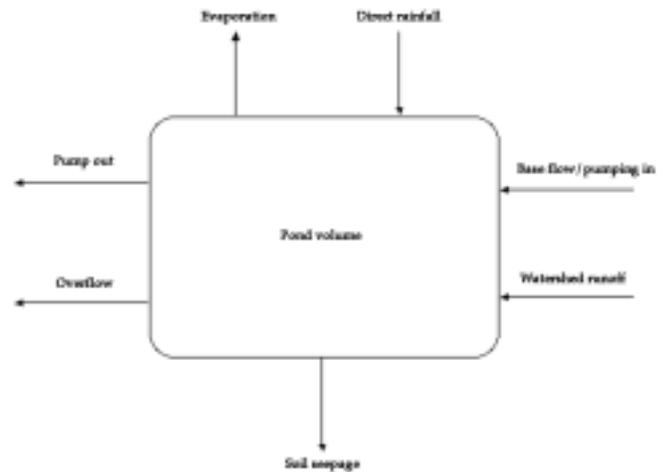


Figure 2. Catchment or hillside pond water balance.

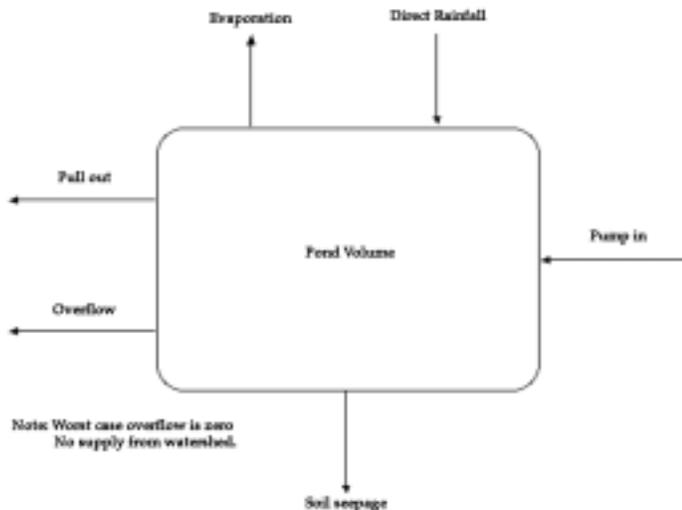


Figure 1. Levee pond water balance.

maintain a full pond given the pond surface area, depth, and climate variables (evaporation, seepage, and precipitation) in the region.

The hillside pond model evaluates the feasibility of developing a sustainable pond with springs and surface water runoff. As previously stated, placing a watershed pond in the main runoff conveyance is likely not feasible due to steep valley slopes. One approach for using a watershed type pond in capturing water is shown in Figure 1, wherein a pond is located out of the main channel and supplied with an excavated ditch which connects with the main drainage conveyance at some point upstream. A diversion structure may be designed to capture nearly all of the runoff during dry months and a

scenarios. The model evaluates the cut-fill ratio for given sized ponds on a specified topography. The volume of soil moved is computed. Input of machine capacity (cubic meters per day as determined by local operators) and machine cost-per-day enables cost estimation.

With the help of Dan Meyer, Suyapa Meyer, and George Pilz of Escuela Agrícola Panamericana El Zamorano, a daylong workshop for local NGO staff and Zamorano faculty was conducted. The program was structured into morning lecture

Once a watershed and/or levee pond is deemed feasible at a site based on topography, soils, and available water, the question of construction cost arises. An EXCEL®-based model was developed for evaluating levee-hillside pond

sessions and an afternoon field trip. The hillside pond model and the levee pond models were demonstrated using slides in English accompanied by handouts in Spanish. The Excel® models were partially translated into Spanish, with the translation service provided by CRSP-sponsored Honduran students studying with Joe Molnar at Auburn University. The workshop was very well received. Faculty members at Zamorano are using parts of the presentation in classes at Zamorano. The success of this workshop is providing the basis

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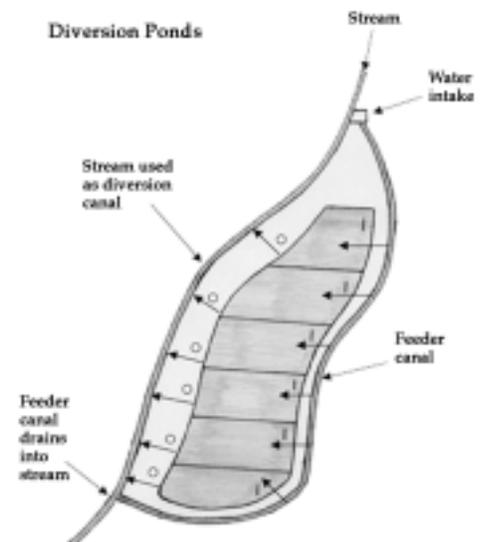


Figure 3. Scenario for capturing watershed runoff into ponds for multiple uses by diverting water from a main watershed conveyance.

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## Graduate Student Profile: Fred Chu

by Steve Sempier

Fred Chu, a native of Peru, first learned of the PD/A CRSP while working in the Peruvian Amazon for Terra Nuova, an Italian nongovernmental organization. Terra Nuova's activity focuses on aquaculture development in the region. While working with Terra Nuova, Chu was approached by Chris Kohler, a PD/A CRSP Principal Investigator at Southern Illinois University at Carbondale (SIUC), who is a collaborative partner with Peruvian counterparts at the Instituto de Investigaciones de la Amazonia Peruana (IIAP) and the Universidad Nacional de la Amazonia Peruana, both in Iquitos, Peru. Kohler invited Chu to pursue a Ph.D. at SIUC.

Chu accepted Kohler's proposal. He has spent the past year at SIUC improving his English skills. As of this summer Chu will be officially enrolled as an SIUC Ph.D. student and will begin his field research. Chu will be studying the use of over 15 native Amazonian plants that are currently being utilized as a source of nutrition for *Colossoma macropomum* and *Piaractus brachyomus* for small-scale aquaculture application. Plants such as lady finger banana, cashew, papaya, and yucca will be analyzed. Often seeds are consumed with the fruit of these plants and later defecated. Chu will delve further into this issue and study the dispersal potential of the plant seeds via fish feces. His work is part of the Feeds and Fertilizer project (10FFR1) titled, "Nutrition of *Colossoma macropomum* and *Piaractus brachyomus*." The project focuses entirely on Peruvian Amazon aquaculture but may have further reaching implications.



PD/A CRSP graduate student Fred Chu.

The Peruvian Amazon is an excellent area for aquaculture. Chu notes several reasons why the Peruvian Amazon is an ideal location for aquaculture: the extremely high fish consumption per capita (the highest in Peru), water in abundance, land, a growing market, a growing interest in aquaculture, and ultimately there is strong political support to develop this activity. Chu also notes that he first gained interest in aquaculture because of its economic growth in the area and its benefit to ecological

systems due to the reduced pressure on natural stocks. Although there is motivation for aquaculture development, Chu notes several constraints. They include lack of basic information on the biology, physiology, and nutritional requirements of the cultured fish; poor technology transfer to farmers; few professionals acting in an extension capacity; and low availability of fry.

Chu will be working with many individuals who are active in the PD/A CRSP project. He appreciates support from several PD/A CRSP researchers as he pursues his Ph.D. Chu identifies Kohler, William Camargo (Coordinator of the PD/A CRSP Peru project), and Fernando Alcántara at IIAP as important

contributors to his work. In fact, Chu will return to Peru and work at IIAP after he obtains his Ph.D.

Chu plans to live in Peru after he completes degree requirements but is also open to future opportunities in an academic or research setting in Brazil or the US. For now, he is focused on his project and classes and tries to find free time to play Peruvian and Latin American songs on his guitar with his friends. 🐟

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## Honduras Water Supply

...from p. 7

for future workshops to be held in Guatemala and El Salvador. The models are being made available on the web by the Red de Desarrollo Sostenible-Honduras (RDS-HN), an NGO with extensive capacity in information technology serving over 700 customers and NGOs with Internet facilities on the RDS website.

Future goals include completing the Spanish translation of the models. We also plan to move the models to a more friendly web-enabled platform. The main disadvantage of using any package for

model development is that the user must have the package. Using a common spreadsheet such as EXCEL®

probably minimizes the disadvantage; nonetheless disadvantages remain, such as the substantial

programming required to make the models applicable or relevant to different geographic regions. Moving the models to a web-enabled platform will allow us to use a more conventional programming platform that can be placed on a central server for universal web access. 🐟

JENNIFER WALDONADO



Scene from the Zamorano pond design workshop.

## Update on WIDeST

...From p. 4

is being redesigned to focus on user needs. We are restructuring the architecture and presenting multiple navigation options for different users. In the new streamlined design, users will work less and think more.

Like in the production of a film, roles people play must be clearly identified for making an effective website. Our project team has jointly outlined production roles. We have identified and assigned critical roles: a content coordinator, a content analyst, a junior producer, a senior producer, and a promoter.

Information flows through these positions and is presented online and promoted if it has been 1) identified as a need or a trend by our content coordinator, 2) rewritten for web presentation and categorized by the content analyst, 3) posted to the web by the junior producer, or 4) passed to the senior producer for

PETER FREY



Jennifer Maldonado—"Being a Content Analyst" course, Zamorano, Honduras, June 2002.

complex programming.

All roles are important, yet it is the content analyst that focuses on user needs and content assessment. This role guarantees good website usability. As a way to build capacity in the host country, in June, Jennifer Maldonado from the University of Georgia taught a course in Honduras on "being a website content analyst."

Maldonado used the redesign of <www.acuacultura-ca.org.hn> as a demonstration for teaching the content analyst's role.

Capacity-building interventions by donor countries that offer technical assistance end up being temporary fixes until the time when the sponsoring entities depart.

The challenge is to conceptualize ways for small-scale farmers, nongovernmental organizations (NGOs), and decision-makers in host countries to easily find usable data and knowledge and to develop the know-how to use to them for decision-making. These abilities will institutionalize host countries capacity for economic development. 🐟

## Congratulations are in order

**P**eruvian Ivano Neira Diaz, a CRSP-sponsored graduate student profiled in the Fall 2000 issue of Aquanews, successfully defended his thesis this May, earning a Master of Science degree in Aquaculture/Fisheries from the University of Arkansas at Pine Bluff. His major professor was Carole Engle.

### ANALYSES OF THE POTENTIAL MARKET FOR FARM-RAISED TILAPIA IN NICARAGUA (abstract of Ivano Neira Diaz' M.S. thesis)

Development of the domestic market for farm-raised tilapia could diversify marketing opportunities for Nicaraguan tilapia growers and expand the industry. The goal of this project was to assess the domestic market and evaluate the potential for developing the market.

Restaurant, supermarket and open-air market surveys were conducted in all major urban and rural areas in Nicaragua from August through September, 2000. All the survey questionnaires were administered in person.

A random sample of 118 restaurants were surveyed with a 100% response rate. A census of the supermarkets resulted in 35 completed supermarket questionnaires with a response rate of 95%. A census of the stands in open-air markets resulted in 109 completed questionnaires with a response rate of 100%. Information was collected on both tilapia and other types of fish and seafood sold, relating to supply characteristics, marketing channels,

demand characteristics, preferences, consumption patterns, and store characteristics. The data and information obtained from the surveys were analyzed using statistical and econometric procedures.

The statistical results indicated that tilapia was a well known fish specie in Nicaragua. It was considered as the fourth, third, and the second most important finfish sold by restaurant, supermarket and fish vendors in open-air markets, respectively. Some respondents were reluctant to admit selling tilapia due to off-flavor and consumer fears related to wild-caught tilapia from Lake Managua. The fear of contamination from Lake Managua and of fish thought to be caught from the lake was a major factor inhibiting sales of freshwater fish. Tilapia were not sold due to off-flavors, lack of awareness, lack of supply, and fears of selling contaminated fish from Lake Managua. The most

...continued on p. 11

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### BRAZILIAN FISH AND SHRIMP STEW

Serves 8

2 onions (6 oz each)  
3 cloves garlic  
1 tsp olive oil  
5 to 7 tbsp minced fresh jalapeno chilies  
3 tbsp minced fresh ginger  
4 cups fat-skimmed chicken broth  
2 cans (15 oz. each) tomato sauce  
1 can (14 1/2 oz.) stewed tomatoes  
1/4 cup sweetened, shredded, dried coconut  
3 tbsp chunky peanut butter  
2 lbs (41 to 50 per lb) frozen, shelled, de-veined shrimp  
1 lb boned, skinned tilapia (or any firm white-flesh fish)  
1/2 cup chopped fresh cilantro  
Salt and pepper  
Cilantro sprigs, rinsed

1. Peel onions and garlic; mince. In a 5- to 6-quart nonstick pan over high heat, stir onions, garlic, oil, jalapenos, and ginger often until onions are limp, about 10 minutes.
2. Stir in broth, tomato sauce, stewed tomatoes (including juices; break tomatoes into chunks with a spoon), coconut, and peanut butter.
3. When mixture is simmering, stir in shrimp. Cover and cook over medium-low heat, 4 minutes. Meanwhile, rinse fish and cut into 1-inch chunks.
4. Stir fish into sauce, cover pan, and cook until fish and shrimp are opaque but still moist-looking in center of thickest part (cut to test), 3 to 4 minutes. Stir in chopped cilantro and add salt and pepper to taste. Garnish with cilantro sprigs.

## Comings and Goings

The PD/A CRSP offices have undergone big changings-of-the-guard this last quarter, having lost several clan members to greener pastures and welcomed new additions.

Cormac Craven, Assistant Director of Research of the Program Management Office, has returned to his native Ireland and a position with the Department of the Marine and Natural Resources. We're happy to announce that Steve Sempier, who has been with the CRSP as a graduate student since 2000, will stay on as Assistant Director of Research through the end of the current grant in 2003. Sempier's degree is in Marine Resource Management, with a minor in Fisheries Science/Aquaculture.



Kris McElwee, Assistant Information Manager of IMNC, left the CRSP at the end of April for Hawaii and a new job at the Pacific Services Center/National Oceanic and Atmospheric Administration in coastal zone and resource management. Madeleine Von Laue, with a background in biology and journalism, is serving as acting Assistant Information Manager.

Another departure of note is that of Heidi Furtado, who was with the CRSP for more than four years, first as a student worker and later as a research assistant. She has lit out for (more dependably) sunny skies in the San Diego area.

We also welcome Ian Courter, a new graduate assistant with IMNC who will begin graduate studies in the Department of Fisheries and Wildlife at Oregon State University in the fall. Courter will be assisting with many myriad aspects of IMNCs operation as well as become the new curator of EdOp Net. 🐟



## Kudos

Congratulations to Wilfrido Contreras-Sánchez, host country principal investigator of the Mexico Project at Universidad Juárez Autónoma de Tabasco, Mexico, who received an award from the National Program for Professor's Improvement. The award includes a grant for office and laboratory improvement that will go towards a student computer and other office equipment. 🐟

## Neira thesis

...from p. 9

were the availability of preferred sizes and insufficient quantities. Tilapia price was low compared to other fish. Nevertheless, tilapia marketing strategies might be developed to position tilapia to compete with whole-dressed guapote and red snapper, and with drum and red snapper fillets. More than half of the stores interviewed indicated that they were likely to begin to sell farm-raised tilapia in the coming year. Store managers had positive attitudes towards tilapia attributes; size and price were not obstacles to sell tilapia.

Discrete-choice models were developed for the restaurant market survey data. Logit analyses were used to measure the effects of consumer attitudes, entrée preferences, and restaurant characteristics on binary choice variables related to whether or not restaurants sold tilapia and the likelihood of adding tilapia to the menu.

Logit results showed that the most promising restaurant market for tilapia appeared to be older restaurants that offered a variety of food on the menu and those that served steaks. Larger restaurants that considered tilapia to be a high-quality product and that offered ceviche on the menu were those that tended to sell tilapia. Restaurants that did not sell tilapia appeared to be newer, smaller restaurants that specialized in seafood. Experience with off-flavor and poor quality tilapia were factors associated with restaurants that did not sell tilapia.

For the domestic market for farm-raised tilapia to develop in Nicaragua, the issue of consumer fears of contamination must be addressed. Broad-based consumer education and labeling programs may be necessary to overcome perceptions of contamination. Tilapia farms and processors would need to guarantee and ensure the flavor, quality, and safety of their product. Promotional efforts that emphasize these attributes will be essential.

## Earth Day at OSU

On April 16 the PD/A CRSP home office hosted an informational exhibit as part of Oregon State University's Earth Day celebration. Numerous OSU organizations joined the CRSP in OSU's Memorial Union Quad with booths of their own, and many students and faculty came to check out the offerings throughout the day. The CRSP booth included a large poster display of the program's goals and design, and several of our publications were assembled as well for those curious to learn more about the program. The booth also sported a finely crafted, homemade ping pong ball toss game, akin to what you might see at a carnival midway, as a method of drawing-in onlookers and passers-by, and lucky winners walked away with prizes ranging from CRSP pencils, fish candy, and even CRSP mugs, and everyone came away knowing a little bit more about the benefits of aquaculture research. 🐟

HEIDI FURTADO



Assistant Director of Research Steve Sempier hands out a winner's prize to a lucky CRSP booth visitor at OSU's Earth Day celebration.

## On the Advent of Petri-Pisciculture...

Authors M.A. Benjaminson, J.A. Gilchrist, and M Lorenz are preparing a manuscript on research related to laboratory-grown fish meat to be published in an upcoming issue of *Acta Astronautica*, Elsevier Science Ltd. The abstract, "In Vitro Edible Muscle Protein Production System (MPPS): Stage 1, Fish," can be read at <[www.touro.edu/shspacefish.asp#abstract](http://www.touro.edu/shspacefish.asp#abstract)>.

The following press story brought this development to our attention.

Mar. 21—WorldCatch News Network—Fish pieces have been grown in a laboratory for the first time by US scientists who used a growth factor to transform small

chunks of fish flesh into larger portions.

The technique, which uses a nutrient-rich serum taken from the blood of unborn calves, could eventually allow meat and fish to be artificially grown in industrial quantities, reducing the need for the slaughter of animals.

The artificial fish has been produced by researchers at Touro College in New York as part of a NASA-funded project to find cheap and viable ways of growing nutritious food for long-distance space travel. (2000 WorldCatch, <[wave.worldcatch.com](http://wave.worldcatch.com)>. Reprinted with permission.) 🐟

## PD/A CRSP @ WAS Beijing

World Aquaculture 2002, hosted by the China Society of Fisheries and the World Aquaculture Society, was held in Beijing, China, 23 to 27 April 2002. The PD/A CRSP was a co-sponsor. This year many CRSP researchers and participants authored papers:

- Bart, A.N., A.R.S.B. Athauda, M.S. Fitzpatrick, and W.M. Contreras-Sanchez. Ultrasound Enhanced Masculinization of Nile tilapia, *Oreochromis niloticus*, in immersion protocol.
- Boyd, C.E. Inland shrimp farming.
- Boyd, C.E. The status of codes of practice in pond aquaculture.
- Boyd, C.E. and G.W. Chamerlain. The Global Aquaculture Alliance best aquaculture practices program.
- Boyd, C.E. and F. Gomes. Chemical composition of farm-reared, Black Tiger Prawn, *Penaeus monodon*.
- Luu, L.T., Y. Yi, C.K. Lin, J.S. Diana, and N.X. Cuong. Assessing watershed ponds for aquaculture development: A case study in Thai Nguyen Province, Vietnam.
- McIntosh, D., K. Fitzsimmons, J. Aguilar, and C. Collins. Problems encountered in integrating inland shrimp farming with a field crop.
- Nadirom, P., Y. Yi, and G.C. Mair. Comparison of growth performance of different sex genotypes (XX and YY) of Nile tilapia *Oreochromis niloticus* and the effect of androgen treatment.
- Obaldo, L.G. and D.H. Ernst. Modeling zero exchange shrimp farming system using Aquafarm®.
- Phuong, N.T., Y. Yi, C.K. Lin, and J.S. Diana. The current status of *Pangasius* catfish cage culture in Vietnam.
- Wahab, M.A., Y. Yi, C.K. Lin, and J.S. Diana. Comparison of effects of different fertilization regimes on fish production, water quality, effluents and economic returns in Bangladesh.

## CRSP Co-sponsors Nutrition Conference in DC

The Global Livestock CRSP, with the PD/A CRSP as co-sponsor, hosted an international conference on "Animal Source Foods and Nutrition in Developing Countries" in Washington, DC on 24-26 June 2002.

Malnutrition is responsible for a large share of preventable mortality, morbidity, blindness, and poor cognitive development among children in developing countries. The cost of even mild to moderate malnutrition is high in terms of human capital and ultimately, economic development of countries and regions. The conference explored and highlighted research being done on the role of animal source foods (ASF).



Enrique Flores, Universidad Nacional Agraria La Molina, Peru, explains an aspect of his poster to an interested onlooker.

The main goals of the Conference were to: present what is known about the importance of ASF for the nutrition, function, and economic status of populations in developing countries; to examine recently-completed efficacy trials where ASF were fed to specific groups; to review Case Studies of programs intended to increase ASF production and/or consumption; to examine constraints on ASF production and utilization and how these might be alleviated; to articulate and integrate

economic, nutritional and agricultural issues; and to develop a policy and research agenda based on these discussions.

The PD/A CRSP sponsorship funds will go towards a forthcoming proceedings publication.

To learn more about the conference or the Global Livestock CRSP, visit the website <[glcrsp.ucdavis.edu/](http://glcrsp.ucdavis.edu/)>.

## American Fisheries Society to Host 132<sup>nd</sup> Annual Meeting

The 132<sup>nd</sup> AFS annual conference is being touted as having a charming venue—the Inner Harbor at Baltimore, Maryland. The event will take place at the Hyatt Regency from 18–22 August 2002. The title of the meeting is, "Turning the Tide: Forging Partnerships to Enhance Fisheries." Over 1,500 people from 22 countries are already planning to attend the meeting.

Fisheries scientists, administrators, educators, consultants, field biologists, research supervisors, aquaculturists, and agency directors will be represented at the meeting. In addition to concurrent sessions on topics ranging from sharks to corals and management to historical fisheries, there will be a tradeshow during most of the conference. For more information go to the American Fisheries Society website at: <[www.fisheries.org/annual2002/](http://www.fisheries.org/annual2002/)>.

SUSAN JOHNSON

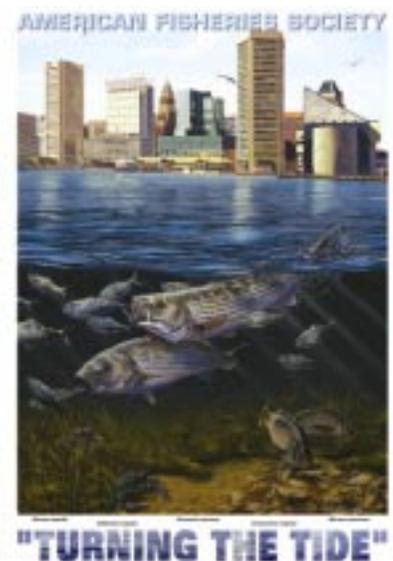


Immaculate Nduma, Egerton University, Kenya, discusses her poster with Connie Gewa, UCLA, at a poster session reception sponsored by Land O'Lakes.

SUSAN JOHNSON



Barbara Underwood, National Academy of Sciences Institute of Medicine, talking with Edith Mukudi, ULCA, during a poster session/reception sponsored by Land O'Lakes.



## Upcoming Conferences and Expositions

Date	Topic/Title	Location	Contact Information
November 17–20, 2002	17th Symposium of the International Farming Systems Association	Lake Buena Vista, Florida	Peter Hildebrand; University of Florida/ IFAS, International Programs, PO Box 110240, Gainesville, FL 32611-0240; Phone: 352-392-1965; Fax: 352-392-7127; Email: peh@ufl.edu
August 4–10, 2002	14th International Association of Astacology (IAA) International Symposium	Queretaro, Mexico	Pedro Joaquin Gutierrez-Yurrita; Biological, Universidad Autonoma de Queretaro, Center Universitario s/n, Col. Cerro de las Campanas, Queretaro 76010, Qro., Mexico; Phone/Fax: 52-42-15-47-77; Email: yurrita@sunserver.uaq.mx
September 1–5, 2002	Fourth International Symposium on Aquatic Animal Health	New Orleans, Louisiana	Ronald L Thune; Louisiana State University, Dept of Pathobiological Sciences, 3305 Vet Medicine Bldg, Baton Rouge, LA 70803; Phone: 225-578-9680; Fax: 225-578-9715; Email: thune@mail.vetmed.lsu.edu; Website: <www.vetmed.lsu.edu/isaah2002.htm>
September 3–6, 2002	International Symposium on Aquaculture Nutrition	Mexico	Gabriela Gaxiola Cortes; Phone: 52-938-382-8730
September 3–7, 2002	Aquamar International, Aquaculture, Fishery and Seafood Show	Cancón, Quintana Roo, Mexico	Conference Manager; 2423 Fallbrook Place, Escondido, CA 92027; Phone: 760-432-4270; Fax: 760-432-4275; Email: worldaqua@aol.com
September 18–20, 2002	Bordeaux Aquaculture, Exhibition and Conference	Bordeaux–Lac Exhibition Centre, France	Allée Ratabou–BP; 105, 33030 Bordeaux Lac Cedex, France; Phone: 33-0-556-11-88-88; Fax: 33-0-556-11-88-22; Email: bxaqua@bordeaux-expo.com; Website: <www.bordeaux-aquaculture.com>
September 19–22, 2002	Aquafest Australia, "Meeting the Challenge" Aquaculture Conference and Exhibition	Wrest Point Hotel Casino, Hobart, Tasmania	Aquafest 2002, Convention Wise, Mures Building, Victoria Dock, Hobart, Tasmania 7000; Phone: 03-6234-1424; Fax: 03-6231-5388; Email: mail@conventionwise.com.au; Website: <www.aquafest.com.au>
September 26–28, 2002	IFAF, 4th International Fair for Aquaculture, Fisheries and Fish Products	Culture Park Fair Ground, Izmir, Turkey	Selin Akpinar; FGS Fairs; Phone: 90-212-282-88-08; Fax: 90-212-281-27-13; Email: fgs@fgsfair.com.tr; Website: <www.fgsfair.com.tr>
October 16–19, 2002	Aquaculture Europe 2002, "Seafarming—Today and Tomorrow," EAS International Aquaculture Meeting	Stazione Marittima Congress Centre, Trieste, Italy	Email: ae2002@aquaculture.cc; Website: <www.easonline.org>
October 29–31, 2002	Offshore Mariculture, International Conference Exploring the Feasibility of Farming the Ocean Beyond the Territorial Sea	Den Pasar, Bali, Indonesia	Jean Pritchard; Society for Underwater Technology, Innovation Centre, Offshore Technology Park, Bridge of Don, Aberdeen AB23 8GX, UK; Fax: 44-0-1224-820-2376, Email: jeansut@sstg.demon.co.uk
October 29–31, 2002	Aquaculture China 2002	Qingdao International Convention and Exhibition Center, Qingdao, China	Phone: 206-789-5741; Fax: 206-789-0504; Email: china@seafare.com
November 25–28, 2002	5th Symposium on Diseases in Asian Aquaculture	Gold Coast International Hotel, Australia	OzAccom Conference Services; Phone: 61-7-3854-1611; Email: daa5@ozaccom.com.au



## Workshops and Short Courses

Date	Title/Topic/Site	Contacts
July 31– August 2, 2002	Pre-Meeting Symposium—The Impacts of Myxozoan Parasites in Wild and Farmed Finfish/Nanaimo, British Columbia, Canada	Simon Jones; Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, BC, Canada; Email: goatert@mala.bc.ca; Website: <www.pac.dfo-mpo.gc.ca/sci/aqua/english/symposium.htm>
August 6– October 4, 2002	Responsible Aquaculture Development/Iloilo, Philippines	Pastor L. Torres Jr.; Head, Training and Information Division, SEAFDEC Aquaculture Department, Tigbauan, 5021 Iloilo, Philippines; Phone: 63-33-336-2937; Fax: 63-33-336-2891; Email: pltorres@aqd.seafdec.org.ph; Website: <aqd.seafdec.org.ph/4647.html>
August 6– December 3, 2002	Basic Principles of Aquaculture Nutrition/Iloilo, Philippines	SEAFDEC (see above)
August 25–30, 2002	Aquaculture Feed Preparation, Nutrition, and Feed Management/Texas A&M University, College Station, Texas	Mian N. Riaz; Food Protein R&D Center; Email: mnriaz@tamu.edu; Website: <www.tamu.edu/extrusion>
October 7–12, 2002	Integrated Soil Fertility Management in the Tropics/Lomé, Togo	Director IFDC–Africa Division; BP 4483, Lomé, Togo; Phone: 228-221-79-71; Fax: 256-381-7408; Email: hrd@IFDC.org; Website: <www.ifdc.org>
October 16, 2002	Workshop on Fish Health Management/Trieste, Italy	European Aquaculture Society (EAS), Slijkensesteenweg 4, B-8400 Oostende, Belgium; Phone: 32-59-32-38-59; Fax: 32-59-32-10-05; Email: ae2002@aquaculture.cc
October 16, 2002	Workshop on Certification in European Aquaculture/Trieste, Italy	EAS (see above)
November 25–December 13, 2002	Assessment and Reduction of the Environmental Impacts of Aquaculture/Wageningen, The Netherlands	International Agricultural Centre; Fax: 31-317-495395; Email: training@iac.agro.nl; Website: <www.iac.wageningen-ur.nl>
November 29–30, 2002	Epidemiology and Risk Assessment/Gold Coast International Hotel, Australia	Chris Baldock; Phone: 61-7-3255-1712; Email: chris@ausvet.com.au
December 2–6, 2002	Asia-Pacific Regional Molluscan Health Management Training Program Phase II/Gold Coast International Hotel, Australia	Rob Allard; Phone: 61-7-3840-7723

### MEXICAN TACOS DE PESCADO: FISH TACOS

Serves 6

- 1 1/2 lb fish filets, cut lengthwise into strips
- 1 cup flour
- 1 tsp salt
- 1/4 tsp ground black pepper
- 1 tbsp vegetable oil
- 2 eggs, separated
- Oil necessary for frying
- Corn or flour tortillas, warmed to soften

For the garnish:  
 Shredded cabbage, lightly dressed with your favorite coleslaw dressing  
 Raw onion rings, marinated in vinegar with a pinch of oregano  
 A thin, tomato-free guacamole sauce  
 A selection of salsas: red, green, and pico de gallo (fresh salsa)

1. Pat the fish filet strips dry with paper towels.
2. Mix the flour, salt, pepper, vegetable oil, and egg yolks to form a batter.
3. Beat the egg whites until stiff and fold into the mixture.
4. In a large skillet, heat oil to a depth of 1 inch. Dip each fish strip in the batter, fry quickly on one side, turning to fry the other until golden brown. This should only take a couple of minutes on each side. Drain on paper towels.
5. Arrange pieces of fish in softened tortillas and serve at once, accompanied by the shredded cabbage, marinated onions, guacamole sauce, and a selection of salsas.

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CRSP publications can be accessed electronically at [pdacrsp.orst.edu/pubs/publications.html](http://pdacrsp.orst.edu/pubs/publications.html); print copies can be ordered online, by sending an email to [courteri@onid.orst.edu](mailto:courteri@onid.orst.edu), or by writing to:

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- I have discovered *Aquanews* online and no longer need to receive it on paper.
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## AQUANEWS

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