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# AQUACULTURE ASIA

Giant river prawn broodstock

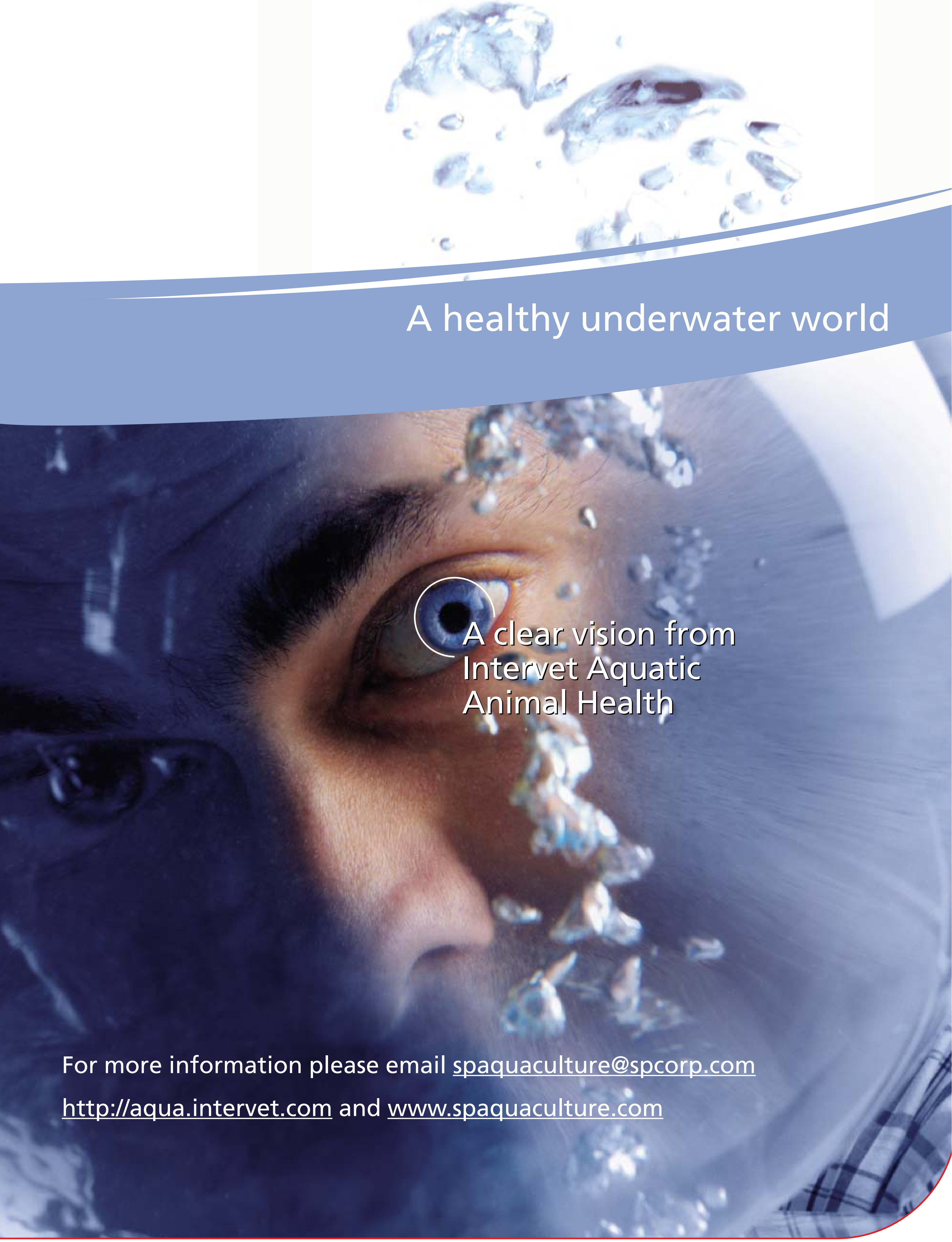
Farm-made feeds and growth of humpback grouper

Simple device aids holding of live fish

A visit to Vientianne

Impacts of alien species

Striped catfish in India




Intervet
Schering-Plough Animal Health

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# The future of fish

According to UN estimates the planet will probably have an extra 1.3 billion people by 2030, mostly added in the developing world. These people will need to be fed. While we are at it, we also need to find better ways to feed the 1.02 billion undernourished people that we already have, nearly all of whom also live in the developing world. At present, hunger is mainly due to poverty rather than food shortages *per se*, but there is no escaping the fact that we will need to produce a lot more food in future than we do now.

According to FAO, the world will need to produce an additional 27 million tonnes of foodfish by 2030 just to maintain per capita fish consumption at current levels, an increase of about 36% over 2009 production. As wild fisheries production peaked some fourteen years ago, the additional foodfish must come from farmed supplies and aquaculture production will have to almost double by 2030 to meet this demand. However, the reality is that per capita demand for fish is not static, it is *increasing*, having grown from 9.9 kg in the 1960s to 17.1 kg in 2009.

Can we do it? Probably. But at what price? There is no denying that farming has an environmental impact. Land, water, fishmeal and other feed ingredients are limited and supplies are under increasingly serious stress. There are legitimate arguments (and deliberate misdirection from some quarters) about whether it is an efficient use of resources, or even ethical, to feed animals with food that could be eaten by people. There are arguments about whether farming animals for meat is sustainable at all, given the enormous amount of agricultural land and other resources currently allocated to such activities.

What if we don't do it? Fish is often the only animal protein that is affordable to the poor. If fish availability is reduced prices will rise and it will be the poor and malnourished - the people who need it the most - who are the first to miss out. This is not some idle fantasy, it's happening *now*. In 2008 the FAO's estimate of the absolute number and proportion of undernourished people increased for the first time in decades to 1.02 billion. *There are more hungry people now than at any other time since 1970.* This was due in part to the spike in food prices that followed the most recent oil shock.

It's an ugly and extremely unpopular fact that we are trading population size off against environmental quality. Sustainability is in part a question of scale: Most activities are sustainable when conducted on a small scale, but as the population grows our farming practices must improve to compensate. We need to find more efficient ways to produce food that will increase output while consuming fewer resources and reducing unit impact on the environment.

In the medium term, it seems likely that both environmental and economic pressures will start to push aquaculture production away from carnivorous species towards those lower in the food chain, the omnivorous and herbivorous fishes, which tend to offer a reduced environmental footprint, lower feed costs and are more affordable. For policy makers and researchers, it might be time to start investing more heavily in such species and seeing if the process can be pushed along a bit in the interests of food security.

Simon Wilkinson

# AQUACULTURE ASIA

# CONTENTS



Peter Edwards writes on

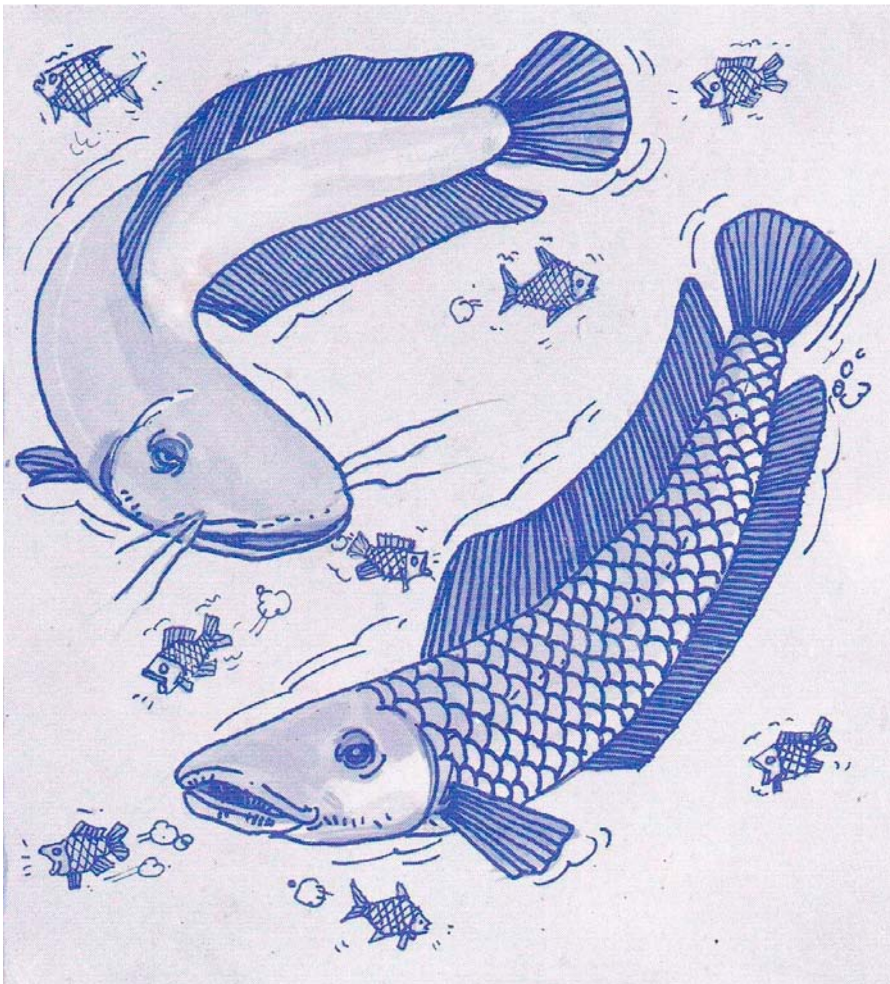
# Rural Aquaculture

## A visit to Vientianne, Lao PDR

*Dr Edwards is a consultant and Emeritus Professor at the Asian Institute of Technology in Thailand where he founded the aquaculture programme. He has over 30 years experience in aquaculture education, research and development in the Asian region. Email: pedwards1943@gmail.com.*

Last August I was invited by Xaypladeth Choulamany, Fisheries Programme Coordinator of the Mekong River Commission (MRC) Fisheries Program to attend the Stock Enhancement Consultation Meeting Vientiane, Lao PDR and make a presentation on ‘Aquaculture development and culture-based fisheries in the Lower Mekong Basin’. At first I declined because I have not worked in stock enhancement but after he insisted I attend and make a presentation on any relevant topic to the theme of the meeting, further reflection led to the realisation that a major constraint to many stock enhancement schemes is the small size of stocked fingerlings, a topic which I am familiar with. I recall that the Thai Department of Fisheries representative at the final meeting in 1991 of the MRC Review of the Fishery Sector in the Lower Mekong Basin, for which I was Aquaculture Specialist in the six-man team of consultants, stated that their stocking programme was mainly of political significance as the stocked fish were so small that they merely provided feed for wild carnivorous snakehead in large water bodies.

*Tilapia are raised in modern floating cages on the Mekong river in Luang Prabang.*



Cartoons from AIT Aqua Outreach extension booklets.

My presentation on seed production and especially the need for advanced nursing prior to stocking is outlined below. MRC kindly arranged a field trip for me to catch up on recent aquaculture developments in and around Vientianne. I also could not drag myself away from fish completely as I took a short holiday in the ancient capital of Luang Prabang.

## Stock enhancement meeting

Although my knowledge of stock enhancement is minimal, I witnessed the development of aquaculture seed production networks in the region and specifically R & D by AIT colleagues on the development of seed production technology, especially breeding and nursing tilapia, decentralised seed production, and capacity building of local staff in the region. Imperial College later carried out stock enhancement research in NE Thailand and Lao PDR in cooperation with local government with facilitation by the AIT Aqua Outreach programme.

## Definitions regarding stock enhancement

Seed from aquaculture mainly comes from hatcheries (breeding, early nursing of hatched eggs to fry). Advanced nursing of fry to large fingerlings may also be carried out by hatcheries but if it is carried out at all, it is more likely to be done by farmers due to the large amount of space required. Grow-out is defined as capture fisheries in large water bodies where fish are usually not owned and managed and are mainly from self-recruiting species rather than stocked fingerlings; and is defined as aquaculture in small water bodies if the stocked fish owned by an individual, company or community.

## Aquaculture development - seed production

Techniques for seed production have been developed for most cultured species, especially herbivorous/

Tilapia are sold live in a Vientianne market.

*Tilapia dispayed in an aquarium in a Vientianne market.*

omnivorous fish. This includes Chinese carps although grass carp can be difficult to breed in the tropics, Indian major carps although catla can also be difficult to breed, common carp and silver barb, as well as tilapia which breeds readily without human intervention.

## Aquaculture development - need for nursing

A major issue regarding stock enhancement as mentioned above is the need for advanced nursing to produce large fingerlings to stock large water bodies. Tropical hatcheries often sell 0.2-0.5 g (2-3 cm) fingerlings which are stocked in grow-out ponds. High mortality usually occurs because the small fingerlings are either not strong enough to survive or are predated by wild carnivorous fish such as climbing perch, snakehead and walking catfish.

## Aquaculture development - government or private hatcheries

Another issue in seed production is whether the seed should be produced by government or private hatcheries. Governments tend to build large centralised hatcheries with several disadvantages: they are expensive to build, operate and maintain; institutional capacity is often weak; and the sustainability of government-led systems may be limited. Furthermore, the private sector soon out-competes government seed production as the former is more responsive to market forces; is more efficient; and seed production is a 24 hour job during the breeding season which does not correspond to regular government working hours. However, the government does have roles to play in aquaculture seed development. Government investment is usually needed to develop and/or disseminate new technology; to develop improved aquaculture techniques; and to develop and maintain quality broodstock or germplasm. Clearly there is a need for public-private partnerships in fish

*Descaling a tilapia purchased while still alive in Vientianne.*

seed. Research into breeding indigenous species, which are usually considered to be more appropriate for stock enhancement as they may have less adverse environmental impact than exotic species, has been carried out through the MRC project, Aquaculture of Indigenous Mekong Species (AIMS).

## Aquaculture development - decentralised seed supply

It is best to decentralise seed production closer to where it is required for stocking if transportation of seed is difficult over long distances or long periods of time or even impossible due to poor infrastructure. Decentralised seed production improves access to high-quality seed for widely dispersed famers or large water bodies. Furthermore, the economic benefits of seed production are more widely distributed.

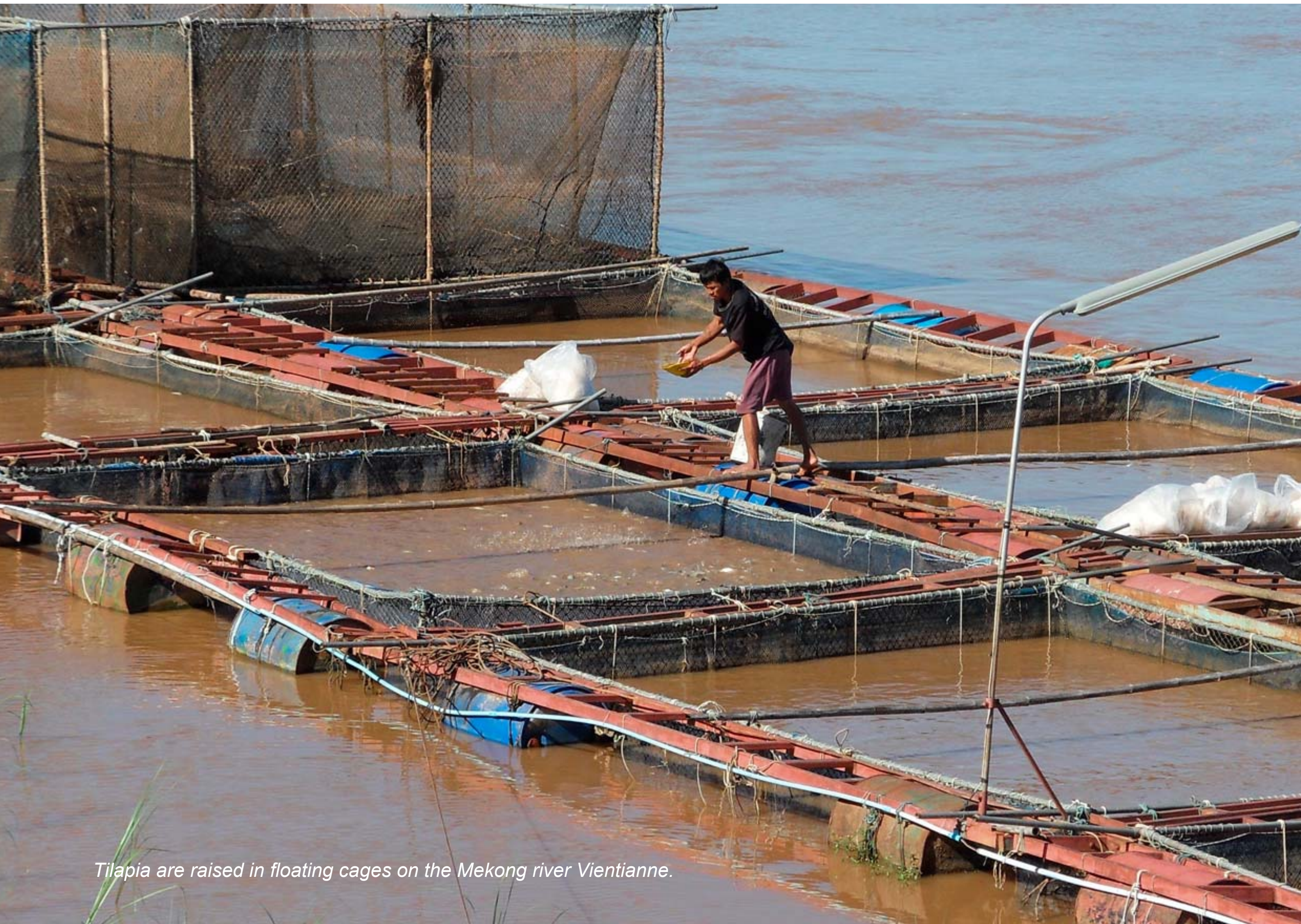
*Wild red tail catfish Hemibagrus wykioides in a Vientianne market.*

## Aquaculture development - relatively simple techniques available

Fry can be nursed to fingerlings at community or village level to produce large fingerlings (advanced nursing) for stocking. Most herbivorous/omnivorous fish can be bred easily so there can be decentralised breeding and early nursing too. Fry can be nursed in rice fields, ponds, cages, pens or hapas-in-ponds or other water bodies. There is no need for conventional nursing in specially designed and prepared ponds which is a specialised business – relatively simpler and cheaper hapas (suspended cages) can be used.

## Hatchery and nursery

Hatcheries are often relatively capital intensive and dominated by better-off entrepreneurs as breeding and early nursing to produce fry are highly profitable because of the rapid turnover of large numbers of fry. Hatcheries seldom



*Tilapia are raised in floating cages on the Mekong river Vientianne.*

*Nursery pond on a fish farm in Vientianne Prefecture.*

produce large fingerlings through advanced nursing as it is land-intensive. This is another reason to decentralise at least fingerling production to small-scale farmers and fishers. Informal, private and decentralised fish seed networks have developed in many countries in response to need.

## Complexity of stock enhancement

Stocking has been defined as a technical intervention into aquatic resource systems of great complexity as, according to my review of the literature it is characterised by widely different levels of uncertainty. Outcomes are determined by various natural, socio-economic and institutional conditions. As I mentioned above, a major issue is the size of stocked fish as ecological studies suggest a threshold size for mortality when a fish outgrows predation by carnivorous fish.

Therefore one of most crucial aspects of stocking is to ensure that stocked fish are of sufficient large size. Unfortunately there is a bottleneck in advanced nursing of fry to fingerlings suitable for stocking in water bodies.

*Farmer in Vientianne Municipality next to Moina production tanks to feed ornamental fish.*

## Seed network case studies

Advance nursing is a well established practice in commercial aquaculture with cost-effective advanced nursing taking place in rice fields, ponds, hapas, pens and cages. Well developed culture-based fisheries in Chinese reservoirs are stocked with 12-15 cm (25-27 g) advanced fingerlings. I described examples of commercial aquaculture systems of advanced nursing in previous columns from Indonesia (Aquaculture Asia 14, 4: 3-8; Aquaculture Asia 15, 1: 3-9), Myanmar (Aquaculture Asia 10, 2:5-8.) and Thailand (Aquaculture Asia 15, 3:7-14). Seed production networks are especially impressive in Indonesia where freshwater fish seed production is dominated by small-scale farmer-operated hatcheries as outlined in my column. Small-scale hatcheries owned by individual small-scale farmers or farmer groups supply 80% of national seed demand with most small-scale farmers in West Java changing from low-profit traditional grow-out to nursing common carp and tilapia to stock in grow-out cages of better-off farmers in reservoirs.

Choice of nursing system depends more on farming context than on technical efficiency: availability of land e.g. cages may have to be used if land is not available; and socio-economic status e.g. the poor may nurse in rice fields which used to dominate in Indonesia although most advanced nursing now takes place in ponds.

## Development and extension of hapa nursing technology

AIT Aqua Outreach carried out R & D on hapa nursing systems in Thailand, Lao PDR and Cambodia, initially on the AIT campus and subsequently with farmers in partnership with national institutions. Imperial College later conducted research into stock enhancement through the same institutional set-up in NE Thailand and Lao PDR.

Seed was widely available in NE Thailand at the start of the research in the 1980s but only as small 2-3 cm fingerlings which were readily consumed by wild carnivorous fish when stocked in farmers' ponds as well as in reservoirs. Farmers were reluctant to pump their ponds dry as water is a precious resource in drought-prone NE Thailand. Farmer recommendations were developed by AIT through on-station research on the AIT campus, followed and by researcher-managed on-farm trials and finally farmer-managed on-farm trials in partnership with the local DoF to assess how farmers respond to the technology. Field-tested extension materials and extension methodologies were developed as well as the hapa nursing technology.

The technology includes a nylon net nursing hapa suspended in a fish pond. Two sizes of hapa were recommended, either 22.5 m$^2$ (3,000 fry) or 5.4 m$^2$ (1,000 fry), both stocked at 150 fry/m$^2$. The profits were Baht 2,000/large hapa and Baht 400/small hapa. Some farmers nursed for more than one nursing cycle and sold fingerlings in excess of those needed to stock their pond to earn income.

AIT Aqua Outreach developed decentralised seed networks in Lao PDR based on the hapa technology from NE Thailand. Capacity building of staff was carried out at the Department of Livestock and Fisheries at provincial and district levels and a

*Goldfish for sale on a farm in Vientianne Municipality.*

*Rather poor quality koi carp for sale on a fish farm in Vientianne Municipality.*

*Young ornamental fish enthusiastics selecting koi carp on a fish farm in Vientianne Municipality.*

*Floating cages in Nam Houm reservoir Vientianne Prefecture.*

Regional Development Committee was set up in Savannakhet province to handle multiple donors. Families in six provinces produced a total of 13.6 million fingerlings in S. Lao PDR in 2003.

An FAO/UNDP sponsored fisheries development project visited Savannakhet in central Lao PDR in 1998 and subsequently promoted hapa nursing in other provinces in the country. According to S. Funge-Smith (pers. comm., July 2010), the AIT Aqua Outreach network is a 'great example of getting seed to stock small water bodies – sustained by fishers paying for service so cost recovery built in'. However, according to N. Innes-Taylor (pers. comm., August 2010), while the 'technical aspects of nursing technology very simple and robust…hard part is organising cost-effective community level training and monitoring'.

## Small-scale water body enhancement in NE Thailand and Lao PDR

Imperial College, London carried out research on culture-based fisheries for about a decade, initially in NE Thailand and later in Lao PDR.

Small 2-3 cm fingerlings were stocked without nursing in 1-20 ha 'village fish ponds' in NE Thailand in the 90s. Outcomes in terms of production, distribution of benefits and institutional sustainability were often different from those expected although predation pressure on small stocked fish was low in the engineered water bodies of NE Thailand, unlike the natural water bodies in Lao PDR as was discovered later (K. Lorenzen, pers. comm., August 2010).

Community-based nursing was introduced into community water bodies in the Lao PDR and 52 villages in two provinces had registered community fisheries programmes by 2003. Yields were the same in stocked and non-stocked water bodies although catch per unit effort (CPUE) was higher in the former than the latter. Access restriction introduced with stock enhancement led to a low level of fishing and selected harvesting of larger stocked fish. There was no evidence of a negative effect of stocking exotic fish on stocks of wild fish.

Stocking and harvesting strategies were improved in 2000-2006 with stocking of larger 3-5 cm seed as advanced nursing had been promoted at community level (K. Lorenzen and N. Innes-Taylor, pers. Comm., August 2010). Standing stocks of fish were higher in stocked than non-stocked lakes and there was a higher CPUE as there was also reduced fishing intensity. There was also a dramatic increase in wild fish stocks in stocked lakes. Again the change in management involved lowered fishing pressure and much reduced fishing intensity as well as targeting large stocked fish. This exploitation system led to a 'size refuge' and a dramatic increase in wild fish. It was concluded that the above 'indirect' effect of stocking may have affected standing stocks and also probably yields more than the direct effect of stocking.

The impact of stocking exotic fish was also specifically studied by the Imperial College researchers. Paired comparisons were made of 23 wetlands stocked with nursed 3-5 cm fingerlings and 23 not stocked with carps and tilapia. An experimental study was also made of 14 wetlands stocked (carps only, tilapia only, 1:1 ratio of the two) and 14 not stocked. Stocking again led to a significant increase in total fish biomass but with no effect on native fish biomass.

## Conclusions

Stocking is a potential win-win situation leading to increased fish yields and with no effect on biodiversity.

As communities in the Lao PDR made special arrangements to allow poor households to fish throughout the year with small gear, the changes in the management of the communal water bodies introduced with stock enhancement did not disadvantage poor households.

Regarding the need for R & D, there is a need for more D than R as the technology exists for breeding and early and advance nursing. The major requirement for stock enhancement programmes of small water bodies to be

*Fish harvested from Nam Houm reservoir, native as well as exotic species.*

successful is for participatory, action-based community learning in each and every water body to be stocked and sustainably managed.

## Field trip in and around Vientianne

Dr. Sinthavong Viravong, Deputy Director of the Living Aquatic Resources Research Center (LARReC) kindly guided me on a one day field visit to get up to date on recent aquaculture developments.

### Thong Kham Market

First we visited a fish market as I always try to do to see what is available and in demand. A wide range of fish was on sale, both native and exotic species in Thong Kham market, a large central market in Vientianne, the capital city of the country. The major fish being sold was live normal dark coloured Nile tilapia (*Oreochromis niloticus*) in aerated bowls and aquaria at US$ 2.67/kg for fish between 0.5 and 1.0 kg in weight. In contrast to Central and N. Thailand but in common with NE Thailand, consumers do not like red tilapia in Vientianne. Rohu (*Labeo rohita*) about 0.5 kg in size was being sold for a lower price of $1.94/kg. I was surprised not see any silver carp (*Hypophthalmichthys molitrix*), usually the cheapest farmed fish. Wild fish were more expensive then farmed fish such as striped catfish (*Pangasianodon hypophthalmus*) at $3.64/kg and some species were much more expensive e.g. red tailed catfish (*Hemibagrus wykioides*) at $7.88/kg and Wallago sp. at $7.89/kg.

### Mekong river cages

There are two sites for cages on the Mekong river in Vientianne, to the north and south of the city. I visited the site to the south where I interviewed a lady farmer. She had been raising fish for 10 years, previously having been a maths and physics teacher. She mostly taught herself from Thai fish farming manuals and visiting other fish farmers although the Thai company Charoen Phokphand later provided advice when it supplied her with tilapia fingerlings.

She borrowed money from a bank to set up with a single cage which cost $700 and purchased feed from a local store. At the time of my visit she had 28 almost 50 $m^3$ cages of 4 x 6 x 2m dimensions each of which she stocked with 3,000 14 cm fingerlings on the inside row of cages and 2,000 on the outer row as the current was strong. Fingerlings were now purchased from a local fish farm, Ta Bor. She fed pelleted feed twice a day and the fish reached 0.7- 1.0 kg in 4 months. Mortality was about 5%, mainly at the start of the rainy season.

She reported that business was not so good now because of competition from more numerous cage farmers along the Nam Neum river, some of whom were Chinese investors. There were about 10 cage farms at this site involving about 20 families as some of them shared a farm although one farm had recently gone out of business as the farm gate price of tilapia dropped to only $1.45/kg although it was at its highest point at $ 2.30/kg during my visit. Some of the cages were out of the water during my visit to sundry the nets for a week to kill fowling organisms. She reported that once a tourist boat crashed into the cages.

### Fish farm in Vientianne Municipality

The farm was mainly raising ornamental fish but also Nile tilapia and African catfish (*Clarias gariepinus*). Previously the family were rice farmers but the son, who now managed the 1.5 ha farm, previously had raised 16,000 chicken layers over fish ponds before the outbreak of bird flu. Most of his income now came from raising goldfish, koi carp and Siamese fighting fish followed by sale of African catfish seed.

Other fish farmers in the area I was informed had only a single pond to raise African catfish and tilapia for household consumption. A very large farm in the area, Ta Ngone, which was originally constructed through an MRC project has had a long and not that successful history but I was informed that it is now being used to raise giant river prawn (*Macrobrachium rosenbergii*) for live sale to markets and restaurants, using post larvae imported from Thailand.

### Nam Houm Reservoir

Extensive cage culture was introduced into the reservoir over 20 years ago through an FAO/UNDP project using only natural food and continues today. The reservoir is managed by a Reservoir Fisheries Management Committee which overseas fish conservation zones and the prohibition of illegal fishing methods.

The cage is very simple, consisting merely of large diameter pieces of bamboo and wooden poles to provide the floating cage frame which support the net enclosure. I understand that the design was transferred from the Pokara lakes in Nepal where it was initially developed and continues there successfully today. I interviewed the farmer who has 150 cages out of the total of 300 cages in the reservoir, the other 150 owned by the military. The cages are almost 50 $m^3$ in volume with dimensions of 4 x 4 x 3 m. They are stocked with bighead carp (*Aristichthys nobilis*), common carp (*Cyprinus carpio*), mrigal (*Cirrhinus mrigala*), rohu, silver carp and tilapia in approximately equal numbers with a total of 300 4-5 cm fingerlings per cage, a rather low stocking density of only 6.25 fish/$m^3$ as no feed is given. Catla (*Catla catla*) may also be stocked but only at a very low density of 20 fingerlings per cage as there is not enough seed available. Common carp and tilapia graze the net so the cages do not need to be cleaned. In 10 months the carps reach a size of 1.5-2.0 kg. There has never been any fish disease although there is high mortality of stocked fingerlings. There is also mortality of large fish in some years, up to 40%, when the water level falls due to drought.

*Selling live tilapia on a Luang Prabang market.*

*Tilapia also sold dead on a Luang Prabang market.*

Cage culture is good business. Vendors come to the reservoir to purchase fish. Catla fetches the highest price of $1.70-1.80/kg, followed by common carp, mrigal, rohu and tilapia at $1.45/kg, with silver carp at $1.20/kg and bighead carp at $0.97/kg fetching the lowest prices.

The interviewed fish farmer reported that ten years ago there were 460 cages and about nine owners, including Chinese investors. However, most cage farmers ceased to raise fish in 2005 when there was a major drought. The water level in the reservoir fell, sediments were stirred up by the wind and the caged fish died. The farmer interviewed only had six cages initially but reinvested to continue and expand cage farming although he now has to hire a guard.

### Luang Prabang

On holiday for a few days after the Vientianne meeting and field visit in Luang Prabang, I came across a street market selling fish. Tilapia were being sold live for $2.42/kg but unlike in the market I visited in Vientianne, here they were also for sale dead at $1.81/kg. Striped catfish were retailing for $7.27/

kg, possibly for the tourist hotels at such a high price as the price was almost double that in Vientianne whilst the live tilapia prices were comparable.

On enquiring about the source of the tilapia at the market, I was informed that tilapia was being raised in cages along the Mekong River not far from the city. I hired a tourist boat to visit a cage site. The boat driver told me that tilapia cage farming started 3-4 years ago using seed and feed imported from Thailand. Although my Thai is far from fluent, I was puzzled about being unable to communicate with the farm workers as the Lao language is closely related to Thai. The problem was soon resolved as the not too friendly Chinese farm manager appeared, also confused, as to why a foreigner was asking so many questions about the operation of the farm. I decided to beat a hasty retreat and resume my holiday.

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# The princess of aquaculture and the plights of the fish farmers

**Krishna, R.R.[1], Rao, K.V.P.[1] and Reddy, D.M.[2]**

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## The princess

The striped catfish *Pangasianodon hypophthalmus* is called ‘the princess of Vietnamese aquaculture’. It was introduced in to India (West Bengal) without authorisation from neighbouring Bangladesh for the first time in 1994-95[1]. From West Bengal, in 1995-96, it reached Andhra Pradesh, the leading aquaculture state in India especially for the commercial pond culture of Indian major carps. The introduction, culture and seed production of this species in India was officially regularised as recently as December, 2009[2].

*Part of the harvest of pond-cultured striped catfish.*

## The inviters

The Princess charmed the Indian fish farmers with its fast growth and high production levels. What about Andhra Pradesh fish farmers specifically? Well, they have fallen in to love with it. The pouring in of news and personal witnesses that the princess was blessing the Vietnamese farmers with hundreds of tonnes of production per hectare was music to their Indian counterparts. The first group of people attracted to it were the seed producers and sellers in Bangladesh and West Bengal and seed commission agents in Andhra Pradesh. The common bond of attraction among them was a lucrative business, in Andhra Pradesh particularly. They sensed the opportunity correctly and at the right time. The fish farmers of Andhra Pradesh had long been searching for an alternative to the Indian major carps, with which they had their own problems. On the other hand, most of the shrimp farmers in the state had abandoned shrimp culture subsequent to 1993-94, mainly due to devastating out-breaks of white spot virus disease. They too were in a bad need of an alternate species for low saline water (0-10 ppt) to bring abandoned ponds back under culture again. The striped cat fish satisfied this need also. Another group of potential inviters of the princess were the commercial pellet feed manufacturers. Many members of this group had enjoyed a thriving business when shrimp culture was in its glory, during 1990-93, but subsequently left without business because of the slump in the shrimp industry. They were eagerly waiting and watching carefully for a second takeoff opportunity. Then enter the American Soy Bean Association, whose goal is to promote the use of soybean in aquafeeds, particularly in the pellet feeds. The association tried to convince the Indian major carp farmers first to use pellet feeds through field demonstrations. They did not respond enthusiastically as they were somehow satisfied with the use of traditional mash feed. The striped catfish culture offered a great opportunity for the use of soybean as a major component in commercial pellet feeds. In Andhra Pradesh the rapid expansion and intensification period of striped cat fish culture and the introduction of commercial pellet feeds occurred almost in parallel and were mutually dependent.

## A red carpet welcome

So by 2002, everything was set and was in its place to extend a red carpet welcome to the princess. The welcome resulted in an amazingly rapid expansion and intensification of the culture of the striped catfish, in Andhra Pradesh with an expansion phase from 2005 to 2009. The estimated annual

*Striped catfish as a minor component in polyculture with pacu.*

increase of the culture area during this period was 36% to 73%[3]. The other Indian states in which the striped catfish culture is developing are Bihar, Tamilnadu, Karnataka, Kerala, West Bengal, Orissa, Panjab, Maharashtra, Uttar Pradesh and Assam.

## The charming characters

The major reasons for the farmers adopting the striped catfish culture are the following: Fast growth, the possibility of stocking at high density to achieve a far higher production than is ever possible with Indian major carps, tolerance to low dissolved oxygen even at higher densities; plenty of available seed, suitability for monoculture and polyculture with Indian major- and Chinese carps, easy to implement management practices, and consumer acceptability. An added advantage was the well developed, readily available infrastructure of the Indian major carp culture system and industry.

## Culture area and production

The currently estimated culture area in Andhra Pradesh alone is 32,000 ha[3], with a production range of 12.5 to 50 tonnes/ha/year. The total annual production is estimated to be 800,000 tonnes, at an average production of 25 tonnes/ha/year. This production is next only to the annual Vietnamese production of this species at 1.2 million tonnes in 2008[4]. Thus by 2010, probably, India has emerged as the second largest producer of the pond-cultured striped catfish. In a pilot scale commercial cage culture in October 2010, in a minor irrigation reservoir in Maharashtra, a production of 13 tonnes/year in a 4×6×3 m cage (72 $m^3$) was achieved[5].

It is interesting to note that it took Indian major carp farmers about 30 years to achieve an annual production of 800,000 tonnes with self sufficiency in seed production. In contrast, the striped catfish farmers achieved the same level of production in just over four years, without a single established commercial hatchery in the state.

## Consumer markets

The striped catfish fish produced in Andhra Pradesh is ice-packed and transported to the consumer markets mainly in Bihar, Uttar Pradesh, Delhi, Assam and in some other North-Eastern states. As compared with the well established consumer markets of the Indian major carps in about twenty states, those of this new species are very limited and with a far limited selling capacity. One processing plant with a fillet production capacity of 40 tonnes per day has recently came into operation in 2010 in West Godavari district, Andhra Pradesh.

*Pellet feed is the most widely used supplementary feed.*

## The seed

Almost all the seed used in Andhra Pradesh is brought from West Bengal. From this state the seed of both striped- and albino variety of the fish are sent to eight other Indian states[6].

There are two important problems with the seed brought in from West Bengal. Firstly, the health status of this seed is often bad, perhaps due to the stress induced by long distance transport under high density and without supplemental oxygen. Frequent bacterial disease related mortalities are noticed even by the time it reaches farmer. Many farmers report 50% to 80% mortalities during 1-3 days after stocking. Secondly the genetic quality of the seed is not known.

## Culture systems

The most widely practiced culture system of the striped catfish in Andhra Pradesh is monoculture. Polyculture with the striped catfish as the major component and Indian major carps as minor components is the second most important culture system. The other polyculture systems of minor importance are, with Chinese major carps and pirapatinga (*Piractus brachypomus*). The culture systems of the striped catfish are spread in both inland and coastal regions, and the culture areas in these regions are interspersed with those of commercial Indian major carp culture, and in some coastal regions with the shrimp culture areas.

## Supplementary feed

Filed data recorded in our research station during April 2010 to September 2010 indicate that floating pellets are the most widely used type of pellet feed (42% farmers), followed by mash feed consisting of de-oiled rice bran, groundnut cake, cotton seed cake (31%), sinking pellets (12%), and other types of feed ingredients, for example distiller wet grains (15%). The mash is fed through demand bag feeding, and sinking pellets either through demand bag feeding or open distribution. The total production of floating pellets from a total of twelve producers is an estimated 525,000 tonnes and that of sinking pellets, 300,000 tonnes. The commercial pellet feed producers are almost entirely dependent on the striped catfish culture for their sales. Six more commercial pellet feed companies are in the pipe line at different stages of construction, with a total future production capacity of 430,000 tonnes, floating- and sinking pellets together. All commercial feed producers claim in general an FCR of 1 to 1.25 but farmers put it at 1.25 to 1.6.

## The crisis

The farm gate price of striped catfish reached a peak price of Indian rupees (INR) 55/kg in November 2009 to December 2009 (roughly US$1 = INR45). By July 2010, the price declined to INR36/kg and by September 2010 it collapsed to INR27/kg. At the time of writing this article (December 2010) the price is only INR33/kg, as against the estimated production cost of INR40/kg. Even now the exact reasons for the steep price fall are not clear. But the most probable reason is excess production.

As an adaptive measure farmers have resorted to partial harvests of market size fish, to meet the mounting investment and switching over to cheaper feeds, either mash or pellet. But they are still very much worried because of the prolonged culture period with the associated additional management costs and are eagerly waiting for the crisis to pass.

There has also been another disturbing news to the Indian striped catfish producers. A considerable quantity of the striped catfish fillets are being imported in to India from Vietnam at a cheaper price, although the exact quantity is not known. It appears that from now on the Indian striped catfish farmers will have to compete with imported fillets from Vietnam.

## Diseases and other problems

Bacterial haemorrhagic septicaemia caused by *Aeromonas hydrophila* has become persistent, necessitating the repeated use of antibiotics. Several farmers had to resort to crash harvest because this disease could not be controlled, an indication that the pathogenic bacteria has developed resistance to the antibiotics used.

Three other types of bacterial diseases with different clinical signs caused by un-identified pathogens are also frequently occurring. Increasing incidence of gill flukes and yellow discoloration of body have also been recorded. The other important problem is water quality deterioration with total ammonia levels reaching up to 2-8 ppm in these still water culture ponds.

## The lesson

The well wishers of the Indian major carp culture In India in general and in Andhra Pradesh in particular had advocated caution. They emphasised that the exotic catfish princess should not affect the native queens, the Indian major carps. This apprehension is now lurking in the minds of these farmers. But this council was overridden by the supposedly guaranteed allurements of ‘tonnes and tonnes of production, and millions of rupees of profit’ that the princess would bestow upon the farmers.

This ‘princess and farmer’ story can be repeated in any other state in India or in any other country, if any foreign princess of aquaculture is invited in to their native waters for culture, without carefully studying the important risks involved[6], including market demand in the long run.

*Cooked mash feed.*

*Mash feed consisting de-oiled rice bran, groundnut cake, and cotton seed cake.*

*Wet distiller grains.*

Now, one is not sure whether Indian farmers, or for that matter the Vietnamese farmers with 55% to 73% of them incurring a loss[7], still call the striped catfish the ‘princess of aquaculture’. But, is ‘the princess’, really at fault with its positive characters that any farmer seeks, the fastest growth and the highest yield capacity amongst all cultured freshwater fish? Are not 'the inviters' who disregarded the long term consequences of the sudden expansion and intensification of the culture driven by the desire for quick profits within a short period of time?

## Acknowledgements

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*Bacterial red disease (haemorrhagic septicaemia).*

*White gill disease with bacterial red disease sign in the eye (seed).*

*Women attending to the final stage fillet making.*

# Development of captive broodstock of giant river prawn *Macrobrachium rosenbergii*

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*Adult male Macrobrachium are spectacular animals.*

The giant river prawn *Macrobrachium rosenbergii* is one of the most widely cultured freshwater prawn species globally. Asia contributes more than 95% of farmed production of this species. China, India, Thailand, Taiwan Province of China and Bangladesh account for the bulk of the production. Farmed production of this species has shown a rapid decline in India since 2006. A decrease in productivity was the major reason for the decline in production. Poor quality seed and diseases have been cited as reasons for the falling productivity.

Seed production technology of *M. rosenbergii* has been standardised since the 1970s and commercial hatcheries are able to meet demand in many of the producing countries. Commercial seed production of this species uses both wild caught females and pond-reared females, depending on the location and availability. As the quality of the seed depends to a large extent on the quality of mother prawn, it is essential to develop a high quality captive broodstock of this species.

Broodstock is one of the most critical production components that is directly related to the success of any hatchery. Healthy and good quality broodstock ensures good quality seed. In practice most of the hatcheries world over source broodstock either from grow-out ponds, or from its natural habitat (rivers, canals, backwaters etc). In many cases it is not possible to collect sufficient number of berried females of the same ripeness from grow-out ponds. An additional issue is that the nutritional requirement of broodstock is specific and may not be met by normal grow-out feeds. When broodstock is collected from grow-out ponds there is a possibility of deterioration in the egg quality, in turn affecting egg viability. The availability of broodstock from the wild is also dependent on season. Although  breeds throughout the season under tropical conditions (26-31°C), the availability of berried females is restricted to certain seasons even in the tropics as the peak breeding activity of this species is different in different river systems of India. There is a danger of introducing unknown pathogens when we use wild broodstock. Thus development of captive broodstock is essential to ensure the quality of seed.

## Factors affecting quality of captive broodstock

The genetic makeup of the animals, quality and quantity of the feed and the environment where they are grown are the most important factors affecting the quality of broodstock. Genetic factors are important as they determine the fitness and adaptability of organisms. So far no genetically improved breed of *M. rosenbergii* is available and hence we have to depend on juveniles raised from quality post larvae supplied by known reputed hatcheries to ensure seed quality.

Regarding feed quality, broodstock should be provided with pellet feed having a crude protein content of 35-40% and lipid content of 8-10%. The protein source of the feed should include both plant and animal protein (oil cakes and fish meal). Similarly the lipid source of the feed should preferably include lipids from both plant and animal origin (vegetable oil and fish oil). High quality ingredients ensure high quality feed.

The environment also plays a crucial role in the quality of broodstock. Rearing ponds should be well managed to provide optimum environmental conditions for fast growth and improved health. Low stocking density, maintenance of minimum depth of water, provision of aeration facility, prevention of predation and competition and routine water quality analysis to maintain optimum water quality are important to achieve this goal.

Provided below is an account of the requirements and practices to be followed for the production of good quality captive broodstock of giant river prawn *Macrobrachium rosenbergii*.

## Broodstock ponds

Freshwater ponds are ideally suited for the development of captive broodstock. The size of the pond depends on the seed production target of the hatchery. The requirement of grey-berried females for one cycle of operation may be calculated to decide on the size of the pond. For example a prawn hatchery with a production target of 10 million seed per annum and operating in four cycles producing 2.5 million seed per cycle require around 150-180 grey-berried females of 50-60 g. As approximately 5 to 10% of the females only will be in berried condition at any given time at least 7,200 female prawns need to be stocked to provide 180-berried females in 5 to 6 months (50% survival, 5% of female spawning at any given time). Along with the females 1,800 male prawns would also be required for successful breeding. This system would support a continual supply of grey-berried females for seed production. At 2/$m^2$ stocking density the area requirement for broodstock pond is 4,500$m^2$ (0.45 ha). It is advisable to have two ponds of 0.22 ha or 0.25 ha each than having one 0.45 ha pond.

Broodstock ponds should be well prepared prior to stocking following the standard pond preparation practices of drying, liming, filling and fertilising. Sufficient numbers of hides in the form of earthen pipes (45 cm length: 10cm diameter) or similar materials may be provided in the pond as shelter for moulting prawns. The addition of substrates in the form of nylon nets planted vertically or horizontally in the pond also has been found to improve survival. Predation by birds is a major cause of low survival in prawn ponds. Large mesh nylon nets may be tied above the pond surface to exclude bird access. Once the pond is ready for stocking (a week or 10 days after fertilisation) it should be stocked with fast growing advanced juveniles (>5 g) at a male female ratio of 1:4.

## Feed and feeding

Freshwater prawns are omnivorous bottom feeders, mainly consuming bottom living plants and animals. They also feed on dead and decaying organic matter. Gut content analysis

*Berried female, the orange colour of the eggs indicates they have been recently laid.*

**Steps involved in pond preparation**

| Steps involved | Activity involved | Advantage |
|---|---|---|
| Eradication of predators | Complete drying of the pond and exposing the pond bottom until cracks develops | Eradicate the predators and competitors. Sun drying helps in the mineralisation of the organic mater, helps in soil aeration and sanitises the pond bottom. |
| Liming | Application of lime as either calcium carbonate ($CaCO_3$), calcium oxide (quick lime-CaO), calcium hydroxide (slaked lime-$Ca(OH)_2$) @200-1,000 kg/ha depending on the soil pH. | It helps to correct the pH; increases the buffering capacity of the water and disinfects the pond bottom also act as a source of calcium, which is very important for exoskeleton formation of prawns. |
| Fertilisation/ Manuring | Application of cattle dung @1,000 kg/ha or poultry manure @ 500 kg/ha and single super phosphate @100 kg/ha to initiate a plankton bloom. | Manures and fertilisers help in the development of phytoplankton cover, which in turn prevents the development of bottom algae and rooted vegetation in the ponds. Phytoplankton also purifies the water and produce oxygen during daytime. They also helps in the development of bottom living animals (benthic micro and macro fauna) on which prawn feed. |

of prawns has revealed a variety of feed particles including the remains of insects, molluscs, crustaceans, filamentous algae, sand and detritus. Prawns will accept a variety of food items including grain, worms, mollusc flesh, crustaceans and fish under captivity. Broodstock should be fed with specially formulated broodstock diet preferably in pellet form (crude protein – 35-40%, lipid – 8-10%) twice daily @ 10% of the biomass for the first two months and subsequently at rates ranging from 3-5% of the biomass. Feed should be spread evenly along the peripheral area of pond. Use of check trays placed at different locations in the pond will be helpful to check the consumption rate and for managing the feeding rate. Since the prawns are more active during night feeding should be done during late evening and early morning. Daily observation regarding the consumption of feed should be the main criteria for deciding the quantum of feed to provide.

## Water quality management

Giant river prawn being a tropical species grows best at temperature ranges of 28-31°C. Temperature plays a major role in growth as well as timing and intensity of spawning. Colder temperatures (<26°C) reduce the growth rate, prolong the embryonic period and appear to promote fungal growth on eggs. Dissolved oxygen is also a very critical environmental parameter affecting survival of prawns in ponds. Hence it is preferable to provide aerators in the ponds to prevent any oxygen related mortality. Water may be exchanged at 25-30% on a monthly basis to maintain better water quality in ponds. Daily monitoring of important water quality parameters such as temperature, dissolved oxygen and pH is preferable to properly manage water quality. The visibility and colour of the pond water gives a visual assessment of the condition of the pond ecosystem. Ideally, visibility should be maintained in the range of 30-40 cm to avoid water quality deterioration. In unproductive ponds the water may be clear with visibility extending to the bottom. In highly eutrophic and/or turbid ponds the visibility may only be a few centimetres (<10 cm). Water depth may be maintained at 3-4 feet by frequent water addition.

## Sampling of prawns

Regular monthly sampling with cast nets or small mesh seine nets should be done to assess the growth of prawns. The prawns attain maturity in two to three months and females bearing grey eggs can be collected from these ponds regularly for the seed production purpose.

## Collection of berried females for seed production

Berried prawns for seed production are usually selected based on the apparent ripeness of eggs and clutch size. Ripeness is indicated by the egg colour. Newly spawned eggs are bright orange in colour. As the eggs undergo development the colour of the eggs gradually changes from orange to yellow and then to deep grey. The embryonic period is usually 19-21 days at 28-31°C. Grey eggs usually hatch within a span of 24-48 hours. Hence, females with grey eggs are usually selected to bring into the hatchery. Post hatch fecundity of the female prawns range from 600-1,000 larvae per gram body weight of the females. As the number of eggs produced per spawn is proportional to female size, selecting the largest grey-berried females available for seed production helps in reducing the number of prawns required for seed production. Selecting broodstock as early in the production cycle as possible has been suggested to enhance the growth rate of future progeny. While selecting the broodstock the following criteria should be adhered to:

- Active and well pigmented berried prawns with a full clutch of eggs, with apparently no injury or appendage loss only should be selected.
- Prawns should be carefully examined for any apparent infection and for presence of external parasites.

| Water quality parameter | Optimum range |
|---|---|
| Temp erature (ºC) | 28 - 31 |
| pH | 7.0-8.5 |
| Total hardness (ppm) | 40-100 |
| Dissolved oxygen (ppm) | > 4 |
| Calcium (ppm) | 50-100 |

- It is preferable to screen the selected berried prawns for viral pathogens especially that of white muscle virus using latest available diagnostics.

## Transportation of broodstock

Broodstock can be transported in open containers for short distances, but for long distance transportation they should be packed in double polythene bags under oxygen pressure. The polythene bags should be kept inside insulated boxes. Ice can be used to maintain lower temperature as it lowers metabolic rate and increase survival. The prawns should be fasted for 24 hours prior to transportation so that their fecal matter does not pollute the media. The pointed rostrum and telson can be made blunt by cutting the tips, further the rostrum can be inserted in a plastic tubing to prevent damage to polythene bags. The chela are also usually tied using a rubber band to make it immobile. The optimal temperature for transportation is 19-20ºC. Earlier studies have shown that 12-15g of prawn/l can be transported up to 42 hours at 19-20º C. However, at 29-30°C, prawns packed at 25 g/l suffered 25% mortality within 6 h, those packed at 6.5g/l suffered 15% mortality within 24 h and no mortality could be observed after 24 h when packed at 3g/l.

Broodstock should be disinfected upon arrival to the hatchery by placing them in freshwater containing 30-50 ppm formalin for 30 minutes. Aeration should be provided during this period. After disinfection the prawns may be preferably screened for the presence of virus (noda virus) using latest available diagnostic kits. The berried females may be stocked in hatching tank or larval rearing tanks.

## Conclusions

Quality of broodstock depends on the genetic make up of the animals, feed and environment they live in. Thus selecting fast growing juveniles from a reliable source, providing a highly nutritious feed and maintaining them in a good environment are important while developing captive broodstock. As the life span of prawn is nearly three years we need to replace the broodstock every alternate year. One year plus females are found to be most suitable for breeding purposes. Very young or very old females are not good as the quality of their eggs may not be very good.

# Alien introduction and its impact on native fishery and aquatic biodiversity of West Bengal, India

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In the last 15 years, or so the north-eastern states have served as the gateway for introduction of alien fish species to India from Bangladesh, Thailand and even South America and Africa. The species chosen for transfer are mainly carnivorous in habit. The species introduced are African catfish, *Clarias garipineus*; Thai catfish, *Clarias macrocephalus*; pangasid catfish, *Pangasius sutchi*; pacu *Piaractus brachypomus* and many others still not known to scientific community.

The introduction of a new species in an environment unit (river, lake, pond etc) can be dangerous for local native communities. It is difficult to determine in advance the long range of effects that the introduction of an alien species will have on local communities. Though there exists a prescribed code of practice for alien transfer, it is easier, in the absence of strong rules, to introduce foreign species than to conduct a study on the possible impact of the newcomer in the unit of destination. It is known that introduction of predatory species such as the largemouth bass *Micropterus salmoides* and various salmonids, amongst others, have caused a number of extinction worldwide (IUCN, 1977, 1988). One most dramatic examples of radical extermination caused by alien transfers was the introduction of the Nile perch *Lates niloticus* in lakes Victoria and Kyoga, which caused the extinction of hundreds of endemic species (Barel et.al 1985; Ogatu-Ohwayo 1989).

The fish breeders of Bengal have conducted various hybridisation programmes unscientifically between native and introduced fishes. How many undesirable hybrids are produced through indiscriminate hybridisation and the extent of their distribution to diverse geographic territories is not known. It is also not known the nature of damage already done in the native fishery due to alien transfer and how many native fishes are threatened and or endangered.

Hybridisation attempted between non-native and native species include virtually all the Indian major carp species with bighead carp (*Aristichthys nobilis*), silver carp (*Hypopthalmicthys molitrix*) and common carp (*Cyprinus carpio* var Communis).

The hybrids produced out of the said outbreeding resulted in the production of some hybrids with some distinctly different morphological characteristics such as almost complete absence of scale or a single row of enlarged scales in some pockets.

## Genetic concerns with stock transfers

The genetic consequences of alien transfer on native fish fauna are of two types. One is direct effects, that results from hybridisation and another is indirect effects, which results from factors such as competition, predation and disease transfer. Stock transfers that lead to hybridisation can affect biodiversity in two ways:

- Through reduction in levels of differentiation between populations.
- Through reduction in fitness within populations.

## Differences between populations

While hybridisation can increase the heterozygosity or average gene diversity within hybridising populations at the same time it results in a relative loss of gene diversity between populations. The prime concern is that locally adapted populations may be replaced by a smaller number of relatively homogenous ones. This process of consolidation and homogenisation may limit the evolutionary potential of the species as a whole. We cannot know which alleles or populations may be significant in future so it is important to avoid actions that may reduce the genetic diversity of wild stocks.

## Population fitness

Population admixtures following hybridisation may also affect fitness and may be either positive or negative. This can be viewed along a continuum of the breeding system . At one end assortive breeding, small population size or both lead to strong inbreeding which ultimately lead to genetic consequences such as inbreeding depression and reduction in fitness. Outbreeding i.e. hybridisation between two populations or related species can reduce inbreeding depression. Outbreeding reduces inbreeding depression in two ways:

- By masking deleterious alleles.
- By increasing overall fitness through heterosis.

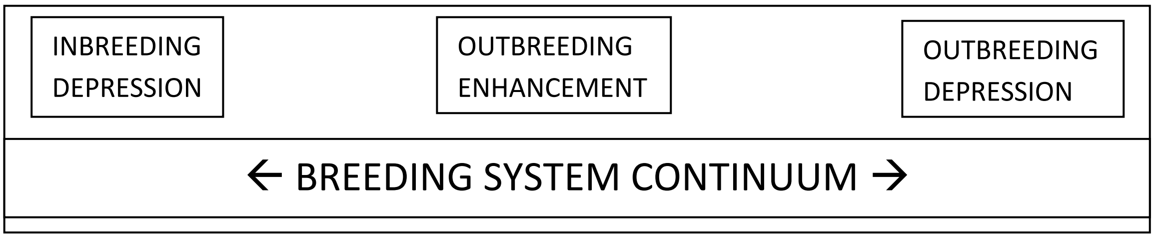
Instead of these positive impacts outbreeding also create outbreeding depression due to:

- Loss of local adaptation.
- Breakdown of coadapted genes at different loci.

Outbreeding depression occurs when there exists differences between the hybridising populations or species that are genetically based. In case of hybridization of alien species with native one, the hybrids may exhibit reduced fitness to either of the environment as they are not adapted to either of the parental environment. In such a case outbreeding depression results due to increasing frequency of maladapted genes in the population. Increased fitness also depends on favourable interactions in “coadapted gene complexes” (Dobzhansky 1955) that evolve to function efficiently as a

*Hatchery-produced catla x common (mirror) carp.*

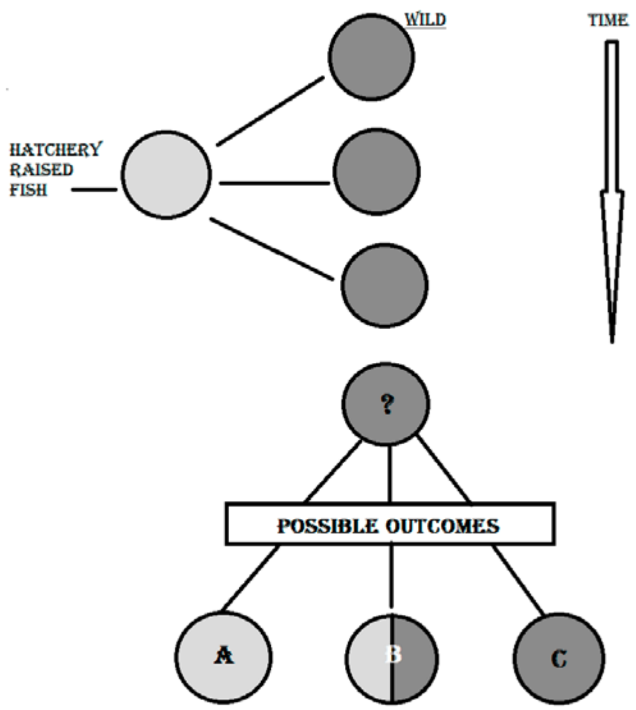
**Continuum of breeding systems that can lead to inbreeding depression or outbreeding depression**




unit. Outbreeding depression can result from the breakup of these favourable genetic combinations. The effect of stock transfer on the fitness of a population can be gauged by determining the relationship between fitness and degree of outcrossing and the place on the breeding system continuum where a hybrid population will fall. Hybridisation resulting from stock transfer can be detrimental as it shifts the hybridising population towards the right of the breeding continuum, potentially putting the hybrids lower on fitness scale.

## Effect of stock transfer on fish biodiversity

Protein electrophoresis and nested gene diversity analysis (Gyllensten,1985) suggests that, the possibility for adverse genetic consequences of stock transfers is greater for freshwater fishes (29.4%) compare to marine (1.6%).




*Three possible outcomes results from the supplementation of hatchery raised fish into the wild are (1) total replacement of wild genepool by hatchery raised fish (2) integration (coexistence or hybridization) of native and hatchery gene pools (3) persistence of native gene pool with little or no permanent genetic effect of hatchery stock.*

Experience with two subspecies of large-mouth bass and their hybrids, when they are raised in the native environment of northern species, showed that there is maximum probability for the introduced species to contribute to the extensive "hybrid zone".

Hybridization, even at species and subspecies level, may results in virtual disappearance of the pure native forms, but the introduced species and the hybrids registered a reduced growth rate compare to native.

## Possible impact of the hatchery raised fish into the wild

Supplementation of hatchery raised fish seed into the natural habitat to increase the population, through ranching, is a common practice now-a-days. Due to a lack of scientific investigation, for most ranching activities it is usually not known whether the transplanted fish replace the native population, hybridise with them or have no permanent effect on them. According to Hinder et.al (1991) each of the three outcomes are possible as indicated in the adjacent figure.

## Final impact

Stock transfer can have detrimental effects on aquatic biodiversity by way of reducing between population variability and within population fitness. Concerning the negative impact of stock transfer on native fishery, the following steps may be adopted:

- Stock transfer should be considered only after a full, open and scientific evaluation of risks involved.
- Stock transfer even with positive and or neutral short term effects may have substantial negative long term effects on the resources.
- More thoughts and research needs to be devoted to the issue of defining appropriate units for conservation.

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# Ecological impacts of exotic fish species in India

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In spite of already rich and diverse fish genetic resources of India, more than 300 exotic fish species have been introduced into the country (Lakra et al. 2008). While a vast majority of them are ornamental fishes, which remain more or less, confined to aquaria, some 28 species have been introduced in aquaculture. Silver carp, grass carp and the three varieties of common carp were brought into the country with the objectives of broadening the species spectrum in aquaculture and increasing the yield through better utilisation of trophic niches. In recent years, the bighead carp *Aristichthys nobilis* African catfish *Clarias gariepinus*, sutchi catfish *Pangasianodon hypophthalamus*, Nile tilapia *Oreochromis niloticus*, red-bellied piranha *Pygocentrus natterei* and Pacu *Piaractus brachypomus* have been introduced illegally and are reported from the aquaculture systems. These exotic fishes are becoming popular among aquaculturists and their accidental and deliberate introductions into the open waters have caused deleterious impact on the fish biodiversity.

## Spread and impact of exotic food fishes

Some of the commonly used exotic food fishes for aquaculture have escaped from culture facility and formed natural population in open waters like rivers. Recent explorations of exotic fishes has revealed their presence in Cuavery, Sutlej, Beas, Ken, Betwa, Yamuna, Ghaghra, Saryu, Gomti and the Ganga rivers besides their occurrence in canals, lakes reservoirs, beels and wetlands. The fish catches of river Yamuna and Ganga is presently dominated by exotic fish species. The highly carnivorous fish, *Clarias gariepinus* has entered into Cauvery, Yamuna and Ganga rivers.

Impact assessment studies of alien fishes have been carried out in the river Yamuna, Ganga and Periyar; back waters of Kerala, Jaiselmer lake (Rajasthan), Ramgarh lake (Uttar Pradesh.) and Kolleru lake (Andhra Pradesh) and the species covered were *Oreochromis mossambicus*, *O. niloticus*, *Pangasianodon hypophthalamus*, *Litopenaeus vannamei*, *Clarias gariepinus*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Ctenopharyngodon idella* and *Aristichthys nobilis*. The impacts of introduced fishes have been assessed by our developed protocol for the Fish Invasiveness Screening Test (FIST) which covered the ability of the introduced fish to reproduce naturally, high dispersal ability (propagule pressure), fast growth, phenotypic plasticity (tolerance of range of salinity and temperature), ability to live off a wide range of food types and other successful invasive characters.

In the Yamuna and Periyar (Kerala) rivers as well as in Jaiselmer lake (Rajasthan), Oreochromis mossambicus was found to displace Gangetic carps, and from the southern region it displaced *Puntius dubius* and *Labeo kontius*. Bighead carp *Aristichthys nobilis* strongly competes with *Catla catla* in aquaculture and has potential to hybridise with catla and silver carp (*Hypophthalmichthys molitrix*). This fish is now available in several reservoirs and rivers including the Ganga river. The common carp *Cyprinus carpio* has now naturalised populations in rivers, lakes and reservoirs. It has displaced local species such as mahseer *Tor putitora*, *Schizothorax*

*African catfish Clarias gariepinus caught from a lake.*

*An ornamental fish Pterygoplichthys sp caught from river.*

spp. and others from upland waters. It has also displaced an endemic fish species *Ostebrama belangiri* from Loktak Lake (Manipur). Recent upsurge in the population of exotic fishes particularly *Cyprinus carpio* and *Oreochromis niloticus* in the Ganga river in Uttar Pradesh has declined the catch of local fishes by 24.56% whereas the catch of exotic fishes has increased by 115.80% during 2009.

The silver carp formed a breeding population in Govind sagar Reservoir (Himachal Pradesh) and Kulgarhi reservoir (Madhya Pradesh) and changed the trophic structure thereby replacing the catla fishery. African catfish *Clarias gariepinus* is cultivated in almost every part of the country including lower reaches of hills and has been assessed to possess invasive characters. It is highly carnivorous and recently the critically declined bird Moorhen *Gallinula chloropus* has been found from the gut of a 67 cm long fish in Rajasthan near Bharatpur bird sanctuary (Anoop et al. 2009). This fish is causing loss to the local fish biodiversity and it is important to mention that the local *Clarias batrachus* has virtually disappeared from most of the habitats. The unregulated spread of *Pangasianodon hypophthalamus* in India has also caused concern regarding disease threats affecting biodiversity and socio-economic conditions (Singh et al 2009). Recently introduced *L. vannamei* for brackish water aquaculture has attracted farmers owing to its high export value. As per our risk assessment study, the potential of some ecological impacts such as reducing aquatic biodiversity or spreading alien pathogens may undermine the sustainability of *L. vannamei* aquaculture (Singh and Lakra, 2008). Disease concern (particularly Taura syndrome) as well as socio-economic issues are also being raised in the culture of *L. vannamei* in India. However, it is important to mention here that incidence of Taura disease has not yet been found from India. Of late culture of pacu *Piaractus brachypomus* has also started clandestinely in the state of West Bengal and it is becoming popular these days (Chatterjee and Mazumdar 2009).

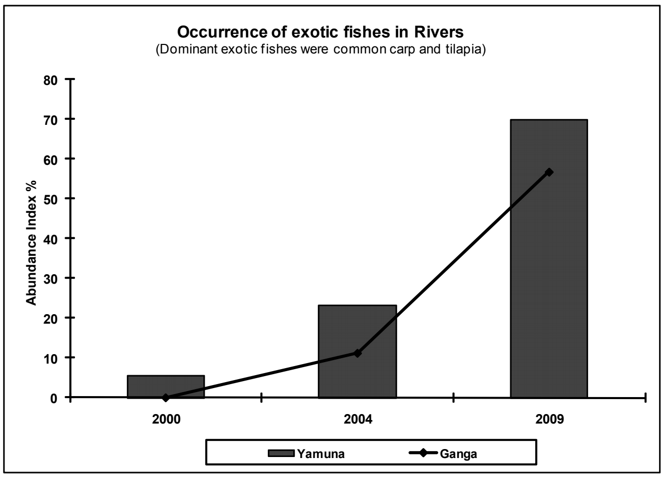
## Spread and impact of aquarium fishes

Twenty-one alien aquarium fish species have been found to occur in natural aquatic bodies in different parts of the country. Eleven species of exotic aquarium fish have been found in the inland waters of the Kerala State, a biodiversity hot-spot region of the country. Of these, four are popular aquarium pets - guppy (*Poecilia reticulata*), three-spot gourami (*Trichogaster trichopterus*), platy (*Xiphophorus maculatus*) and sucker catfish (*Pterygoplichthys multiradiatus*). Guppies have been collected from second-order streams of the Chalakudy river and are found to be present in good numbers in branches of the Meenachil river in Kottayam apart from the drainage canals in Ernakulam city, which are connected to various natural water bodies such as Vembanad Lake (Raghavan et al. 2008; Krishnakumar

*Pacu Piaractus brachypomus from a fish farm.*

et al. 2009). The three-spot gourami, on the other hand, is a new entrant. The gourami is an "opportunistic carnivore having territorial and aggressive behaviour that can prove harmful to native species". The sucker catfish *Pterigoplichthys multiradiatus* was found in Vembanad Lake recently apart from Vylathur in Thrissur and the Chackai canal in Thiruvananthapuram. This fish has potential to alter and reduce food and physical cover for other aquatic insects due to its algae-devouring habits (Raghavan et al. 2008; Krishnakumar et al. 2009).

During our survey study, we have captured some live specimens of red-belied piranha *Pygocentrus nattereri* from Periyar river of Kerala. This fish also existed in the Dimbhe reservoir near Pune, Maharashtra and there are incidences of some people bitten when they entered into the reservoir for their day to day work. This fish is hardy and occasional breeding in aquaria has also been found. Since this fish is original inhabitant of South America, the tropical humid climate of Kerala is likely to support its establishment (Gopalakrishnan and Ponniah, 1999). We have also recorded more than ten other aquarium fish species from wetlands of West Bengal, Assam including other north eastern regions; Kolleru lake (Andhra Pradesh) and also from Bihar and Uttar Pradesh. Two species of highly invasive fish *Pterygoplichthys* fish namely *P. dijunctivus* and *P. perdalis* have been recorded to breed in large number in wetlands of West Bengal where thousands of live specimens have been captured. They were also captured from lakes, rivers and reservoirs in Andhra Pradesh, West Bengal, Bihar and Uttar Pradesh. Alien aquarium fish species introduced purposefully or accidentally into natural water bodies can adversely affect local fauna through genetic impacts, disease introduction and ecological impacts such as predation, competition and environmental modification (Lakra et al 2008).




## Conclusion

Aquarium fish trade and fish introductions for aquaculture are likely to increase in future. Hence, effective quarantine measures are required to prevent their adverse impacts and the introduction of exotic pathogens and parasites along with introduced species. A general plan and guidelines have been developed to regulate fish introduction in India (Lakra et al 2006). Detailed species specific guidelines have also been developed for introduction of *Litopenaeus vannamei*, ornamental fish species, tilapia and *Pangasius sutchi* in India and submitted to the Department of Animal Husbandry, Dairying and Fisheries (DAHD&F), Ministry of Agriculture, New Delhi for implementation and monitoring. All farmers and fish breeders are expected to follow the prescribed quarantine guidelines developed by this institute for reducing the resultant economic losses to the country due to unplanned and indiscriminate introductions of exotic fishes.

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# Farm-made feeds support good growth and survival of the humpback grouper

**Shapawi, R.[1], Mustafa, S.[1], Ng, W.-K.[2]**

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## Grouper farming and feeding

Grouper aquaculture has been practiced for many decades in many parts of the world, especially in the Asia-Pacific region. It was started using simple cage culture systems along the coastal area and this culture system is still the mainstay of the grouper farming industry to this day. Groupers are high value marine fish in the live fish trade market in Southeast Asia, commanding wholesale prices of up to US$90-100/kg, in many instances. The humpback grouper, *Cromileptes altivelis*, usually fetches a much higher price than any other grouper species with prices increasing two to three-fold during festive seasons, especially the Chinese New Year. In Malaysia, major cultured species of groupers are *Epinephelus coioides*, *E. malabaricus*, *E. tauvina*, *E. fascoguttatus*, *E. lanceolatus*, *Plectropomus leopardus*, *P. maculatus*, *E. areolatus*, *E. bleekeri*, and *C. altivelis*. With the exception of slower-growing species such as *E. akaara* and *C. altivelis*, groupers exhibit good growth rates in captivity.

Despite the continuing expansion of grouper aquaculture, there remain several important constraints to the sustainable development of this industry. One of the major constraints is problems related to feeding practices. Trash fish or low-value fish has been traditionally used as the main feed source for farmed groupers. This method of feeding is preferred by most

*The humpback grouper commands a higher price compared to other grouper species and is easily distinguishable by its arched dorsal and polka-dotted body.*

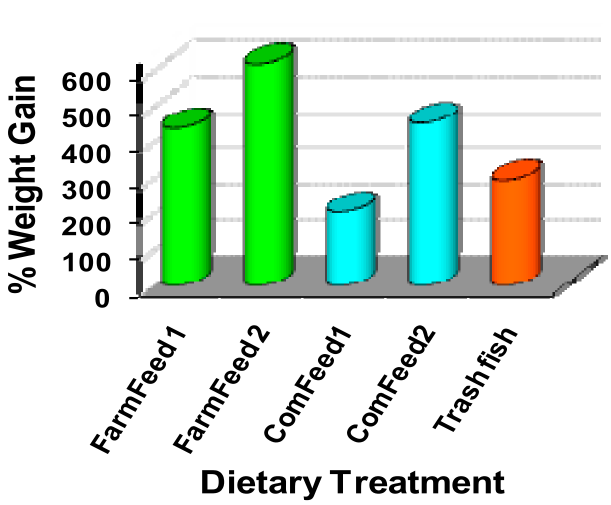
farmers due to the availability of trash fish and the perception by farmers of lower cost when using trash fish compared to the high price of commercial pelleted Feed[1]. The low usage of pelleted feeds by grouper farmers is also due to inadequate information on the use of such feeds and limited supply of weaned stock[2]. Trash fish is a term commonly used to describe low value fish species, which include crustaceans, molluscs and other invertebrates[3]. In Malaysia, the term is used for part of the fishery catch which is not fit for direct human consumption, including undersized fish of commercially important species[4]. The demand for trash fish has increased steadily despite the declining wild fish stocks in South East Asia[5]. Fresh and properly managed trash fish can be a very good source of food for culturing carnivorous marine fish. Nevertheless, there are several major issues and problems related to the use of trash fish in marine fish farming such as the depletion of wild fish stocks, long-term ecological sustainability of these finite resources, increase in costs due to seasonal supply, ethics of using potentially food-grade fishery resources for animal feeding rather than for direct human food, negative impact on the environment resulting from feed losses (FCR 6 to 17:1), spread of fish diseases, fluctuations in the nutritional quality of trash fish, necessity for trash fish to be stored frozen or refrigerated in order to avoid spoilage and loss of nutritional value, and the high labour input as trash fish should be gutted, de-boned and heads removed before feeding to groupers.

Globally, the use of pelleted feed in the farming of tropical marine fish species is much lower compared to feeds targeting salmonids or freshwater fish. In the case of groupers, efforts have been made to use pelleted feeds as an alternative to trash fish. However, constraints to the development of pelleted feed are mainly due to the lack of data on nutritional requirements of groupers, together with the high price of key ingredients such as fishmeal and fish oil. One of the main aims in feed development research is to develop feeds that are derived from sustainably-sourced ingredients, are lower-polluting, and cost-effective alternatives to trash fish feeding[6]. Therefore, finding suitable alternatives to fishmeal and fish oil is critical to achieve this aim. Effective feed development will ensure the sustainability of the grouper aquaculture industry. Therefore, in a recent study, we evaluated two farm-made grouper feeds developed based on our previous findings on using alternative protein, lipid and carbohydrate sources, in humpback grouper diets[7-9] and compare these prototype feeds with two commonly used commercial marine fish feeds and trash fish of monospecies composition.

*Farm-made feeds formulated with alternative ingredients for humpback grouper.*

*Trash fish (Sardinella spp.) used in the study.*

*Growth of humpback grouper fed farm-made feeds, commercial feeds or trash fish.*




*FCR of farm-made feeds, commercial feeds or trash fish fed to humpback groupers.*

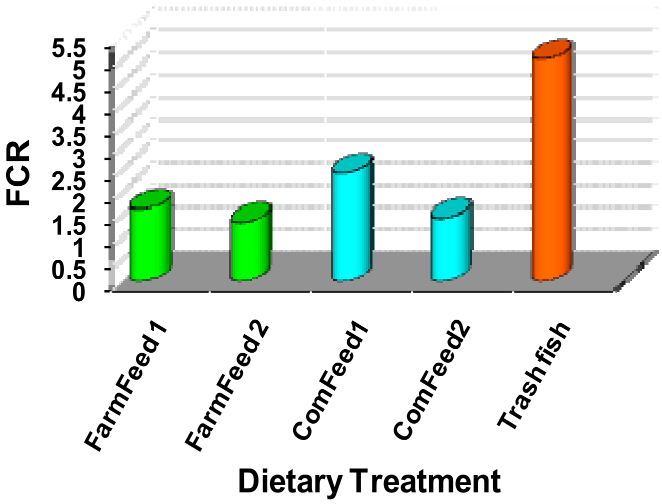


**Table 1: Proximate, fatty acid and amino acid compositions of pelleted feeds and trash fish (Shapawi et al., 2011b).**

| | Farm Feed 1 | Farm Feed 2 | Com Feed 1 | Com Feed 2 | Trash fish |
|---|---|---|---|---|---|
| **Proximate composition (g kg$^{-1}$)** | | | | | |
| Dry matter | 887 | 886 | 915 | 917 | 248 |
| Crude protein | 497 | 503 | 452 | 516 | 701 |
| Crude lipid | 108 | 104 | 109 | 175 | 44 |
| Ash | 134 | 135 | 92 | 99 | 151 |
| Crude fiber | 32 | 30 | 26 | 39 | - |
| Nitrogen Free | | | | | |
| Extract | 229 | 228 | 321 | 171 | 104 |
| **Amino acid composition (g 100g$^{-1}$ amino acid)** | | | | | |
| Histidine | 2.8 | 2.7 | 2.8 | 3.1 | 3.5 |
| Arginine | 8.9 | 8.9 | 7.4 | 9.4 | 8.4 |
| Threonine | 4.6 | 4.4 | 4.2 | 4.5 | 4.7 |
| Valine | 4.5 | 4.6 | 5.2 | 5.1 | 5.0 |
| Methionine | 2.7 | 2.4 | 2.8 | 2.3 | 4.0 |
| Isoleucine | 3.9 | 4.0 | 4.6 | 4.6 | 4.7 |
| Leucine | 6.4 | 6.7 | 8.6 | 7.8 | 8.2 |
| Phenylalanine | 4.8 | 4.4 | 5.1 | 4.7 | 5.5 |
| Tryptophan | 1.3 | 0.8 | 1.3 | 1.1 | 1.9 |
| Lysine | 5.5 | 5.3 | 5.8 | 5.6 | 8.6 |
| **Fatty acid composition (% of total fatty acid)** | | | | | |
| Total saturates | 38.3 | 34.3 | 30.7 | 32.4 | 49.5 |
| Total monoenes | 43.0 | 42.9 | 23.5 | 35.0 | 15.3 |
| Total PUFA | 18.6 | 22.8 | 45.8 | 32.5 | 35.2 |
| Total n-3 PUFA | 6.6 | 7.3 | 35.5 | 21.9 | 30.7 |
| Total n-6 PUFA | 11.8 | 15.2 | 10.2 | 10.5 | 2.4 |
| n-3/n-6 | 0.6 | 0.5 | 3.5 | 2.1 | 13.0 |

**Table 2. Body indices, proximate composition (% wet weight) and fatty acid content (% total fatty acids) of muscle tissue (Adapted from Shapawi et al., 2011b[10]).**

| Body Indices | Farm Feed 1 | Farm Feed 2 | Com Feed 1 | Com Feed 2 | Trash fish |
|---|---|---|---|---|---|
| HSI | 2.0$^{a}$ | 1.9$^{a}$ | 3.7$^{b}$ | 3.5$^{b}$ | 1.5$^{a}$ |
| VSI | 7.1$^{ab}$ | 7.2$^{ab}$ | 8.5$^{b}$ | 10.0$^{b}$ | 5.1$^{a}$ |
| IPF | 0.6$^{a}$ | 0.8$^{a}$ | 0.6$^{a}$ | 1.5b | 0.1$^{a}$ |
| **Proximate Composition** | | | | | |
| Moisture | 70.5$^{a}$ | 70.6$^{a}$ | 71.5$^{ab}$ | 70.2$^{a}$ | 74.0$^{b}$ |
| Protein | 17.6 | 17.6 | 17.0 | 16.7 | 17.1 |
| Lipid | 6.2$^{ab}$ | 6.4$^{ab}$ | 5.4$^{b}$ | 7.6$^{a}$ | 3.1$^{c}$ |
| Ash | 5.2 | 4.9 | 4.9 | 4.5 | 5.2 |
| **Fatty Acid Composition** | | | | | |
| Saturates | 34.3 | 31.2 | 31.1 | 32.9 | 33.1 |
| Monoenes | 35.5$^{b}$ | 38.9$^{b}$ | 28.1$^{a}$ | 33.9b | 26.5$^{a}$ |
| PUFA | 30.3$^{ab}$ | 29.2$^{a}$ | 40.2$^{c}$ | 33.1$^{b}$ | 40.2$^{c}$ |
| n-3 PUFA | 17.9$^{b}$ | 14.4$^{a}$ | 26.2$^{d}$ | 21.8$^{c}$ | 34.3$^{e}$ |
| n-6 PUFA | 12.0$^{bc}$ | 14.4$^{c}$ | 13.7$^{bc}$ | 11.1$^{b}$ | 5.7$^{a}$ |
| n-3/n-6 | 1.5$^{ab}$ | 1.0$^{a}$ | 1.9$^{b}$ | 2.0$^{b}$ | 6.1$^{c}$ |

## Feeding trial

Fishmeal in both farm-made feeds (Farm Feed 1 and Farm Feed 2) was replaced with poultry by-product meal (PBM) at a significant level to supply the needed dietary protein. Added dietary lipid was in the form of crude palm oil (CPO) and fish oil in Farm Feed 1, and only fish oil was used in Farm Feed 2. Tapioca starch was used as the carbohydrate source in both feeds. The proximate, amino acid and fatty acid composition of the experimental feeds as well as trash fish are presented in Table 1. The performance of the two farm-made feeds was compared with a local commercial marine fish feed (Commercial Feed 1), an imported commercial high-fat marine fish feed (Commercial Feed 2), and trash fish.

According to the respective feed manufacturers, Commercial Feed 1 is a fishmeal-based feed and Commercial Feed 2 consists of fishmeal, plant protein and poultry proteins. Both commercial feeds are used by local grouper fish farmers. The trash fish used was Sardinella spp. which was minced and formed into small balls by hand before feeding to the experimental fish. The diets were fed close to apparent satiation twice a day to triplicate groups of humpback grouper fingerlings for 14 weeks. Fish were raised in fiberglass tanks (300L) with a flow-through water system.

*Trash fish stacked up in an on-farm freezer at a grouper farm in Sabah, Malaysia.*

## Growth performance of humpback grouper

Weight gain of fish fed the PBM-based Farm Feed 2 were significantly higher ($P<0.05$) compared to fish fed the other feeds. No significant difference ($P>0.05$) was observed in the weight gain of fish fed Farm Feed 1 or Commercial Feed 2. Similarly, the weight gain of fish fed Commercial Feed 1 or trash fish were not significantly different. FCR ranged from 1.3 to 2.4 in fish fed pelleted diets. These values were not significantly different between Farm Feed 2, Commercial Feed 2, and Farm Feed 1. However, FCR of fish fed Commercial Feed 1 was significantly lower than that of Farm Feed 2, but not significantly different from that of Farm Feed 1 and Commercial Feed 2. Feeding fish with trash fish resulted in a significantly higher FCR of 5.0.

The survival of groupers fed the pelleted diets was more than 90% but groupers fed trash fish had a survival of only 50%. Whole body composition was also affected by the feeds used, especially the lipid content. Groupers fed trash fish had the lowest body lipid content and fish fed Commercial Feed 2 had the highest body lipid deposition. Groupers fed the two commercial feeds had higher hepato- and viscero-somatic indices (HSI and VSI, respectively) as well as higher deposition of intraperitoneal fat (IPF). Groupers fed the commercial feeds or trash fish had higher levels of omega-3 fatty acids compared to fish fed the experimental prototype feeds (Table 2).

## Conclusion

When formulated correctly, farm-made pelleted feeds are able to support good growth, efficient feed utilisation and survival of cultured groupers, and give better or comparable growth performance when compared to commercial extruded marine fish feeds. Being a cheaper protein source, good quality PBM has high potential to become a major protein source in the diets of carnivorous fish species. Feed costs can be substantially reduced with the inclusion of greater quantities of PBM in the diets of slow-growing marine fish such as the humpback grouper. From our findings, trash fish appeared to be the least desirable method for feeding cultured grouper as shown by the poor growth, poor FCR values and low survival rate of the fish.

### Authors' note

The full report of this study has been recently published in "Shapawi, R., Mustafa, S. & Ng, W.K. 2011. A Comparison of the Growth Performance and Body Composition of the Humpback Grouper, Cromileptes altivelis Fed Farm-Made Feeds, Commercial Feeds or Trash Fish. Journal of Fisheries and Aquatic Sciences 6, 523-534.".

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# An easy way to hold live fish

**Kowarsky, J.**

Keeping live fish in good condition while holding them is a major challenge to fish farmers and others in related industries. Measures must be taken to ensure that fish are not too crowded, that they have good water quality, that there are no stagnant pockets of water with low oxygen levels, that fish are easily accessed and, in the case of bottom-living fish, that they have sufficient floor area. At the same time the fish farmer must minimise water, energy, space and labour use in order to maximise profitability.

Often, holding facilities use large tanks. Large tanks mean large volumes of water, and water is heavy. Once a system is built, it is virtually fixed and there is no flexibility in terms of changing the floor plan.

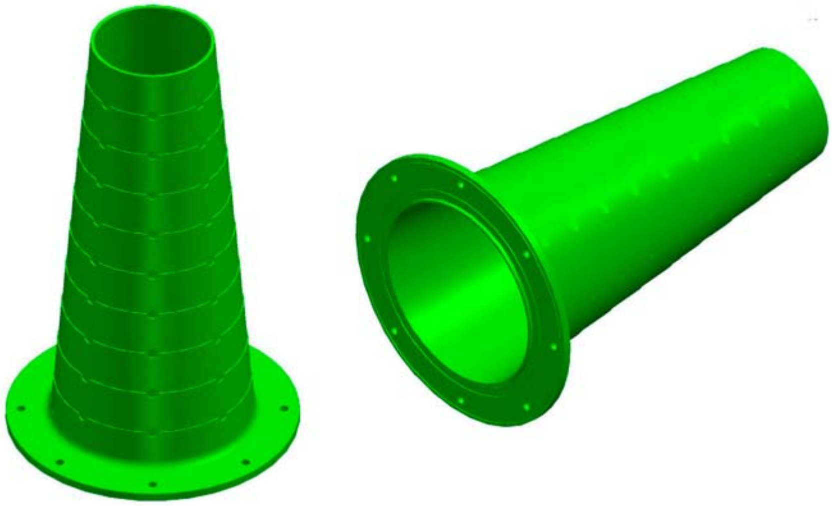
In many situations there is a potential alternative approach. Instead of relying on large tanks, the operator can establish batteries of smaller units that will enable the system to be flexible and adaptable. The size and number of units can be adjusted to meet current live fish needs, supplies and sales. All that is needed to establish such a system is an overhead water supply and a base water collection capability.

One approach to such a modular system is to use a 'K Box Cone', a simple overflow device that can be fitted to a variety of tubs and tanks. It works on the tried and true principle of a standpipe. Water flows into a container, reaches the level of the standpipe and overflows to be collected beneath the container. Systems using standpipes are common in hatcheries, holding facilities and experimental laboratories.

## The K Box Cone

We will firstly describe the K Box Cone and then outline how it can be used. The K Box Cone is a simple, food-grade, UV-stabilised plastic fitting made by injection moulding.

As its name suggests, The K Box Cone is conical and it has a flange around its base. A number of features have been included in its manufacture including:



*The K Box Cone stands 20 cm high, with a flange around its base to allow easy attachment to the container base.*

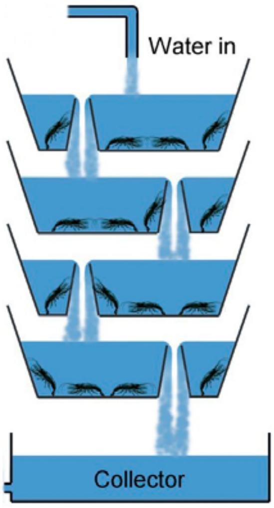
- Holes in the flange for attaching the Cone to the tub base.
- Score marks around the Cone to allow it to be neatly cut to whatever height is required.
- Indent marks around each level of the Cone to allow for easy drilling of intermediate overflow holes if required.
- The K Box Cone can be adapted and fitted to a wide variety of plastic tubs which can be readily purchased.
- To modify a plastic tub, all that is required is to drill a hole in its base and attach a Cone using stainless steel screws or bolts.

*K Box Cones fitted to a ariety of tubs.*

*Attaching a K Box Cone to a tub with a 92 mm diameter hole cut in its base.*

## How the system works

The system works by having an overhead water supply directing water into the uppermost tub. Water cascades to the next tub via the K Box Cone. This continues down the stack until the water overflows into the base collector. Depending upon the particular circumstances, water may be allowed to flow to waste or alternatively, it may be recirculated with or without a filtration and purification process. By having tubs one above another, the use of available floor space is maximised.




*Basic set-up for tubs.*

A significant feature of the system as described is that K Box Cones can be fitted to plastic tubs that are self-stacking. This means that racks or shelves, generally used with conventional standpipe systems, are not needed. The system is self-supporting and can be built to any safe height.

A stack can be progressively built as more live product becomes available, and the stack can be progressively dismantled as product is used or moved on. In all cases as long as there is the same overhead water supply and the same collector container, the system is functional irrespective of the number of levels.

If the tubs used are nesting as well as stacking, they can then be efficiently stored because the shape of the K Box Cone allows nesting to still take place.

A simple self-contained system that is completely portable uses a submersible pump in the collector with the water being pumped to the top tub of the stack. This re-circulating system can be set up in minutes and is ideal where there is a need to have a suitable live storage facility offsite for the short-term holding of product.

*Yabbies (freshwater crayfish Cherax destructor) being held in a portable tub and collector system. An electric submersible pump in the collect delivers water to the top tub of the stack.*

*The uppermost tub of stack of prototype tubs holding yabbies. Drainage in this case is through holes in the side of the Cone, and mesh has been placed over the top of the Cone to prevent yabbies escaping!*

In some cases it may be preferable to have the water draining through one or more holes in the side of the K Box Cone rather than over the top. This is simply accomplished by drilling holes centred on the pre-formed indents moulded into the K Box Cone wall. And by adjusting the flow rate of water through the system, it is possible to have an arrangment where the overflow operates over the top of the K Box Cone under normal conditions, but when the pumping slows down or stops, the water drains to a lower level to keep the product moist in shallower water.

The cascading water from one level of the stack to the one below raises oxygen levels and reduces the risk of stagnant water pockets. Clearly, this can be adjusted by altering the flow rate through the stack. The relatively small volume and the more uniform distribution of fish through the water in this sort of system (as opposed to a large tank where fish may tend to congregate in one area) will also reduce the chances of dead water pockets by keeping the water moving. By intermittently putting higher-flow pulses of water through a stack any waste solids will tend to be re-suspended and carried down and out of the stack.

## The benefits

There are a number of benefits of this system using K Box Cones.

- Simple assembly – can be quickly put up and taken down by one person.
- Simple plumbing – all that is needed is an overhead water supply and a collector tank.
- Self-supporting if stacking tubs are used – shelving is thus unnecessary.
- Space efficient – multiple layers best utilise available floor space.
- Water efficient – reduces layer of under-utilised water column so that crowding need not occur.
- Water quality – cascading water reduces the chances of stagnation.
- Adaptable – can be used with flow-through and re-circulation systems

*A stack of inexpensive tubs that both nest and stack. These were obtained from a local variety store.*

*The same five tubs as shown in the previous photograph, nested for storage.*

- Product separation – the modular system allows for easy identification of batches.
- Easy storage if nesting tubs are used.

## Frequently asked questions

**Why can't I just make a system similar to this myself using commonly available plumbing fittings?**

Of course you can, but the cost of such fittings to achieve a good seal with the tub base would not be significantly less expensive and the features already mentioned that allow the Cones to be modified for a wide variety of tubs and uses are not present in conventional plumbing equipment.

**Why have a cone shape rather than a cylindrical shape for the stand pipe?**

The conical design is stronger and the broad base together with the flange allow firm attachment to the tub base. The conical shape allows the tubs to nest for efficient storage. It is also easier to manufacture by injection moulding.

**Can I inspect the fish in an operating system?**

This depends upon the type of tub used. If transparent or translucent plastic is used (such as the tubs shown in the photograph of the five-stack), it is possible to see the product through the sides of the tubs.

In other cases using opaque tubs this is not possible. However the simplicity of the set-up and plumbing means that a large stack can be dismantled and re-assembled easily if a detailed inspection is required.

**If I can't see the product and a fish dies, will this lead to a mass mortality due to poor water quality?**

The likelihood of this outcome will depend upon factors such as the rate of flow of water through the stack and the efficiency of the filtration and purification system used if the water is re-circulated. Exactly the same consideration applies to a single large tank where fish deaths can and do occur undetected. Our experience using a trial of yabbies was that there was minimal mortality in a simple system that operated for several weeks.

The main application for the K Box Cone tub system is for relatively short-term (days to weeks) convenient storage of live product. It is not suggested that a system be established and left unattended for months.

**What sort of operations might benefit from using K Box Cones?**

We see that K Box Cones have potential applications in aquaculture, the live seafood industry, the ornamental fish industry, live bait holding, freshwater and marine research, and for purging and depurating shellfish and finfish.

Further information about K Box Cones can be found at: www.kboxcones.tk

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# *Litopenaeus vannamei* introduction: Sound management or expediency?

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Throughout Latin America, hatcheries maintain captive stocks of *Litopenaeus* (= *Penaeus*) *vannamei* broodstock, some of them pathogen-free, some of them pathogen-resistant and some of them in captivity for 30 years. The successful attempt culturing exotic, imported SPF *L. vannamei* in the Indian sub-continent has led to more farmers adopting this species in India. But what about the environmental issue of 'escapees' to the natural ecosystem, even if this is strictly denied by the farming community in public? This issue of escapees of hatchery larval stages is serious and the magnitude of this effect remains unknown. There is every opportunity for the escapees to establish a natural population. *P. vannamei* has been reported in fisherfolk's catches on Andaman

*Just a white shrimp...or a shrimp with uninvited guests?*

and Gulf of Thailand coasts. During the late 1970s and early 1980s *L. vannamei* was introduced to Hawaii and the Eastern Atlantic coast of the Americas from South Carolina and Texas in the North to Central America and as far south as Brazil (Briggs et al., 2004). Now though not confirmed, it is well assumed that *L. vannamei* has gotten established in Hawaii and Gulf of Mexico. Relevant research, involving long-term monitoring of established introduced populations of *L. vannamei* are lacking. It had been reported that pathologic viruses could be transmitted to native wild penaeid shrimp populations (Overstreet et al., 1997), thus introduced exotic shrimp viruses may be capable of infecting native wild shrimp populations. IHHNV which severely affected the culture of L. vannamei and *Litopenaeus stylirostris* in the west was not known there and is said to have been introduced with live *P. monodon* imported from Asia.

Taura has spread to every country in the western hemisphere with the exception of Venezuela where hatcheries maintain captive broodstock and restrict the introduction of new broodstock. Concrete research on specific pathogen free larval shrimp in disease-laden Indian hatchery environment needs stringent studies. Indian farmers are still often of the incorrect view that *L. vannamei* resists WSSV. Cohabitation with diseased or latent carriers can always infect new hosts. Many of the viruses infecting shrimp are hidden or cryptic and, although present in their host, may produce no gross signs of disease or notable mortality.

Many of these viruses, without methods of diagnosis, are probably being harboured unknown within the wild and cultured populations of shrimp throughout the world. It may not be until shrimp species are moved from one location another and their natural viral 'flora' comes into contact with new and/or naive or intolerant hosts that disease epidemics begin. Crustaceans may be particularly problematic since they tend to have persistent, often multiple, viral infections without gross or even histological signs of disease (Flegel and Fegan, 2002). 25 years back, India brought *Penaeus monodon* broodstock from Taiwan Province of China and Thailand, those mistakes proved costly and Indian shrimp farmers paid a heavy price within one or two decades (Babu et al., 2000). Today, India has not yet learnt from its mistakes but remains hooked onto the indefinitive learning curve. When *P. indicus* could sustainably lead in the Middle East especially, Saudi Arabia for a quarter century, Indian farmers failed to choose *P. indicus* as an alternative to *P. monodon*.

The potentially thunderous and explosive epidemic effect of the associated impacts of transboundary introductions of *L. vannamei* shrimp is a story that may yet be unfolding. For example, the Taura Syndrome virus is a highly mutable RNA virus and could mutate into a more virulent form for native Asian shrimp, as it has occurred in Latin America (Flegel and Fegan, 2002; Lightner, 2002). Even today, the pathways of viral pathogen transfers in shrimp are still far from clear. Although the original stock of SPF shrimp may have been certified as clear of specific pathogens, shrimp can no longer be regarded as SPF once they leave the biosecure environment and the offspring produced from this stock are at the mercy of the poorly biosecure production facility in India. Inbreeding of pond-reared *L. vannamei* broodstock in India is potentially also a concern, if broodstock are not carefully managed.

The use of alien animal species to increase food production and income has been an established practice in India since the middle of the 20th century. India was a leading exporter of black tiger shrimp to the US until this market was threatened by the cheap *L. vannamei* shrimp production rapidly expanding within India. By switching to the latter, India has lost its relatively parallel scores with leaders in *monodon* farming and is now forced to compete with countries such as China and Thailand. The market has already seen overproduction and price crashes. India has already seen the impact of imported shrimp pathogens and little consideration has been given to how exotic species could potentially affect native flora and fauna. Aquatic veterinary research teams in India and globally must be prepared to face the threat of disease outbreaks caused by careless transboundary movement of aquatic animals. Decisions to import alien aquatic species must be made based on sound science rather than the expediency of the moment, otherwise it may be that history will judge these decisions poorly.

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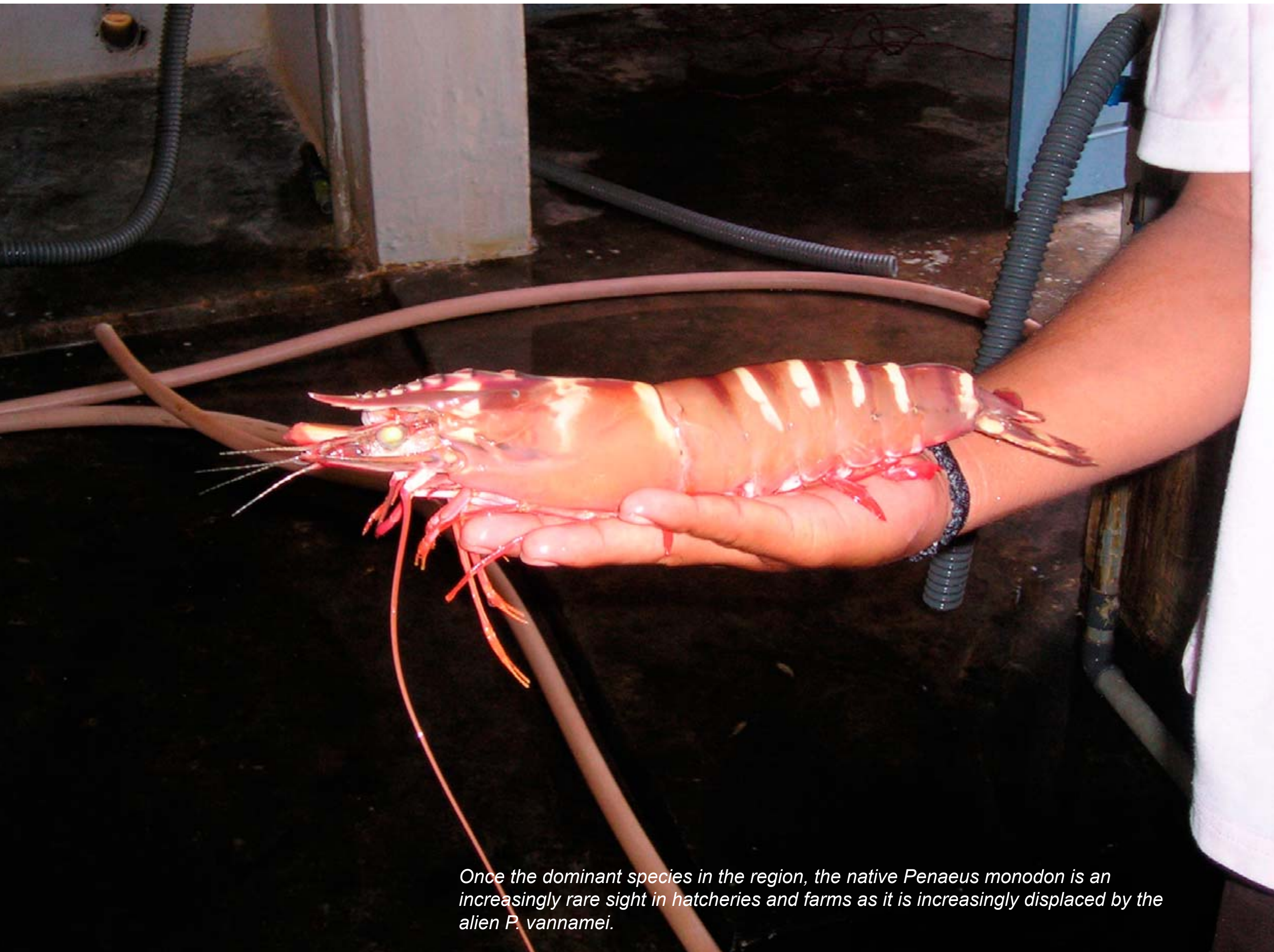

*Once the dominant species in the region, the native Penaeus monodon is an increasingly rare sight in hatcheries and farms as it is increasingly displaced by the alien P. vannamei.*

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# Collaborative project "Group/cluster certification of aqua societies" completed

This two-year project by MPEDA, NaCSA and NACA developed guidelines and methodologies for group certification and pilot tested it in three selected aqua societies in Andhra Pradesh, India, from January 2009 to December 2010. Implementation of the project contributed to significant capacity and awareness building of small scale farmers on concepts of aquaculture certification, group/cluster certification, functioning of Internal Control Systems, compliance to mandatory and voluntary standards, traceability, and market access. Pilot testing of the group certification methodology enabled the project partners to understand the issues and limitations of small scale farmer aqua societies to comply with standards and functioning of Internal Control system. The project produced the following key documents:

- Guidelines cum methodology for group/cluster certification of aqua societies.
- Reference standards and road map for pilot testing of group certification methodology.
- Pond data register to facilitate record keeping and traceability.
- Cluster certification brochure.
- Group/cluster certification training manual.
- Pilot test findings on functioning of internal control system (ICS) and compliance to reference standards.

The project outputs will serve as useful resource material to extend the concept of group certification in the aqua societies established under NaCSA and help prepare aqua societies in India to participate in future certification programs. The project has helped to open avenues for linking small scale farmers to modern markets using the concept and principle of group certification and compliance with mandatory and voluntary standards. The project outputs will also have regional relevance for promoting the concept of better management practices (BMP) adoption through a group/ cluster management approach and group/cluster certification in order to link small scale farmers to modern markets and support responsible aquaculture in the region.

## Background

Aquaculture contributes significantly for food production leading to food security and poverty alleviation, supports livelihood for millions, creates employment opportunities and generates national income; thus it forms an important economic activity. With 70% of the Aquaculture production coming from the small scale farmers, of which 90% have < 2ha of land, aquaculture in India is basically an enterprise of small scale farmers. Therefore, the well being of the small scale farmers is an index of well being of the aquaculture industry. Aquaculture is highly diverse activity consisting of many species, systems, practices, people, and environments. With the limited financial resources and inadequate technical knowledge the small scale farmers are subjected to variety of challenges (animal health and welfare, risk on investment, impact on environment and society, inconsistent demand and fluctuations in market price and so on) both in production and in marketing their produce.

## Better Management Practices for improving the aquaculture production

MPEDA - NACA collaboration since 2002 has demonstrated that bringing the individual small farmers of a locality into a compatible and cohesive entity (group/cluster) towards sharing the common resources coupled with adoption of Better Management Practices (BMPs) is the key towards sustainable aquaculture. Motivated by the concept and encouraged by the results, many small scale farmers have come forward and a good number of aqua societies have been formed in maritime states. Complimenting the interest shown by the small scale farmers, MPEDA in 2007 has established a new institution, the National Centre for Sustainable aquaculture (NaCSA) to service the needs of the aqua societies. There are presently 712 aqua societies in operation comprising of 15,753 farmers, covering an area of 16,126 ha with an annual production of about 16,000 tonnes.

## Aquaculture certification to enhance opportunities in marketing of aquaculture produce

Production and marketing are the two sides of an enterprise which needs synchronisation in meeting consumer demand. Aquaculture products are perishable with a short shelf life; therefore distribution skills and production planning have to be honed to meet market demands. Sharing the food production guidelines with growers, food producers and retailers - specifying how food is grown and what has been used to produce it - is an important contribution to the harmonisation of trade enabling clear and transparent processes.
Thus certification is seen as a tool of communication between the primary producer and the end consumer enabling primary producer economic freedom with social responsibility. "Certification is a procedure by which a certification body gives written or equivalent assurance that a product, process or service conforms to specified requirements and is carried out by competent and accredited body" (Adopted from

IFOAM). Keeping in view of the fact that nearly 90% of the aqua farmers are small scale operators and the certification for individual farmers is not only prohibitively expensive but also impractical, grouping small farmers with common natural resources becomes imperative to extend coverage to all the small scale farmers cost effectively.

### Group certification

The certification of groups of small scale farmers at a given locality, who share common resources and employing common technology is a practical approach for promoting sustainable aquaculture. It can be achived by using an entity (Aqua Society) that manages and documents a clear and transparent Internal Quality Assurance System. The society provides a legal mechanism for granting recognition to a group of farmers and to manage certification, with certificates issued in the name of the society. Compliance to the set standards both by i) every individual member and ii) collectively (the society) is mandatory for group certification. Responsibility (both individual and collective), unity and compatibility of members are the essence of group certification which calls for an efficient co-ordination among the farmers.

### MPEDA /NaCSA NACA collaborative project on "Certification of Aqua societies"

With the objective to assist the small scale farmers to improve the marketing of their produce (in terms of wider accessibility and better remunerative price) through group certification, MPEDA and NaCSA have signed a memorandum with NACA towards development of group certification methodologies for the aqua societies that would enable them to prepare for and seek group certification from independent third party certifiers or for proposing voluntary certification by the societies themselves.

### Methodology

The methodology of study is outlined in the following steps:

### Pilot testing analysis on group certification of aqua societies

The pilot testing performed analysis on the compliance to mandatory and voluntary standards (legal aspects, adoption of BMPs, food safety, traceability, documentation, social and environmental issues) in each of the aqua societies and also assessed compliance to efficient functioning of the Internal Control System (ICS). The pilot testing has clearly shown that it is possible to build capacity of small scale farmer groups/clusters and prepare them to participate in group certification programs. The study clearly identified that small scale farmers should be motivated and adequately trained in ICS operation so that small scale farmer groups/clusters can set up and operationalise efficient ICS and comply with standards of the chosen certification program. ICS provides the quality assurance and proof of compliance on behalf of the farmer group/cluster to the external certification body and hence efficient functioning of ICS is vital for seeking group certification.

### Final workshop

The workshop finalised the guidelines/methodology, road map, and other related documents on group certification of aqua societies. A detailed analysis on the pilot testing of group certification guidelines/methodology was made, limitations were identified and solutions explored. The workshop acknowledged that the MPEDA / NaCSA/ NACA collaborative project had made important progress on developing and pilot testing the group certification concept, methodology and emphasised the need to continue the journey to attain better marketing by addressing the limitations identified. The workshop realised that the economic success of aquaculture depends on the ability of small scale operators not only in sustainable production but also in marketing the same for commensurate prices in global markets through appropriate value chain linkages (e.g. using the market intelligence of the processor combined with group certification for small scale producers). The workshop agreed that it would be very valuable now to proceed to the next stage of developing linkages of selected small scale farmer clusters/groups to the global market through interested processors in the efforts towards empowerment of small scale aqua farmers.

### Project outputs

The project has:

- Contributed to significant strengthening of capacity and awareness among the various stakeholders on the concept of group certification.
- Contributed to the development of following resource material.
- Guidelines cum methodology for group/cluster certification of aqua societies.
- Reference standards and road map for pilot testing of group certification methodology.
- Pond data register to facilitate record keeping and traceability.
- Cluster certification brochure.
- Group/cluster certification training manual.
- Pilot tested findings on functioning of internal control system (ICS) and compliance to reference standards.

### Project recommendations

Considering the global developments with certification programs and the need to comply with mandatory and voluntary standards, it is strongly recommended that MPEDA/ NaCSA and NACA should continue the present work on group/cluster certification and provide technical support to small scale farmer clusters/societies in order to build their capacity and prepare them for participation in group certification programs in future.

Considering the importance of ICS in any group certification program, it is recommended that the project partners develop a strong training program on ICS and implement the training in a structured manner so that the capacity of ICS committees is significantly strengthened.

Recognising the importance of BMP adoption through cluster management approach and the efficient functioning of ICS to comply with standards (mandatory and voluntary), it is recommended that the project partners implement a systematic compliance analysis program in place so that more clusters under NaCSA can be monitored and evaluated for compliance to standards and compliance to ICS functioning.

Considering the globalisation of trade coupled with consumers' awareness on the product quality (food safety, traceability), need for responsible aquaculture (adoption of BMPs, reducing social and environmental impacts) and strategy on linking producers and processers towards efficient marketing of produce (win-win business relationship) it is strongly recommended that small scale farmers must be linked to modern markets so as to remain competitive and sustainable.

Recognising the value of supply chain integration, role of processors, niche markets, ecosystem marketing concepts, etc, it is strongly recommended that NACA develop a long term project on linking small scale farmers to modern markets through group certification for funding consideration by MPEDA/NaCSA.

Considering the need to motivate small scale farmers to prepare for group certification, it is suggested that as a promotional gesture in the initial stages, Government may consider incentives in the form of equipment, capital, and infrastructure for groups willing to participate in the project.

Recognising the value of documents (e.g. group certification guidelines, road map for group certification, brochure, training manual on group certification, etc) produced under the project, it is recommended that the documents be made available widely within India and in the region.

All documents produced under the project are available for free download from NACA website.

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## Report of the Advisory Group on Aquatic Animal Health available

The report of the 9th Asia Regional Advisory Group on Aquatic Animal Health is now available for download. The report provides the latest information on disease trends and emerging threats for fish, crustaceans, molluscs and amphibians; outcomes of the OIE General Session and the Aquatic Animal Health Standards Commission; and the status of disease reporting in the region. Download the report from:

http://www.enaca.org/modules/wfdownloads/singlefile.php?cid=132&lid=1025

## Guidelines on Aquaculture Society Certification released

These guidelines are the key output of the MPEDA/NaCSA/NACA collaborative project on the certification of aquaculture societies.

Draft guidelines developed by the project partners were discussed at the inception meeting on aquacutlure society certifiction held at Kakinada during 1-2 September 2009. The meeting was attended by leaders of the aquaculture societies, representatives of certifying bodies and institutions.

As per the recommendations of the inception meeting, pilot testing of group certification was carried out during January to September 2010 in three societies and the draft guidelines were revised in October 2010, considering the lessons learnt from the pilot testing.

The guidelines developed are independent of commodity and certification standards. The guidelines prepare and enable aquaculture societies to seek group certification from independent third party certification programmes.

Download the guidelines from:

http://www.enaca.org/modules/wfdownloads/singlefile.php?cid=162&lid=1026

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## Listen to us online

NACA has begun making audio recordings of technical presentations given at aquaculture workshops, meetings and projects in which we are involved. We are doing this to allow people throughout NACA member states to access these materials. Only a handful of people can ever physically attend a workshop, but not anyone can listen to the proceedings, wherever they may be.

Recordings are made available in the podcasting section of the NACA website (link below). The recordings may be freely downloaded or you can listen to them online (stream) them from our server:

http://www.enaca.org/modules/podcast

The recordings are also available as podcasts. If you have a podcasting client software installed on your computer, or use an online service such as Google Reader, we encourage you to sign up for our recent podcasts feed. This will ensure that you receive new recordings as they are released. The feed URL is:

http://www.enaca.org/modules/podcast/rss.php

Lastly, the software we use to distribute podcasts has been developed in-house and is available as an open source module for the ImpressCMS content management system. Download it from:

http://addons.impresscms.org/modules/wfdownloads/singlefile.php?cid=37&lid=1376

# Workshop on ecosystem approach to inland fisheries: data needs and implementation strategies

NACA coordinated an international workshop Ecosystem approach to inland fisheries: data needs and implementation strategies, in Vientiane, Lao PDR, 7-11 December 2010 as part of its continued engagement on inland fisheries issues. The workshop was supported by the FAO and the US Geological Survey, and brought together 28 experts in inland fisheries from 12 countries and representatives from regional and international organisations.

The contribution inland fisheries makes to improve the human well-being, and the status of inland fishery resources and the ecosystems that support them, are in general relatively poorly known and often undervalued. As recognised by FAO and others, this is because of (a) the importance of fisheries is not reflected in the formal economy, because much production is consumed locally or traded for other goods (b) the varied and diffuse nature of many inland fisheries operating in remote areas, associated with lack of formal landing areas; (c) lack of awareness and policies on inland fisheries in national agendas, (d) poorly defined market chains or infrastructure dealing with catch from inland waters, and (e) the high cost of collecting dispersed information. Moreover, in many developing countries inland fisheries are considered a traditional, non-economic activity that for the betterment of the nations should be replaced by more obvious industrial or agricultural activities that contribute directly to formal economies. Also where information is lacking, either improvement must be made to acquire it, or alternative strategies must be developed to manage inland fisheries responsibly. Additionally, inland fisheries are greatly impacted by other sectors that use freshwater resources, such as hydro-electric development, irrigation and agriculture, catchment and upstream land development and navigation.

In order to address these broad issues FAO, the scientific community and others are adopting an Ecosystem Approach to Fisheries (EAF) and Aquaculture (EAA). The ecosystem approaches are consistent with and will help implement to FAO Code of Conduct for Responsible Fisheries (CCRF) [1]. The purpose of an EAF is to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by aquatic ecosystems. The EAF encourages the participation of all relevant stakeholders in a participatory process in order to:

- Identify the fishery, area and all relevant stakeholders.
- Identify broad social, economic and ecological (including the fisheries resource) issues for the fishery, based on the broad international and national policy goals and aspirations.
- Identify external drivers affecting inland fisheries.
- set broad objectives for these issues.
- Break down broad issues into issues sufficiently specific to be addressed by an identified management measure(s).
- Rank the issues based on the risks they pose to a fishery.
- Set agreed operational objectives for the high-priority social, economic and ecological issues identified in step V and develop linked indicators and performance measures.
- Formulate management decision rules.
- Monitor the fishery using the selected indicators, and regularly evaluate the performance of management in meeting operational objectives – by inference, because of the linkages developed between policy goals and operational objectives, this will provide an assessment on how well management is achieving the broader policy goals.
- Goals and objectives of the workshop

The goals of the workshop were to examine strategies to incorporate inland fisheries sectoral policy objectives into ecosystem approaches for management of inland waters through:

- Considering ways of enhancing the profile of inland fisheries as a significant contributor to human well being/
- Determining elements of guidelines and strategies for application of an ecosystem approach to fisheries that is relevant to the multitude of inland water types.
- Defining ecosystem services provided by inland fisheries.
- Examining tradeoffs in management of freshwater ecosystem services.

Determining strategies to improve acquisition and quality of inland fisheries data as a solid basis for policy-making in relation to the above-mentioned considerations and in line with the FAO Strategy for Improving Information on Status and Trends of Capture Fisheries.

The workshop reached consensus on the following:

- To prepare a suitable “policy framework” manuscript and to seek publication of it in the journal Science. In this regard the group discussions were held on the possible contents of the manuscript and confirmed in plenary. The main aim of the said manuscript would be to increase the profile of the inland fisheries sector among public and especially among policy makers.
- The workshop agreed to have manuscripts, based on the presentations, prepared for publication in a peer reviewed journal for wider dissemination.
- The workshop also agreed to prepare a manuscript on the importance of inland fisheries in a more popular journal dealing primarily on policy developments in order to attract attention of policy/ decision makers on the importance of inland fisheries to development, food security and

livelihoods. In this regard, the meeting report has been accepted for publication in Biology Letters and will be available online in March 2011.[2]

The workshop also decided that avenues be explored to have a special session in relation to inland fisheries at the forthcoming Fisheries Congress, in 2012, Edinburgh, Scotland. In this regard Dr. Doug Beard will take the initiative and keep the participants informed of the progress.

[1] FAO (1995). Code of Conduct for Responsible Fisheries, pp. 41. FAO, Rome, Italy.

[2] Beard, T.D., Arlinghaus, R., Cooke, S.J., McIntyre, P., De Silva, S. Bartley, D. and Cowx, I.G. (2011). Ecosystem approach to inland fisheries: research needs and implementation strategies. Biology Letters. (doi.org/10.1098/rsbl.2011.0046).

# Disease advisory: Infectious myonecrosis (IMN) status and threat

Infectious myonecrosis (IMN) is a viral disease caused by infectious myonecrosis virus (IMNV). It affects Pacific white shrimp *Penaeus vannamei,* tiger shrimp *P. monodon* and blue shrimp *P. stylirostris*. IMN is associated with heavy losses in farmed shrimp of 40-70%.

Originally reported from Brazil, outbreaks were reported in East Java, Situbondo District in Indonesia in May 2006. In 2009 several other provinces were affected.

With the current spread of the disease there is a high threat of the disease spreading to neighbouring *P. vannamei*-producing countries. Suspected outbreaks should immediately be reported to the authorities.

NACA has published an infectious myonecrosis (IMN): Status and Threat Information Sheet. For more information, please download the sheet from the NACA website at:

http://www.enaca.org/modules/news/article.php?storyid=1891

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# 7th Regional Grouper Hatchery Production Training Course, 25 September - 15 October, Situbondo, Indonesia

Applications are invited for participation in the 7th Regional Grouper Hatchery Production Training Course, which will be held at the Brackishwater Aquaculture Development Center in Situbondo, Indonesia from 25 September to 15 October.

Grouper culture has led to a significant contribution to fish production and rural economy in coastal communities in Asia and also played an important role in conservation of the fragile coral reef fishes which are increasingly being threatened with overfishing and habitat destruction. However, one of the major constraints to furthering grouper culture is seed supply. Realising the need to produce commercial quantities of grouper seed, the Network of Aquaculture Centres in Asia-Pacific (NACA), in collaboration with its collaborating centres in the region, has offered a training course on grouper hatchery production six times. Drawing expertise throughout the region and supported by experienced field experts in our collaborating centres, this highly hands-on training course aims to provide participants with a favorable learning environment to update their knowledge and enhance their skills in grouper seed production and hatchery management.

### How to apply

Download the application form from NACA website, fill in and send it to NACA through post, fax or email. You will be acknowledged of acceptance after your application is approved by NACA Director General and Director of BADC.:

http://www.enaca.org/uploads/temporary/grouper_hatchery_application_2011.doc

We would also appreciate it if you would fill in an information sheet about your farm.

http://www.enaca.org/uploads/temporary/training_data_collection_form.xlsx

### Course contents

This course is designed to provide hands-on training on all aspects of grouper seed production. Participants will learn to select, maintain and handle broodstock, induce fish to spawn, incubate eggs, prepare live feed and develop feeding regimes for newly hatched larvae, and practice nursing prior to seed harvesting, packaging and transportation. Participants will also be presented with a theoretical background on biology, reproductive physiology, nutrition and health management. Field visits will showcase production technology and status of small and medium-scale grouper hatcheries, nurseries, grow-out farms, live food suppliers, traders and live seafood exporters in Indonesia. Some government research and extension institutes will also be visited. Topics covered in the training course are:

- Biology of grouper.
- Site selection, hatchery design, equipment and setup.
- Broodstock selection and management.
- Eggs handling and development stages.
- Culture environment and water quality management.

- Larviculture and nursery.
- Live food production – phytoplankton and zooplankton.
- Nutrition and feed for grouper larvae (including artificial feeds).
- Disease and fish health management in the hatchery.
- Harvesting, packaging and transportation.

### Training venue

The Brackishwater Aquaculture Development Center - Situbondo (BADC-Situbondo) was established in 1994 as a sub-center for brackishwater aquaculture development by the Ministry of Agriculture to support the program to increase fish production in Indonesia. Since 1 May 2001 it has been upgraded and become a center with 3 divisions: Finfish, Shrimp and Aquaculture. BADC-Situbondo is the Technical Implementation Unit (TIU) of the Directorate General of Aquaculture.

BADC-Situbondo has been involved with applied research on grouper aquaculture particularly for hatchery technology since 1994. In 1996 it produced its first batch of grouper fingerlings. With continuous applied research and also technology exchange with other research institutes such as Research Institute for Mariculture in Gondol, the technology for grouper hatchery has improved and taken up by private sector, including large-, medium-, but mainly small-scale hatcheries.

The marine species that on which BADC Situbondo focuses its research and development work include *Cromileptes altivelis*, *Epinephelus fuscoguttatus*, *Epinephelus lanceolatus*, *Cheilinus undulatus*, Pompano, hybrid grouper, and milkfish *Chanos chanos*. The hatchery technology for *C. altivelis* and *E. fuscoguttatus* have been developed and taken up by many private sector operations. Consequently, numerous grouper hatcheries have been established and are now doing good business.

### Training facilities

BADC-Situbondo has good infrastructure and facilities, including:

**Finfish division**: broodstock tanks, pond, larval rearing tanks, quarantine tanks, live food culture tanks, seawater reservoir, floating cages, and laboratories.

**Shrimp division**: spawning tanks, larval rearing tanks, live food culture tanks, seawater reservoir, and laboratories.

**Aquaculture division**: brackishwater ponds, nursery ponds, reservoir pond, and laboratories.

A section of the centre incorporating 12 microalgae production units, 4 rotifer production units and 10 indoor larviculture units are devoted to grouper hatchery training course. All the participants will get hands-on intensive training from egg handling through to harvest of fingerlings.
Resource speakers and trainers

Most of the topics will be delivered by the grouper breeding and larviculture resource persons from BADC-Situbondo, supplemented by specialists inputs from other centers and institutions in Indonesia.

### Who should attend

Hatchery managers, technicians, researchers, extension officers, and other aquaculture professionals who are seeking to expand knowledge and obtain hands-on experiences in grouper seed production.

### Requirements

Knowledge in fisheries science, aquaculture, and other relevant subject areas, plus adequate language proficiency in listening, speaking and reading in English.

### Course fees

The training fee covers costs for tuition, shared-room accommodation during stay in BADC (from 25th September to 9th October 2010), most lunches and some dinners, airport pickup, local transportation and materials and supplies for training related activities.

The fee does not cover international and domestic flights to and from the nearest airport, accommodation during field trips to Bali (from 10th – 15th October 2011), allowance and personal expenses. The room rate for hotel in Bali will be around US$ 40 –50 per night.

**Network of Aquaculture Centres in Asia-Pacific**

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NACA is a network composed of 18 member governments in the Asia-Pacific region.



### Contact point

For more information including course fees and travel arrangements, please download the flyer from:

http://www.enaca.org/uploads/temporary/grouper_hatchery_flyer_2011.doc

Or contact:

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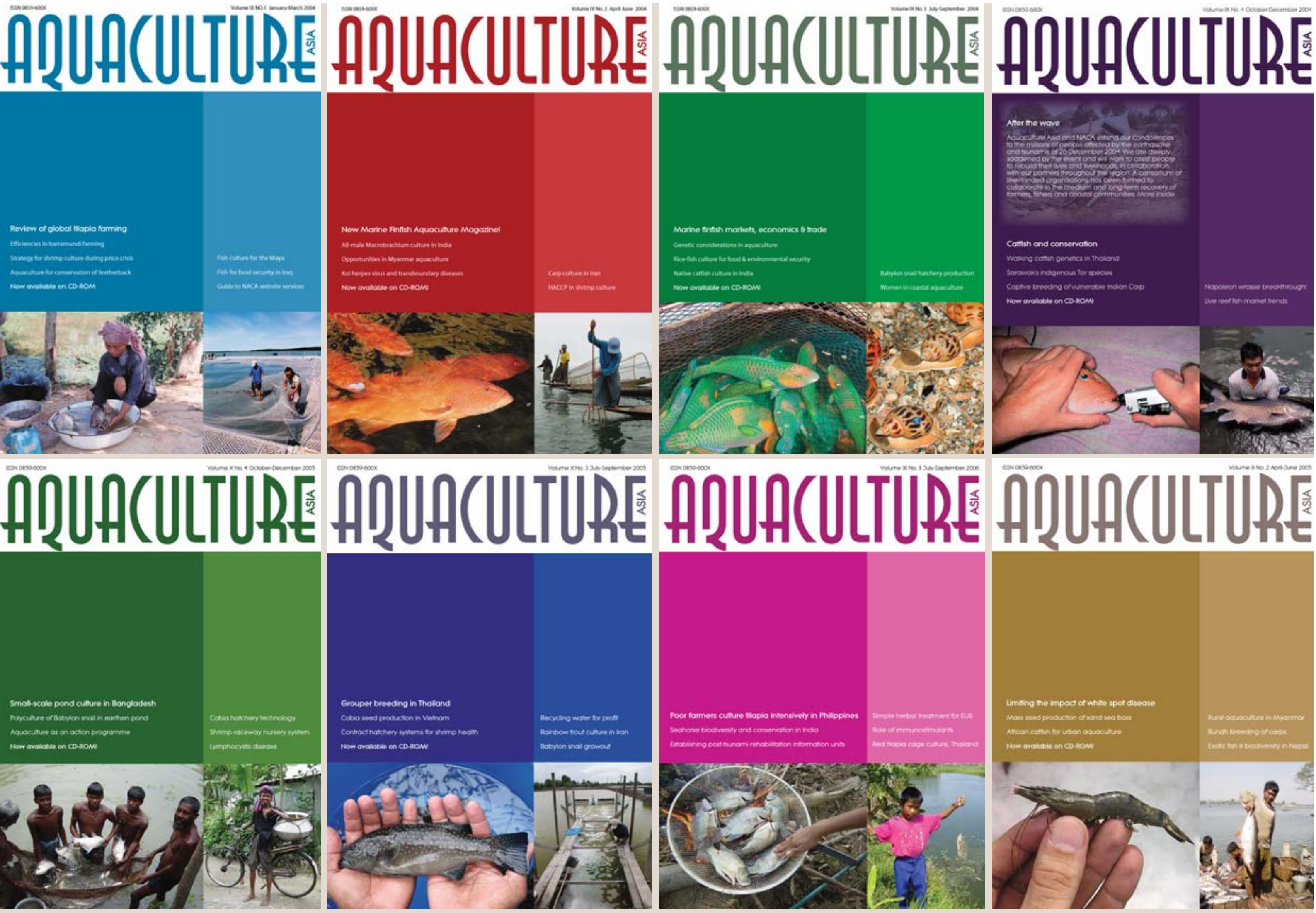
AQUACULTURE ASIA


AQUACULTURE ASIA

AQUACULTURE 2010 Global Conference

# All slides and audio recordings now published on conference website!

## Have your say on the future of aquaculture development

With aquaculture now providing nearly 50% of global food fish supplies, FAO in partnership with NACA and the Thai Department of Fisheries, organised the *Global Conference on Aquaculture 2010*, to evaluate where the sector stands today and prepare for the challenges ahead. The objectives of the conference were to:

- Review the present status and trends in aquaculture development.
- Evaluate progress against the 2000 Bangkok Declaration & Strategy.
- Address emerging issues in aquaculture development.
- Assess opportunities and challenges for future aquaculture development.
- Build consensus on advancing aquaculture as a global, sustainable and competitive food production sector.

The presentations and complete audio soundtracks from the conference are now available for download from the conference website at the link below.

***Enquiries and further information***

Please visit website for more information, or feel free to contact the conference secretariat:

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