

AQUANEWS



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CRSP Kenya Communiqué

by Jim Bowman (Oregon State University, US Regional Coordinator, Kenya Project)
and Karen Veverica (Auburn University, Co-Principal Investigator, Kenya Project)

It's been just three years since Karen Veverica, the Kenya Project's resident US researcher, arrived at Sagana, and during this short time a lengthy list of achievements has been accumulated. On her arrival at Sagana Fish Farm in April 1997, Veverica immediately began the task of helping prepare the facility for CRSP experiments and for serving as an information center for aquaculture in the region.

manageable 800-m² research ponds, expanding the existing laboratory space to hold the additional instruments and apparatus needed to conduct water quality tests required by CRSP protocols, and assembling and installing a complete new weather monitoring system for the station. Fingerling production was improved, and staff needed to be trained in moving large numbers of live fish, keeping data, and managing ponds. Most of the work in these three areas was completed by the end of October 1997, with automatic, continuous weather monitoring beginning at the end of November and the first CRSP experiment (Eighth Work Plan) being initiated in the new ponds at the beginning of December. Since that time the CRSP research ponds at Sagana have been in continuous use. The sequence of experiments and dates of research pond use at Sagana are shown on p. 2.

Under Veverica's supervision, pond construction crews at Sagana have been able to continue renovating and improving more of the older ponds at Sagana. As of this writing, 25 matched, 800-m² research ponds, four miscellaneous ponds of 800 to 880 m² each, and three smaller ponds (150 m² each) have been created through these efforts; an additional large pond (about 1 acre) is currently being renovated. The Fisheries Department has asked that revenues from CRSP-generated fish sales be used towards building more 150-m² ponds.

Education and Training

Probably the most important work that the Kenya Project has undertaken has been in the area of training. This has been accomplished through formal project activities such as the provision of scholarship support for students undertaking master's programs and a series of short courses for Kenyan Fisheries officers and extension agents. For example, the master's programs of two students are fully supported by the CRSP. These include Bethuel Omolo, currently studying at Auburn University in the US (see related article, p. 4), and Robertson Mugo, who is working at Moi University in Eldoret, Kenya. In addition, three

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JIM BOWMAN

Charles Kariuki (far left), head of the seine crew, works with Kenyan university students (standing, left to right) Paul Wamwea, William Nyaga, Cosmas Mungo, Jedidah Atieno, Daniel Mirera, and (front) Enos Were to weigh fish on pond sampling day at Sagana Fish Farm.

The first priorities in preparing the site for CRSP work included converting three of Sagana's 4,000-m² production ponds into twelve more

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Kenya Project

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2-week short courses in pond construction and fish culture basics were completed during the last eight months, and additional training sessions are slated for July and November of this year.



JIM BOWMAN

School groups of all ages frequently visit Sagana Fish Farm. Here, secondary school students listen as station personnel describe daily operations at the farm.

Perhaps more important than these formal training efforts has been Veverica's mentoring of pond crews, computer and lab technicians, and the many students who have come to Sagana to undertake research projects as part of undergraduate or graduate programs. Approximately 15 students have worked on such projects at Sagana during these three years; 12 of them received CRSP support in the form of small monthly stipends, and seven of them were conducting research as part of an M.S. program at a Kenyan University. Students have come to Sagana from Moi University, the University of Nairobi, Kenyatta University, and Mombasa Polytechnic. For those who continue on in aquaculture, the practical experience gained by working at Sagana with real ponds, real fish, and real fish culture problems has probably been a far more useful learning experience than was their formal coursework.

CRSP investigations conducted at Sagana Fish Farm

Dates	Experiment
Dec 97–Mar 98	<i>Relative Contribution of Supplemental Feed and Inorganic Fertilizers in Semi-Intensive Tilapia Production</i>
Apr 98–Oct 98	<i>Optimization of Nitrogen Fertilization Rate in Freshwater Tilapia Production Ponds—Cool Season</i>
Nov 98–Mar 99	<i>Optimization of Nitrogen Fertilization Rate in Freshwater Tilapia Production Ponds—Warm Season</i>
Mar 99–Feb 00	<i>Use of Pond Effluents for Irrigation in an Integrated Crop/Aquaculture System</i>
Nov 99–May 00	<i>Fish Yields and Economic Benefits of Tilapia/Clarias Polyculture in Fertilized Ponds Receiving Pelleted Commercial Feeds or Agricultural By-Products</i>

KENYA LINKAGES 2000

Two significant new linkages to the Kenya Project have been established in 2000. The first is an agreement to work hand-in-hand with the Moi University Department of Fisheries (Eldoret, Kenya) on our training programs for Kenyan Fisheries officers, extension agents, and farmers (see main story). Dr. David Liti, of the Department of Zoology at Moi University, is helping oversee operations and advising students at Sagana Fish Farm when Karen Veverica is not in Kenya. He will return to Eldoret in September 2000. In addition to Dr. Liti, Moi University faculty now collaborating with the CRSP and the Kenya Fisheries Department include Dr. Mucai Muchiri, Head of the Department of Fisheries, and Dr. Charles Ngugi, lecturer in the Department of Fisheries. We expect that this collaboration with Moi University will lead to a productive and long-term partnership between the Kenya Fisheries Department and Moi University Department of Fisheries.

The second new linkage established this year allows the CRSP and ICLARM-Malawi to conduct companion site research at Malawi's National Aquaculture Center (Zomba) and at Bunda College. Students from Bunda College of Agriculture will be involved in studies at both sites. Overall supervision of these efforts will be provided by Dr. Daniel Jamu, of ICLARM-Malawi, and Dr. Jeremy Likongwe, of Bunda College. Jamu was also a CRSP participant from 1995 to 1998, working with Dr. Raul Piedrahita as a Research Assistant on the Aquaculture Systems Modeling Research project at University of California, Davis.

Current Activities

On-farm trials for Central Province were begun in January of this year. Approximately 30 farmers are using at least 60 ponds and rice paddies for these trials, which will continue through about November, at which time fish will be harvested and the results evaluated. On-farm trials for western Kenya (Western and Nyanza provinces) will begin in July and continue on through March 2001. It is expected that approximately 25 farmers will participate in those trials, using about 50 ponds.

A series of training sessions for Kenyan Fisheries Officers was begun in December 1999 and will continue through 2000. Training sessions involve 20 officers and last for two weeks each, covering the basics of pond construction and pond management. Three sessions have already been conducted, and two additional training sessions are scheduled during the remainder of the year. In addition, field days in which more than 70 farmers participated were held in 1999 and up to 100 additional farmers will participate in field days during the year 2000.

Degree Granted to Gichuri

Wilson Maina Gichuri successfully defended his M.Sc. thesis recently and received a M.Sc. from the University of Nairobi, Kenya. Gichuri, an officer with the Kenya Fisheries Department, conducted his thesis research in cooperation with the CRSP Kenya Project at Sagana Fish Farm.

RELATIVE CONTRIBUTION OF RICE BRAN AND INORGANIC FERTILISERS IN SEMI-INTENSIVE TILAPIA (*OREOCHROMIS NILOTICUS*) AND CATFISH (*CLARIAS GARIEPINUS*) POLYCUltURE IN KENYA


(Abstract of Wilson Maina Gichuri's M.Sc. thesis)

Aquaculture development in Kenya has been hampered by lack of appropriate feeds. Available chemical fertilisers can enhance natural food production and thus indirectly provide protein to complement energy-rich rice bran. Consequently, a 20-week experiment was conducted at Sagana Fish Farm, Kenya to realise least-cost combinations of rice bran and fertiliser. Twelve 800-m² ponds were stocked with juvenile (32g) *Oreochromis niloticus* at 2m² and *Clarias gariepinus* fingerlings (4.6g) at 0.2m². Four treatments were applied in triplicates as follows: 1. Urea and DAP to provide 16KgNha⁻¹week⁻¹ and 4KgPha⁻¹week⁻¹; 2. Urea and DAP applied to give 8KgNha⁻¹week⁻¹ and 2KgPha⁻¹week⁻¹, plus rice bran fed at 60Kggha⁻¹day⁻¹; 3. Rice bran fed at 120Kggha⁻¹day⁻¹; 4. Rice bran as in treatment 3 and fertiliser as in treatment 2. Dissolved oxygen, temperature and pH were measured weekly in the morning and the afternoon while total alkalinity and total ammonia nitrogen were measured fortnightly. Ponds were sampled monthly to measure fish growth, and drained completely after 20 weeks. At harvest, average weight of tilapia was 89, 106, 106 and 131g while that of *Clarias* was 110, 217, 236 and 295g for treatments 1 through 4 respectively. Specific growth rate (SGR%^d⁻¹) for tilapia was 0.6, 0.8, 1.0 and 1.0 while that for *Clarias* was 2.26, 2.69, 2.72 and 2.90 for treatments 1 through 4 respectively. Combined Net fish yield (NFY Kggha⁻¹) was 1,127, 1,582, 1,607 and 2,098 for treatments 1 through 4 respectively. The tilapia Net fish yield (NFY Kggha⁻¹) was 894.0, 1200.5, 1241.8 and 1576.5 while that of *Clarias* was 232, 365, 382 and 522 for treatments 1 through 4 respectively. Combined Annual production (AP Kggha⁻¹yr⁻¹) was 2930, 4113, 4179 and 5455 for treatments 1 through 4 respectively. The tilapia Annual production (AP Kggha⁻¹yr⁻¹) was 2,324.5, 3,121.1, 3,228.7 and 4,098.7 while that of *Clarias* was 605, 950, 993, and 1,357 for treatments 1 through 4 respectively. Apparent feed conversion ratio (AFCR) was 5.3, 10.3 and 8.0 for treatments 2 through 4 respectively. Feeding efficiency (FE) was 0.19, 0.10 and 0.13 for treatment 2 through 4 respectively. The Relative Condition Factor (K_n) for tilapia was 1.03, 1.11, 1.13 and 1.15 while that for *Clarias* was 1.20, 1.34, 1.38 and 1.38 for treatments 1 through 4 respectively. A partial economics analysis indicated a Net profit (KSh) of 18,851, 9,895, 3,299 and 7,015 for treatments 1 through 4 respectively. Although treatment 4 had the highest SGR, NFY and AP and the second highest AFCR and FE, its high net expenditure was a serious setback since not many rural fish farmers can afford such an amount of recurrent costs. Even if they could, high unit production costs could jeopardise sales. Treatment 3 had the lowest net profit and was thus the worst treatment in terms of profit margins. This was due to high amount of rice bran inputs. Treatment 2 had the third highest SGR, NFY, AP and AFCR and the second highest Net profit. It had the highest FE while its figures for SGR, NFY and AP compare favourably and closely with those of treatment 3. Probable reasons are that its high FE gives it a higher output (fish production). Feeding efficiency (FE) increases with better diet and we can conclude that treatment 2 was the best diet. Treatment 1 had the highest Net profit but its growth rate began to level off at days 63 and 30 for both tilapia and *Clarias* which means that fish in treatment 1 may not have reached market sizes of 250–300g for tilapia and 500–1000g for *Clarias*. A combination of fertiliser as in treatment 1 and rice bran as in treatment 2 could possibly have produced better results where N and P could have been similar to those of treatment 4 but at much lower recurrent costs.

Significant New Developments in 2000

Several personnel changes of significance have occurred since late 1999. The first was the retirement of former Fisheries Department Director Fred Pertet and the appointment of Booker T.W. Odour, later followed by Nancy Gitonga as Acting Director. Gitonga has taken on her new duties with enthusiasm and has shown considerable interest in and support for the CRSP effort. Simultaneously, former Head of Station Bethuel Omolo left Sagana to undertake graduate studies in aquaculture and extension methodology at Auburn University. Japhet K. Ngatuni was named the new Head of Station in late 1999. He has also taken an active interest in the CRSP, as well as in improving the function and

appearance of Sagana Fish Farm. Gitonga serves as Host Country Principal Investigator for the CRSP project, while Ngatuni is the Kenyan Research Associate.

A significant change in the way the project operates in Kenya has taken place in recent months. The month of March marked the end of Karen Veverica's full-time presence at Sagana. Near the end of the month she returned to Auburn University to take up duties at Auburn's Fisheries Research Unit. Veverica will continue to provide guidance to the Kenya Project, but this will be on a part-time basis, limited to periodic visits to Kenya and participation in project planning, monitoring, and reporting activities by email and telephone contacts with other project participants. 

Excavation Enterprise Emerges

by Karen Veverica

This year, William Kiama J. Njaremwe registered a new business—African Bulldozers: pond construction and consultants. He and his employees specialize in hand construction of ponds. They can do the work for the same or less than what it takes to hire a bulldozer for the job. At least on a small pond or on ponds to renovate, that is. He began working in this field about seven years ago when he contracted with a Belgian project to renovate ponds at Sagana Fish Farm. He was later contracted by the CRSP to renovate ponds for research. During his three years of working with CRSP researchers, he learned some surveying, choice of pond dimensions, choice and setting of inlets and drains, and many other pond construction techniques. One could say that he and his crew are the only specialists in pond construction in the whole of Kenya.



KAREN VEVERICA

Kiama's staff on the D and E line of ponds at Sagana.

Kiama's group does all earth cutting and moving by hand; even wheelbarrows are a rarity. However, as pond size approaches 4,000 m² or if soil has to be moved long distances, some machinery will be used. For example, an ox cart was used to ferry soil from about 300 meters to the levee construction site for ponds E12 through E15 at

Kenya Fisheries Officer Mastering Aquaculture at Auburn

by Kris McElwee

Auburn University graduate student and Kenya Fisheries Officer Bethuel Omolo is dedicated to improving the aquaculture sector back home. "Kenya's aquaculture production has not surpassed 1,200 metric tons for the past four years. Many farmers are giving up fish farming due to frustrating harvests (tilapia, catfish, trout, common carp, etc.). Since the Fisheries Department is the major extension agency, there is a need for people with adequate knowledge of aquaculture to step in and improve this sub-sector of fisheries."

After earning a Bachelor of Science in zoology from the University of Nairobi in 1981, Omolo became involved in fisheries extension work in 1982, working with artisanal fisheries on the Kenya coast for the Kenya Fisheries Department. In 1989 he moved to the Rift Valley Province, this time working with tilapia and catfish farmers. In 1986 Omolo earned a postgraduate diploma in fisheries biology in Norway. Still a Fisheries Officer, he was transferred to Sagana Fish Culture Farm in 1997 and

served as station manager. The CRSP Kenya Project is based at Sagana, where Omolo met and worked with Auburn University CRSP researcher Karen Veverica.

It was the Kenya Project that first brought Omolo to Auburn. He was invited to attend a study tour for CRSP host country research associates in late 1997 that included a visit to Auburn. Omolo was "generally impressed by the ongoing fisheries research and the linkage the University has with fish farmers here in Alabama." He returned to Auburn in 1999 to begin work on a Master of Aquaculture degree with funding from the CRSP Kenya Project. Tom Popma, a principal investigator on the Kenya Project and Omolo's major professor, is supervising his work on a research project to investigate feed conversion ratios in channel catfish.

Asked about the applicability of his association with the CRSP to his aquaculture interests, Omolo explained: "Since 1998 I have been

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Sagana. Kiama's crew can cut a levee at a consistent 1:2 slope and they can follow pegs and line to make a pond bottom slope at any degree desired. They are accurate to about 5 millimeters. They have developed their own technique of compacting soil that has impressed many a visitor.

Kiama's secret comes from realizing the potential of each worker. For example, he has workers who are very good at fine work such as slope cutting but who may have trouble keeping up with the others when it comes to actual cubic meters excavated. He also has people whose strong point is non-stop digging, so they are given the tasks of digging out trenches for drain pipes, but they are not involved in the final stages of pond bottom digging or levee sloping. One of the frequently repeated observations of the government personnel, students, and visitors is that Kiama's crew

seems to enjoy their work immensely.

In 1998, Kiama was elected to the town council of Sagana. He was subsequently elected as chair of the town council. This was due to his ability to find employment for his constituents. He is also a thoughtful leader and has ambitious plans for his constituents. Although he stepped down as town council chairman to set an example of voluntarily handing over power, he continues to be a major player in the development of his community.

His dream? To attend the pond construction course at Auburn University. Perhaps he could even teach part of it. Kiama, his foremen, and pond managers have become some of the best extensionists in the area.

For my part, one thing is certain—we could really use his crew to renovate at least 100 of our research ponds here at the Fisheries Research Station at Auburn. 

Kenya Fisheries Officer

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active in fish farming extension. I have seen many farmers put so much effort but not realize much in terms of fish harvests. I personally enjoy working with fish and farmers, and my wish is to see the fish farming sub-sector develop in Kenya. There have been success stories in horticulture and I feel the same can happen with fish farming. Kenyans are very sensitive to what can provide an income, and therefore if the technicalities of fish farming are overcome, the private sector will definitely take up this economic activity."



XENA CUMMINGS

Auburn University graduate student and Kenya Fisheries Officer Bethuel Omolo

Omolo feels that the results of CRSP research can benefit the citizens of Kenya by identifying problems in aquaculture at all levels from small-scale to commercial, preventing duplication of research by sharing experiences learned elsewhere, conducting relevant research, and disseminating the information to those who need it.

He also sees a potential benefit in "improved coordination between different fisheries institutions in Kenya and East Africa as a whole. This has been a big challenge as different institutions have disparate approaches to fisheries research and management, but the CRSP has attempted in a subtle manner to improve information exchange

between the Fisheries Department, fisheries research institutions, and universities. Attachment [internship] of students from Moi University, Kenyatta University, and University of Nairobi at Sagana is one good example of CRSP involvement in information transfer."

Omolo will continue as an employee of the Fisheries Department when he returns to Kenya, where his role will be to serve as the link between research information and farmers. He is optimistic that he will be able to apply what he learns in his graduate work: "I feel that by the end of my stay at Auburn, I will be able to assist new and ongoing tilapia/catfish farmers if they need assistance from the Department. Before my experience with the CRSP, I never believed that tilapia could be grown commercially, but through the extensive farm visits and literature as well as personal interaction with tilapia farmers in the USA, I can see its potential, especially in the warmer tropical countries." 🐟

PD/A CRSP Profile—Upton Hatch

by Matt Niles

As first reported in the Fall 1999 issue of *Aquanews*, Upton Hatch is Project Leader for "Rapid economic evaluation tools," a Ninth Work Plan Marketing and Economic Analysis study. This project is Hatch's first as CRSP Project Leader, but he was a co-Principal Investigator on an Eighth Work Plan Adoption/Diffusion study entitled "The influence of fish culture technology, extension methodology, and socioeconomics on success of fish culture on limited-resource farms."

The economics of aquaculture has been a focus of Hatch's research since he arrived at Auburn University in 1982. His current project will use fish production data collected by the CRSP in Honduras for the past ten years, along with local input and fish prices to develop tools to enable a rapid determination of whether a particular tilapia production strategy is likely to be profitable, easy to implement, and associated with acceptable levels of risk.

According to Hatch, the rapid economic evaluation tools are

intended to give extension agents and researchers an idea of the economic incentives associated with a particular production practice. For example, the tools might show that a particular treatment could involve prohibitive labor costs or require nutrients that are not readily available or of a quality that doesn't meet research standards.

According to Hatch, "through interactive use of the tool, it is hoped that the researcher can devise research that better responds to actual growing conditions and has some greater likelihood of being used."

In addition to his Ninth Work Plan CRSP work, Hatch has recently been on a sabbatical with NASA focusing on the use of remote sensing technology in agriculture, which might someday prove useful in monitoring pond quality and fish biomass.

Hatch believes that the economics of aquaculture is a very important part of PD/A CRSP research efforts. As his current project illustrates, Hatch feels that a great potential now exists to

emphasize the economic implications of CRSP research by utilizing the groundwork laid by past CRSP researchers.

Hatch also believes strongly in interdisciplinary research and extension: "It's more difficult, but it's almost always the case that real-world problems know no disciplinary boundaries. I've always felt that it would be useful to have at least a couple of the treatments that researchers use in their experiments approximate commercial or indigenous practices. This way you can look at the gap between what researchers feel is the best way to culture a species [and] the way many producers are actually doing it. Why do they stock, feed, aerate, exchange differently than pure research might suggest?" Hatch suggests that such research design might also help extension workers come up with ways to encourage farmers to adopt more productive strategies, even if their practices are still far from "optimal." 🐟

Graduate Student Profile: John Hayes

by Anu Gupta

Oregon State University (OSU) graduate student John Hayes has been conducting research, wielding web work, and going about general exploration in his short time here in the Pacific Northwest.

Hayes is currently working on CRSP reproduction control research at OSU's Fisheries and Wildlife Department, on a question of Nile tilapia sex determination. This work is the heart of Hayes' thesis project and serves as one of the many requirements towards earning a master of science degree. He is working on a method of controlling reproduction through the creation of all-male populations. Past researchers have created such populations using various methods, including manual separation, hybridization through interspecies crosses, and steroid introduction.

An additional method is to manipulate water temperature and pH. Past research on various cichlid species has shown that high temperature and low pH often lead to male-biased populations. "Nobody has done this with Nile tilapia yet," said Hayes. "Based on ecological and physiological similarities, we think that temperature and pH could have the same effect on Nile tilapia." Hayes will experiment with temperatures between 28 and 42°C, and with pH levels as low as 3.5. Based on a window previously identified by CRSP researcher Martin Fitzpatrick, Hayes will apply a 3-hour temperature and pH treatment twice, once at 11 days post-fertilization and again at 13 days post-fertilization.

Hayes is interested in not only how temperature and pH influence sex determination, but also why such environmental factors have an influence at all. "What is the adaptive advantage of having all-male populations at high temperatures?" he asked. "Such a question addresses evolutionary biology."



XENA CUMMINGS

CRSP graduate student John Hayes


The ecologically friendly nature of this project appealed to Hayes: "I was drawn to Marty's work here because he was getting away from steroids and looking at environmentally responsible techniques." Hayes's interest in aquaculture arose out of a long-standing love affair with the ocean; "I've always had a fascination with marine life. But at the same time I wanted to do something practical. I wanted to address a real-world problem faced by natural resource managers, like the depletion of wild fisheries."

Prior to working on his current project, Hayes worked at the National

Oceanic and Atmospheric Administration (NOAA) in Washington, D.C., for four years, serving as a Geographic Information System (GIS) technician, a website developer, and a Statistical Analysis System (SAS) programmer. Prior to that, Hayes attended the University of Maryland, graduating in 1993 with a B.S. in marine biology.

Aquaculture first interested Hayes when he was working at NOAA. He was especially interested in working with tilapia, a species showing high growth potential and fewer limitations than anadromous fish. Hayes was also interested in exploring the West Coast, and thus in September 1999 he started at OSU. While here, Hayes has put his web skills to use at the CRSP Information Management and Networking Component (IMNC) in Corvallis, Oregon. On July 1, CRSP support of Hayes' graduate research assistantship moved from the IMNC to Fisheries and Wildlife; he will then focus full-time on research.

Hayes has recently become interested in the business side of aquaculture. He is contemplating the idea of getting an MBA. "I would like to get a hard science degree that I can apply in a management setting."

When he is not working, Hayes finds time to explore the Pacific Northwest. "On the East Coast the outdoors are not as accessible. Here you can find trails and mountains and forests close to campus. I have definitely been taking advantage of that." 

Publication Announcement

Proceedings of the First International Symposium on Cage Aquaculture in Asia, 2000, 312 pp.

Editors: I Chiu Liao (President, Asian Fisheries Society), and C. Kwei Lin (President, Southeast Asian Chapter of the World Aquaculture Society)

It is well recognized that aquaculture is playing an increasingly important role in world fisheries production to meet the rapidly rising demand for fisheries products. The most significant contribution from aquaculture occurs in Asia, which produces 90% of the total world aquaculture

production. Although cage aquaculture has existed for centuries, only in recent years has it been widely practiced and recognized for its potential to produce mass quantities of a large variety of aquatic animals in diverse environments such as ponds, rivers, lakes, reservoirs, estuaries, and the open sea.

The First International Symposium on Cage Aquaculture in Asia, held 2-6 November 1999 in Tungkang, Taiwan, provided an opportunity for the first time to the aquaculture community in Asia and outside of the region to meet and discuss current developments in cage aquaculture.

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Valderrama, Warrington Successfully Defend M.S. Theses

Congratulations to Lee Warrington, who successfully defended his M.S. thesis on 11 December 1999 at Auburn University under the direction of CRSP Reproduction Control researcher Ron Phelps.

SEX RATIO VARIATION AND SEX DETERMINING MECHANISMS IN *Oreochromis niloticus*

(abstract of Lee Warrington's M.S. thesis)

The variability in the factors affecting sex ratio of *Oreochromis niloticus* was studied using pair spawns from the Egypt, Ghana, and Ivory Coast strains during June - October, 1997 and 1998. Sex ratios from 129 progeny groups were determined by microscopic inspections of the gonads. Of the 12, 450 progeny sexed, 54.14% were males, which differed significantly from a 1:1 sex ratio ($P < 0.001$). Each strain had at least 42% of their spawns differ from a 1:1 sex ratio ($P < 0.05$). Logistic regression demonstrated the percentage of males produced by the Ghana strain to differ significantly from that of the Egypt or Ivory Coast strain ($P = 0.02$). Sex ratios from the 129 progeny groups produced a normal distribution ($P > 0.45$), but did not reflect a binomial distribution ($P < 0.01$), as would be predicted by a simple monofactorial sex determination process. Therefore, other factors must account for the variation observed in sex ratios. Single spawn sex ratios ranged widely from 16% to 100% males. Chi-square tests revealed weak correlations between strain and progeny gender, individual parent and progeny gender, as well as, male-female parent combinations and progeny gender. Sixty-five percent (11/17) of the repeat spawns by the same pairings produced sex ratios that extended beyond a range of 10%. The continuous range of sex ratios within the normal distribution suggested the presence of several minor sex-modifying factors in *Oreochromis niloticus*.

Diego Valderrama successfully defended his M.S. thesis on 1 May 2000 at University of Arkansas at Pine Bluff. He is continuing to work as a Research Assistant with Carole Engle, CRSP Marketing and Economic Analysis researcher, who also served as his thesis advisor.

ECONOMIC ANALYSIS OF SHRIMP FARMING IN HONDURAS

(abstract of Diego Valderrama's M.S. thesis)

An economic analysis of shrimp aquaculture in Honduras was conducted through the development of two separate models. The first model measured the effect of variability of production factors on the profitability of shrimp operations under different farm scenarios for a given production year (1997). Results of this model pointed out a major potential for profit developed by farms employing an alternative scheme of semi-intensive technologies (AST) characterized by higher feeding rates and water exchange rates. However, data limitations did not allow extrapolation of these results to other production years. To overcome this limitation, a new database was compiled to develop a one-year linear programming (LP) optimization model for each farm-size scenario previously identified. Results indicated that maximization of farm income is achieved by selecting intermediate stocking densities, long grow-out periods, and conservative water exchange rates. In addition, farmers should take full advantage of the superior growth rates characteristic of stocking months such as May and June by concentrating use of resources during this period of the year. The LP models also indicated that, under optimal management conditions, shrimp farms in Honduras have the capacity of producing more than 1,000 kg shrimp tails/ha/year, which implies that superior yields reported by the AST farms are within the reach of the farming capabilities of most shrimp farms in the country. Target MOTAD risk programming models were then developed for each farm scenario to assess the risk inherent to the LP solutions and to identify alternative production plans. However, the LP models indicated that shrimp farms have such a tremendous potential to generate income over critical target income levels that little risk is associated with the formulated optimal plans of activities. Additional simulations were conducted to examine the effects of changing conditions on the profit levels and management strategies selected by the LP models. In general, results of these simulations showed that shrimp farms in Honduras possess the potential to maintain acceptable profit levels under a variety of management situations.

Publication Announcement

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The proceedings comprise abstracts and full papers on diverse topics that review the status of cage culture in Asian countries, identify problems and opportunities, assess research needs, and discuss sustainable culture technologies and their management. Papers by CRSP researchers Kwei Lin and Yang Yi are included (see Notices of Publication, p. 13). This publication provides a wealth of information useful for fish culturists, scientists, traders, and planners in private and public institutions.

A list of the papers presented and their authors can be downloaded from the Internet at <www.cgiar.org/iclarm/afs/pubs97~1.htm>. For information on ordering a copy of this publication, email <WASMAS@aol.com> or write to:

World Aquaculture Society
143 J. M. Parker Coliseum
Louisiana State University
Baton Rouge, LA 70803 USA



Kudos

James Diana—US Regional Coordinator for the Thailand Project, co-chair of the PD/A CRSP Technical Committee, and CRSP participant since 1983—was named Associate Dean of the School of Natural Resources and the Environment at The University of Michigan. After receiving a doctorate in zoology at the University of Alberta, Canada, Diana joined the UM faculty in 1979. In addition to his CRSP involvement, Diana works on fish energetics, studying the behavioral ecology of northern pike and other temperate fishes. He is also interested in the conservation of aquatic natural resources, through work on endangered fish species and through the development of ecologically responsible aquaculture practices. 🐟

Award Winning Graduate Students

Wilfrido Contreras-Sánchez was awarded the Savery Outstanding Graduate Student Award by the Oregon State University College of Agricultural Sciences. The Savery award, sponsored by the Agricultural Research Foundation, recognizes graduate students whose research benefits Oregon agriculture and natural resources. Contreras-Sánchez is a faculty member at Universidad Juárez Autónoma de Tabasco (UJAT) and a doctoral student at OSU, working on CRSP Reproduction Control Research. The award was presented at the Great Achievements of Students Celebration held 18 May 2000 on the OSU campus.



XENA CUMMINGS

Savery Award winner
Wilfrido Contreras-Sánchez

In addition to completing a master's degree at the University of Arkansas at Pine Bluff (see p. 7), Diego Valderrama won two awards recently. He received a plaque and a check for one of the best student abstracts submitted to Aquaculture 2000 from the US Aquaculture Society for his paper "Risk Analysis of Shrimp Farming in Honduras." He was also awarded Best Graduate Student Paper in the School of Agriculture, Fisheries, and Human Sciences at the 2000 UAPB Annual Research Forum for his paper entitled "A Risk Programming Model for Shrimp Farming in Honduras." The forum was held 15–16 March 2000 on the UAPB campus. 🐟



Diego Valderrama,
recipient of two awards
and a master's degree.

Ernst Dissertation Describes AquaFarm[®]

Aplaudishments to Douglas Ernst, who successfully defended his Ph.D. dissertation on 17 April 2000 at Oregon State University. Ernst worked under the advisement of CRSP researcher John Bolte.

AQUAFARM[®]: SIMULATION AND DECISION-SUPPORT SOFTWARE FOR AQUACULTURE FACILITY DESIGN AND MANAGEMENT PLANNING

(abstract of Douglas Ernst's Ph.D. dissertation)

A simulation and decision-support software product for aquaculture facility design and management planning is described (AquaFarm, Oregon State University[®]), including comprehensive documentation and applications to practical problems. AquaFarm provides (1) simulation of physical, chemical, and biological unit processes, (2) simulation of facility and fish culture management, (3) compilation of facility resource and enterprise budgets, and (4) a graphical user interface and data management capabilities. These analytical tools are combined into an interactive decision support system for the analysis and development of facility design specifications and management strategies. Intended user groups include aquaculture research, engineering, education, and production. As guided by the user, aquaculture facilities can be of any type, configuration, and management objective, for purposes of broodfish maturation, egg incubation, and/or growout of finfish or crustaceans in cage, single pass, serial reuse, water recirculation, or solar-algae pond systems. User-accessible specifications include (1) site climate and water supplies, (2) components and configurations of fish culture systems, (3) fish and facility management strategies, (4) unit costs for budget items, (5) production objectives (species, time schedules, and fish numbers and weights), and (6) parameters of unit-process and fish performance models. Based on these specifications, aquaculture facilities are simulated, resource requirements are compiled, and operation schedules are determined so that production objectives are achieved. Facility performance is reported to the user as management schedules, summary reports, resource and enterprise budgets, and tabular and graphical compilations of time-series data for unit process, fish, and water quality variables. If unsatisfactory resource requirements or unattainable production objectives are found, procedures of iterative design and management refinement are supported. To provide this analytical capacity, a wide range of existing and newly developed quantitative methods and models are assembled and synthesized into an integrated analytical framework, including aquatic chemistry, aquatic biology, fish biology, aquacultural engineering, and simulation techniques. Unit-process and system-level validation exercises are demonstrated for a wide range of aquaculture facilities in which (1) facilities are constructed according to reported studies, (2) simulation trials are accomplished, and (3) good agreement between predicted performance and empirical observations is demonstrated, given that sufficient specification of site-specific variables is provided.

EEP visits Thailand

In late June two members of the PD/A CRSP External Evaluation Panel (EEP), Kevan Main and David Cummins, undertook the first of three site visits to CRSP research sites. The two visited the Asian Institute of Technology (AIT), located in Pathumthani, Thailand, where they visited with CRSP researchers, students, and extension agents associated with AIT's aquaculture program. They also visited Udorn Thani, where they met with farmers and researchers who are part of a collaborative outreach program between the CRSP and the Thai Royal Department of Fisheries. Participating EEP members Main and Cummins were joined by PD/A CRSP Director Hillary Egna and PD/A CRSP USAID Project Officer Harry Rea.



This site visit is part of the five-year in-depth review process required by BIFAD (Board of International Food and Agriculture Development) guidelines. The EEP will also participate in site visits to the Instituto de Investigaciones de la Amazonia Peruana and the Universidad Nacional de la Amazonia Peruana in Peru in September 2000. In November, the EEP is scheduled to visit institutions in Kenya, including Sagana Fish Farm, Moi University, and the University of Nairobi.

The review process will continue through the program annual meeting in Orlando, Florida, in January 2001. 🐟

Meet the External Evaluation Panel

Kevan L. Main currently serves as the Deputy Director of the Harbor Branch Oceanographic Institution's Aquaculture Division, in Fort Pierce, Florida. Main joined Harbor Branch in 1997; for more than ten years before that, she served as the Director of the USDA's Center for Tropical and Subtropical Aquaculture, located in Waimanalo, Hawaii. She also directed its Oceanic Institute's Asian Interchange Program. Main received her Ph.D. from Florida State University, where she focused on seagrass meadows. Main is a member of the World Aquaculture Society's Board of Directors and serves as the chairman of the Affiliations Committee for the Society.

Christine Crawford has worked in the marine aquaculture field for over twenty years, primarily in finfish and shellfish aquaculture research, and in aquaculture extension. She is currently the Marine Environment Section Leader for the Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, located in Taroona, Tasmania. Recently, Crawford has begun investigating the effects of aquaculture on the marine environment. Prior to joining the University of Tasmania, Crawford served as a consultant and lecturer around the world. She holds a Ph.D. in marine ecology from the University of Tasmania, Australia.

David Cummins has been closely allied with CRSP research for over twenty years, having served as Program Director and Associate

Director of the Peanut CRSP, administered through the University of Georgia. As Director, Cummins organized research programs between the US and host countries and implemented research. Cummins holds a Ph.D. in Agronomy from the University of Georgia. He has traveled throughout the world, and from 1986 to 1988 served as the Agricultural Research Advisor for USAID in Manila, the Philippines. In 1996 Cummins was named recipient of the D.W. Brooks Award for Excellence in International Agriculture.

Edna McBreen has over twenty years of experience with domestic and international education. She is currently Associate Vice Chancellor for the Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, Nebraska. Previously, McBreen was Associate Dean and Director of the Cooperative Extension of the College of Agriculture, University of Wyoming in Laramie, Wyoming. She received her Ph.D. from Cornell University in Ithaca, New York, where her dissertation focused on the interface between family law and home economics. McBreen has served on the EEP of the Bean/Cowpea CRSP and the Global Livestock CRSP. 🐟



Two members of the External Evaluation Panel were among those who learned about cage culture in aquaculture ponds during a field visit in Thailand.

IIFET 2000 Conference

The tenth biennial conference of the International Institute of Fisheries Economics and Trade (IIFET 2000) took place 10–13 July 2000 at Oregon State University in Corvallis, Oregon, USA. The conference included presentations by historians, legal scholars, industry spokespeople, policy-makers, biologists, nutritionists, and social and behavioral scientists.

The theme of the conference, Microbehavior and Macroresults, reflected the relationship of individual behavior to the aggregate consequences of that behavior. Conference presentations covered a broad range of topics under this theme, including fishery biology and the social sciences; aquaculture: past, present, and future; fisheries in economic development; issues in international trade; consumer demand for seafood; seafood market behavior; and seafood consumption and human health. (Visit the IIFET 2000 website at <osu.orst.edu/dept/IIFET/2000/> for a complete list of presentations and abstracts.) As with past IIFET conferences, IIFET 2000 provided both formal and informal opportunities for interaction among the participants. (More detailed conference coverage will follow in the Fall 2000 issue of Aquanews as this issue went to press during the final days of the conference.)



The PD/A CRSP co-sponsored the event and provided the following researchers from PD/A CRSP host countries the opportunity to attend and present:

Eunice Pérez Sánchez, Institute of Aquaculture, University of Stirling, UK

Aquaculture Impacts in the Socio-economics of the Coastal Communities of Tabasco, Mexico (online abstract: <osu.orst.edu/dept/IIFET/2000/abstracts/sanchez.html>)

Ruben Sevilleja, Freshwater Aquaculture Center, Central Luzon State University, Philippines

Adoption and Economics of Tilapia Farming Technology in the Philippines (online abstract: <osu.orst.edu/dept/IIFET/2000/abstracts/sevilleja.html>)

Ruamporn Siriratrakul, National Statistical Office, Thailand

Dramatic Development of Shrimp Aquaculture in Thailand (based on the 1985 and 1995 Thai Marine Fishery Census) (online abstract: <osu.orst.edu/dept/IIFET/2000/abstracts/siriratrakul.html>)

Mathias Wafula, Fisheries Department, Kenya

Socio-economic Impact of Aquaculture Support Programmes on the Communities in the Lake Victoria Basin of Kenya (online abstract: <osu.orst.edu/dept/IIFET/2000/abstracts/wafula.html>)

Congratulations to conference participants and organizers for making IIFET 2000 a success. 🐟

CRSP Co-Sponsors ISTA V

The PD/A CRSP is pleased to be a co-sponsor of the Fifth International Symposium on Tilapia Aquaculture (ISTA V), which will take place 3-7 September 2000 at the Sofitel Rio Palace, Rio de Janeiro, Brazil. ISTA V will focus on the rapid advances in large-scale commercial farming and the development of international markets. The symposium will include a trade show, which will provide a forum for industry suppliers, seafood marketers, and the aquaculture press to meet directly with researchers and producers. Field trips are being organized to nearby aquaculture sites. Additional information about ISTA V is available on the Internet at <ag.arizona.edu/azaqua/ista/announce.htm>.

CRSP Sponsorship

The PD/A CRSP is providing an opportunity for three scholars with ties to existing and previous PD/A CRSP host countries (Malawi, Philippines, and Thailand) to attend and present papers. The scholars chosen for sponsorship were selected by ISTA V conference organizers. The three scholars are listed below, along with the papers they will present:

Remedios B. Bolivar, Freshwater Aquaculture Center, Central Luzon State University, Philippines

1. *Response to Selection for Body Weight of Nile Tilapia (Oreochromis niloticus) in Different Culture Environments*

2. *Timing of the Onset of Supplemental Feeding of Nile Tilapia (Oreochromis niloticus) in Ponds*

Yang Yi, Aquaculture and Aquatic Resources Management, Asian Institute of Technology, Thailand

Analyses of Various Inputs for Pond Culture of Nile Tilapia (Oreochromis niloticus): Profitability and Potential Environmental Impacts

Daniel Jamu, International Center for Living Aquatic Resources Management, Zomba, Malawi

A Pilot Study on the Spatial and Temporal Soil Moisture Distribution in Integrated Crop-Fish-Wetland and Crop-Wetland Agrosystem in Zomba-East, Malawi 🐟

Fishellaneous Items

This month's Fishellaneous Items section contains two articles written for Aquanews covering non-CRSP aquaculture activities. The Peru article was donated by CRSP participant Konrad Dabrowski, while the update on Malaysia was donated by Aquanews subscriber TJ Tan.

Aquaculture Update from Malaysia

by TJ Tan

Kuala Lumpur

The growing demand for fish and the heavy expense involved in developing deep-sea fishing have generated increasing interest in aquaculture in Malaysia.

The Malaysian government expects demand for fish for human consumption to increase from 1.2 million tonnes per year now to 1.9 by 2010, as the population expands from 22 million to almost 29 million. Much of the increase is expected to come from aquaculture. The government's target for aquaculture is 600,000 tonnes per year, which entails a 460% increase from 133,000 tonnes at present.

Currently, farming is focused on cockles, shrimp, tilapia, carp, and catfish. Efforts are being made to farm snapper, grouper, and seabass in offshore cages and to attract big business to the sector. There are also plans to expand seaweed culture.

The Malaysian agriculture ministry has teamed up with the private-sector companies, public-listed Consolidated Plantation, Aquacon, and Langkawi Marine Farm, in a project to farm snapper and grouper in cages off the island of Langkawi in the Straits of Malacca.

The farms use adapted Norwegian technology and the companies provide the cash and manpower, while the ministry supplies fingerlings and the expertise.

Public-listed Golden Hope Plantations has embarked on a project to farm grouper in cages off the island of Penang further south, also using Norwegian technology. Shipping company Halim Maznim is farming seabass and grouper in cages located about a kilometer offshore in the Straits of Malacca.

In the states of Malacca and Johor in southern peninsular Malaysia, fishermen will take part in an offshore fish breeding project costing US\$13 million. The Malacca government and a private-sector company, Muara Aquaculture Park, are funding the project. The project involves breeding of fish and bivalves. Some 50,000 square metres off Nangka Island has been earmarked for offshore cage culture.

Under the first phase, a fish hatchery will be built to produce some 24 million fish per year of local species such as *kerapu*, *siakap*, and *jenahak*. Under the second phase, 16 fish cages will be placed off the island, and each cage is expected to produce up to 2,000 tonnes of marine fish.

The East Malaysian state of Sabah is setting up seaweed nurseries on Balambangan Island off the northern coast to expand seaweed farming in the state. Large-scale nurseries will also be set up on Omadai Island, off Semporna in the south where local entrepreneurs have developed 200 hectares of seaweed farms.

... continued on p. 12

Rainbow Trout Culture in the Peruvian Highlands

by Konrad Dabrowski

Although rainbow trout culture has been practiced in the Peruvian Highlands for over 70 years, recent interest in expanding this activity has been sparked by the success of fish culturists in other Central and South American countries. The initiative is also coming from researchers in the Department of Nutrition at the National University of Agriculture La Molina in Lima, Peru. Dr. Carlos Gomez, chair of this department, organized two workshops in March on nutrition of rainbow trout for industry representatives, state fisheries biologists, and private farmers from local cooperatives. Konrad Dabrowski, PD/A CRSP researcher on the Peru Project from Ohio State University, spoke at the workshops on nutrient requirements, diet formulation, and general aspects of trout culture. Dabrowski also visited two of what may be the highest elevation trout farms in the world. The farm at Patchakayo, at 11,216 feet above sea level, is operated by a local cooperative and annually produces 100 tons of trout for export and local markets. The facility in Huancayo Province, operated by the Regional Directorate of Fisheries, provides stocking material for local farmers and serves as a public education center. These Andean trout facilities offer unique opportunities for experimental and applied research on the effect of high altitudes on fish performance. Abundant, high quality water available in the highlands and an unlimited supply of fish meal from the Peruvian sea fishery make this region favorable for aquaculture development. 🐟



The "El Ingenio" trout farm of Junin Province Directorate of Fisheries with expanded facilities for visitors and educational purposes.

Notices of Publication

These Notices of Publication announce recently published work carried out under PD/A CRSP sponsorship. To receive a full copy of a report, please contact the author(s) directly unless it is otherwise noted.

CRSP Research Report 00-146

EFFECTS OF FEEDING PELLETED VERSUS NON-PELLETED DEFATTED RICE BRAN ON NILE TILAPIA *OREOCHROMIS NILOTICUS* PRODUCTION AND WATER QUALITY IN PONDS

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Department of Aquaculture and Fisheries
University of Arkansas at Pine Bluff
P.O. Box 4912
Pine Bluff, AR 71611 USA

Effects of pelleted versus non-pelleted defatted rice bran on fish production and water quality were evaluated at the Aquaculture Research Station, University of Arkansas at Pine Bluff. Mixed-sex Nile tilapia (*Oreochromis niloticus*) were stocked at 2.3/m² into each of six 0.04-ha earthen ponds. Largemouth bass (*Micropterus salmoides*) were added at 0.17/m² for population control. Defatted rice bran was fed to fish at 2% body weight daily. After 169 days, tilapia harvests averaged 2,924 kg/ha in pellet-fed and 3,031 kg/ha in loose bran-fed treatments (a non-significant difference). Stocked fish comprised an average of 52% and 39%, respectively, in these treatments, and approached a significant difference (P=0.2). Average amounts of inorganic fertilizer required to maintain chlorophyll a levels of 100-150 mg/m³ were significantly different at 736 and 1,108 kg/ha in pelleted and loose bran treatments, respectively.

This abstract was excerpted from the original paper, which was published in *Asian Fisheries Science*, 12(1999):49-55.

CRSP Research Report 00-147

SOUND POLICIES FOR FOOD SECURITY: THE ROLE OF CULTURE AND SOCIAL ORGANIZATION

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Dept of Agricultural Economics and Rural Sociology
Auburn University, AL 36849-5406 USA

Culture conditions the ability to organize and to provide food security, but social organization is the immediate source of policies that prevent food insecurity or determine what happens when it does occur. Weather, war, terrorism, conflict, overpopulation, environmental degradation, corruption, and faulty policies have been identified as causes of food insecurity. Perhaps most of the blame for food insecurity should go to faulty policies or poor implementation of sound policy. This article identifies reasons for both kinds of failure that are linked to culture and social organization. The central task of government is to allow the food system to manage its own affairs, but policies must be ready to guide action when market, crop, or policy failures create food insecurity among those with no other means of coping with adversity.

This abstract was excerpted from the original paper, which was published in *Review of Agricultural Economics*, 21(2):489-498.

Aquaculture Update from Malaysia

...from p. 11


Local fishermen are increasingly turning to growing the algae as an alternative source of income, particularly as it does not require heavy investment.

Sabah hopes to export seaweed to the Philippines, which has a thriving seaweed processing industry, and to Singapore.

Researchers have developed a stratified fish rearing technique that they say has a capacity about ten times that of conventional ponds. With the technique, nearly a million fish could be cultured in a 0.5-hectare pond by stratifying

the habitat of different fish, compared with about 100,000 using conventional methods, say the researchers at Technology Park Malaysia.

"Different fish have different feeding habits. For example, tilapia prefer to eat near the surface while *patin* and catfish like to feed at the middle and bottom levels," TPM director Professor Ishak Ismail says.

The technique is a novel solution to the problem of land shortage faced by the aquaculture sector in peninsular Malaysia. 

Notices of Publication (cont.)

CRSP Research Report 00-148

INTEGRATED CAGE CULTURE IN PONDS: CONCEPTS, PRACTICE AND PERSPECTIVES

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Aquaculture and Aquatic Resources Management Program
Asian Institute of Technology
P.O. Box 4, Klong Luang, Pathumthani 12120
Thailand

The integrated cage culture in ponds refers to the system in which high valued species are stocked in cages suspended in ponds while filter-feeding species are stocked in open water outside the cages. While the caged fish are fed with high protein diets, the open-pond fish are solely dependent on the natural foods generated from cage wastes.

The following advantages make the integrated cage culture in ponds attractive and promising:

- (1) Wastes derived from high protein diets of caged fish are reused as a valuable nutrient source to generate natural foods for open pond fish.
- (2) Nutrients in wastes derived from cages are recovered thus reducing nutrients contained in effluents, which are usually released directly or indirectly to the surrounding environment, causing accelerated eutrophication in those waters.
- (3) It is used in polyculture ponds to confine costly high protein diets to caged high valued species to achieve higher economic returns.
- (4) It is used in sub-tropical or temperate regions, where tropical fish species cannot overwinter, to make full use of growing seasons and make management such as fish harvest easy and convenient.
- (5) This system makes it possible to fatten large fingerlings with high protein diets in cages and nurse fry with natural foods derived from cages wastes in open water in a single pond, which could allow small-scale farmers with one pond to maximize fish production and profitability.

The integrated cage culture in ponds has been practiced in caged catfish-open pond tilapia and caged large tilapia-open pond small tilapia. Encouraging results have been achieved from the above trials.

This abstract was excerpted from the original paper, which was published in I.C. Liao and C.K. Lin (Editors), Proceedings of the First International Symposium on Cage Aquaculture in Asia. Asian Fisheries Society, Manila, Philippines, pp. 217-224.

CRSP Research Report 00-149

AN OVERVIEW OF FRESHWATER CAGE CULTURE IN THAILAND

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Asian Institute of Technology
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Thailand

Despite its long history and a large number of rivers and reservoirs in Thailand, cage culture contributed only 0.3% of 200,000 tons in total fish production from freshwater aquaculture. Over the last decade, the peak of annual fish production from freshwater cages reached 2,700 tons in 1991 and declined since to a minimum of 600 tons in 1995. Although cage culture takes place in various habitats such as river, reservoirs, irrigation canals and large ponds, its predominant habitats are in flowing waters. Among a dozen of cultured species, red snakehead (*Channa micropeltes*), catfish (*Pangasius* spp.), marble goby (*Oxyeleotris marmoratus*) and tilapia (*Oreochromis* spp.) topped the list. The production of those species fluctuated drastically resulting mainly from deteriorating water quality, competing for trash fish feed, changing market value, and shifting culture practices. However, disease and fingerling supply caused the reduction and limitation in culture of the most valued marble goby. Recently, the cage culture of tilapia has gained great popularity in certain parts of the country. Cage culture has been a small-scale, artisanal operation with little research and technical innovation. Further development of cage cultures in freshwater lies on ecologically sound multiple uses of reservoirs and flowing waters. In addition, integration of intensive cage culture with semi-intensive species in ponds should also be promoted.

This abstract was excerpted from the original paper, which was published in I.C. Liao and C.K. Lin (Editors), Proceedings of the First International Symposium on Cage Aquaculture in Asia. Asian Fisheries Society, Manila, Philippines, pp. 237-242.

Upcoming Conferences and Expositions

Date	Topic/Title	Event Location	Contact Information
July 20-23	3 rd International Conference on Recirculating Aquaculture	Roanoke, Virginia, USA	Dr. George Libey, Recirculating Aquaculture Conference 2000, Virginia Tech, Blacksburg, VA 24061; Phone: 540-231-6805; Fax: 540-231-9293; Email: CFAST@vt.edu
July 23-26	International Congress on the Biology of Fish	Aberdeen, Scotland	Don MacKinlay; Phone: 604-666-3520; Email: MacKinlayD@pac.dfo-mpo.gc.ca; Website: <www.fishbiologycongress.org>
July 24-July 28	4 th International Conference on Aquaculture: Fundamental & Applied Aspects	Liege, Belgium	Raymond Gilles; Email: R.Gilles@ulg.ac.be; Website: <www.ulg.ac.be/physioan/aquacult.htm>
August 20-24	130 th American Fisheries Society Annual Meeting	St. Louis, Missouri, USA	Betsy Fritz; Phone: 301-897-8616/212; Email: bfritz@fisheries.org
September 3-5	5 th International Symposium on Tilapia in Aquaculture	Rio de Janeiro, Brazil	Phone: 021-553-1107; Fax: 021-553 3487
September 28-Oct 1	2nd International Exhibition on Fishing and Aquaculture	Athens, Greece	Phone: 301-92-21-254; Fax: 301-92-21-589; Email: europart@hol.gr
September 29-October 5	International Marine Biotechnology Conference (IMBC) 2000	Townsville, Queensland, Australia	Phone: 61-7-4781-6219; Fax: 61-7-4781-5822; Email: imbc_2000@aims.gov.au
October 1-2	1 st Annual Southern New England & 5 th Annual Rhode Island Aquaculture Conference	Newport, Rhode Island, USA	David Alves; Phone: 401-783-3370; Fax: 401-783-3767; Email: dalves@crmc.state.ri.us
October 5-7	III Simposium Internacional de Acuicultura	Sinaloa, Mexico	Phone: 52-67-172720; Fax: 52-67-146705; Email: terramar@pacificnet.com.mx
October 25-28	4 th Latin American Aquaculture Congress & Exhibition	Atlapa, Panama	Email: camaricultura@gfce.com
October 31-November 3	Third World Fisheries Congress	Beijing, China	Phone: 86-10-64194233; Fax: 86-10-64194231; Email: scfish@agri.gov.cn
November 1-4	Marketing Live Aquatic Products 2000	Annapolis, Maryland, USA	Phone: 302-645-4060; Fax: 302-645-4007; Email: ewart@udel.edu
November 9-12	AgAsia 2000	Bangkok, Thailand	Email: agasia@reedtradex.co.th
November 14-17	FISHERY 2000	Jakarta, Indonesia	Phone: 852-2851-8603; Fax: 852-2851-8637; Email: topreput@hkabc.net
November 19-22	V International Symposium on Aquaculture Nutrition	Yucatan, Mexico	Phone: 52-99-812973; Fax: 52-99-812334; Email: sinav@kin.cieamer.conacyt.mx
November 29-December 5	Expo Pesca 2000 & Acuicultura 2000	Santiago, Chile	Phone: 509-838-8755; Fax: 509-838-2838; Email: sue.hill@informa.com
December 7-9	Northeast Aquaculture Conference and Exposition	Portland, Maine, USA	Phone: 888-454-7469
January 21-25, 2001	Aquaculture 2001	Orlando, Florida, USA	WAS Conference Manager, World Aquaculture Society, 21710 7th Place West, Bothell, WA 98021; Phone: 425-485-6682; Fax: 425-483-6319; Email: worldaqua@aol.com
April 26-28, 2001	Acquacoltura International 2001	Verona, Italy	Phone: 425-485-6682; Fax: 425-483-6319; Email: worldaqua@aol.com
August 19-23, 2001	131 st American Fisheries Society Annual Meeting	Phoenix, Arizona, USA	Betsy Fritz; Phone: 301-897-8616 ext. 212; Email: bfritz@fisheries.org

Workshops and Short Courses

Date	Title/Topic/Site	Contacts
July 25-29	Recirculating Aquaculture Systems/ACTED	Aquaculture Center for Training, Education, and Demonstration (ACTED); Contact: Harbor Branch Oceanographic Institution, 5600 US Hwy 1 North, Ft. Pierce, FL 34946; Phone: 800-333-4264 or 561-465-2400 ext. 416; Fax: 561-466-6590; Email: acted@hboi.edu; Website:<www.aquaculture-online.org>
August 14-18	Intensive Shrimp Culture/ACTED	ACTED (see above)
August 14-September 8	Advances In Tilapia Fry Production And Grow-Out/Asian Institute of Technology, Thailand	Training and Consultancy Unit (TCU), Aquaculture and Aquatic Resources Management Program, Asian Institute of Technology, PO Box 4, Klong Luang, Pathumthani 12120, Thailand; Phone 66-2-524-5219; Fax: 66-2-524-5484; Email: tcuaasp@ait.ac.th; Website: <www.agri-aqua.ait.ac.th/tcu>
August 15-17	OSU Surimi Technology School/ Thai Department of Fisheries, Bangkok, Thailand	Phone: 662-642-5322; Fax: 662-248-8304; Email: jae.park@orst.edu
August 21-22	Production Planning/ACTED	ACTED (see above)
August 23-25	Opportunities in Aquaculture/ACTED	ACTED (see above)
September 15	Backyard Aquaculture/ACTED	ACTED (see above)
September 19-21	Opportunities in Aquaculture/ACTED	ACTED (see above)
September 22	Marine Aquarium Keeping/ACTED	ACTED (see above)
October 4-6	Aquaculture Marketing Seminar 2000/ Asheville, North Carolina	Aquaculture Magazine, PO Box 2329, Asheville, NC 28802; Phone: 828-254-7334; Fax: 828-253-0677; Email: seminar@aquaculturemag.com Website: <www.aquaculturemag.com/>
October 13	Shrimp Farming Opportunities/ACTED	ACTED (see above)
October 16-20	Hard Clam Aquaculture/ACTED	ACTED (see above)
October 23-27	Bivalve Hatchery Operations/ACTED	ACTED (see above)
November 3	Backyard Aquaculture/ACTED	ACTED (see above)
November 12-15	Design and Operation of Aquaculture Facilities/The Hotel Roanoke Conference Center, Roanoke, Virginia, USA	Dr. Greg Boardman, Phone: 540-231-2013; Email: gboard@vt.edu Website: <www.conted.vt.edu/doaf.htm>
November 13-17	Recirculating Aquaculture Systems/ACTED	ACTED (see above)
December 6-8	Opportunities in Aquaculture/ACTED	ACTED (see above)
January 24-February 18, 2001	Coastal Planning and Management for Aquaculture Development/Asian Institute of Technology, Thailand	Training and Consultancy Unit (see above)
March 20-31, 2001	Coastal Aquaculture Study Tour/Asian Institute of Technology, Thailand	Training and Consultancy Unit (see above)
May 1-12, 2001	Inland Aquaculture Study Tour/Asian Institute of Technology, Thailand	Training and Consultancy Unit (see above)
Year-round	Training and Research in Fisheries and Stock Management/Wageningen Agricultural University, the Netherlands	G. van Eck, Dept of Fish Culture & Fisheries, PO Box 338, 6700 AH Wageningen, The Netherlands; Phone: 31-8370-8330; Fax: 31-8370-83937; Email: gerrie.van.eck@alg.venv.wau.nl
Year-round	Tropical Aquaculture Advanced Training in a Third World Country/Escola Agrícola Panamericana (EAP), Honduras, and Asian Institute of Technology, Thailand	Zentralstelle fuer Ernährung und Landwirtschaft (ZEL) Feldafing/Zschortau, Deutsche Stiftung fuer Internationale Entwicklung (DSE), D-82336 Feldafing, Germany; Phone: 49-8157-938-0; Fax: 49-8157-938-777
Year-round	Various courses and study tours tailored to meet the training needs of a specific group or agency/Asian Institute of Technology, Thailand	Training and Consultancy Unit (see above)

Comings and Goings in the Pond

The last quarter was a busy one for the CRSP pond, with many comings and goings. The Program Management Office (PMO) welcomed Joan Westfall as Administrative Program Assistant. Prior to joining the PMO, she worked at the Oregon State University (OSU) Foundation.

New to the Information Management and Networking Component (IMNC) is graduate research assistant (GRA) Anu Gupta. Gupta studies in the Marine Resource Management (MRM) program at OSU, where she works on wetland restoration. Here at the IMNC, however, she is putting long-forgotten skills from her undergraduate English degree to work as a technical editor.

The CRSP will miss its escapees, including Matt Niles, Kevin Bokay, and John Hayes.

Niles is familiar to many of you as EdOp Net editor; he served over two years as GRA in the IMNC. He has moved to Hawaii, where he is working on his MRM master's project, focusing on construction setbacks for coastal development. We at the IMNC office hope that those setbacks make for a better surfing experience...

Another graduate student to escape was John Hayes, who



HILLARY EGNA

Departing GRA and EdOp Net Editor Matt Niles

moved from the IMNC to doing full-time graduate study and research. (See p. 6 for a full profile on Hayes.)

Kevin Bokay, the former Administrative Program Assistant, has taken a faculty position at OSU's Valley Library. In the Fall 1999 issue of *Aquanews*, Bokay stated that he "always wanted to know more about the management of the University." We hope that his new position is giving him an inner window to the complicated machinations of the university.

The CRSP pond also felt ripples from members outside the PMO and IMNC. US Regional Coordinator for the Mexico Project Martin Fitzpatrick left OSU and has moved to the Oregon Department of Environmental Quality. He will continue advising students and working on Reproduction Control Research.

Finally, Chris Brown, US Regional Coordinator for the Philippines Project, moved from the University of Hawaii to Florida International University, where he will continue with his CRSP research. Brown will really be swimming with the fish as he directs the university's Marine Biology Program.

We wish everyone luck and success as they settle into their new niches! 🐟



HILLARY EGNA

Former Coordinator of the Mexico Project Martin Fitzpatrick

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AQUANEWS

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