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## EVALUATING THE EFFECTS OF INVASIVE SPECIES INTRODUCED INTO MAJOR RESERVOIRS IN CHINA AND VIETNAM

*James S. Diana, Liping Liu, Weimin Wang, and Le Thanh Hung*



*Harvest being sorted by species at Tri An Reservoir, Vietnam. (Courtesy of Jim Diana)*

One of the main concerns with aquaculture in Asia is the release of invasive species. Potentially devastating to native ecosystems, this is particularly an issue when cage culture of exotic fishes is done in reservoirs. These stores of water are created by obstructing natural river flow with dams or other embankments. Over time, lacustrine fish populations

replace the former riverine species in these artificial lakes. Further alteration to the systems occur when non-native fish species are introduced through aquaculture practices managing for commercial fisheries.

Managers in Thailand and China have stocked many non-native species in an attempt to improve fishing in reservoirs, although there has been little effort to monitor the impacts of these introductions. AquaFish CRSP researchers in China and Vietnam, under The University of Michigan project, have taken on the task of documenting the influence of aquaculture on native species. Recording these influences is made difficult, however, by the many changes occurring simultaneously in these aquatic ecosystems.

Recently, AquaFish CRSP research teams at Huazhong Agricultural University and Nong Lam University have undertaken comparative investigations in a major reservoir in each respective country to document the nature of fishing on these reservoirs, to evaluate the importance of these non-native species in the fishery, and to evaluate changes in the fish community as a result of these introductions.

*Invasive Species continued on page 6...*

## THE ROLE OF FISH PRODUCER ORGANIZATIONS FOR DEVELOPING COMMERCIAL FISH FARMERS IN UGANDA

By Emily Stutzman Jones

In the words of a Ugandan fish farmer, the news is out: "Households with land and water can earn good incomes through fish farming." Many Ugandans have joined fish producer organizations in hopes of improving their household food security and incomes. Fish producer organizations have a crucial role to play in developing a commercial fish farming sector, linking people to each other and to valuable resources. In the Ugandan aquaculture context, fish producer organizations are stores of technical information, experience, and relationships with fingerling producers, feed sources, extension staff, funding agencies, and other networks.

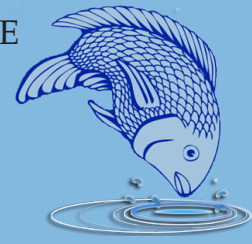


*Fish ponds in Uganda* (Courtesy of Joseph Molnar)

Uganda is well poised to increase its aquaculture productivity and develop a thriving commercial aquaculture sector. All of the necessary factors (i.e., availability of quality fingerlings, formulated feeds, quality technical information, affordable long-term investment capital, access to land and water resources, and a favorable governance climate) are currently present or are being strengthened. Besides the factors listed, another important element of commercial aquaculture development is strong fish producer organizations, which is the focus of this study.

*Fish Producer Organizations continued on page 8....*

## GOINGS-ON IN THE POND...



Kevin Fitzsimmons, US Lead PI from the University of Arizona was featured in the Winter 2010 issue of *Waterlines*. *Waterlines* is the newsletter of the Western Regional Aquaculture Center. The article can be found on the AquaFish CRSP website at: [aquafishcrsp.oregonstate.edu/aroundtheworld.php](http://aquafishcrsp.oregonstate.edu/aroundtheworld.php)

Former CRSP HCPI, Dr. Dan Meyers was featured in the Zamorano Outreach publication ¡Soluciones! in Honduras. The article highlights the successes that Dr. Meyers and his CRSP team has had with promoting tilapia farming in rural Honduras as well as his dedication to his role as a Zamorano professor. The article can be found at: [aquafishcrsp.oregonstate.edu/news\\_events.php](http://aquafishcrsp.oregonstate.edu/news_events.php)

To start off the school year, Oregon State University celebrated University Day, an exhibition of campus-wide programs aimed to honor the diverse accomplishments of the people of OSU. The management team of AquaFish CRSP was able to highlight program achievements with a booth at the September Expo. This marked a rewarding opportunity to engage the university community on the collaborative research efforts of the program and encourage dialog about sustainable seafood choices. To learn more about this year's event, go to: [oregonstate.edu/dept/ncs/lifeatosu/2010/university-day-2010/](http://oregonstate.edu/dept/ncs/lifeatosu/2010/university-day-2010/)

Two AquaFish CRSP graduate students, having received the Borlaug LEAP Fellowship, will participate in the World Food Prize 2010 this fall. The Prize acknowledges improvements in global food security drawing on what can be accomplished in the future. Nhuong Van Tran (Vietnam) and Rafael Martinez-Garcia (Mexico) were rewarded LEAP Fellowships for demonstrating strong promise as leaders in agriculture related fields.

## IIFET 2010 MONTPELLIER

By Ann Shriver



The four awardees - Jayasekhar Somasekharan, Taiwo Mafimisebi, Indah Susilowati, and Giap Nguyen - at the IIFET conference (Photo by of Hillary Egna)

The IIFET 2010 Montpellier conference was the fourteenth biennial conference of the International Institute of Fisheries Economics & Trade (IIFET), and took place in Montpellier, France, 13-17 July, 2010. The four-day conference was entitled "Economics of Fish Resources and Aquatic Ecosystems: Balancing Uses, Balancing Costs."


The conference program provided four keynote addresses in plenary sessions, as well as 438 oral and poster presentations in 92 parallel sessions. The conference included 13 special sessions on topics including the Economics of Forage Fish (as used in aquaculture feed), Global Tuna Management, Productivity Measurement, Marine Conservation, Co-Management, Responsible Fisheries, Rebuilding Fisheries, Recreational Fishing, Integrated Modeling, Fisheries Aid, Food Security, By-catch Reduction, and Global Ocean Fisheries.

Ten concurrent sessions were held on aquaculture-related topics, including

- Aquaculture Development
- Aquaculture Structures and Management
- Aquaculture and the Environment
- The Contribution of Aquaculture to Socioeconomic Wellbeing
- Aquaculture Efficiency and Management
- Aquaculture and Risk.

Each concurrent session featured three to five presentations on the economics of aquaculture in a wide variety of countries.

As a direct result of AquaFish CRSP planning support, IIFET was able to leverage financial support for Aquaculture Economics Professional Travel Awards. This year's awardees were Giap Nguyen of Vietnam, Taiwo Mafimisebi of Nigeria, and Indah Susilowati of Indonesia. AquaFish was also able to support this year's "Developing Country Aquaculture Economics Best Student Paper" award. This prize was given to Jayasekhar Somasekharan of the Centre for Development Studies in India.

AquaFish Director, Dr. Hillary Egna, attended the conference to represent the program and to present certificates at the award ceremony. To facilitate discussions, a poster was displayed at the conference emphasizing AquaFish's efforts in poverty alleviation in developing countries through sustainable solutions in aquaculture and fisheries. The highlight of this conference's poster was Marketing, Economic Risk, and Trade, which drew upon the on-going investigations within this topic area by program collaborators. 



Jayasekhar Somasekharan, winner of the Best Student Paper Prize, in front of the AquaFish poster on display at the conference (Courtesy of Ann Shriver)

## GRADUATE STUDENT PROFILE: GIFTY ANANE-TAABEAH

**G**ifty Anane-Taabeah has been working with AquaFish CRSP at Virginia Polytechnic Institute and State University (Virginia Tech) since 2009 under the guidance of her major professor, Dr. Emmanuel Frimpong. In 2008, Gifty received her Bachelor of Science degree in Natural Resource Management from Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana southeast of her hometown of Berekum in the Brong Ahafo Region. At Virginia Tech, she is currently working to complete her Masters of Science degree in Fisheries Science with the hopes of gaining the experience and knowledge necessary to one day influence the management of fisheries and aquatic resources in Ghana.



*Gifty and her major professor, Dr. Emmanuel Frimpong.*  
(Photo by Stephanie Ichien)

Gifty's research, "Harnessing Opportunities and Overcoming Constraints to Widespread Adoption of Cage Aquaculture in Ghana," is part of the AquaFish CRSP Project with Purdue University, "Improving Competitiveness of African Aquaculture Through Capacity Building, Improved Technology, and Management of Supply Chain and Natural Resources." The Purdue Project has established long-standing partnerships in Ghana, providing Gifty with a history of AquaFish CRSP research there and a comprehensive baseline for her work.

Gifty will analyze data from the Ghanaian community through interviews and questionnaires about the constraints and




*Gifty in San Diego at the World Aquaculture Society's Aquaculture 2010 conference in March 2010.* (Courtesy of Gifty Anane-Taabeah)

opportunities of adopting cage aquaculture. Once the data are compiled and evaluated, Gifty and the research team hopes to provide recommendations for an aquaculture policy review in Ghana.

Gifty first realized the importance of aquaculture during her undergraduate work at KNUST and has since made aquaculture a part of her life. In Ghana, she has seen the industry grow over the past decade. "However", she says, "the contribution of aquaculture to total fish production in Ghana [remains] insignificant".

Gifty identifies several obstacles preventing aquaculture from continuing to progress, including the lack of inexpensive locally manufactured feeds and lack of quality seed. She hopes her graduate research at Virginia Tech will "provide a platform to influence decisions in management and fisheries of aquatic resources in Ghana". She adds, "This [research] should help speed up the adoption rate of cage aquaculture in Ghana and ultimately increase the fish production for local consumption".

Through her work at Virginia Tech and with AquaFish CRSP, Gifty plans to gain a comprehensive understanding of the theoretical and practical aspects of fisheries science to support her long-term goal of a career in fisheries and aquaculture research. "I enjoy working with different people both in workshops and field work", Gifty says about her work with the CRSP. "I hope to combine my research with training other students in my research area". 

## BIVALVE RELAY & DEPURATION IN NICARAGUA

*Maria Haws, Eladio Gaxiola, Guillermo Rodriguez, Carlos Rivas, Nelvia Hernandez, Erick Sandoval, and John Supan*

The University of Hawaii at Hilo project on bivalve aquaculture development and shellfish sanitation in Latin America builds on six years of CRSP work. Bivalves are a heavily utilized resource throughout the region, with some of the more marginalized groups of the population heavily dependent upon them for income and food. Bivalve aquaculture thrives in some areas of Latin America, but its potential has generally not been reached. This situation, compounded by the decline of many of the bivalve fisheries and the resulting ecological and economic impacts, leaves the sector in need of more effective resource management and innovation. With an emphasis on native species, this AquaFish CRSP project focuses both on the development of bivalve aquaculture and fisheries management recommendations, primarily emphasizing improvements in shellfish sanitation.

Bivalves such as clams, oysters and cockles are healthy foods high in protein, vitamins and minerals and low in fat, demonstrating their potential for aquaculture. However, without proper sanitation their consumption can pose health dangers if they are taken from contaminated waters. Most bivalves are filter feeders and can accumulate and concentrate potentially lethal impurities such as bacteria, viruses, toxins, and heavy metals. Thus, good water quality is essential to producing a healthy, safe bivalve product.

Residents of poor coastal communities who rely on shellfish are particularly vulnerable to shellfish-borne diseases since they often lack even basic sanitary accommodations. Improving shellfish sanitation through a variety of approaches is important locally as well as regionally and nationally since shellfish are often marketed or exported out of local areas. The optimal way to improve shellfish sanitation is to improve water quality in shellfish growing areas. Often, this approach is not feasible in the short-term since it may require expensive infrastructure, such



*Woman gathering black cockles (Anadara similis) during periodic population monitoring in the Aserradores Estuary, Nicaragua. (Photo by Nelvia Hernandez)*

as wastewater treatment systems or minimally adequate latrines for entire villages or towns.

One method to improve shellfish sanitation is by “relay and depuration,” which involves moving shellfish from contaminated waters to a clean-water area for a predetermined time period. By filtering clean water, shellfish can reduce the concentration of bacterial pathogens in their tissues to safe levels. Using fecal coliform bacteria as an indicator, researchers are able to track bacterial concentrations to determine when acceptable levels are reached. A more costly version of “relay and depuration” uses land-based depuration plants, usually consisting of raceways or tanks of treated water for the depuration process. It should be noted that depuration methods are only effective for lowering bacterial concentrations, whereas viral contamination is better addressed with sound shellfish harvesting controls based on sanitation and shoreline surveys.



*Black cockles (Anadara similis) gathered from the Aserradores Estuary in Nicaragua. (Courtesy of Maria Haws)*

In Nicaragua, the primary species of concern are black cockles (e.g. *Anadara similis*, *A. tuberculosa* and *A. grandis*), which are collected from Pacific Coast mangroves by mostly poor women and children. *Anadara similis* is the most heavily collected species, but little information exists regarding depuration rates. Water quality monitoring from 2007-2008 showed that of three coastal estuaries where intensive cockle gathering takes place, only the Aserradores Estuary had sufficiently clean waters throughout the year

*Nicaragua continued on page 10...*

...Invasive Species continued from page 1

### TRI AN RESERVOIR, VIETNAM

In Vietnam, tilapia were introduced into the Tri An Reservoir as a means to improve the fish caught by the Dong Nai Fishery Company. There were multiple introductions into the region during the period between 1951 and 1997 for culture in ponds, cages, and rice fields. Populations were established in Tri An Reservoir and became an important commercial fish. While there has been no stocking of tilapia in the reservoir since 2000, their populations remain abundant indicating successful natural reproduction. Over the past ten years, there has been large-scale stocking of other herbivorous fish such as silver carp, bighead carp, and common carp. The intentional introduction of these non-native cultured fish has contributed to changes in the biodiversity of the reservoir.

As a result of fish stocking and other changes, there has been a significant increase in catch-per-unit effort of all species combined over the last 15 years. These data indicate increasing harvest and potentially increasing fish production since 1993. While tilapia were a large component of the fish collected for this study, they have not been an important component of the fishery harvest. The fish catch by the top five fishing gears took 81.7% of the total catch in the reservoir (about 3,124 tons per year), but did not take many tilapia. This is in spite of the fact that tilapia represented the second most abundant species taken by experimental seines in 2008. This suggests that better gear could be used for harvesting tilapia more effectively considering tilapia are the more valuable fish species in this reservoir.

Original data showed that there were 109 fish species in Tri An Reservoir, but the efforts of the research team and that of the commercial fishery collected only twenty and forty different species, respectively, in 2008. It is unclear whether biodiversity has decreased within the reservoir, or if these additional species are more difficult to collect and not important in the commercial fishery. What is clear is that the overall catch per unit effort has increased over recent years, in spite of increasing fishing effort, which is an indication of improvements in the fish community. There is little evidence that tilapia have damaged other fish populations within this region.

## THE SUCKERMOUTH CATFISH



The suckermouth catfish (*Hypostomus plecostomus*) was imported from South America and introduced into Vietnam in the 1980's for the ornamental fish market. By the 1990's, culturists had realized that the fish bred easily at the bottom of aquaculture ponds spurring the release of the catfish into ponds for quick production. As the supply of suckermouth catfish increased, the market price of the fish began to drop. When the species escaped into surrounding environments in the 2000's, the invasive population began to increase rapidly. However, with dwindling incentives for fishermen to catch the suckermouth catfish the species has become a nuisance. The armor-like scales on the dorsal portion of the fish can easily destroy fishing gear and there is now very little consumer demand. The current selling price is 0.05 USD per kg, making it cheaper to throw it away and so the fish continues to invade Vietnam's lakes and reservoirs.

### ZHANGHE RESERVOIR, CHINA

A very different story emerges from Zhanghe Reservoir in China. Once again, there has been a long history of introducing fish species into the area, both through aquaculture and intentional stocking. In 1992, the Taihu icefish (*Neosalanx taihuensis*) was introduced into Zhanghe Reservoir.

Invasive Species continued on page 7...

...Invasive Species continued from page 6

This was done because the fish were declining in abundance in natural water bodies and was an important fish for harvest. Researchers from Huazhong Agricultural University set out to evaluate the current status and the historical trends in the icefish in Zhanghe Reservoir. The Taihu icefish was abundant in early years, but has not been recorded as caught since 2006 (Figure 1).

The most common fish taken in Zhanghe Reservoir were silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Hypophthalmichthys nobilis*), and three different species of culter (*Culter spp.*) (Figure 2). Even after extensive sampling efforts for this study, only 55 grams of icefish were taken during our collections.

The overall impacts appear to be a series of top-down changes, driven by predation in the reservoir. The various culters consumed a variety of fish, particularly Taihu icefish, which was the most important prey item by mass (34.4%) and by number (39.5%). Originally, the culters were held in control by the yellowcheek (*Elopichthys bambusa*), another larger carnivorous fish that was also of value to the commercial fishery. As the yellowcheek declined in abundance, the yield of culters increased.

Thus, changes in Zhanghe Reservoir appear to be related more to trophic interactions between species within the reservoir than to stocking and commercial fishing. Over fishing on yellowcheek resulted in a decline in their population, an increase

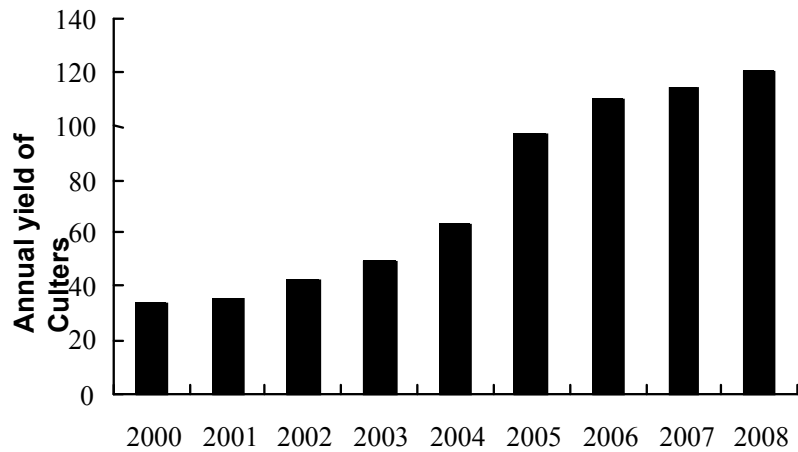



Figure 2: Annual yield (tons) of culters in Zhanghe Reservoir, China.

in top-mouth culters (their prey fish), and a decline in the icefish (prey to the culters). This trophic cascade appears to be mediated by commercial fishing and has been the major cause of changes within the reservoir. Once again, in this case, the Taihu icefish was an important commercial fish, and stocking was the main means of introduction, although the population maintained itself by natural reproduction after stocking in 1992. However, the harvest has declined dramatically as a result of other predatory interactions among species in the reservoir.

For these cases, both biotic interactions and human perturbations have influenced the fish communities of these unnatural reservoir systems within each country. Since there is concern about biodiversity preservation, we have held a series of workshops to extend information on the trends and conditions of each reservoir to local fisheries. AquaFish CRSP has developed appropriate techniques for evaluating changes in fish community structure

and relating it to human perturbations of the ecosystem. Building the capacity of research for field-based evaluations of natural fish communities has been an important component of the CRSP and has had strong influences on commercial fishing and on fishery regulations within Vietnam and China. This research capacity will be important to each country as well. 

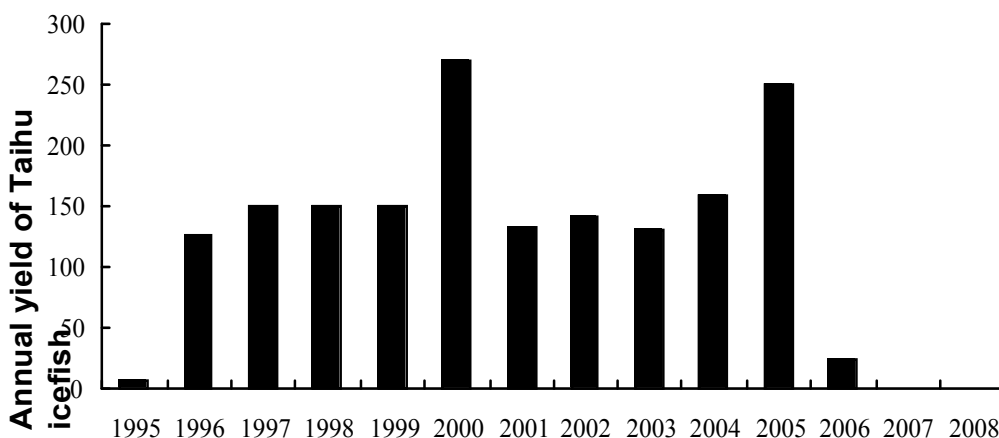


Figure 1: Annual yield (tons) of Taihu icefish in Zhanghe Reservoir, China.

*...Fish Producer Organizations continued from page 2*

According to the aquaculture development literature, the long list of beneficial roles for fish producer organizations include: influencing policy and regulations, providing technical services, facilitating market access, providing extension services, developing and encouraging adherence to codes of conduct or better management practices, extending credit to member farmers, and facilitating knowledge-sharing. All of these activities contribute to the development of commercial fish farming sector.



National Fisheries Resources Research Institute (Courtesy of [www.firi.go.ug/under\\_construction.html](http://www.firi.go.ug/under_construction.html))

Despite enthusiasm for fish producer organizations in Uganda, no framework or set of guidelines exists for creating effective fish producer organizations. In fact, many fish producer organizations are described as ineffective or short-lived. Emily Stutzman Jones, a Masters student in Rural Sociology at Auburn University, under the direction of Dr. Joseph Molnar, collaborated with AquaFish CRSP host country investigators to identify key elements inherent in successful fish producer organizations.

We examined four fish producer organizations in Uganda with the goal of understanding the characteristics of fish farmer organizations with productive member farmers. The host country investigators, Gertrude Atukunda and John Walakira, worked extensively with fish farmer organizations through their professional roles at Uganda's National Fisheries Resources Research Institute (NaFIRRI). We used qualitative social science

research methods including semi-structured interviews and participant observation.

Producer organizations were selected in diverse areas of the country: one in northern Uganda, one in central Uganda, and two in western Uganda. Each focuses on tilapia production, although one also raises African catfish. Two of the producer organizations practice lake cage culture, one on Lake Victoria and one in western Uganda. One producer organization produces and sells fingerlings. One is involved exclusively in pond culture.

These four producer organizations are similar in some important ways. Each organization is formed based on the advice of a government official and with the goal of accessing government or NGO funding. Most importantly, all producer organizations operate under government organized umbrella groups.

With all four programs, the nature and focus of the umbrella organization has important effects on the member group. In one case, the umbrella organization focuses on poverty alleviation, and operates a variety of income-generating projects for their members. Their activities include handicraft production, roadside food vendors, and fish farming. To this umbrella organization, fish

farming is viewed as a project, not as a business. In another case, the umbrella organization focuses on environmental conservation. Their projects include beekeeping, animal husbandry, improving stoves, environmental education, and fish farming.



Road sign for fish farm in Mpigi, Uganda (Courtesy of Joseph Molnar)




...Fish Producer Organizations continued from page 8

Here, too, fish farming is viewed as one of many projects, and not as a commercial activity. These two fish producer organizations received the most donor funding. With donor funding comes donor requirements, which include serving the disabled, providing HIV/AIDS education, and caring for orphans. While these are laudable efforts, they can distract from the focus on developing commercial fish farmers.

In a third case, the umbrella group is a national fish farmers' cooperative society, and their member groups are fish farmer organizations. Compared to the umbrella groups with a variety of activities, the producer organization that operate under the fish farmer-focused umbrella group is the most productive. They also receive the least donor assistance of any of the four groups. Also, through a national fish farmer cooperative society, the local fish producer organization have access to aquaculture-specific information and resources.

Although conclusions about these four case studies cannot be extended to all fish farmer organizations in Uganda, our study identifies some key characteristics of strong leaders within these organizations in the Ugandan context. For example, strong leaders have already achieved success as fish farmers, putting them in a position to serve as mentors for beginning fish farmers. Also, as successful fish farmers, they are less likely to see leading a fish producer organization as a financial end in itself. Additionally, strong leaders value good technical training. Ironically, the leaders of the least productive fish farmer organizations feel that their training is sufficient, focusing instead on their needs for financial assistance. On the other hand, the leaders of the most productive fish producer organizations stress their need for more technical training.

Development professionals urge fish farmers to form or join organizations. Our research suggests that not all fish farmer organizations serve the interest of developing commercial fish farmers. Specifically, fish farmer organizations belonging to umbrella organizations specializing in aquaculture are more effective at increasing member fish farmers' production than umbrella organizations with diverse activities and wide-ranging goals. 

## PONDERINGS...

EXCERPTED FROM *THE WALRUS AND THE CARPENTER*  
(*Through the Looking-Glass and What Alice Found There*, 1872)

By Lewis Carroll

"The time has come," the Walrus said,  
"To talk of many things:  
Of shoes--and ships--and sealing-wax--  
Of cabbages--and kings--  
And why the sea is boiling hot--  
And whether pigs have wings."

"But wait a bit," the Oysters cried,  
"Before we have our chat;  
For some of us are out of breath,  
And all of us are fat!"  
"No hurry!" said the Carpenter.  
They thanked him much for that.

"A loaf of bread," the Walrus said,  
"Is what we chiefly need:  
Pepper and vinegar besides  
Are very good indeed--  
Now if you're ready, Oysters dear,  
We can begin to feed."

"But not on us!" the Oysters cried,  
Turning a little blue.  
"After such kindness, that would be  
A dismal thing to do!"  
"The night is fine," the Walrus said.  
"Do you admire the view?..."

"...It seems a shame," the Walrus said,  
"To play them such a trick,  
After we've brought them out so far,  
And made them trot so quick!"  
The Carpenter said nothing but  
"The butter's spread too thick!"

"I weep for you," the Walrus said:  
"I deeply sympathize."  
With sobs and tears he sorted out  
Those of the largest size,  
Holding his pocket-handkerchief  
Before his streaming eyes.

"O Oysters," said the Carpenter,  
"You've had a pleasant run!  
Shall we be trotting home again?"  
But answer came there none--  
And this was scarcely odd, because  
They'd eaten every one.


...Nicaragua continued from page 5



Nelvia Hernandez and Alfonso Fletes monitoring water quality and cockle populations in Aserradores Estuary, Nicaragua. (Photo by Juan Ramon Bravo)

to be considered as a candidate site for depuration trials.

Due to the limited knowledge about depuration rates for *A. similis*, a series of laboratory trials were conducted. Before depuration, cockles used in these trials initially had high levels of *E. coli* and fecal coliforms (>330 MPN/g), low levels of *Vibrio parahaemolyticus* (<1.0x10<sup>3</sup> UFC/g) and undetectable levels of *Salmonella*. Within 24 hours, both *E. coli* and fecal coliform levels reduced to <20 MPN/g, within acceptable limits, indicating that field trials might also be successful. Concurrently, water quality monitoring was conducted in the Aserradores Estuary to find locations that could function as depuration sites. Cockles were then placed in one of these sites with water and tissues sampled over a 72-hour period. Similar to the laboratory results, *E. coli* and fecal coliform levels reduced to <20 MPN/g in 24 hours. These trials demonstrate that relay and depuration can successfully be used with cockles in the Aserradores Estuary.

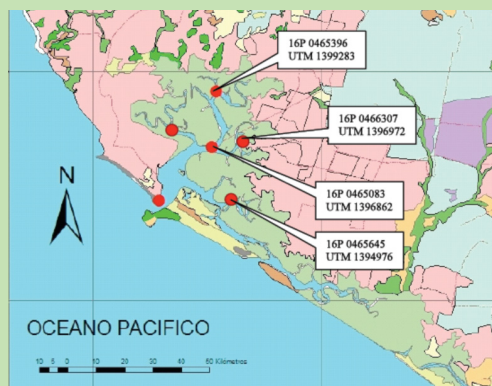
The success with relay and depuration in Nicaragua has helped the Central American University, the AquaFish CRSP partner in this work, in obtaining a major grant from the European Union to continue the work. Next steps include the use of a solar-powered, land-based depuration plant to be tested and operated by a local cooperative. This work can also potentially serve as a model for other Latin American countries that have similar problems in their coastal areas where communities depend on bivalve fisheries and aquaculture. 

## Sidebar: USAID SUCCESS Shellfish No-Take Zones in Nicaragua

At the same time that the UHH depuration trials were undertaken, a separate study sponsored by the USAID SUCCESS (Sustainable Coastal Communities and Ecosystems) Program experimented with community members in using no-take zones as an alternative management scheme for the cockle fishery. It previously was being managed rather ineffectively through a four-month closed season.

The approach was to designate areas of the estuary as depuration sites as a complement to the resource management strategy. Under this scheme, no-take zones could be located in the most contaminated areas, while collection and depuration areas could be sited in the cleanest areas, thereby making the most efficient use of estuary space and the cockle resources. These community-managed no-take zones proved a success after two years. Cockle populations increased significantly in the no-take zones and adjacent areas compared to unrestricted gathering areas.

Management of the cockle fishery using community-managed no-take zones in Aserradores and two additional estuaries continues under the AquaFish CRSP project. If successful, the Nicaraguan government has said it will consider making this form of management a legal alternative for communities that are dependent on cockles. With the adoption of this combined depuration technology and shellfish management, these Pacific coastal communities will have a reliable, year-round source of income and safe food.



Location of the water sampling stations in the Aserradores Estuary indicated by red dots. Stations with locations noted are the no-take cockle zones. (Courtesy of Maria Haws)

## NOTICES OF PUBLICATION

Notices of Publication announce recently published work carried out under AquaFish CRSP sponsorship. To receive a full copy of a report, please contact the author(s) directly. All past and present Notices of Publication can be found on the AquaFish CRSP website at: [aquafishcrsp.oregonstate.edu/publications.php](http://aquafishcrsp.oregonstate.edu/publications.php)

### EFFECTS OF ADDITION OF RED TILAPIA (*Oreochromis spp.*) AT DIFFERENT DENSITIES AND SIZES ON PRODUCTION, WATER QUALITY AND NUTRIENT RECOVERY OF INTENSIVE CULTURE OF WHITE SHRIMP (*Litopenaeus vannamei*) IN CEMENT TANKS (10-257)

Derun Yuan<sup>a</sup>, Yang Yi<sup>b</sup>, Amaratatne Yakupitiyage<sup>c</sup>, Kevin Fitzimmons<sup>d</sup>, James S. Diana<sup>e</sup>

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<sup>d</sup>Environmental Research Lab, Department of Soil, Water and Environmental Science, University of Arizona, Tucson, USA

<sup>e</sup>School of Natural Resources and Environment, University of Michigan, Ann Arbor, Michigan, USA

An experiment was conducted in 21 outdoor cement tanks (2.5x2x1.2 m) from 8 December 2005 to 3 March 2006 to determine the effects of adding red tilapia (*Oreochromis spp.*) at different densities and sizes on production, water quality and nutrient recovery in intensive culture tanks of white shrimp (*Litopenaeus vannamei*). Shrimp post larvae of 0.06 g were stocked into all tanks at a density of 60 post larvae m<sup>-2</sup>, while either small (13.8±0.2 g) or large (41.9±0.3 g) mono-sex tilapia fingerlings were stocked into the shrimp tanks two weeks later at low (0.4 fish m<sup>-2</sup>), medium (0.8 fish m<sup>-2</sup>) or high (1.2 fish m<sup>-2</sup>) density. Water depth in all tanks was maintained at 1 m and salinity at 20 ppt. Water loss due to evaporation was compensated weekly. The experiment was conducted in a 2x3 factorial design, while three additional tanks for shrimp monoculture were set as a control. All treatments

and the control were randomly allocated to tanks in triplicate each. Shrimps were fed three times daily with commercial pellets using feeding trays made with metal frame and nylon mesh (0.6x0.6x0.05 m) at the same feeding rates as those for the control. No separate feed was given to tilapia.

The highest shrimp survival rate of 66.8% was obtained in the small-low density tilapia treatment, which was significantly higher than those in other treatments and the control. The small-low density tilapia treatment had the highest shrimp yield and lowest feed conversion ratio, which was similar to those in the control and the large-low and small-medium density tilapia treatments, but significantly better than those in other treatments. Factorial analyses revealed that the increase of tilapia density from 0.4 to 1.2 fish m<sup>-2</sup> and size from 13.8 to 41.9 g negatively affected shrimp production performance but remarkably increased the combined production of shrimp and tilapia. Polyculture incorporated 36.0-49.5% of the total nitrogen input and 14.2-26.5% of the total phosphorous input into shrimp and tilapia, which were significantly higher than those (27.1% and 8.9%) in the monoculture, respectively. The nutrient recovery efficiency increased with increased tilapia stocking size and density. Polyculture with small tilapia stocked at low density had the best economic performance among all treatments and control, and significantly better than small-high, large-medium and large-high density tilapia treatments.

It was concluded that addition of red tilapia at suitable stocking densities and sizes into intensive white shrimp monoculture can improve productivity, profitability, nutrient utilization and environmental friendliness of shrimp monoculture. The suitable stocking density and size of red tilapia identified in this study were 0.4 fish m<sup>-2</sup> and 13.7 g respectively. Red tilapia could be stocked at higher density and larger size up to 1.2 fish m<sup>-2</sup> and 42 g respectively to maximize system productivity and minimize nutrient waste without affecting shrimp survival, but economic performance could be negatively affected. Shrimp-tilapia

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polyculture should be promoted to improve sustainability of shrimp culture.

This abstract was excerpted from the original paper, which was published in *Aquaculture* 298:226-238, 2010.

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**GROWTH PERFORMANCE, SURVIVAL, FEED UTILIZATION AND NUTRIENT UTILIZATION OF AFRICAN CATFISH (*CLARIAS GARIEPINUS*) LARVAE CO-FED ARTEMIA AND A MICRO-DIET CONTAINING FRESHWATER ATYID SHRIMP (*CARIDINA NILOTICA*) DURING WEANING (10-258)**

Chepkirui-Boit, V.<sup>1</sup>, Ngugi, C.C.<sup>1</sup>, Bowman, J.<sup>2</sup>, Oyoo-Okoth, E.<sup>1,3</sup>, Rasowo, J.<sup>4</sup>, Mugo-Bundi, J.<sup>1</sup> and Cherop, L.<sup>1</sup>

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Problems of limited number of dry feeds as supplement or replacement of live feeds have led to poor larval nutrition in many species of fish. Therefore, the suitability of co-feeding 8-day old African catfish (*Clarias gariepinus*) posthatch larvae using live feed (*Artemia salina*) and formulated dry diet containing freshwater atyid shrimp (*Caridina nilotica*) during weaning was investigated. The experiment ended after 21 days of culture and respective groups compared on the basis of growth performance, survival, feed utilization and nutrient utilization. Larvae co-fed using 50% *Artemia* and 50% formulated dry diet resulted in significantly ( $P < 0.05$ ) better growth performance, food gain ratio (FGR), protein efficiency ratio (PER) and productive protein values (PPV) than other treatments. The lowest growth performance occurred in larvae weaned using 100% formulated and commercial dry diets. Better survival of over 90% was obtained in larvae weaned using 50% *Artemia* and 50% dry diet, while abrupt weaning using 100% dry diets resulted in lower survival (<75%). These results support a recommendation of co-feeding *C. gariepinus* larvae using a formulated dry diet

containing *C. nilotica* and 50% live feed when weaning is performed after 8 days posthatching period.

This abstract was excerpted from the original paper, which was published in *African Journal of Microbiology Research, Aquaculture Nutrition* 2010: 1-8.

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**COMPARATIVE STUDIES ON SURVIVAL AND GROWTH PERFORMANCE AMONG DIPLOID, TRIPLOID AND TETRAPLOID DOJO LOACH (*MISGURNUS ANGUILLICAUDATUS*) (10-259)**

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To determine the cytotype with better traits for the aquaculture practices of the dojo loach (*Misgurnus anguillicaudatus*) from the viewpoint of fish farming improvement, factorial crosses ( $2n_{\text{♀}} \times 2n_{\text{♂}}$ ,  $2n_{\text{♀}} \times 4n_{\text{♂}}$ ,  $4n_{\text{♀}} \times 2n_{\text{♂}}$ ,  $4n_{\text{♀}} \times 4n_{\text{♂}}$ ) were conducted between natural diploids (D) and tetraploids (T), producing DD, DT, TD, and TT groups (female listed first). The potential benefits of the different cytotypes in culture were evaluated by comparing growth performance and survival rate for a 15-month rearing trial under the same production conditions. The average fertilization rate in DT and TT was significantly lower than in the DD and TD groups, possibly indicating the poor fertilizing capacity of the tetraploid sires. Survival rate in DT and TD was slightly lower than in DD but significantly higher than in the TT groups. Tetraploid females produced obviously larger eggs than diploids and, subsequently, significantly longer initial body length of TT and TD than DD and DT fry. However, from the second month of the growth trial, TT suffered higher mortality than other cytotypes, which significantly influenced morphometric growth parameters. The TD group

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exhibited superior growth performance throughout the experiment. The mean body length of DT was comparable with that of DD fish during the first 7 months but began to outgrow DD from the 9th month. This study suggests that the relatively better growth of tetraploid and higher survival rate of diploid can be integrated via inter-ploidy hybridization to get TD triploids with better culture traits.

This abstract was excerpted from the original paper, which was published in *Aquaculture International* 18:349–359.

### MARKETS FOR HONDURAN TILAPIA (10-260)

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Honduras

The first reports of tilapia in Honduras date from the mid-1930s when broodstock of Java tilapia (*Oreochromis mossambicus*) was introduced to Honduras from El Salvador. In 1955, the Honduran government, through the Secretariat of Natural Resources, created the Jesus de Otoro Aquaculture Station for the culture of freshwater shrimp (*Macrobrachium rosenbergii*). In 1958, because of various problems, this activity was discontinued. In 1968, the station resumed activities, this time oriented to the culture of tilapia. Two additional aquaculture stations were created by the government during the 1960's and 70's. The El Carao National Fish Culture Research Station was constructed in 1979. That station was utilized to initiate a national program of fish culture through extension programs and distribution of tilapia fingerlings to local farmers. The program focused on promoting subsistence-level fish culture throughout the country. Target groups included rural farmers and community organizations.

This abstract was excerpted from the original paper, which was published in *World Aquaculture*: 41(2):39-40,72, 2010.

## UPCOMING MEETINGS AND EVENTS...

### Asian-Pacific Aquaculture 2011

17-20 January 2011

Kochi, India

[www.was.org/WasMeetings/meetings/Default.aspx?code=APA2011](http://www.was.org/WasMeetings/meetings/Default.aspx?code=APA2011)

### Aquaculture America 2011

28 February - 3 March 2011

New Orleans, Louisiana

[www.was.org/WasMeetings/meetings/Default.aspx?code=AA2011](http://www.was.org/WasMeetings/meetings/Default.aspx?code=AA2011)

### ISTA 9

International Symposium on Tilapia in Aquaculture  
21-24 April 2011

Shanghai Ocean University  
in Shanghai, China

[ag.arizona.edu/azaqua/ista/ISTA9/ISTA9.htm](http://ag.arizona.edu/azaqua/ista/ISTA9/ISTA9.htm)

### 9AFAF

Asian Fisheries & Aquaculture Forum

21-25 April 2011

Shanghai Ocean University (SHOU)

Shanghai, China

[www.9AFAF.org](http://www.9AFAF.org)

### World Aquaculture 2010

6-10 June 2011

Natal, Brazil

[www.was.org/WasMeetings/meetings/Default.aspx?code=WA2011](http://www.was.org/WasMeetings/meetings/Default.aspx?code=WA2011)



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*Aquanews* is published by AquaFish CRSP, Oregon State University, 418 Snell Hall, Corvallis OR 97331-1643, USA. [Aquafish@oregonstate.edu](mailto:Aquafish@oregonstate.edu)

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The AquaFish Collaborative Research Support Program activities are funded by Grant No. EPP-A-00-06-00012-00 from the United States Agency for International Development (USAID), and by participating US and Host Country institutions.

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