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1994

# Aqua Farm News Volume 12(01)

## January - February 1994

Aquaculture Department, Southeast Asian Fisheries Development Center

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<http://hdl.handle.net/10862/2504>

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# AQUA FARM NEWS

ISSN 0116-6573

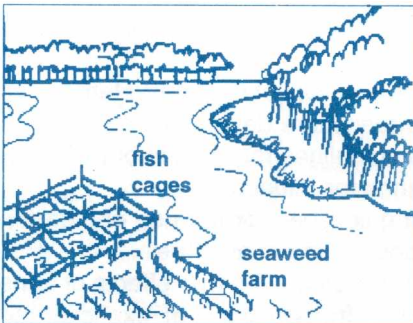
A publication of the SEAFDEC Aquaculture Department, Iloilo, Philippines

Vol. XII No. 1

January-February 1994

## The last frontier?

# Farming the sea



After 14 years of R & D, the SEAFDEC Aquaculture Department in 1987 redirected some of its resources to pursue research on seafarming and sea ranching. The premise is that seafarming and sea ranching are more sustainable, more environment-friendly, and give more social benefits than inland aquaculture. Inland aquaculture is causing the rapid deterioration of water systems, particularly the Laguna de Bay and Sampaloc Lake in the Philippines. Farming the sea may well be the last frontier in aquatic food production.

Seafarming is the growing of fishes, molluscs, and seaweeds to market size on the seabed or on special structures, excluding the culture of brackishwater and marine organisms in ponds or impoundments. Stocking the open seas with hatchery-reared seed of fishes and molluscs that are then recaptured when grown is referred to as sea ranching.

Seafarming in the Philippines concentrates on seaweeds and molluscs. Technologies for oyster and mussel culture are ripe but their culture is limited to traditional areas. Farming giant clams is new and hatchery is mostly geared to sea ranching. Seafarming of fishes is constrained by the lack of seed, feed and appropriate engineering. Sea ranching is planned by the government, with a few trials now on-going.

In Thailand, sea bass, grouper, tiger shrimp, and molluscs (more commonly blood cockle, green mussel, pearl oyster) are farmed. Seaweeds are collected in natural beds. Artificial reefs were constructed in 1987 for sea ranching.

In Singapore, net cages account for the bulk of fish produced. The fishes cultured are sea bass, grouper, snapper, yellowfin jack, golden trevally, bream, and rabbitfish. The green mussel, mangrove crab, banana shrimp, and spiny lobster are also farmed. Sea ranching has not been done.

This issue focuses on the achievements of SEAFDEC/AQD in seafarming, on some technologies for farming the sea, and on the effects of mariculture on the environment.

# Guidelines for environmentally acceptable coastal aquaculture

The ecological and socioeconomic benefits and costs of aquaculture are potentially so significant that action-oriented policies are necessary. In order to ensure that financial gain is not at the expense of the ecosystem or the rest of society, aquaculture developments must follow established principles.

## General principles

- Coastal aquaculture has the potential to produce food and to generate income contributing to social and economic well-being.
- Planned and properly managed aquaculture development is a productive use of the coastal zone if undertaken within the broader framework of integrated coastal zone management according to national goals for sustainable development and in harmony with international obligations.
- The likely effects of coastal aquaculture on the social and ecological environments must be predicted and evaluated, and measures formulated to contain them within acceptable, pre-determined limits.
- Coastal aquaculture must be regulated and monitored to ensure that impacts remain within pre-determined limits and to signal when intervention is necessary.

## Strategies and objectives

- Sound use of the coastal zone to produce aquatic products and generate income.
- Development of policy and management techniques to reduce conflict with other coastal activities.
- Prevention or reduction of adverse impacts of coastal aquaculture on the environment.
- Management and control of aquaculture to ensure that the impacts remain within acceptable limits.
- Reduction of health risks from the consumption of aquaculture products.

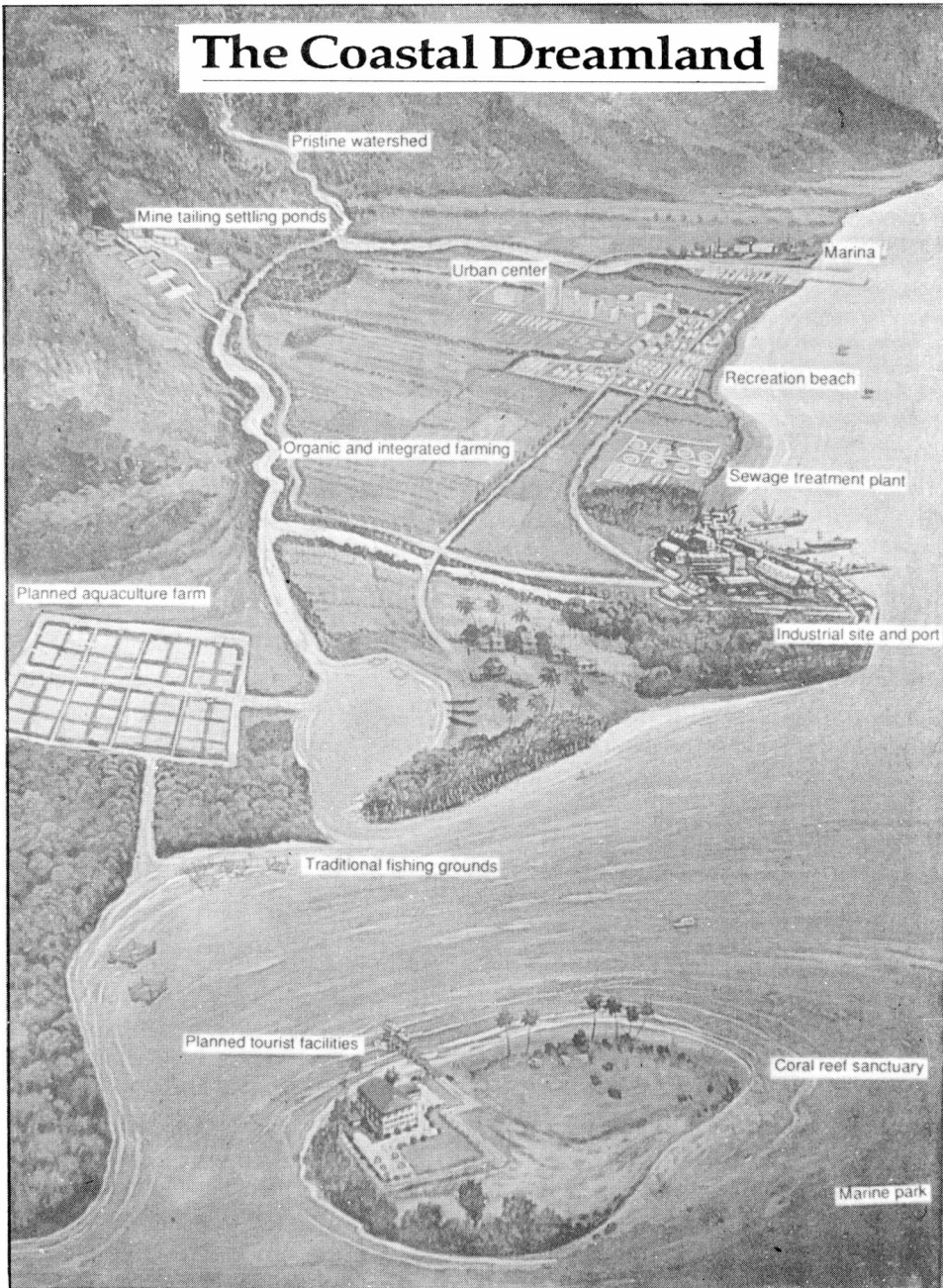
These strategies allow equitable balance between those seeking a simple livelihood, those wanting to make a profit, the quality of the environment, and the interests of the local people and the wider community.

## Action plans

- Formulate coastal aquaculture development and management plans.
- Formulate integrated coastal management plans.
- Apply the environmental impact assessment process to all major aquaculture proposals.
- Select suitable sites for coastal aquaculture.
- Improve the management of aquaculture operations.
- Assess the capacity of the ecosystem to sustain aquaculture development.
- Establish guidelines for the use of mangrove wetlands for aquaculture.
- Establish guidelines for the use of bioactive compounds in aquaculture.
- Assess and evaluate the true effects of transfers and introductions of exotic organisms.
- Regulate discharges from land-based aquaculture through the enforcement of effluent standards.
- Establish quality control measures for aquaculture products.
- Increase public awareness of the safety aspects of consuming seafood.
- Apply incentives and deterrents to reduce environmental degradation from aquaculture activities.
- Monitor ecological change.

Source: *Reducing Environmental Impacts of Coastal Aquaculture* Joint Group of Experts on the Scientific Aspects of Pollution (GESAMP). **Reports and Studies No. 47**, FAO, 1991.

# The Coastal Dreamland



Artwork by Papp/Aque

What's in the world's coasts? A US\$1.9 trillion travel industry, more than half of the planet's people, and a yield of 80 million tons of seafood a year from 17 major fishing areas that have reached or exceeded their limits.

Increasing population and economic and social development inflict heavy demands on coastal resources. The results — natural resources depletion, environmental degradation and resource use conflicts. These problems constrain development and require expensive remedial measures. But, adequate planning and proper management — like the one presented above — may allow sustainable development in the coastal areas and ensure that natural resources are available for the future generations.

Sources: (1) Worldwatch Institute as cited by *TIME*, 13 Dec. 1993; (2) TE Chua and AT White (eds.). 1989. *Policy recommendations for coastal area management in the ASEAN region*. **ICLARM Conference Proceedings 20**, p 10. ICLARM, Manila, Philippines.

## Research and development at SEAFDEC/AQD

*The mandate of academic institutions is basic research, or that which pursues knowledge for knowledge's sake. SEAFDEC/AQD is a research and development institution that caters to the aquaculture industry in the region, and hence should pursue applied research.*

*The technologies developed by SEAFDEC/AQD must take into consideration sustainable development of the region's aquatic resources. In doing so, a multidisciplinary approach is necessary. The natural scientists working with the social scientists and the fisherfolk open many venues for investigation of a problem viewed from different perspectives. The participation of fisherfolk in particular allows them access and understanding of the technologies developed, they who are the traditional users of aquatic resources and who are most affected when the environment is sacrificed for the sake of progress.*

*SEAFDEC/AQD must help make aquaculture sustainable.*

- Dr. Efren Ed. C. Flores, Chief, SEAFDEC/AQD (1992-present)

### AQD's 20 years of R & D

The SEAFDEC Aquaculture Department, established in 1973, has had 20 years of research and development. It has contributed substantially to the rapid expansion of the giant tiger shrimp industry in the Philippines, through technologies for broodstock development, hatchery and nursery operations, and pond culture, disease prevention and control in hatcheries and ponds, and in feed development for various life stages.

SEAFDEC/AQD made advances in milkfish culture. Existing grow-out technology was refined. Milkfish has been bred in captivity. The techniques developed in artificial propagation and seed production enabled the Philippine Government to launch a milkfish breeding program in the country in 1980-1992. Feeds were also developed for milkfish broodstock, larvae, and juveniles. Milkfish ecology was documented.

As with milkfish, spontaneous spawning of grouper, hormone-induced spawning of red snapper, and improved spawning, hatchery and nursery techniques for sea bass are expected to solve the problem of fry supply.

Tilapia research has shifted to genetics and to the nutritional requirements of fry and

fingerlings. Carp and catfish research include induced spawning and seed production.

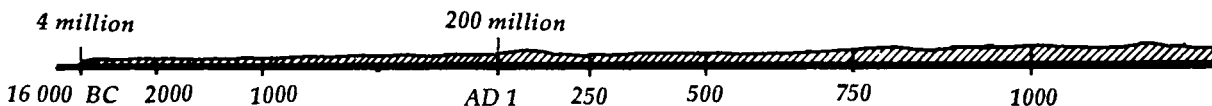
SEAFDEC/AQD's contributions to the development of the aquaculture industry in the region include the many bits and pieces of laboratory findings that filled up the knowledge gaps in:

- small-scale hatchery technology for shrimps
- nursery and pond culture of shrimp and milkfish
- culture of oysters and mussels
- culture of tilapia
- pen culture of milkfish
- disease and pollution control
- feeds and feeding methods
- identification of seaweed species for culture

As a result, the aquaculture industry has developed significantly and total production has increased.

The impact of aquaculture on the environment and the cost-effectiveness of developed technologies have recently been the concern of AQD. More studies are planned for ecologically sound aquaculture.

More precisely, SEAFDEC/AQD's transferable technologies — those that can be picked up by the private sector — are reflected in the training courses it has conducted on:



- shrimp hatchery and nursery operations
- marine fish hatchery (including milkfish and sea bass)
- fish health management
- fish nutrition
- brackishwater pond culture
- aquaculture management, methodology, and engineering
- sanitation and culture of tropical bivalves
- freshwater fish hatchery
- freshwater aquaculture
- culture of natural food organisms (including *Artemia* culture)

Or that which have been written up as manuals and pamphlets or produced as video programs, including:

- farming of tiger shrimp, sea bass, tilapia, and molluscs
- broodstock management for tiger shrimp, milkfish, and carps
- hatchery of tiger shrimp, sea bass, milkfish, and tilapia
- diseases and its control for tiger shrimp
- feeds and feeding tiger shrimp
- biology and taxonomy of siganids, milkfish, seaweeds, sea bass, and tiger shrimp
- culture and use of algae
- soil and water quality determination, feed analysis

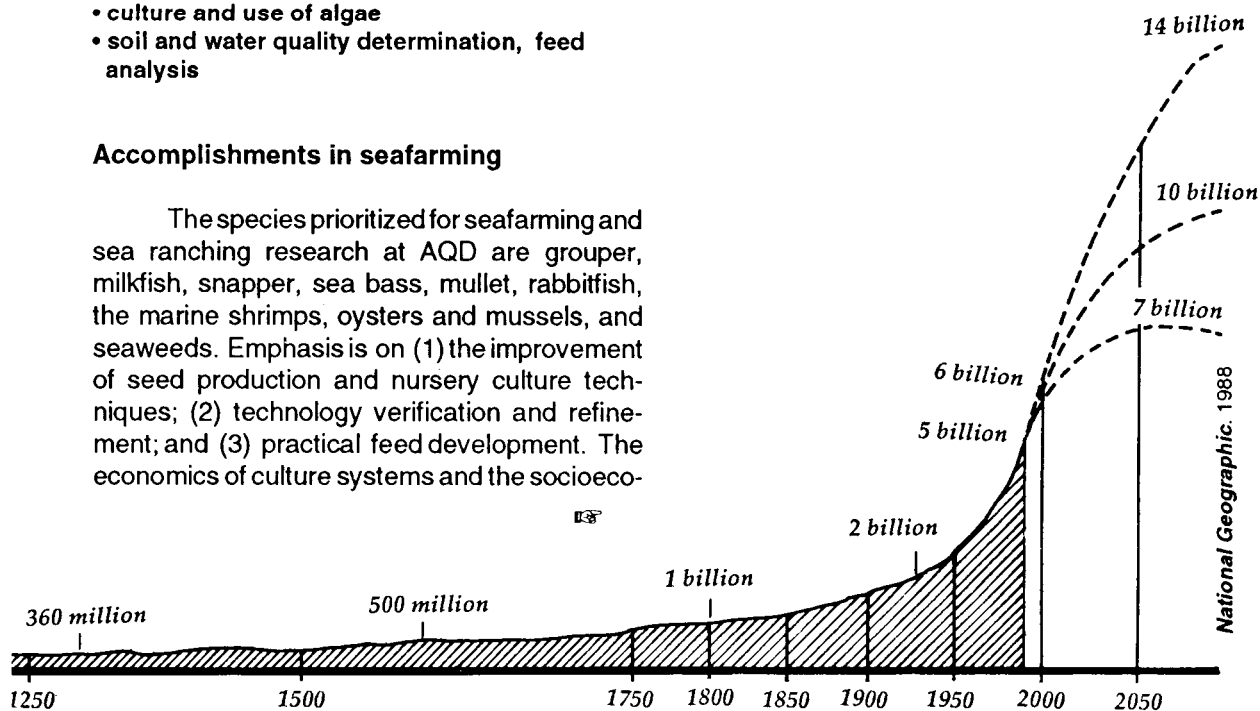
### Accomplishments in seafarming

The species prioritized for seafarming and sea ranching research at AQD are grouper, milkfish, snapper, sea bass, mullet, rabbitfish, the marine shrimps, oysters and mussels, and seaweeds. Emphasis is on (1) the improvement of seed production and nursery culture techniques; (2) technology verification and refinement; and (3) practical feed development. The economics of culture systems and the socioeco-

### Too many mouths to feed

The 5 billion human beings alive today probably represent 6-7% of all who have lived in our species' 350 000 to 100 000 - year genealogy. As infant and childhood survival rates improve with public health, growing numbers reach childbearing age; life expectancies also increase. The doubling period for world population has shortened from centuries to mere decades. Three ranges (below) project the size of the future population — and the need for more and more food.

Fish is one of the cheapest protein sources for human consumption being studied in research institutions across the world. In the Philippines, institutions such as the SEAFDEC Aquaculture Department, the International Center for Living Aquatic Resources Management, the Department of Agriculture, and the University of the Philippines are involved in fisheries and aquaculture R & D, and are expected to find ways to produce more food for even just the country's 65 million people.



conomic status of coastal communities are also studied. Research on freshwater fishes now concentrate on genetic improvement, breeding, feed development, and the effects of aquaculture on the freshwater environment.

As a pilot study, an integrated sea-farming and sea ranching project has been set up in Malalison Island off western Panay. The project seeks to show the effectiveness of participatory research involving the fisherfolk in making aquaculture sustainable. To date, biological studies and test farming have been conducted. The results obtained in 1992-93 are given below. These results are unpublished and must not be cited without the authors' permission.

### **The Case of Malalison Island**

Community-based management of fishery resources in Malalison Island was studied by Giselle Samonte. Low fish catch and poverty were identified by the Malalison residents as the priority issues that need to be addressed. Management techniques suggested by Malalison fishers include prohibitions on illegal fishing (muro-ami and dynamite), setting seasonal exploitation limits, public education on resource conservation, and alternative livelihood.

The traditional marine boundaries and territorial use rights in fisheries in Malalison Island were investigated by sociologist Susan Siar. Aside from Malalison fishers, traditional users of fishing grounds around Malalison come

### ***World Aquaculture in the '90s***

- About 152 species of algae, fish, crustaceans, molluscs and other aquatic animals are under some form of culture.
- Production continues to be dominated by 20 countries (China is number one), and 12 of these are Asian (including the Philippines)
- The value of global production is about US\$19 billion (capture fisheries is valued at US\$73 billion).
- Production in the marine environment is almost entirely molluscs and algae, whereas freshwater production is almost entirely fish.
- Aquaculture, like agriculture, relies on a small number of crops like salmon and seaweeds for the greater part of its total production.

Source: *World Aquaculture* Vol. 21 (No. 2), June 1990.

#### **What is aquaculture?**

AQUACULTURE is the farming of aquatic organisms -- fishes, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention to enhance production -- regular stocking, feeding, protection from predators -- and individual or corporate ownership of the stock being farmed. Categories: inland aquaculture (or freshwater culture) and coastal aquaculture.

COASTAL AQUACULTURE means farming and harvest of stock in brackish or seawater including offshore activities, coastal ponds, and onshore tanks supplied with brackishwater or full-strength seawater. This includes species that spend part of their life cycle in freshwater.

Source: *Regional Workshop on Fisheries Information and Statistics in Asia*. Bangkok, Thailand, 8-12 Jan 1994. FAO/SEAFDEC.

from 12 of 16 coastal barangays of Culasi, including the nearby island of Batbatan. These fishing grounds possess the characteristics of open access, communal, and state property. There is no claim or ownership of specific fishing spots. Certain arrangements are observed for setting up gears. The accepted practice of "first come" determines allocation of fishing space for hook and line. Fishing nets are usually set about 50 meters apart.

The economic utilization of resources in Malalison Island was determined by Rene Agbayani. A village transect enumerating and depicting the location of water- and land-based resources was completed along with a survey of the income and expenses of 35 fishermen using different gears. The coastal resources are the main sources of income for 90% of the households. Land-based activities, that is, fish selling, net mending, and boat making, are also fishery-related. There are also households that raise pigs and chicken for market. Fishermen who use nets have the highest average annual income of P17 600. Those who use spears earn P12 900 a year; and hook and line, P5 040. The peak fishing season is April-May; incomes fall during the rest of the year.

Resource assessment in the waters around Malalison Island was conducted by Ronald Cheong in 1991. A total of 210 species of fish belonging to 29 families were identified. Labrids and pomacentrids were dominant in terms of species richness and abundance. Five species of seagrasses and 64 species of macrobenthic algae were identified (21 greens, 15 browns, and 28 reds). At the south side of the island, encrusting corals were dominant and live coral cover was poor (17%). At the north side of the island, non-*Acropora* branching corals were dominant, and live coral cover was in fair condition (35%).

Stock assessment of fish populations in Malalison Island was conducted by Edgar Amar. Some 494 fishing operations were recorded from February 1991 to January 1992. Mean catch per unit effort (CPUE, kilograms per man-hour) by gear type were: spear, 1.1; spear with compressor, 1.4; set gill net, 0.4; drive-in gill net, 2.4; drift gill net, 1.2; and hook and line, 0.7. The

common species caught by the various gears were: surgeonfish and octopus by spear; fusiliers and surgeonfish by gill nets; and emperors, snappers and groupers by hook and line. The total catch by all gears was highest in July and October and lowest in November and December.

The work on resource assessment in Malalison was continued by Clarissa Marte in 1993. The coral species were identified. A manta tow survey around Malalison showed that live coral cover on fringing reefs varied from 19 to 69% with a mean of 35%. Reefs on the northeast side of the island were in better condition than those on the southwest side. The number of fish species and the abundance of fish populations varied with the coral cover. The comparatively low estimate of fish yield in Malalison reefs based on data from fish landing indicates an overfished condition.

The cage farming of siganids (*Siganus* spp.) in Malalison Island was studied by Edgar Amar as an alternative livelihood for coastal fisherfolk. Weekly sampling by dragged seine showed that juveniles less than 2 cm long appeared in seagrass flats in Malalison between the new moon and first quarter; numbers were

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highest in June but very few in July. New schools of juveniles appeared in September and October but not in November. The dominant species were *S. spinus* and *S. canaliculatus*. Juvenile *S. guttatus* were not present in the seine samples, but a few 6 cm long were caught by gill nets. So, *S. guttatus* (about 7 grams) were obtained from an estuary in nearby Pandan town and transported to Malalison for cage farming. Stocked at 30 per cubic meter, the juveniles grew to 33 grams after 75 days. These were transferred to lgang for grow-out in cages. They grew to 202 grams after 120 days on a SEAFDEC formulated diet with 40% protein; feed conversion ratio was 1.3. A cost-return analysis showed a 10% return on investment. Feed was the major expense, about 60% of production cost. If a low-cost feed can be developed for juvenile *S. guttatus* (siganids are herbivorous in nature) and if two crops can be raised each year in a sheltered location, then cage farming of siganids may be profitable. But it is not a suitable alternative livelihood for Malalison fisherfolk.

Cultivation of the seaweed *Kappaphycus alvarezii* with the grouper *Epinephelus* sp. was initiated by Anicia Hurtado-Ponce in Malalison Island. In one experiment, the seaweed was grown on horizontal lines, vertical lines, or clusters. The % weight increase per day varied significantly by culture technique, but production was not different. In another run, the sea-

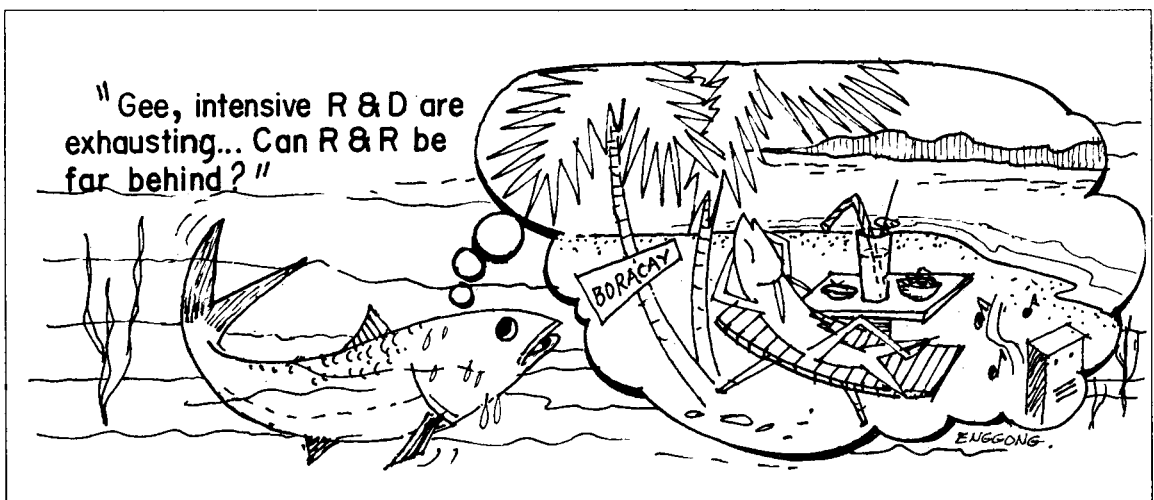
weed was grown for six months on a bamboo raft with or without an enclosing net cage with juvenile groupers. Highest growth and production of seaweed were recorded in March-April and a total of 406-454 kg was harvested. About 24 kg of grouper (97%) survived, each 170 gram on average.

Case studies on women in fishing and oyster farming were made by Susana Siar, focusing on women in Malalison Island and Binaobawan, Capiz. Based on whole-village interviews and time allocation charts, women work longer hours than men each day. In Malalison, women work 4 hours at home and 6 hours in income-generating activities. Men spend 2 hours in house work and 7 hours in fishing and other livelihood. In Binaobawan, women work 4 hours at home and 5 hours in buy and sell activities; men spend one hour in house work and 5 hours in fishing and other livelihood.

### Snappers for Sea Ranching

Territorial reef fishes such as snappers are being considered for sea ranching trials in Malalison. First, a sufficient seed supply must be assured. Thus, breeding and rearing studies were conducted.

A broodstock of the mangrove red snapper is being developed by Arnil Emata for purposes of seed production for seafarming and sea ranching. Snappers caught from the wild were

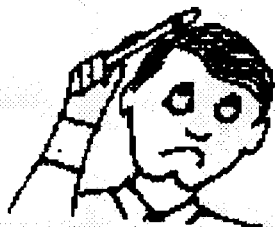


kept in a floating net cage or a concrete tank. They were sexually mature in May-October 1992. In August, mature females and spermiating males were injected 50 micrograms LHRHa or 1 500 IU hCG per kilogram body weight. About 1.2 million eggs were spawned 27-36 hours after injection. Fish that spawned rematured 4-5 weeks later. In 1993, the snapper broodstock in cages were sexually mature from March to November, but the tank-reared ones only from May to October. Among broodstock in a 5 x 5 x 3 meter deep cage, 1 kg males and 2.5 kg females were already sexually mature. Single injections of 1 500 IU hCG per kilogram body weight resulted in spawning 32-40 hours later. About 0.5-2.2 million eggs were collected from different females.

Larval rearing techniques for the mangrove red snapper are being developed by Marietta

Duray. Snapper larvae only 2.3 mm long started feeding on rotifers on day 2. All larvae 3 mm long were feeding by day 7 and rotifer intakes increased as the larvae grew. On day 22, snapper larvae 6.3 mm long started feeding on *Artemia* nauplii. In one experiment, snapper larvae were reared for the first two weeks on either rotifers alone or rotifers supplemented with two microparticulate diets. Larvae fed rotifers with FRIPPAK were bigger than those fed rotifers alone or rotifers with Nosan R-1. Survival was not significantly different among the treatments.

Another experiment by Marietta Duray determined the appropriate density of *Artemia* nauplii for rearing three-week old snapper larvae to day 35. Survival was as high as 81% but not different among treatments. Another set of three-week old snapper larvae were fed 2 nauplii per ml



#### Document delivery service

SEAFDEC/AQD now supplies information materials from various sources using the ASFA on CD (Aquatic Sciences and Fisheries Abstracts on compact disc), BRAIS (Brackishwater Aquaculture Information System), in-house data bases, and the British Library Document Supply Center (an international photocopy service). Send queries — title of document or article; author; title of journal, book, or conference proceedings; volume and issue number; page number — to The Library, SEAFDEC/AQD. Charges include photocopy and mailing cost at P3.50 for the first page plus P1.75 for every page thereafter.

#### Back issues of *Aqua Farm News*

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- Artificial reefs, Sept-Oct 1991
- Seaweeds, Nov-Dec 1991
- Ornamental fishes, Jan-Feb 1992
- Mud crab, Mar-Apr 1992
- Farming the grouper, May-June 1992
- Mollusc culture, Jul-Aug 1992
- Snappers, Nov-Dec 1992
- Milkfish breeding, Mar-Apr 1993
- Tilapia culture, May-June 1993
- Policing fisheries, Jul-Oct 1993

either 1, 2 or 4 times daily. Survival on day 35 was much better among larvae fed 4 times a day than among those fed once or twice daily. Rearing snapper larvae is easier than rearing grouper larvae.

### The Case of Molluscs

Technical and socioeconomic assessment of oyster and mussel culture in Binaobawan, Pilar, Capiz and Lakaran, Dumangas, Iloilo was conducted by Wenresti Gallardo and Susana Siar. Rapid rural appraisal was used to understand the physical layout of the two villages and the livelihood and socioeconomic situation of the villagers, particularly the oyster and mussel farmers. Fishing is the major source of livelihood in both villages. In Binaobawan, 77% of the villagers are engaged in oyster and mussel farming. Oysters are cultured by the bottom method and mussels by the platform method. Production of oysters in Binaobawan could be increased by adapting the method used in Lakaran. In Lakaran, all residents are engaged in oyster farming by the rack hanging line method. Culture of green mussel (*Perna viridis*) and brown mussel (*Modiolus metcalfei*) is being developed in Lakaran with the active participation of the oyster farmers.

A survey of the kapis (*Placuna placenta*) fishery in the Philippines was conducted by Wenresti Gallardo. There are 27 remaining kapis beds, six of which are now the major

sources. Kapis stocks are declining and many beds are already depleted due to excessive gathering, siltation, trawling, and pollution. Kapis shells support an open access fishery; anybody can gather shells by handpicking in shallow areas, compressor diving in deeper areas, and dredging. To prevent further depletion of this resource, several measures are recommended: establishment of sanctuaries, ban on trawling and other destructive fishing, enforcement of existing regulations, community-based fishery management, and further research on seed production, restocking, and transplantation.

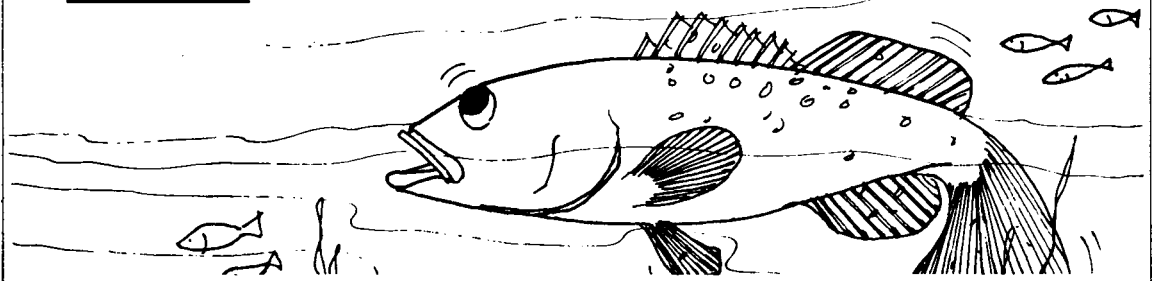
The reproductive biology of the abalone *Haliotis asinina* is being studied by Emmanuel Capinpin. Monthly field sampling was conducted in Panagatan Cays (between Antique and Palawan) in November 1993-February 1994. Ninety-five specimens with shell lengths of 4-10 cm have been collected. A modified gonad bulk index was calculated, then gonads were preserved and processed for histological observations.

### Future direction

In the next decade and beyond, SEAFDEC/AQD will continue research on economically important species in Southeast Asia. The Department aims to develop sustainable aquaculture.

### Support sustainable aquaculture

"Loaded slogan this! The key to survival – ours and theirs."



## The basics of cage and pen culture

Cage and pen culture nearshore has these advantages: simple technology, low investment compared to pond culture, and suitability in almost any body of water. There are many commercially important species that can be cultured in pens and cages: salmonids, groupers, carps, tilapias, sea bass, catfish, snakehead, and milkfish. A recent trend is the culture of shrimp, crab, and lobster in cages, and sea cucumber in pens.

### Site selection

Consider three factors: water quality, depth and current. Water temperature, pH, salinity and dissolved oxygen should meet the specific requirements of the fish species to be cultured. Water depth should allow a minimum distance of 1 meter between the cage and bottom sediment. This makes for better water flow through the unit and minimizes contact between the stock and the bacteria in the bottom sediments. (Settled cages are set up in calm, relatively clear waters.) For pens, water depth should be at least 3 meters and the bottom not very muddy. Too much organic matter lowers water quality. Current speeds of more than 40 cm/sec should be avoided; 10-20 cm/sec is desirable to maintain good water quality and to prevent fishes from spending too much energy swimming.

### Nets, floats, frames, and anchors

Flexible nylon or polyethylene nets are common materials for cages and pens. They are cheap, and can be treated with anti-fouling chemicals. Plastic construction materials and galvanized or plastic-coated steel are used for rigid cages and pens. The net mesh should be as large as possible to encourage a good flow of water without letting out the stock. Large mesh allows high oxygen content and reduces fouling.

Floats and pontoons may be made of empty oil drums, plastic containers, styrofoam or especially designed air- or foam-filled plastic floats. More resistant materials are preferred, as

crustaceans and molluscs can bore into softer material.

Frames must be strong, corrosion-resistant, and easily replaced. Aluminum, wooden beams, bamboo poles, galvanized pipes, steel and flexible rubber hoses are examples. As cages have become bigger, non-slip walkways with guard rails and that can ride waves have been designed.

Strong anchors are necessary to hold the cage in position, particularly in rough seas. (See separate story, this issue.)

### Choice of culture method

Cages and pens may be classified as extensive, semi-intensive or intensive. Extensive and semi-intensive methods are suitable for fishes that feed on plankton and detritus and do not require much protein. In intensive culture,



### Environmental considerations for sea farms

- Sea farms must be sited in locations with good water exchange -- fast-flushing bays or the open sea -- and not over stagnant deep waters.
- Loss of uneaten feeds must be minimized by paying attention to stock numbers and feed requirements, and avoiding heavy reliance on automatic feeders. Dust should be removed by sieving the feed to reduce waste. Moist or wet feeds should not be used.
- Dead fish and predators caught in anti-predator nets should be regularly removed and disposed onshore. Undersized and dead molluscs and other fouling organisms, too.

feeds represent 40-60% of total operating costs. The market and other factors must be able to justify the high cost of feeds involved.

### Variations of the theme

More and more systems are now completely integrated. Units for staff accommodation, power generation, automatic or computerized feeding, feed storage, and fish grading and transport equipment are built together. In a

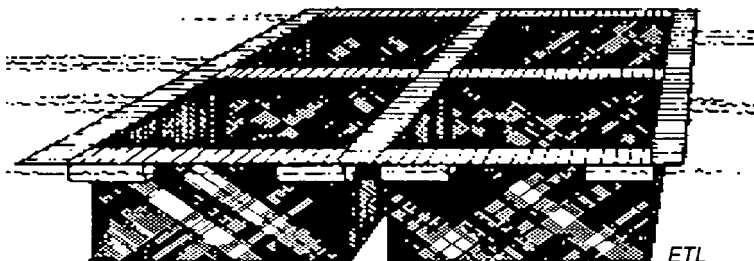
vacuum pump system, fish are sucked into a hose and into a sorter that removes the water and size grades the fish. This minimizes damage during transfer of fish to cages or boats.

Some farms use a computer program in stock management. The program simulates biomass changes during the growth cycle and records stocks and feeds.

Source: F Buranudeen. *The basics of cage and pen culture*. INFOFISH International 2/89.

## Cage culture of sea bass in Malaysia

*Cages are generally rectangular and are made of polyethylene nets. Their sizes vary: 3 x 3 x 2 m, 4 x 4 x 3 m. The estimated cost of one platform (4 cages of size 3 x 3 x 2 m) is MYR 2000-2500.*



Sea bass 5-8 cm long are stocked in cages at densities of 15-25 fingerlings per m<sup>3</sup>. After several weeks, densities are reduced to 10-23 per m<sup>3</sup>. Although there is a large government hatchery and some local seed suppliers, the bulk of sea bass stock is imported from neighboring countries, especially Thailand.

Sea bass are fed "trash fish" once a day. As they grow, sea bass are periodically graded to prevent cannibalism.

Sea bass attain marketable size (500-600 grams) in about 6-8 months. Survival is 60-80%. They are marketed live in local restaurants or exported to Singapore. The ex-farm selling price is around M \$ 9-10 per kilogram.

### Problems

Foremost among the problems are feed and seed. "Trash fish" is the main source of feed for the cage culture industry; supply is limited

and the quantity and price subject to seasonal variations. Although a number of prepared feeds have been introduced by both the government and the private sector, their use has not quite caught on, mainly because of high cost and doubts about their efficiency.

Most of the seed supply is from Thailand and the longer transport time means stress. Transport costs add to the price of the fry. The government encourages and provides training in hatcheries. Many have already set up their own sea bass hatcheries after attending the government courses.

Another problem is overcrowding of fish cages in a particular area. Water flow is hindered, resulting in accumulation of feces and uneaten food. Excessive stocking and feeding by some overzealous but misguided culturists further worsens the problem. Overcrowding and poor water quality stress the fish and they suc-

ETL p. 15

# Tiger shrimp pens in Thailand

## Site selection

Protected bays, coves, and inland sea are ideal for pen culture. Suitable sites for pen culture of the tiger shrimp *Penaeus monodon* have these characteristics:

- Protected from strong winds, waves and current
- Free from domestic, industrial and agricultural wastes and other environmental hazards
- Water depth of 1 meter at the lowest tide during the full and new moon periods
- Clay soil
- Bottom slope of less than 15°
- Adequate water circulation
- These water characteristics:

	Range
pH	7.5 - 8.3
Dissolved oxygen	4-8 mg/l
Salinity	10 - 32 ppt
Temperature	26 - 32°C
Ammonia-nitrogen	< 0.02 mg/l
Current	< 1 m/sec
Hydrogen sulphide (in soil)	none

## Pen construction

A cubical pen is the most convenient design. It is made of synthetic net framed by wood or bamboo. Stout poles are placed at the corners. The size is 6 x 6 x 5-6 meters with a 1.4 mm net mesh. A larger mesh, 5 mm, is used for shrimps after one month. As fouling organisms, crabs, or flotsam can damage nets, a two-layer net may be used to prevent the stock from escaping.

## Rearing

The stocking density of 5-cm fry is 4000 per pen. Fry are given feeds with ground "trash fish" or squid at 10-20% of body weight per day.

Feed is given 4-5 times a day at 0700, 1200, 1600, and 2200 H. The feed is placed on feeding trays, six trays in each pen. The trays consist of wooden frames (0.5 x 0.5 meter) with nylon nets, are weighed down with stones but suspended 30 cm above the bottom. The feeding trays are checked for leftovers and the amount of feed is adjusted according to consumption.

Growth and survival are checked by sampling with a cast net. Sampling is done every week in the first month of culture, and bimonthly after that. Water quality is checked regularly.

The pen is checked biweekly for damage and the nets cleaned and changed. Spare nets should always be available.

## Harvest

Harvest early in the morning. Use cast nets so that the shrimp can be transported live to the restaurant or market. Production usually reaches 100 kg per pen after 3-4 months of grow-out. Survival is 75% for shrimps of size 30/kg.

## Return on investment

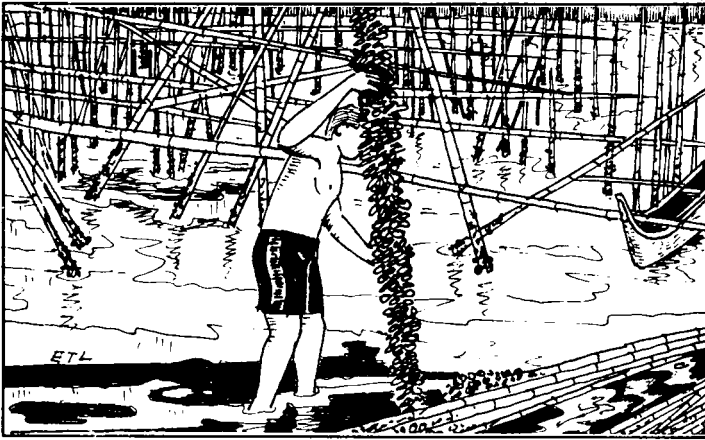
The cost of pen and frames is about Baht 8000; the fry and feed per crop, B 6000; and the total cost per crop, B 8500.

The production per crop is 100 kg per pen, and the sales B 15 000. Thus, the fish farmer can profit B 6500 per crop or B 13 000 per pen per crop (1 Baht roughly 1 Philippine peso; 1 US\$ = P28).

Pen culture of the black tiger shrimp could indeed be profitable for fish farmers throughout Southeast Asia.

Source: S Tookwinas. *Pen culture techniques of marine shrimp in Thailand*. INFOFISH International 2/90.

## Oyster and mussel farming



### Philippines

In western Visayas, oysters and mussels are farmed mostly by small-scale fishermen in estuaries, bays, and other sheltered coasts. Farm size is about 3000 square meters.

Culture starts with spat collection. Farmers have their own methods of forecasting spatfall. The indicators for oysters include barnacles on spat collectors, yellowish and itchy water, mixing of seawater and freshwater, and water bubbles. Farmers note that barnacles, fat mussels, and itchy water indicate mussel spatfall in 2-3 weeks. Visual inspection confirms spatfall.

Oyster spat is collected year-round. Mussel spat is collected in May-July and October-January. Spat collectors for oyster include empty oyster shells, stones, bamboo poles, nipa petioles, palm wood, mangrove branches, and old tires. For mussels, they can be bamboo poles.

Oysters and mussels are mostly farmed where they are collected but some are transplanted to better growing areas.

The stake method is preferred for oyster culture because it is cheap and productive. The stakes are easy to manage and can not be easily stolen. In this indigenous technology, rows of stakes are arranged less than a meter apart, with 86 stakes per row and 35 rows per farm.

The stake and raft methods are popularly used for mussel culture. In the stake method, bamboo poles 10 meters long are staked 1 meter apart and tied to 3-5 horizontal braces. Poles may also be tied wigwam style in a 2-meter circle. Rafts measure 9 x 12 meters and are made of 40-50 bamboo poles. During the first 2-3 months, the rafts are allowed to float within the confines of a rectangle of bamboo posts. Thereafter, when the mussels become heavy, the raft is tied to the posts at a fixed position in the water column. Posts may be added to

further support the heavy raft. Raft culture in western Visayas differ from the Japanese system where floats and anchors are needed.

The stake and the raft methods allow for easy harvest and can yield high returns at less expense. The raft method causes less siltation than the stake and bottom methods of farming oysters and mussels.

Management of oyster and mussel farm include thinning out stocks and removing attached pests and visiting predators.

Oysters are harvested as early as 6 months and mussels at 8 months, but usually 10-12 months after spat collection. Oysters are harvested when they are 7-8 cm long and 5 cm wide, mussels when 6 cm long and 3 cm wide. Harvesting is usually done in the morning and lasts from 1 to 4 hours. The oyster or mussel farmer harvests 4 to 5 times a week during the harvest months. Oysters may be harvested year-round but mussels for only 2 months.

Source: GPB Samonte, WG Gallardo, RF Agbayani, SV Siar, RS Ortega, RE Tumaliuan, DZ Bermejo, and LAT Espada. *Socioeconomics of oyster and mussel farming in western Visayas, Philippines*. Report submitted to the Asian Fisheries Social Science Research Network based at the International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines. 1993.

## Pearl culture in abalone



Pearl culture in the abalone *Haliotis* is carried out in Japan, Korea, Canada, and the United States. The quality of abalone pearls, as determined by surface texture, is superior to

those produced in freshwater mussels and comparable to those of the marine pearl oyster *Pinctada*. Abalone pearls are priced at about US\$300 for a 13-millimeter AAA grade semispherical or mabe piece.

The farmer can grow pearls in 6-8 cm abalones for a year or so. This size of abalone, however, takes about 3 years to grow. Hatchery-bred abalone seed cost Canadian \$16 per pound. Pearl culture can take 3-18 months depending on water temperature, and age and food of abalone. But the abalone can be sold as food, and production costs can be more than offset by the price of the pearls.

Pearls are produced by nucleation, where plastic, soapstone, or mother-of-pearl is slipped beneath the mantle epithelium of the abalone.

The nucleus must be secured against the movement of the abalone's muscular foot. Following nucleation, the mobile abalones are placed in a secure enclosure to prevent their escape. In British Columbia and California, screened plastic drums suspended in the sea are used. Abalones must be fed at least weekly with the kelp *Macrocystis*, and the seaweeds *Gracilaria*, *Laminaria*, and *Nereocystis*. Fouling organisms, sea stars, and octopuses must be regularly removed from the culture area.

Within several days following nucleation, a thin chalky layer is secreted against and around the nucleus. Then, a thick, tan-brown layer of conchiolin is deposited. Conchiolin forms the foundation for a layer of porcelain-like, prismatic aragonite crystals, and a layer of nacreous aragonite. In a properly cultured abalone pearl, the conchiolin is about 1 mm thick. In Vancouver, semispherical pearls can be cultured in *Haliotis kamtschatkana* to a diameter of 17 mm. In Japan, pearls can be grown to 22 mm in *Haliotis discus*.

Source: P Fankboner. *Pearl culture in abalone*. INFOFISH International 4/91.

### New Zealand

A mussel farm is usually 3 hectares with 10 surface longlines. The farm is sited in areas with a current flow of 0-4 knots, in unexposed, semi-enclosed bays and moderately exposed open seas with depths of 5-40 meters. Spats are collected where they are abundant by "catching ropes" and transferred to farms. It takes 1-6 months for the mussel to grow to the ideal reseeding size of 10-20 mm. The mussels take 10-12 months to grow to market sizes in reseeded lines.

Source: P Large. *Mussel culture success*. INFOFISH International 4/89.

### SEA BASS CAGES IN MALAYSIA ... FROM PAGE 12

cumb easily to diseases and parasites. Mass mortalities of fish have occurred in a number of cage farms.

### Cage culture booms, nonetheless

In spite of these problems, sea bass farming has so far managed to sustain its boom in Malaysia. In 1989, the sea bass production of 1538 tons was 21% higher than the preceding year. In fact, production has been increasing steadily over the last 5-6 years. With good management and attention to some of the problems being faced, there is every likelihood of a further increase in production in the future.

Source: T Singh. *Malaysia enjoys the sea bass boom*. INFOFISH International 2/91.



## Offshore fish farming

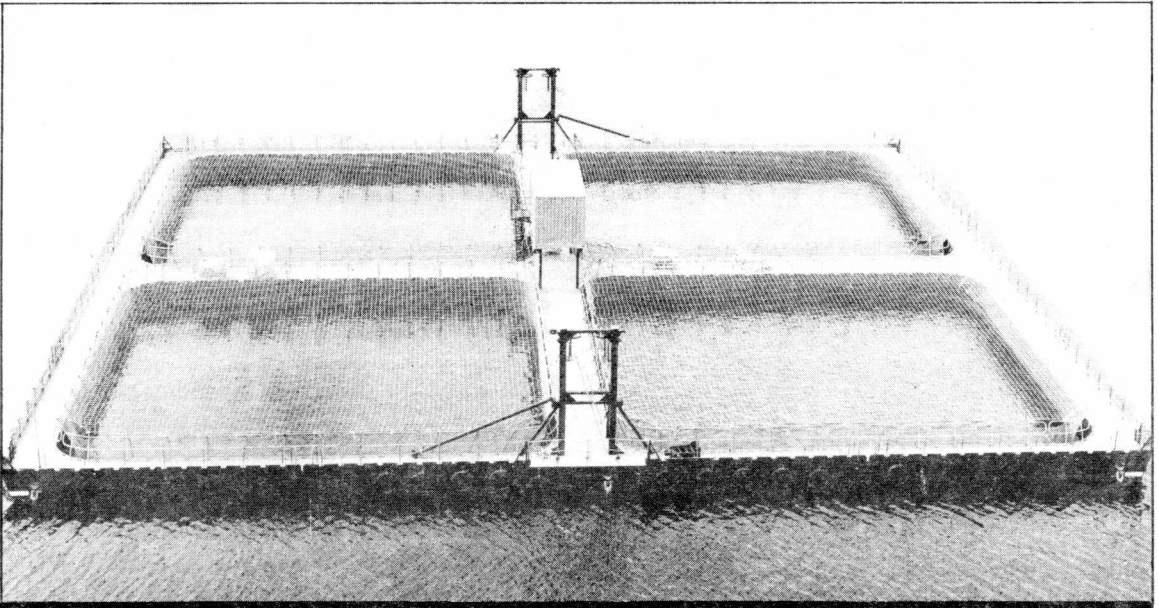
Marine fish farming in pens and cages is new, and concentrates mainly on intensive production of high-value fish. Species grown in offshore farms include yellowtail and red sea bream in Japan, sea bass and sea bream in the Mediterranean, and Atlantic salmon in western Europe. The salmon industry provides the most dramatic illustration of technical developments in offshore fish farming.

Atlantic salmon farming is dominated by Norway. Scotland and Ireland are also major producers. Other producers include Chile, Canada, Australia, Faroe Islands, and Iceland. At the end of the '70s, about 20 000 tons of salmon have been produced by aquaculture and up to 360 000 tons are forecast by the year 2000.

### The need to move offshore

Three strong motivations for offshore fish farming:

- Urban and industrial pollution has prevented the development of inshore fish farms. In some areas, there are simply no more suitable or undeveloped sites.
- The strong pressure to preserve the remaining mangroves and coral reefs. (See also the impact of seafarming, this issue.)
- The potential profitability of offshore farming in countries that do not have sheltered coasts but have suitable water quality.



**A prototype offshore cage system built by a Scottish shipyard. For further information, contact: Campbeltown Developments Ltd., Trench Point, Campbeltown, Argyll PA 28 6EP. Fax: +44 586 552 728.**

Source: *Fishfarming International*, Aug 1993.

## The challenge

In the more exposed offshore environment, the cage unit is at the mercy of wind and waves. The cage must withstand these forces. This is not in itself a difficult task given the technology for oil production at sea. Oil rigs can withstand the most extreme conditions and there are very few mechanical failures. The important factor in offshore farming is the cost, which must be justified by the value of the fish produced. It is appropriate technology at the right price.

The next consideration is management. The ideal offshore system should be fully equipped and mechanized to allow automation of monitoring and control. The economics of fish farming do not allow helicopter transport of staff yet!

Fully serviced systems are being evaluated by a Norwegian company. The system has its own accommodation, power, automated feeding system, and equipment for mechanical grading, harvesting and off-loading of fish. The steel structure is 126 x 32 meters wide, with a total volume of 25 000 m<sup>3</sup>. Annual production is estimated at 500-700 tons.

Other concepts include a "mother" platform, containing all support services, surrounded by submersible "satellite" production units. The culture units are protected from waves and wind and could even allow aquaculture under ice in Atlantic Canada, for example.

Finally, the effect of the offshore environment on the fish must be studied. More exposed conditions may cause stress or damage to stock.

## What of the future?

The potential for offshore fish farming is enormous. However, it is costly, and can therefore happen only in buoyant markets. The market for farmed fish may or may not continue to grow at its present remarkable rate. But, under the right circumstances, offshore fish farming will dramatically increase marine fish production from aquaculture.

Source: C Clarke and M Beveridge. *Offshore fish farming*. INFOFISH International 3/89.

# SEA RANCHING

*To improve productivity, aquaculture development will involve the dispersal of 50% of government-produced milkfish and shrimp to the open sea.*

- Philippine Department of Agriculture Medium-term Development Plan

Migratory fish species such as salmonids have long been ranched in the western USA and in Japan. With the emergence of cheap mass-produced seed, sea ranching of other species has been tried -- red sea bream and kuruma shrimp (*Penaeus japonicus*) in Japan, tiger shrimp in Taiwan, and *Trochus* and the giant clams in several Pacific Island countries.

Japan releases 2/3 of all hatchery raised kuruma shrimp in open waters -- about 600 million fry a year.

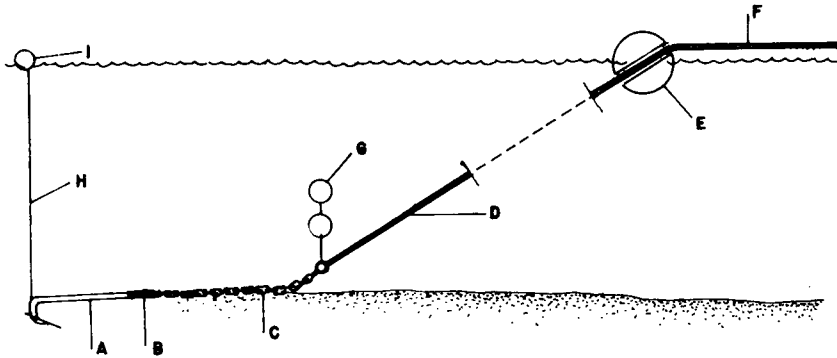
In PR China, the government has released artificially hatched juvenile marine shrimp (*Penaeus orientalis*) in the open sea. In 1986, more than 4 billion juveniles were released in the Pohai Sea and the Yellow Sea at a cost of about US\$4 million. The recapture rate was 4.6-8.2%. This amounted to 4800 tons with a value of US\$24 million in 1986.

In the Philippines, the government plans to disperse milkfish and shrimp. SEAFDEC/AQD also plans the sea ranching of reef fishes off Malalison in western Panay. Snapper juveniles will be test-released in the artificial reefs that will be deployed around the island. Stock enhancement of the abalone *Haliotis asinina* is also planned in depleted areas.

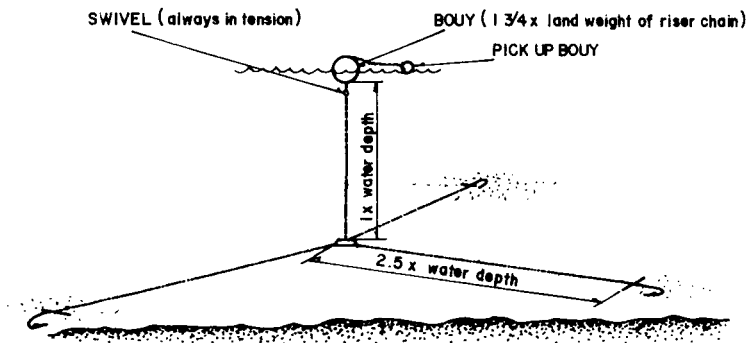
Sources: (1) Csavas. *Recent developments in coastal aquaculture in the Asia-Pacific*. INFOFISH International. 4/89. (2) YC Shang. *Marine shrimp farming in PR China*. INFOFISH International. 2/89. (3) 1992-1993 Report of SEAFDEC Aquaculture Department.

## Safer moorings

A mooring system must be powerful enough to resist the worst possible combination of winds, waves, and tides. To achieve this, cages are attached to the seabed with ropes or chains and anchors.



A typical mooring: A, anchor; B, special connector; C, chain that is equal to the water depth; D, rope for the buoy (4x water depth); E, mooring buoy; F, rope for the fish cage; G, chain-lifting floats; H, rope (1.5x water depth); I, marker buoy



Single-point mooring

In a single-point mooring, the cage is secured to one buoy with one chain or rope to the seabed. It allows the cage to swing to the point of least resistance. It is essential to have a swivel situated immediately under the buoy.

Fixed moorings are used in 90% of fishfarms. Cages are tethered at several points so they do not swing to the elements. When accidents happen, there is a better chance of saving the farm. However, fixed moorings are more expensive.

Consider moorings as any piece of mechanical equipment with moving parts: **they need regular maintenance.** Don't use shackles unless you simply cannot avoid it. Splice rope directly into the last link of heavy chain if possible. If you have to use shackles, weld them shut. Where rope joins chain, the rope must be protected from abrasion on the seabed.

Source: A Thoms. *Pointers to safer moorings.* FishFarmer Vol. 12 No. 3, May/June 1989.

## Impact of seafarming: fish farms vs. mussel farms

### Solid waste production

Intensive fish culture such as for salmon produces solid wastes, including uneaten feeds, feces, and smaller quantities of fish scales, mucus and other detritus. Fish feed wastage is 1-5% for dry feed, 5-10% for moist feed and 10-30% for wet feed or trash fish. Feed losses from cages is greater than in land-based tanks and ponds. Fish feces are the second largest source of solid wastes in fish farms. An estimated 25-30% of the dry weight of consumed feed is voided as feces. The wastes can amount to 820 kg dry solids per ton of fish in freshwater sites. No estimates are available from marine fish culture other than for salmonids (see box next page). Wastes from farms using moist or wet feed may be greater than in those using dry feeds.

Mollusc farming also produces solid wastes -- organic feces, pseudofeces, shells and other detritus -- although amounts are smaller than from fish culture. A typical oyster raft containing 420 000 oysters produces 16 tons dry weight of feces and pseudofeces. A significant proportion of mollusc solid waste is intercepted and consumed by epifauna living at the farm.

### Water flow and sedimentation

Mariculture structures can impede water flow and modify the sediments, particularly in the intertidal zone. Accumulation of silt and erosion of the bottom have been noted beneath oyster racks and mussel poles in France. However, offshore hanging culture has lesser effects. Fish culture is unlikely to cause similar effects, because nets are flexible, permeable and normally positioned above the sea bed.

Sedimentation rates vary with current speed. Sediments accumulate at low-speed sites, but the effects are usually limited to near the farm within about 50 meters.

Sedimentation affects the productivity of the bottom-dwelling organisms and increases the oxygen consumption. If the additional oxy-

gen demand exceeds oxygen supply, both the natural populations and the fish farming operation suffer. Below salmon cages, such effects range from undetectable in well-flushed locations to severe. However, the solids from below cages may be carried to and accumulated in other locations.

In the absence of oxygen, hydrogen sulfide, ammonia and methane are generated within the sediments and may be released to the water column. Ammonia levels below freshwater fish cages may be 3x higher than in unfarmed areas. About 65-82% of nitrogen waste is discharged directly in the water column; the rest comes from sediment nitrogen.

There have been several reports of outgassing of hydrogen sulfide and methane from sediments below marine cages. Hydrogen sulfide is highly toxic to fish, causing gill damage and death. Incidence of diseases in Japanese yellowtail farms have been correlated with sulfides in sediment. Greater problems occur in farms located in sheltered, poorly flushed, and shallow waters.

### Effect on native bottom fauna

The sediments and the fauna under and around fish and mussel farms may be classified into zones:

- Azoic zone — if present, usually restricted to sediments directly below the cages
- Opportunistic zone — normally restricted to the immediate vicinity of the cages up to 30 meters from the site.
- Return to background — normally at 30 meters away from the farm, but sometimes at 100 meters.

Below salmon net cages, extreme organic enrichment reduces the numbers of molluscs and crabs. It is interesting to note, however, that commercial catches of crustacean have improved in the vicinity of cage operations in the USA.

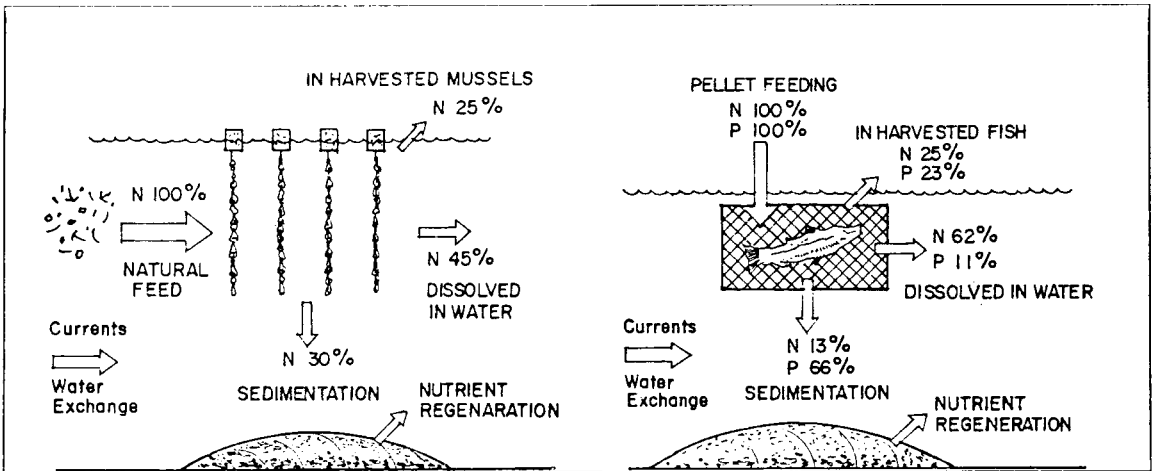
The effects of mussel farms on the bottom organisms are similar to those under salmon cages but are generally less severe. Within 6-15 months of mussel farming, brittle stars, bivalves, and sea urchins disappear from below the farm and are replaced by opportunistic polychaetes typical of organic enrichment. The affected area may extend 20 meters beyond the farm. Communities below the mussel rafts consist typically of a few kinds of pollution-resistant animals such as polychaetes and nematodes. Thus, both salmon farming and mollusc farming may result in the loss of native fauna.

Benthic communities will return to normal after the source of organic enrichment has been removed. The rate of return is site-specific. Disappearance of the actual wastes may be

quicker than benthic recovery. Benthic oxygen consumption returns to normal within 2 months of the removal of salmon cages, and deposits disappear within 4-6 months. Physical changes in the seabed take longer to reverse.

**Further readings:**

- (1) N de Pauw and J Joyce (eds.). 1992. **Aquaculture and the Environment**; Reviews of the International Conference AQUACULTURE EUROPE '91; Dublin, Ireland, 10-12 June 1991. European Aquaculture Society Spec. Publ. No. 16. Ghent, Belgium.
- (2) DP Weston. 1991. The effects of aquaculture on indigenous biota. In: DE Brune and JR Tomasso (eds.). **Aquaculture and Water Quality**. South Carolina, USA, World Aquaculture Society. *Advances World Aquaculture* 3: 534-567.



Mussel culture represents a self-regulated natural system. It does not need feed since mussels live on plankton naturally occurring in the water. The net effect is that nutrients are removed from the environment.

In contrast, fish cage culture is a strongly man-regulated system that needs large inputs to function, both from the economy and the ecosystem. It requires artificial feeds that contribute to organic enrichment.

In general, the more a culture system resembles a natural ecosystem, and the less subsidized it is by inputs of energy and manpower, the less serious the effects on the environment.

Source: N Kautsky and C Folké. 1990. *Environmental and ecological limitations for aquaculture*. p. 245-248. In: R Hirano and I Hanyu (eds.). **The Second Asian Fisheries Forum**. The Asian Fisheries Society. Manila.

## Effects on wild fish populations

It is inevitable that some of the farm stock escape. Fish escape through nets damaged by predators, floating objects, or rough weather. In this way, a foreign or exotic species is introduced to an environment. In a lake in Poland, an estimated 4 tons of trout escaped in one year. There are many records of the impacts of escaped or deliberately transplanted fishes on indigenous fish stocks. These include the extermination of local fishes through predation or competition, interbreeding with native fishes and adulteration of the genetic pool, habitat destruction, and the outbreak of disease epidemics.

**Diseases.** The large stocks in aquaculture can harbor and foster disease agents. Diseases can easily be introduced by seed from other areas in the country, or by fish imported without proper precautions. Recent surveys have shown that the numbers and species of parasites in wild fish differ markedly from expected. Although some parasites may have been imported, others may have been present in wild fish but only reached abnormal numbers under overcrowded conditions and after the environment changed with the introduction of cages. Little is known about the transmission of parasites from cage to wild fish, or vice versa. Caged fish in several farms have become severely infested with cestodes, resulting in heavy mortalities. Those infections were traced to wild fish populations carrying the parasites.

**Predation.** Cages and pens act as magnets to many kinds of fish-eating fishes, reptiles, birds, and mammals. Many of these species are also attracted by the feeds at the farms.

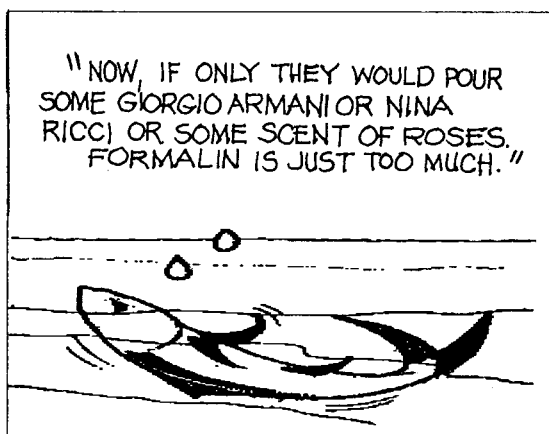
Damage to nets by unsuccessful predators such as birds, turtles, monitor lizards, and rats has been reported from several cage farms. Predation on wild fish may increase through the attraction of predators to the farm site. Another serious, although as yet little studied, impact of the immigrant predator population, is their contribution to disease. Certainly, birds and mammals play important roles in the life cycles of many parasites and other disease agents. For example, birds act as intermediate host for the nematode *Contracaecum*, and fish-eating mammals such as the otter act as final host for the digenean *Haplorchis*, both common parasites of tilapia.

## Toxic chemicals and drugs

The use of chemicals and drugs to control disease is not widespread in cages. Water flow can rapidly dilute the chemical used and render the treatment ineffective. The addition of large amounts of chemicals to compensate for losses can make the treatment too costly.

Many farmers enclose cages in polythene sheets during treatment, or transfer diseased fish to an especially modified enclosure to minimize loss of chemicals. Both are labor-intensive. Thus, chemicals are employed much less frequently in sea farms, and the addition of foreign substances to the sea is small.

Source: MCM Beveridge. 1984. *Cage and pen fish farming, carrying capacity models, and environmental impact*. FAO Fisheries Technical Paper: 255.



## Multi-use conflict

Multi-use conflicts surrounding aquaculture in the marine environment take as many forms as there are vested interests. In the Bay of Fundy in Canada, for example, the steady expansion in number and size of salmon farms

has irritated some upland owners and navigational and recreational interests. Most of the heat has come from the fisheries industry, which includes herring, lobster, scallop and some groundfish. The latter three involve vessels of various size that require access to fishing grounds that -- some claim -- are being pre-empted by salmon cages with their extended mooring systems.

Source: *World Aquaculture*, Vol. 21 (2), June 1990.

In Laguna de Bay in the Philippines, about 70,000 fisherfolk dependent on the lake are losing their livelihood. The introduction of fish pens in the lake and its expansion beyond legal limits have displaced the fisherfolk. "Piracy" in the lake has also driven the fishermen away from the fishing grounds. There are reported thefts of

fish nets, motor engines, and catch. With the loss of capital, it is difficult for the fisherfolk to start operations again. The Cavite-Laguna-Rizal Fishermen Federation are looking into land-based livelihood projects to ease the plight of the fisherfolk.

In the next few years, the government's Metropolitan Waterworks and Sewerage System will tap the lake for potable water to supply the growing Rizal and Cavite population. Tied to this plan is the closure of the Napindan hydraulic control structure to prevent seawater from entering the lake. The fisherfolk object to this since seawater backflow maintains the lake's primary productivity, which supports the fishing grounds. Aquaculture and the industries in the lake watershed also contribute to water pollution (see separate story, this issue).

Source: *The Manila Chronicle*, 28 Mar - 3 Apr 1992.

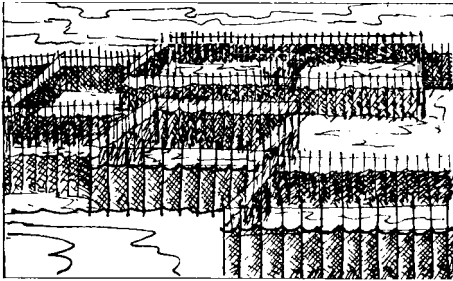
**The potential negative interaction between aquaculture and traditional fisheries in Canada**

<b>Fishery</b>	<b>Competition for space</b>	<b>Operational interference</b>	<b>Regulatory conflict</b>
Herring (weir and shutoff)	Conversion of weir sites to aquaculture may cause loss of capacity in weir fishery Limitation of number and size of aquaculture sites by weirs Restricted movement of weirs in response to changes in fish distribution	Physical blockage of fishways Exudates, noise and light may influence or deter fish movement	Inconsistencies created by two levels of government regulations in the same area (leasing and licensing) Maintenance of capacity in traditional fishery Strategy for conversion of one use to another
Lobster, scallop dragging	Loss of area available for fishery	Bottom deposition may reduce habitat Potential accumulation of additives, eutrophication, loss of spawning or nursery areas	As above
Clam		Deposition of exudates on clam flats	As above
Herring seining, groundfish dragging	Loss of area available for fishery	Obstacles to normal fishing patterns	

Source: *World Aquaculture*, Vol. 21 (2), June 1990.

# Aquaculture clinic

**Laguna de Bay and Sampaloc Lake provide lessons in how aquaculture technology can be used and abused. What happened?**



*Laguna de Bay is the largest lake in the Philippines and only about 5 kilometers from Metro Manila; about 90 000 hectares with a 3-meter average depth.*

The fish pens in the lake have exceeded the limits determined by law and science.

In the '70s, two crops were possible in a year and it took only 3-4 months to rear milkfish to marketable size. Annual harvest was 4 tons per hectare. The fishpens occupied 5 000 hectares then. In the early '80s, fishpens occupied 31 000 hectares. Grow-out culture took 8-15 months and harvest dropped to 2 tons per hectare per year. The open water catch also decreased, from 83 000 tons in the '60s to 20 000 in the '80s.

The slow growth of milkfish is due to inadequate natural food as a result of overstocking. Competition for food also occurs between the fish stocks in pens and open-water fishes and molluscs. Stocking the lake with direct plankton feeders like milkfish and bighead carp reduced the volume of food at the base of the food chain.

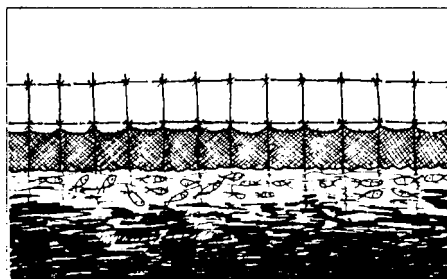
Aquaculture is not the only enemy. Mass fish kills have occurred periodically since the '30s, usually during July-August, due to blooms of the cyanobacterium *Microcystis*, a common enough occurrence in natural lakes. *Microcystis* releases toxins and clogs fish gills. When the blooms died, they consumed the oxygen in the lake water and left little for the animals in the lake. Fish kills also happened when seawater from Manila Bay did not flow back to the lake through the Pasig River. Seawater backflow contributes to primary productivity by settling suspended solids and allowing sunlight into the water. Other causes of fish kills may have been the hydrogen sulfide associated with "masamang tubig" (bad water). In recent years, however, the incidence and severity of fish kills in the lake have increased. The 1993 fish kill in Muntinglupa appeared to have been due to industrial pollution. There are about 1100 industrial and agricultural establishments in the lake watershed whose wastes find their way into the lake. A continuous monitoring program of pollution has been recommended to the government. Implementation of the law is another issue altogether.

Mass fish kills in the lake are being studied by Alejandro Santiago and colleagues at the Binangonan Freshwater Substation of SEAFDEC/AQD from interviews with farmers, historical records, and earlier scientific investigations.

13



*Sampaloc Lake is 82 km south of Manila; 104 hectares; 20 meters average depth*



From 1986 to early 1992, about 6000 tons of feeds went into Sampaloc Lake each year in support of 33 hectares of tilapia cage culture. As a result, the entire water column, except the top 1-2 meters, became nearly devoid of dissolved oxygen. "If the intensive feeding continues," notes SEAFDEC/AQD Research Associate Alejandro Santiago, "the lake will die."

Sampaloc Lake used to be pristine. It still has no industries or factories on its shores; it still has a good watershed. Human population near the lake is about 300 families. In 1976, oxygen levels were 12 ppm in the top 1 meter and near 3 ppm at 8 meters deep. Diatoms and blue-green algae dominated the phytoplankton. When tilapia cage culture expanded to more than 6 hectares in 1982, tilapia growth slowed down due to insufficient natural food. Farmers started using commercial feeds in 1986, about 62.5 tons per hectare per crop to produce three crops a year. Uneaten feeds (about 5-30% of that given), fish feces, and human sewage add to the lake considerable organic load whose decomposition uses up oxygen.

Beginning 1988, the waste load took their toll. Fish kills frequently occurred. SEAFDEC/AQD started to monitor the lake in 1989 and was alarmed at the fast deterioration of the lake. Tilapia cages were 5 meters deep, but only the top 1 meter of water had sufficient dissolved oxygen (3 mg per liter) to support life. The biochemical oxygen demand in the lake was 10-20 ppm, indicating a high organic load mostly due to feeds. At 5 meters depth, ammonia was about 3 ppm and hydrogen sulfide about 5 ppm. Species diversity was low, the green algae and flagellates dominating the plankton. Any disturbance was likely to bring up the anoxic and toxic water and kill the fish.

In January 1993, a massive fish kill occurred and tilapia cage operators suffered P25 million in losses. A Presidential Task Force for the Seven Crater Lakes of San Pablo City was created in March 1993 and the members, including SEAFDEC/AQD, urged the government to dismantle some of the cages and reduce the culture area to 5 hectares that is within the capacity of the lake to support. In July 1993, tilapia culture was temporarily banned. The farmers removed the water hyacinths to allow the growth of phytoplankton and cleared up the abandoned poles and other debris.

Dissolved oxygen levels improved to 3 ppm at 7 meters deep after these measures. However, when the yearly lake overturn occurred in October-December, the surface waters had 1 ppm oxygen and 3 ppm ammonia. Thus, the overall conditions in the lake are still unsuitable for fish culture.

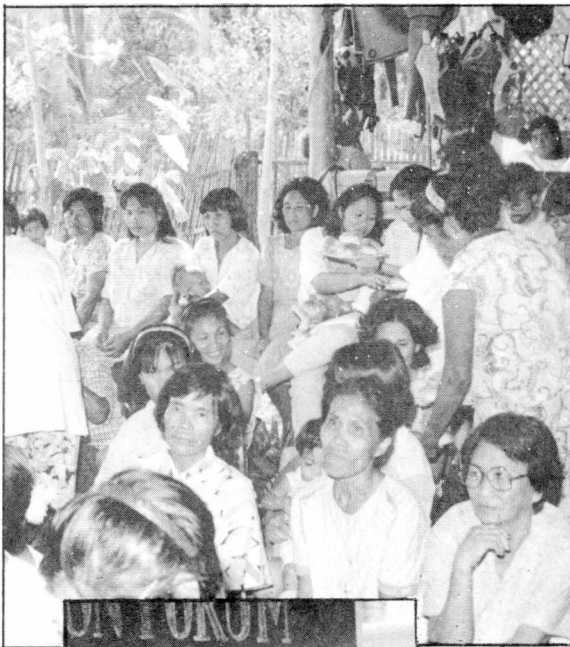
SEAFDEC/AQD continues to monitor Sampaloc Lake.

This article must not be cited or used without the permission of A. SANTIAGO, SEAFDEC/AQD Binangonan Freshwater Substation, Tapao Point, Binangonan 1903 Rizal, phone 304-7800.

Further readings: *SEAFDEC Asian Aquaculture* Dec 1988, Dec 1989, June 1990, Mar 1991, and Dec 1993. Write to Sales/Circulation for photocopies of back issues. - Ed.

## A dialogue with the fisherfolk

The SEAFDEC Aquaculture Department held the *Second Malalison Forum* 23 February 1994 at Malalison Island off western Panay. Department scientists discussed with the Malalison fisherfolk the progress of the pilot study on coastal fishery resource management (see SEAFDEC/AQD R & D, this issue). Department Chief Dr. Efren Ed. Flores talked about the project goals. He noted that the dialogue is a must for fisherfolk and scientists. He emphasized that fisherfolk must take a second look at their condition and appreciate their important role in resource management. AQD scientists Dr. Clarissa Marte and Mr. Renato Agbayani discussed the biological and socioeconomic studies. Among those who attended the forum were the government officials and PROCESS Foundation, the NGO that organized the island community.



**The fisherfolk of Malalison:**  
They asked about the artificial reefs, their role in its deployment and management



**The community organizer:** Bong Demilie of PROCESS Foundation discussed the role of the Fishermen Association of Malalison Island as a cohesive unit in improving the community standard of living.

**The political side:** Culasi Mayor Romulo Alpas expressed support for the territorial use rights in fisheries in Malalison but noted that its legality will be decided by the Culasi Municipal Council because of the Local Government Code.



**ECF on ECF.** Department Chief Dr. Efren Ed. C. Flores instituted an Environment Commitment Fund for projects seeking answers to environmental issues such as alternatives to pesticides and protection of biodiversity. This was announced in the opening ceremony of the meeting.

Dr. Flores also noted that a collaboration between SEAFDEC/AQD, the UPV School of Development Management, and the private sector is being worked out to study the economics of several farming systems and to disseminate these to the industry. He also said that it is quite possible for SEAFDEC/AQD and UPV to hold a joint roundtable discussion to answer the technical questions of the fishfarmers and other industry practitioners.

*Top photo (L-R):* Chancellor Arsenio Camacho of U.P. in the Visayas, former AQD Chief and former UPV Chancellor Dr. Flor Lacanilao, and Dr. Flores. *Bottom photo:* Mr. Dam Arches of Capiz was one of the industry representatives during the meeting.

## Farmers and scientists recommend research priorities

About 40 new studies were proposed by farmers and scientists as research priorities of SEAFDEC/AQD in 1994. Among these were:

- abnormalities in hatchery-reared milkfish fry
- cost-effective feeds for tilapia in the P4-5 range
- protection of biodiversity
- feed development for grouper, snapper, and sea bass
- techniques of resource management
- determination of recruitment of window-pane oyster and abalone
- polyculture of shrimp, seaweed, and mussel
- economics of seaweed pond culture
- economics of pond production of tiger shrimp broodstock

These recommendations were made during the *Roundtable Discussion of 1994 Research Activities of SEAFDEC/AQD* held 3-4 February in Guimbal, Iloilo. The meeting was attended by representatives from the private sector, government and non-government organizations, and research and academic institutions. The yearly meeting is conducted by the Department to fine-tune research priorities according to the needs of the industry.

## 1994 EVENTS AT AQD

### CONFERENCES

**1-2 June: National Seminar-Workshop on Fish Nutrition and Feeds** Discusses feeds for small-scale aquaculture: nutritional requirements, indigenous feed resources, feed formulation and evaluation, equipment, and feeding schemes.

**26-28 July: Aquaculture Development in Southeast Asia III** Assesses existing aquaculture technology for important fishes, shrimps, molluscs, and seaweeds in Southeast Asia, particularly technologies developed from 1992 to 1994 by SEAFDEC/AQD.

Examines the contribution of these technologies to sustainable development in the region.

Sets priority areas for research and collaboration among SEAFDEC Member Countries.

### TRAINING COURSES

**20 Apr-30 May: Fish Health Management** Etiology, isolation, identification, and prevention and control of fungal, bacterial, viral and parasitic diseases; nutritional and environmental diseases affecting aquaculture systems.

**31 May-20 Jul and 2 Aug-21 Sept: Marine Fish Hatchery** Seed production of marine fishes (primarily milkfish and sea bass): broodstock development, hypophysation and other spawning techniques; larval rearing techniques; and transport of fry or fingerlings from hatchery to nursery.

**7 Sept-6 Oct: Aquaculture Management** Overview of aquaculture operations; planning, implementation, and evaluation of aquaculture projects; social, political and ecological factors affecting aquaculture businesses.

**28 Sept-16 Nov: Shrimp Hatchery Operation** Site selection and hatchery design; natural food production and artificial feeds; spawning, larval, and post-larval rearing techniques; disease prevention and control.

**12 Oct-22 Nov: Fish Nutrition** Feeding habits, digestive physiology, and nutritional requirements of fishes and shrimps; feed evaluation with respect to conversion rates, digestibility, and nutritional efficiency; feed preparation and storage; feeding practices.

## NEW PUBLICATIONS

**Feeds and Feeding of Milkfish, Nile Tilapia, Asian Sea Bass, and Tiger Shrimp** (*Aquaculture Extension Manual 21*) By the Feed Development Section. SEAFDEC/AQD technology for small-scale feed development and formulation. Available in June 1994.

**Proceedings of the Seminar-Workshop on Aquaculture Development in Southeast Asia and Prospects for Seafarming and Sea Ranching (ADSEA II)** Edited by FJ Lacanilao, RM Coloso, and GF Quintio. Reviews SEAFDEC/AQD research on sea bass, grouper, milkfish, rabbitfish, mullet, tilapia, carp, catfish, shrimps, bivalves, and seaweeds from 1988 to 1991; aquaculture development and prospects for seafarming and sea ranching in Japan, Philippines, Singapore, and Thailand from 1988 to 1991; and ecological, social and economic considerations for seafarming and sea ranching. Available in July 1994.

**Proceedings of the Aquaculture Workshop for SEAFDEC/AQD Training Alumni** Edited by CT Villegas, MT Castaños, RB Lacierda. Experiences of Department trainees and industry practitioners in aquaculture; review of SEAFDEC/AQD research, training and information dissemination from 1988 to 1992; manpower needs in Southeast Asia.

Book launched on 3 February 1994. SEAFDEC/AQD Chief Dr. E. C. Flores handed over copies in a gesture to transfer "knowledge" to Dr. F. J. Lacanilao of the U.P. Marine Science Institute (to represent the academe), Director Leda Handog of the Negros Agri-Aqua Development Institute (to represent the private sector) and Ms. Simeona Aypa of DA Bureau of Fisheries and Aquatic Resources (to represent the government). Available upon request.

### Discounted subscriptions

Two- to three-year subscriptions to the Department newsletters *SEAFDEC Asian Aquaculture* and *Aqua Farm News* are discounted. Write to the Training and Information Division.

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AFN is a production guide for fishfarmers and extension workers. It discusses the technology for cultured species and other recent information excerpted from various sources.

In citing information from AFN, please cite the institutional source which is not necessarily SEAFDEC/AQD. Mention of trade names in this publication is not an endorsement.

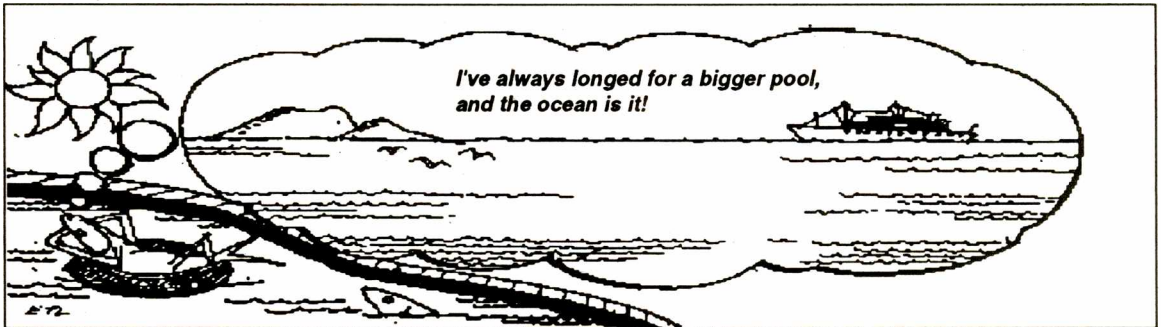
Editor: M. Castaños; Production: D. Badilles, R. Buendia, E. Ledesma, L. Plondaya, J. Requentina, A. Surtida, I. Tendencia; Circulation: R. Tenedero, A.M.J. Ortiz, L. Tabigo-on, Jr.

Subscription rate: P40 per year (local), US\$ 15 per year including air mail postage (foreign). Please make remittances in postal money order, bank draft, or demand draft payable to SEAFDEC/AQD.

Entered as second class mail matter at the Iloilo City Post Office on Aug. 3, 1984

Aqua Farm News is published bimonthly by the Aquaculture Department of the Southeast Asian Fisheries Development Center P.O. Box 256 Iloilo City 5000 Philippines

### The deep blue sea



by E. LEDESMA



Better life through aquaculture