

# AQUACULTURE ASIA

Availability of wild grouper seed, Vietnam  
Spatial planning for coastal shrimp production

Training in Fiji  
Portable FRP hatchery





## Aquaculture Asia

is an autonomous publication that gives people in developing countries a voice. The views and opinions expressed herein are those of the contributors and do not represent the policies or position of NACA.

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### NACA

An intergovernmental organisation that promotes rural development through sustainable aquaculture. NACA seeks to improve rural income, increase food production and foreign exchange earnings and to diversify farm production. The ultimate beneficiaries of NACA activities are farmers and rural communities.

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Printed by  
Scand-Media Co., Ltd.

# AQUACULTURE ASIA

Volume XX No. 1  
January-March 2015

ISSN 0859-600X

## Changes to the magazine in 2016

The magazine will undergo some significant changes in 2016. Probably the most substantial and controversial of these is that we will stop printing paper copies. The October-December 2015 issue is the last one that will be distributed on paper. The main reason for this are budget restrictions (going forward we will only distribute extension publications in printed form), and we have also found that most people actually access the magazine electronically. Postage is the main expense, but we can distribute the magazine electronically in PDF format, which we have been doing for the last thirteen years anyway, more or less for free.

I am expecting a fair bit of pushback from people who still like their paper copies, but sorry, we really can't afford to do that anymore and it's time to move on. A high-resolution version of the magazine file will be produced, so if you really want to enjoy a paper copy or see the photos in high-resolution colour you will be able to print one out locally yourself.

Freedom from paper also provides a lot more flexibility in layout and design. For a start, there are no constraints on length in an electronic-only version. I don't need to fiddle about rearranging things trying to maximise use of the limited and diminishing plate space, I don't need to be hounding authors about exceeding length limits so that I can fit other people's papers in, and I don't have to squish interesting photographs down in size or throw them away to make things fit.

In practical terms, this means we can have more articles, longer articles, bigger pictures, and much faster publishing (sounds awful, right?). Articles will be produced and published singly as they become available and essentially bound into an issue later on. Selected articles will also be released in the news section of the NACA website.

Paid subscriptions for the magazine will no longer be available; the magazine will only be available free and it will continue to be distributed under a Creative Commons Attribution license. To ensure that you don't miss issues, an email subscription service will be offered that will send you a personal link to download new issues when they are released.

*Simon Wilkinson*

# AQUACULTURE ASIA

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Peter Edwards writes on

# Rural Aquaculture

## Further training provided to aquaculturists in Fiji

Both the Fiji Ministry of Fisheries and Forests (MoFF) and the Secretariat of the Pacific Community (SPC), an Associate Member of NACA, have recognised that commercial tilapia farming is starting to develop rapidly in Fiji, as reported in my previous article (Commercial tilapia farming at 'take-off' point in Fiji. *Aquaculture Asia* 19, 3: 3-11, 2014). Hence there is a pressing need for more training to help to maintain this momentum in Fiji. The participants in the previous workshop on aquaculture extension identified pond construction as a topic on which they would appreciate training. I was invited back to Fiji as a resource person

to work with Tim Pickering, SPC Inland Aquaculture Advisor, and Avinash Singh, SPC IACT (Increasing Agriculture Commodity Trade) Aquaculture Officer, for the SPC Capacity-building Workshop for Fiji Aquaculture Farm Development Teams on Fish Pond Construction which was held from 7-11 December, 2015. The workshop was attended by an enthusiastic total of 27 participants, 23 aquaculture farm development team officers or fisheries extension officers from throughout Fiji, including Suresh Chand, the MoFF Acting Director of Fisheries, 2 commercial fish farmers and 2 tilapia entrepreneurs.



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*Measuring out the area of the large pond.*





*Tim Pickering briefing the participants at the start of the workshop.*

## Workshop outline

The goal of the participatory training workshop comprising both theory and practice was to increase the capacities of Fiji aquaculture extension officers to carry out extension and advisory services, to provide farm development assistance and to assist them to scope out the key issues, skills, tools and techniques for effective discharge of their duties. The workshop emphasised experiential learning or 'learning by doing', as the participants were taken through all the steps involved in construction of both a machine-dug commercial tilapia pond and a hand-dug subsistence tilapia pond.

A real farm was selected as the site for the practical aspects of the workshop by arrangement with the farm owner, Chandra Sen, whose commercial tilapia farm at Baulevu on the banks of the Rewa River in Tailevu, was visited during the previous extension workshop.

## Theory

The theory of pond site selection and construction was introduced as PowerPoint lectures on the mornings of Days 1, 2 and 5. The course began as it should have done with an introduction to basic theory but once the practical construction of a commercial pond had begun on the first afternoon, further lectures had to be fitted around the actual construction by digger (back hoe) as it was essential for the participants to view all aspects of the process. The pond construction topics comprised basic theory on principles of pond construction, site selection (water, topography and soil), types and characteristics of fish ponds, and pond construction and maintenance. A photo gallery of real world pond construction methods and issues in 11 countries that I have collected over my career was also presented, both successes as well as failures, or rather how to build and manage the physical aspects of ponds most effectively. By request of the participants, hungry as they were for even more aquaculture knowledge than was scheduled for, I presented a PowerPoint bonus topic on low-cost feeds in aquaculture on Day 5.

As I was not involved in any other physical activity, I made a photographic record of all stages in the practical pond construction training. These images were presented to the participants in a report back session to further emphasise pond construction and management, and have been provided to SPC as a basis for any future training materials on pond construction as well as given to the participants on flash-drives. In addition, SPC presented copies of the newly translated SPC Tilapia Farming Manual Vol. 2 which has a section in it covering pond construction and is expressed

*Removal of plants from the pond site.*







*Starting to dig down into the pond bottom area to remove soil to build a dike.*



*Measuring the level of the future pond bottom with spirit levels.*





*Continued removal of soil from the pond bottom area to form a dike.*

*Compacting the a dike.*







*Shaping the slope of a dike.*

in the vernacular Fijian language. Additional copies of the manual were given to each participant so that they could hand-carry and distribute them back to the four corners of Fiji.

## Practice

The weather was eminently suitable for pond construction, and apart from a hydraulic hose failure on the digger rented to construct a full-sized (22m x 33m water surface area) commercial size tilapia pond, which was repaired overnight, there were no delays in the work. A small (3m x 5m water surface area) hand-dug subsistence-scale pond was designed, measured out and constructed by all participants who engaged in the hard labour of digging with enthusiasm which well-reinforced the basic pond construction steps through this learning by doing" approach. All aspects of machine-dug pond design and construction were witnessed by the participants who also engaged in some of the steps in the construction of the large commercial pond, such as measuring out the pond design with marker pegs and tapes, setting a level-indicator line for the digger's reference, laying the outlet drain pipe through the dike, and doing correct compaction of soil in the critical outlet-drain area.

A field visit was made to see a leaky pond site on hilly topography at Homes of Hope, Wailoku, a rehabilitation centre for disadvantaged single mothers. A soil water retention test carried out at the site indicated that the 3 year old pond should have been able to retain water, indicating a possible weakness in the dike from improper clearing of felled trees and vegetation or improper compaction in the dike leading to subsequent inability to retain water. As the organisation wanted to farm fish to provide food as well as to teach the women residents aquaculture as a possible livelihood option following their re-entry into society, a liner donated by a NGO



*Swivel stand pipes used for pond drainage.*



*Excavating through the dike to place the drainage pipe.*





*Placing the pond drainage pipe.*



*Compacting the soil around the drainage pipe.*

in the USA had been used to seal another pond, although this was recognised as a very expensive solution to pond water retention.

## Wrap-up session and follow-on

A plenary discussion was held on the final day about costing time, labour and the volume of earth required to dig ponds manually and by machine. The aim of this was to equip participants with skills to negotiate future pond construction contracts based upon realistic appraisal of the volume of earth to be moved and the time expected for digger or hand-spades to move it. This was a revealing exercise because it showed that a machine-dug pond cost only about US\$2.50 per cubic metre to construct whereas a hand-dug pond cost much more, about US\$12.5 per cubic metre. The conclusion was that, wherever possible, fish farmers in Fiji should employ machines for to dig ponds if access roads would allow.

Participants were also asked to discuss future priorities for capacity building and training needs. The following emerged from this brainstorming session:

- Marketing – how to avoid gluts.
- Value-adding of tilapia, wholesale market.
- SPC economic decision making tools for tilapia farming.
- How to use a farm log book for day to day farm management.
- Training on MT tilapia incubation method, and advice about methyltestosterone (MT) policy (human safety issues).



- Water source, pumping options, rate of flow, hydrology.
- GIS tools for selection of farm sites – review of past work, and consider possible follow-on?

It was instructive to note that apart from incubator hatchery, no major fish production technical or pond management issues were raised for further capacity building, a sign of the maturation and emerging commercialisation of Fiji's tilapia farming sector. The topics requested mainly related to marketing, post-harvest, and business literacy.

As discussed in my previous article on Fiji, tilapia was introduced decades ago but only recently has interest grown in tilapia as a commercial-level business rather than the subsistence-level, small-scale farming activity which had been promoted in the past. Following training at AIT in 2013 on the regular short course, 'Training on Tilapia Hatchery and Grow-out Technology', a commercial farm in Fiji set up a scaled-down AIT hatchery and nursery system to produce MT-seed required for commercial-level aquaculture. More recently with SPC support, training on the AIT incubator technique was held at the government's Naduruloulu Freshwater Aquaculture Station (NRS) for their staff with a view to adopting this technique to supplement and upgrade tilapia fingerling production by their current dated method of collecting swim-up fry. Since completing this training, the Department has requested SPC to assist them to design and build a scaled-up MK-II incubator system modelled on the AIT set-up.

*Compacting the soil around the drainage pipe.*



*Doing it the hard way: Manually digging a small pond.*



*Shaping and compacting the dikes and laying drainage pipe.*





The selection of the topics also indicated that the fishery extension officers, who primarily respond to requests for assistance before they visit a fish farm, were spending a disproportionate amount of time responding to requests for assistance from larger-scale commercial fish farmers and were hard-pressed to assist the small-scale farm sector in more distant or wide-spread areas. However, the potential contribution of fish farming to national welfare needs to be addressed if Fiji is to improve both food security and the livelihoods of the poorer farming sector that mostly resides in more remote mountainous areas and isolated islands. Promotion of Asian-style Farmer Groups, to foster mutual self-help and exchange of information and services between commercial-scale farmers, will relieve government of some of this burden on their free services which were originally intended to assist the poorest of the poor.

I was provided with a copy of a SPC funded GIS study of the potential of aquaculture in SPC countries and territories by Nadia Chagnaud, 2008, 'Application of GIS tool to strategic planning of freshwater aquaculture in SPC countries and territories'. The study based on Viti Levu and Vanua Levu, clearly indicates tremendous potential for the development of

small-scale freshwater aquaculture at numerous sites on these two large Fijian islands. As there does not appear to have been any significant follow-up of the study's findings, I recommended that a 'ground truthing' exercise be carried out in selected representative

areas to capitalise on the findings of GIS study, to determine the potential for small-scale tilapia farming as a livelihood option as well as to provide badly needed fish in remote rural areas of Fiji.



*Hillside pond that did not hold water, Homes of Hope.*



*Above: Below: Pond with liner.*



*Harvesting eggs from tilapia brood stock, Naduruloulou Freshwater Aquaculture Station.*



*AIT-style tilapia egg incubators, Naduruloulou Freshwater Aquaculture Station.*



# Spatial planning for sustainable coastal shrimp production

Olivier M. Joffre, Pham Dang Tri, Tran Thi Phung Ha, Roel H. Bosma

The coasts in most South East Asian countries are threatened by sea level rise due to climate change. Mangrove belts are an important and cheap instrument as a first line for coastal protection. Some countries have realised this since the 1980s while other have neglected the conservation of the mangrove belt along the coast line and in estuaries. The complete replacement of the mangrove belt by traditional shrimp ponds may have devastating consequences as can be seen in Demak province, east of Semarang in Indonesia.

In some countries such as the Philippines a ban on mangrove deforestation led to so-called separated mangrove-shrimp systems that were later emulated in South America. In such systems, the mangroves are well connected to the surrounding water and contribute to normal ecosystem functions including land accretion. Indonesia and Vietnam by contrast developed mixed mangrove-shrimp farming systems with in-pond mangrove plantations. Collectively or individually, shrimp farmers are potentially good stakeholders to plant, protect and manage mangroves if they have full rights and responsibilities over these forests. The province of Ca Mau in Vietnam aims to provide mixed mangrove-shrimp farms with a better future through their certification as organically-produced shrimp. However, this model is not spreading within the coastal zone, although there are large areas of extensive shrimp farming, some of which could be converted to integrated mangrove-shrimp systems. Farmers will benefit from a more diversified production system, while presence of mangroves can deliver various ecosystem services that will benefit the coastal zone.

Farmer decisions regarding the choice of production system depends on a multitude of drivers. Their interpretation of and reaction to external drivers depends on the knowledge and experience of the individual. This is rarely taken into account in coastal planning; while farmer decisions to develop one production system or another is deeply grounded within

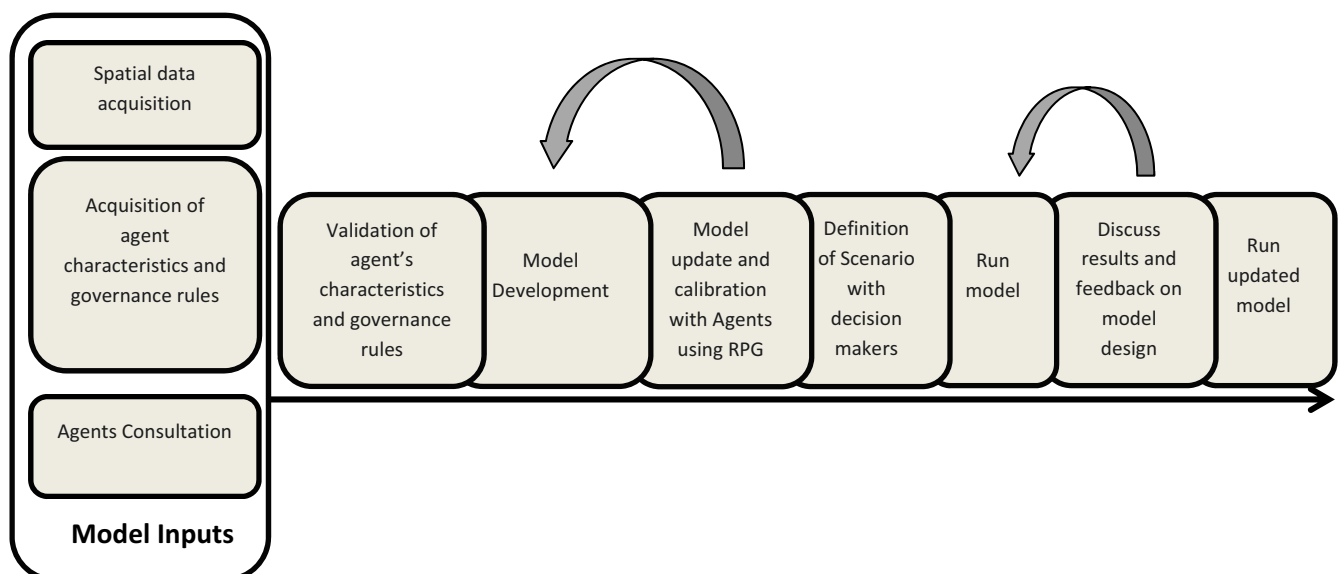
their local knowledge. One of the intended outcomes of the RESCOPAR project was to provide recommendations and tools for governance stimulating equitable participation of people dependent on coastal resources. This research was intended to develop tools for aquaculture planning in the coastal areas that integrate the point of view of farmers and promote an interaction between farmers and decision makers.

## Agent based modelling

To develop such tool, we adapted the participatory land use planning approach described by Voinov and Bousquet (2010). At the core of this approach lies an agent based model (ABM) labelled Coastal Aquaculture Spatial Solutions (CASS). An ABM integrates knowledge of local and higher level stakeholders and analyses effects of development plans on landscape, agricultural yield and farmers livelihoods. The results can be presented to and discussed with the involved stakeholders.

We developed this tool in Dam Doi District, Cam Mau Province in the Mekong Delta, Vietnam. The plots of more than 20,000 shrimp farms were represented on a spatial GIS map and secondary data regarding farm's physical environment were linked to the plots. From the information gathered by ten other RESCOPAR PhD projects on shrimp production and livelihood perspectives we identified drivers for sustainable shrimp aquaculture systems. In workshops and through on-line surveys, local and international stakeholders ranked and weighted these drivers. Farmer decision making in the context of governance rules and other drivers were investigated through eight consultations with the different type of shrimp farmers present in the study area including intensive (INT), improved extensive (IES), integrated mangrove shrimp (IMS) and extensive shrimp farmers (EXT).

Figure 1: Different steps of the approach, with different tools (ABM: Agent Based Model; RPG: Role Playing Game).





With this information we developed an agent-based model that simulates the decision making of 20,000 shrimp farmers (agents) within the study area for every six-month crop cycle. We used the model to investigate the changes over a period of 15 years or 30 crop cycles. The socio-economic characteristics of the 20,000 agents are randomly assigned to each agent, according to their farm type. Farmers decide on the production system based on socio-economic results of the past crops, land suitability, neighbour influence and changes in policy and market prices. The model calculates for each farmer, the shrimp crop results, economic status of the farm and farmer (agent) decision regarding his or her choice of production system. The choice of the production system is visualized spatially on a GIS map, and the model produces tables and figures with the farming systems, and yields.

The rules of the model and agent were validated and calibrated during role playing via a board game. The role playing games were used to investigate outcomes under different socio-economic and policy settings and their influence on farmer decisions. During workshops, farmers from different locations and managing different type of farms played this board game. The rules of the board game are similar to those of the ABM. During the game the decisions of the players (farmers) were recorded and after 10 rounds, each representing one crop the results and the rules are discussed. Thereafter the ABM was adjusted where needed.

Once finalised, the baseline model was presented to decision makers and NGO representatives during a workshop. Agent characteristics, governance rules and the model inputs and outputs were explained to the participants before asking them which scenarios for the future of shrimp farming in the study area they would like to compare. For each scenario participants estimated future trends of the sector for each type of production system, and defined specific policies and the operational cost of each production system. The characteristics of the scenarios were entered into the model to create outputs in terms of spatial repartition of farm type, total production, and the number of abandoned farms. Results and outputs of the model were discussed with the same group of participants at a second workshop.

## Results of national and international expert consultation

The consultation of local and international experts identified that:

- The presence of mangrove can help to reduce the virulence of disease, and can be seen as a more accessible long term strategy for small-scale farmers, compared to the closed system strategy.
- These integrated systems are a management strategy combining two important characteristics for smallholders with low investment capacity: the diversification of income and lower virulence of disease. However, such farms need to be larger than four hectares to provide a decent livelihood. When farms are smaller the farmers may be tempted to reduce the on-farm mangrove area.

- Factors related to governance and markets are important drivers for the development of integrated mangrove–shrimp systems, significantly influencing the financial return of the system.
- The opportunity costs of the mixed mangrove-shrimp systems are high, while farmers receive little financial benefit from mangrove restoration and conservation. Though having higher real cost and being under stress of higher risk, most other systems reward farmers with higher returns. Reconversion to mixed mangrove–shrimp farms will require financial incentives to individuals: e.g. Payments for environmental services, compensation for reducing emissions from deforestation and forest degradation (REDD), and/or premium prices through organic certification.

## Results of consultations and role playing games (RPGs)

During consultation and role playing games, decision making of farmers and willingness to intensify or at the opposite to develop integrated mangrove shrimp system was observed and analysed to fine tune the ABM. Consultation with farmers identified several governance rules such as farmers investing in intensive shrimp farms will any cases shift later to integrated mangrove-shrimp systems. Another rule was about stopping intensive or improved extensive shrimp farms after three consecutive crop failures. These types of rules as well as economic threshold that determine the ability of farmer to invest in one system or the other were validated by farmers during the RPG. In addition the workshop participants established a new type of agent: the hybrid farm combining integrated mangrove-shrimp and improved extensive shrimp systems. This hybrid farm was implemented in the model scenarios.

During the workshops, farmers indicated that they gained skills and knowledge from the role playing game that would benefit their decision making. Farmers found role playing to be a good exercise to test different investment options for the future and thus a good learning tool. Playing the game highlighted the risk of intensive types of production system against the relatively low return but low risk of integrated mangrove shrimp system. This difference could be clearly identified by playing the game for an average time scale (about 5-10 years, or 10 to 20 crops).

## Scenario building and exploration

The workshop with decision makers from local agencies elaborated three scenarios for the future of shrimp farming, namely:

- **Organic coast:** A policy to support organic integrated mangrove-shrimp culture through a premium price, and financial support for planting mangroves and adjusting farm sanitation.
- **Intensification:** A policy stimulating intensive shrimp culture with access to higher loans for farmers.



Farmers analysing the economic results of their farm during the Role Playing Game (RPG). The RPG is based on a board game representing shrimp farms along canals. Each player manages one shrimp farm.



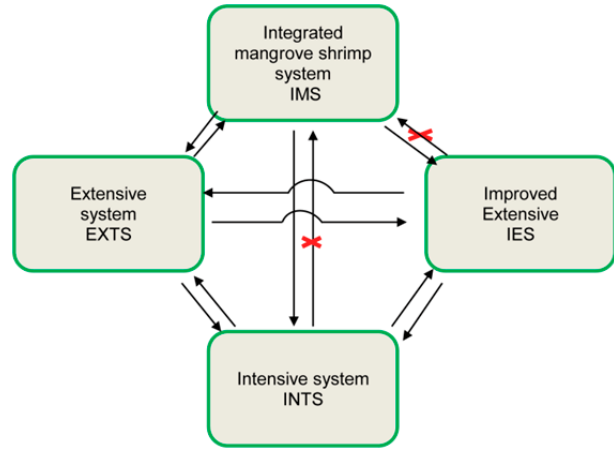


- **Climate change:** A scenario of climate change impact without adaptation measures which was characterised by an increasing operational cost of shrimp farming due to sea level rise, a higher risk of diseases outbreaks and a lower suitability for intensification of shrimp farming.

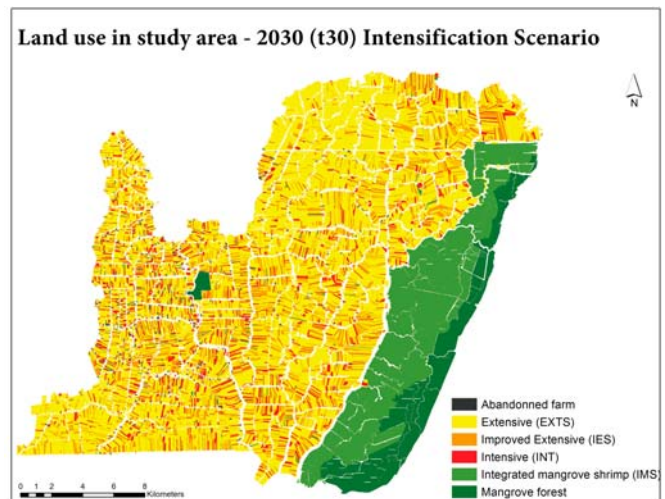
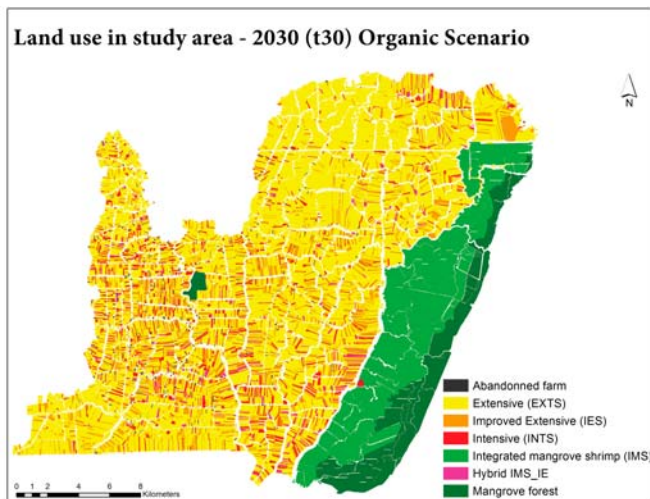
The modelling of these three scenarios showed that:

- Organic certification and the related premium price for organic farming alone are not enough to promote the landscape-integrated mangrove-shrimp system, with limited spread and uptake of this system.
- The scenarios show clear spatial patterns with areas prone to intensification related to land suitability and policies measure to promote intensification and thus supporting intensification in less suitable areas.
- Intensification is not sustainable in the study area at long term (15 years) as too many farmers eventually drop out due to increased frequency of shrimp disease outbreaks, and return to extensive farming.

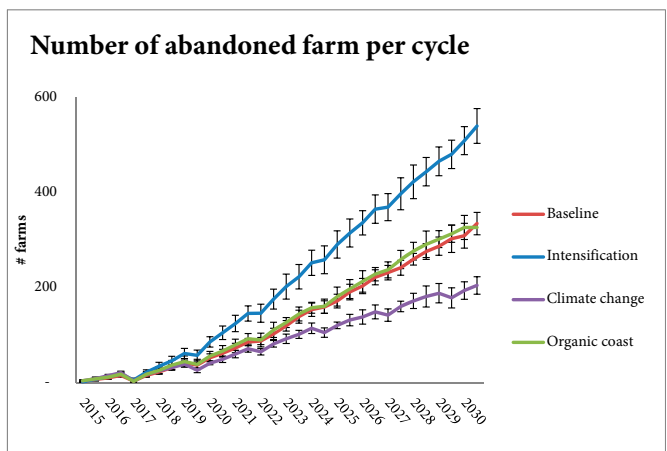
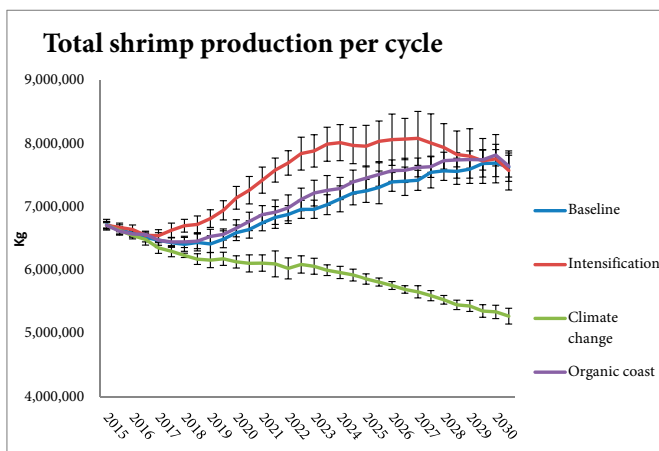
**Potential shift of system between extensive, intensive and integrated mangrove shrimp system. Shifting from intensive or improved extensive to integrated mangrove shrimp system was found not possible (red cross).**



Land use in the study area under intensification scenario (left) and organic coast scenario (right).



Total shrimp production (2015-2030) in the study area (left) and number of abandoned shrimp farms (right) under four scenarios: Baseline, intensification, climate change and organic coast.





- Comparing the intensification scenario to the organic coast scenario shows that the latter achieves a total higher shrimp production while less farmers drop out due to disease outbreaks. Thus the economic result of the organic coast scenario is higher while having a lower social cost.
- Without adaption measures, climate change will cause a rapid decrease of the total shrimp production due to increasing production cost and disease impact.

## Conclusion

The use of the model for this specific case study highlighted the influence of specific policies and changes in the environmental and economic context on farmer behaviours, and on the aggregated outcome at the landscape level. The model integrated a large number of parameters and variables that helped to investigate plausible future scenarios and could support decision making of policy makers.

Farmers gained management skills supporting their decision making on their farm, specifically regarding risk management, from participation in role playing games. Integration of local knowledge helped to bridge the gap between the local farmer and higher level decision-making.

The model and the approach could be improved by integrating more feedback loops, such as adaptive learning of the agents to better reflect agent behaviours. The RESCOPAR approach, combining role playing games and agent-based modelling, will be applied in an IUCN project active in four provinces of the Mekong Delta. An embedded research program will verify the learning effects for policy-makers and farmers.

## References

- Joffre O, R.H. Bosma, A. K. Bregt, P.A.M. van Zwieten, S.R. Bush and J.A.J. Verreth. What drives the adoption of Integrated shrimp mangrove aquaculture in Vietnam. Submitted to Ocean and Coastal Management.
- Joffre O, R.H. Bosma, A. Ligtenberg, V. P. D. Tri and, A. K. Bregt. Combining Participatory Approaches and Agent Based model for better Aquaculture Planning? Submitted to Agriculture Ecosystem and Environment.
- Voinov, A., & Bousquet, F. (2010). Modelling with stakeholders. *Environmental Modelling & Software*, 25(11), 1268–1281. doi:10.1016/j.envsoft.2010.03.007.

# Availability of grouper (Serranidae) fingerlings and seed in the coral reef of Son Tra Peninsula, central Viet Nam

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Coral reefs are unique tropical ecosystems with very high biological productivity, forming a rich and diverse biota. Reef fishes account for about 10% of the global fish catch (Hixon, 2011), and are of significant economic, recreational and aesthetic value. The annual value of coral reef fisheries in Southeast Asia is estimated at US\$ 2.4 billion (Burke et al., 2002). Groupers are among the most economically valuable of reef fishes, with very high market demand, particularly live for the live fish restaurant trade in South East Asian countries (Pawiro, 2005). According to the FAO, grouper production in 2009 was 275,000 tons with a value of hundreds of millions of dollars (Sadovy de Mitcheson et al., 2012).

Grouper farming is widely carried out in many countries in South East Asia. Although some countries have succeeded in artificial propagation of many species such as Malabar grouper (*Epinephelus malabaricus*) and orange-spotted grouper (*E. coiodes*) the prices are very high compared to wild seed (Cesar & Hempel, 2000). Artificial propagation currently provides only 15-20% of the annual demand of grouper seed; the rest is from wild sources. As such a survey of wild grouper seed availability is of much interest.

In Viet Nam, grouper seed availability has been studied since 1995, when the Institute of Marine Fisheries conducted a project, "Technical research for collection and breeding, grow

out and transport of live grouper (*Epinephelus* spp.), amber-jack fish (*Seriola* spp.), and barramundi (*Lates calcarifer*". The results covered twenty-three grouper species and the breeding seasons of these fish were found to be from May to July and September to November in Quang Ninh and Hai Phong waters (Burrows et al., 2001).

According to Lhotka (1994), the annual demand for grouper seed in Vietnam is about three to five million individuals a year, and these are mainly wild caught. Only a small proportion is hatchery produced. There are six species of grouper seed found in Khanh Hoa waters (Le & Hambrey, 2001). Haefner and Dugaw (2000) indicated that seed of five grouper species are commonly collected in Quy Nhon Bay. The annual catch of grouper seed there is estimated to be about 2.4 million individuals. The present survey estimated the availability of grouper fingerlings and seed in the coastal coral reefs of Son Tra, Da Nang, Vietnam.



## Approach

### Sampling

Qualitative analysis of grouper fingerlings and seed was based on purchases from fishers made on site. Twenty fingerlings were randomly purchased from each site to estimate species composition.

Quantitative analysis was conducted at ten sampling sites (Table 1 and Figure 1). We conducted ten sampling trips in total, corresponding to 12 months of 2012-2013, except for October 2012 and February 2013 due to poor weather.

To estimate the density of each grouper species at each sampling site, 100 m measuring tapes were arranged on the bottom. One diver counted all grouper fingerlings that were visible within two metres of either side of the tape along the transect; a second diver used a fishing net to catch fingerlings for identification. The fingerling densities of each species was considered as the number of each species found within the survey area of 400m<sup>2</sup>.

### Sample analysis

Morphological criteria of samples such as total length (TL), standard length (SL) were measured. Fingerlings were identified and classified according to Leu et al. (2005), Heemstra and Randall (1993), Nakabo (2002), Shen and Tzeng (1993), and (Nguyen, 2008), by the series method of Leis and Trnski (1989), (Leis & Rennis, 1983) by grouping individuals with similar morphology and pigment type together. The largest individuals of the group were classified based on the characteristics of adult fish, and it continues so with smaller individuals of the group. Then the different species were separated and compared with fingerling descriptions in the published literature.

## Findings

### Species composition of grouper seed

Analysis of the fish seed samples bought from the fishers and collected at the sampling stations showed that there were eight species of grouper present in the coastal coral reefs of Son Tra (Table 2). These include three economically important and cultured species in Viet Nam, namely yellow grouper (*E. awoara*), orange-spotted grouper (*E. coioides*), Malabar grouper (*E. malabaricus*).

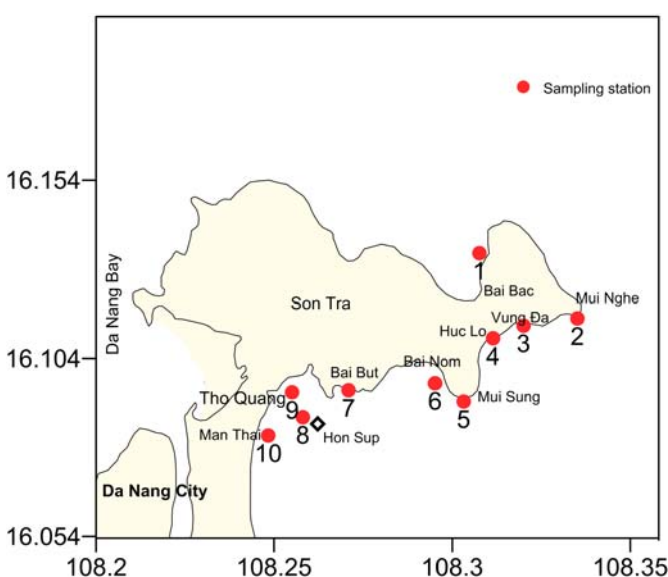
Species composition of each fingerling group showed that *C. boenak* occurred at 8 of 10 sampling sites, except at Mui Nghe and Bai Bac. Its preferred habitat was reef rock, coral and sand bottoms. *E. trimaculatus* occurred at 5 of 10 stations with similar bottom substrata. The fingerlings of *E. awoara* were found at four coral and sand bottom stations. Those of *E. fasciatus* were collected at three stations, while *E. coioides* and *Epinephelus* sp. fingerlings could only be found in near shore waters, on muddy sand bottom stations (Figure 2).

In Son Tra we found three species not reported in Quy Nhon bay, and two not reported in Khanh Hoa (Table 3). However, in Son Tra, *C. boenak* (Bloch, 1790) dominated with 47% of the total collected grouper species, while *E. malabaricus* was

**Table 1. Sampling stations in the coastal coral reef of Son Tra.**

Station	Site	Depth	Bottom substrate
1	Bai Bac	7-12m	Coral + sand
2	Mui Nghe	5-10m	Coral + rock
3	Vung Da	5-8m	Coral + sand
4	Huc Lo	5-8m	Coral + sand
5	Mui Sung	3-7m	Coral + rock + sand
6	Bai Nom	2-5m	Coral + sand
7	Bai But	3.5-7m	Coral + sand
8	Hon Sup	5.5-9.5m	Coral + rock + sand
9	Tho Quang	5-7m	Muddy sand
10	Man Thai	5-7m	Muddy sand

**Figure 1. Grouper fingerlings/seed sampling stations in coastal coral reef.**



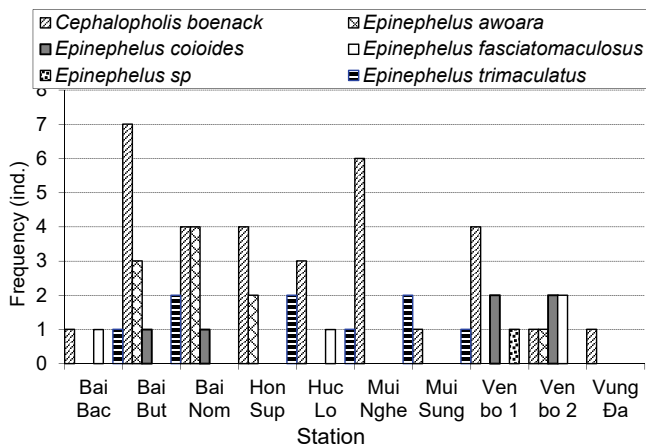
**Table 2. Species composition of grouper seed (Serranidae) in coastal coral reef of Son Tra.**

Species	%	Value*
Chocolate hind <i>C. boenak</i>	46.9	+
Yellow grouper <i>E. awoara</i>	28.3	+++
Orange-spotted grouper <i>E. coioides</i>	5.31	+++
Blacktip grouper <i>E. fasciatus</i>	2.65	+
Malabar grouper <i>E. malabaricus</i>	0.88	+++
Rock grouper <i>E. fasciatus</i>	3.54	+
Threespot grouper <i>E. trimaculatus</i>	11.5	++
<i>Epinephelus</i> sp.	0.88	+

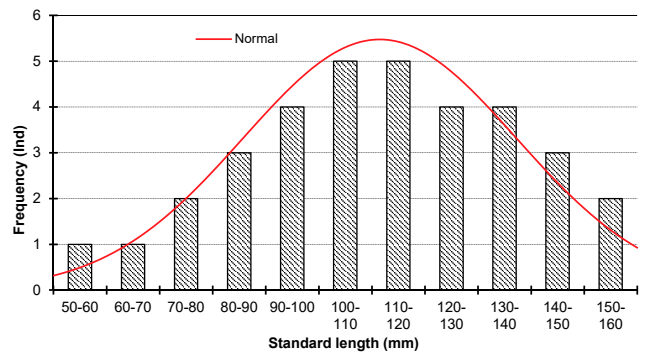
Note\*: +: Economically important; ++: Economically important and cultured; +++: Economically important & widely cultured.



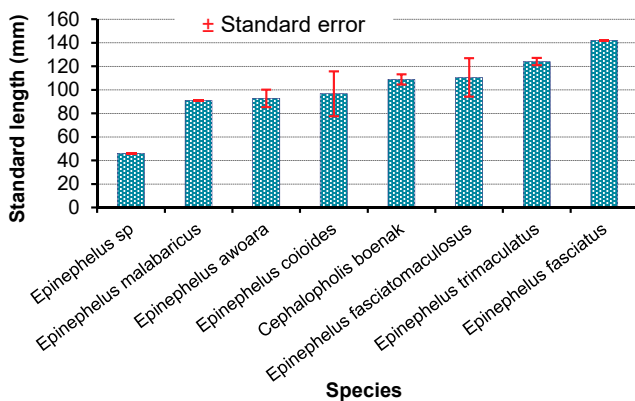
**Figure 2. Frequency of occurrence of seed of each grouper species.**



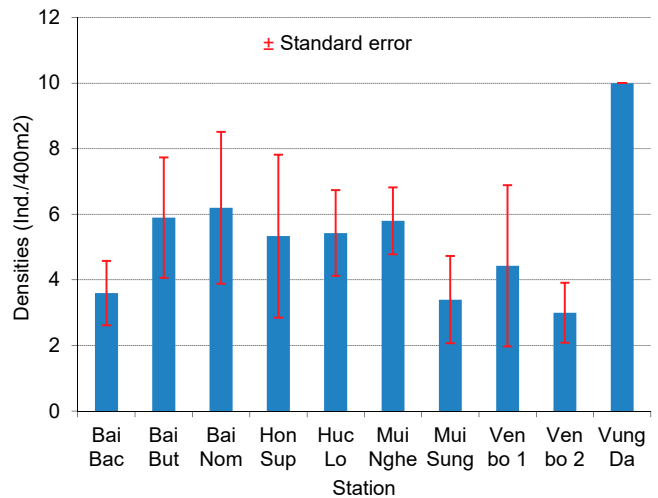
**Figure 4. Length of Chocolate hind fingerlings (*Cephalopholis boenak*).**



**Figure 3. Average total length (mm) of seed of main grouper species in coastal coral reef.**



**Figure 5. Distribution of grouper fingerling density in coastal coral reef of Son Tra.**



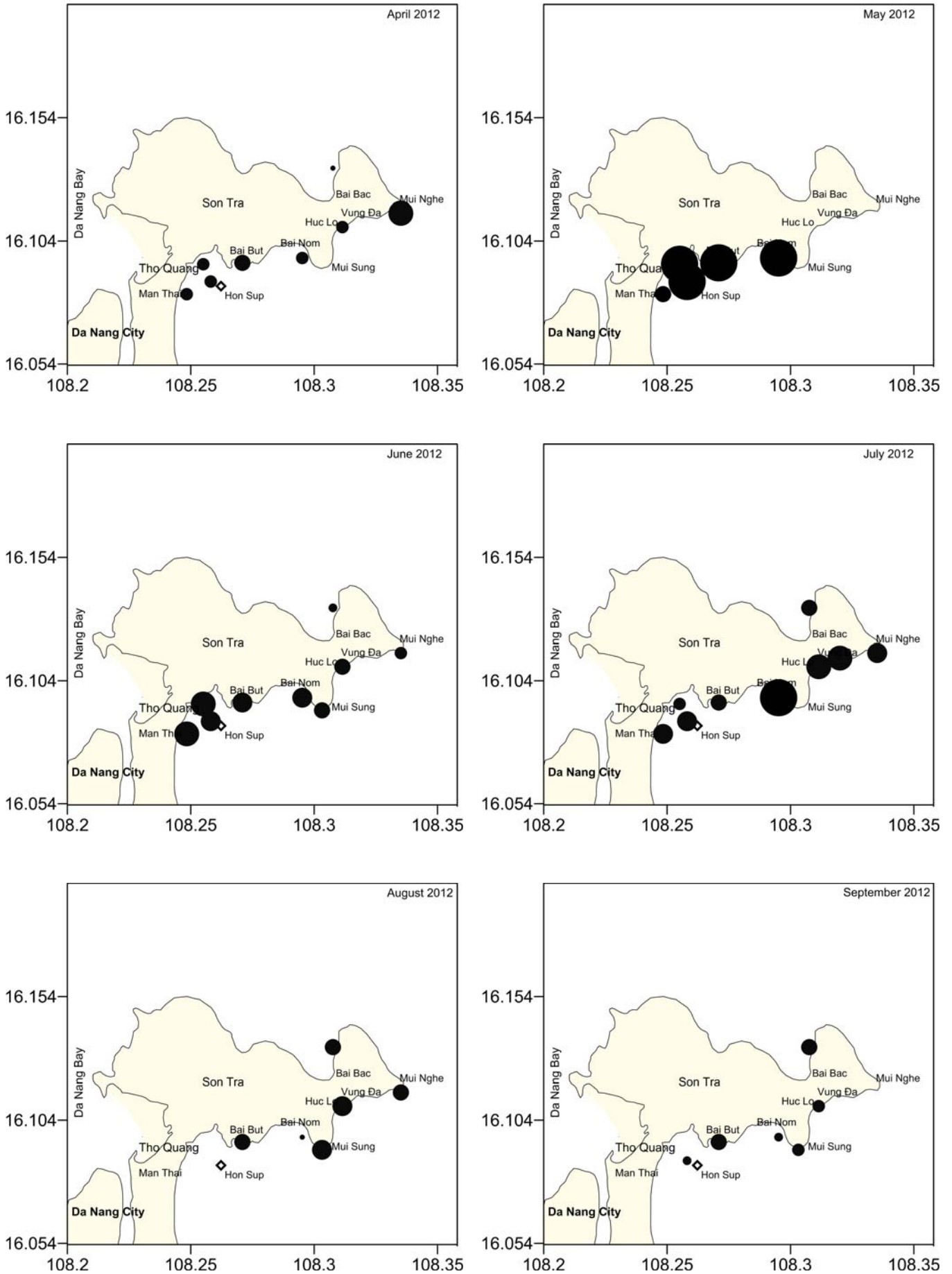
**Table 3: Composition of grouper seed in Son Tra compared to Quy Nhon and Khanh Hoa.**

Species	Coastal coral reef of Son Tra <sup>a</sup>	Quy Nhon bay <sup>b</sup>	Khanh Hoa waters <sup>c</sup>
Chocolate hind ( <i>C. boenak</i> )	+		
Hong Kong grouper ( <i>E. akaara</i> )			+
Banded grouper ( <i>E. amblycephalus</i> )		+	
Yellow grouper ( <i>E. awoara</i> )	+	+	
Duskytail grouper ( <i>E. bleekeri</i> )			+
Longtooth grouper ( <i>E. bruneus</i> )		+	
Orange-spotted grouper ( <i>E. coioides</i> )	+		+
Blacktip grouper ( <i>E. fasciatus</i> )	+		
Rock grouper ( <i>E. fasciatusmaculosus</i> )	+		
Malabar grouper ( <i>E. malabaricus</i> )	+	+	+
Honeycomb grouper ( <i>E. merra</i> )			+
Sixbar grouper ( <i>E. sexfasciatus</i> )			+
Threespot grouper ( <i>E. trimaculatus</i> )	+		
<i>Epinephelus sp.</i>	+	+	
<b>Total</b>	<b>8</b>	<b>5</b>	<b>6</b>

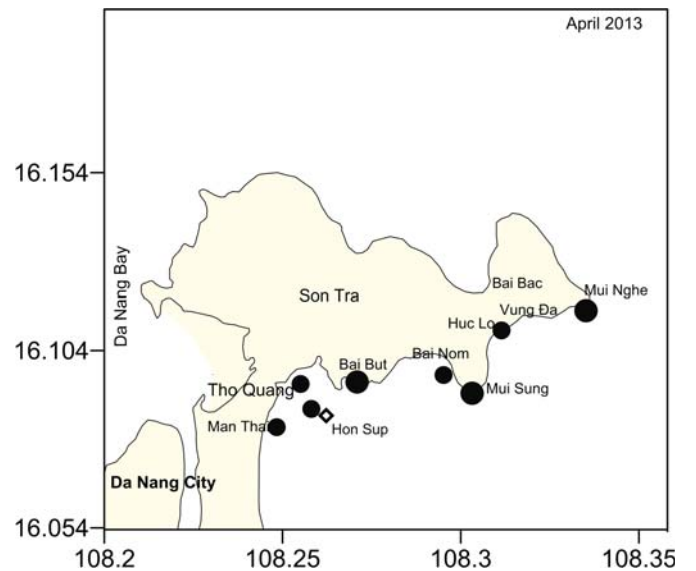
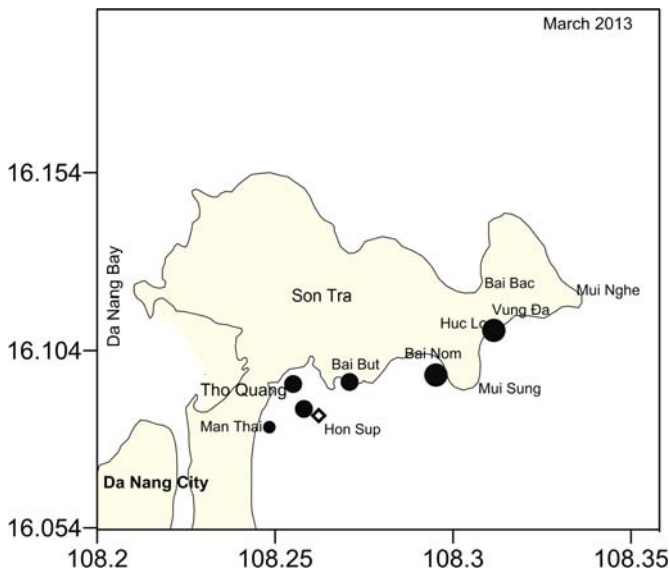
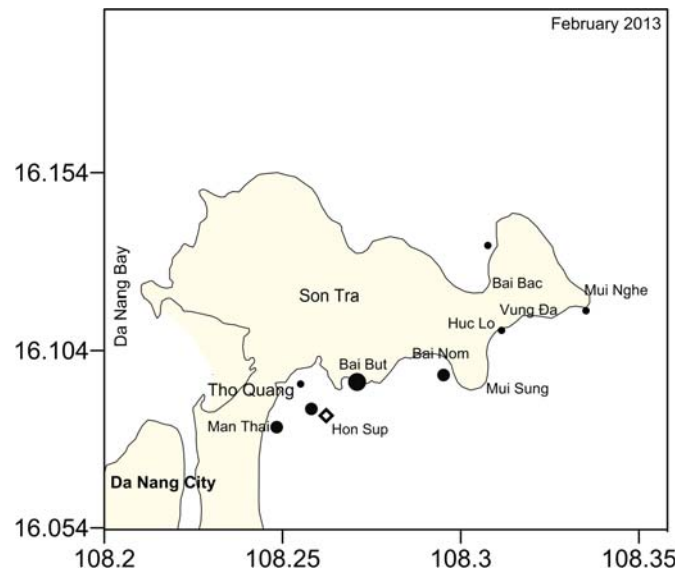
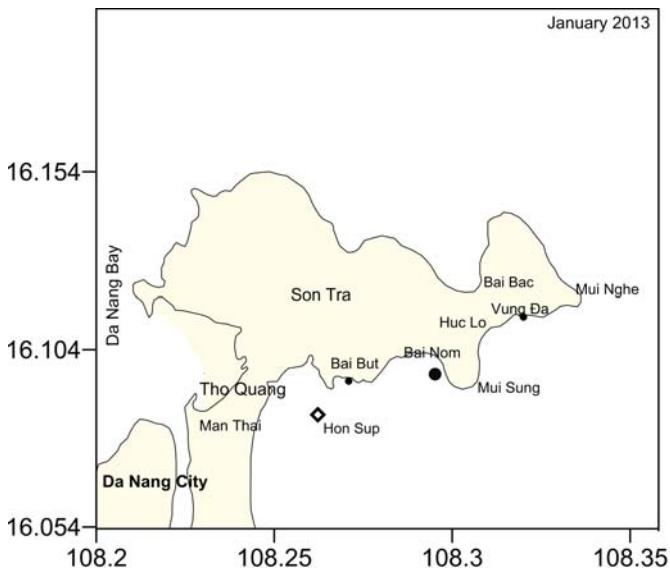
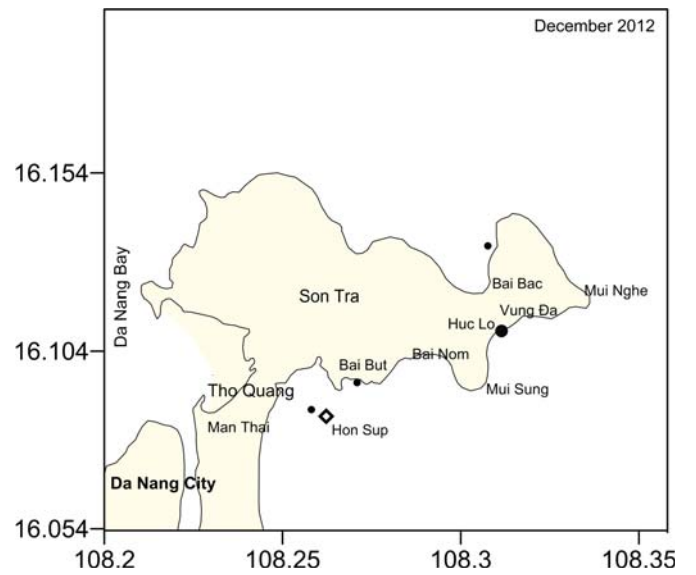
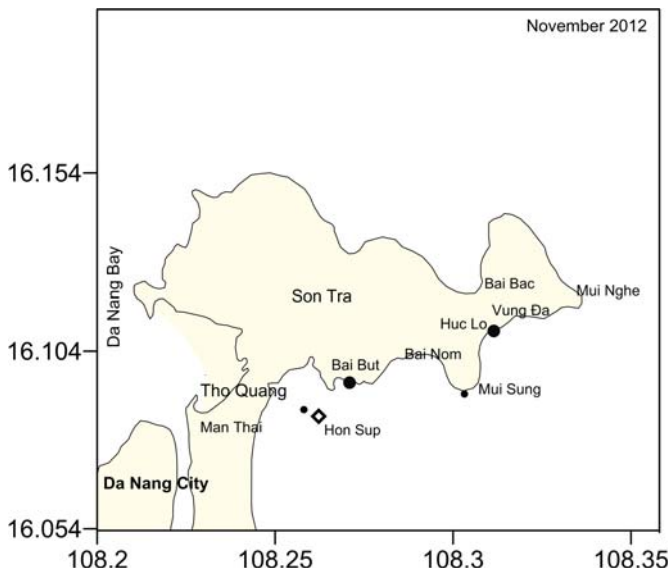
Note: a: this paper; b: Haefner and Dugaw (2000); c: Le and Hambrey (2001).



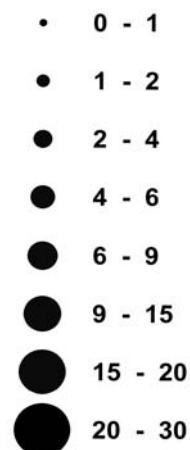
Figure 5. Distribution of grouper fingerling density in coastal coral reef of Son Tra









**Density (Ind./400m<sup>2</sup>)**

the main species in Quy Nhon bay with over 30% (Haefner & Dugaw, 2000; Le & Hambrey, 2001).

The grouper fingerlings collected in coastal coral reef were of different sizes depending on species, and ranged from 58 to 152 mm, of which *E. trimaculatus* had the largest average size, followed by *E. fasciatus* (Figure 2). These species have large adult size, late sexual maturation and long juvenile stages, so the fingerlings are usually larger.

Seed of some species also varied largely in size depending on juvenile stages. The size of Chocolate hind fingerlings ranged from 59 to 152 mm, of which the dominant size was between 80 - 140 mm (Figure 3).

### Density and distribution of grouper seed

Investigation results showed that the average density of grouper fingerlings was 5 individuals/400 m<sup>2</sup>. Grouper fingerlings occurred at all stations with highest density at Vung Da, then at Bai Nom and Hon Sup (Figure 4).

Grouper fingerlings occurred at high density during April 2012 in Mui Nghe. In May and June they concentrated largely in the area from Tho Quang to Bai Nom, and from July to September, the seed density at near shore stations decreased; the fingerlings tended to move to the further sites of the reef, where offshore water showed their influence, such as Huc Lo, Vung Da, Mui Nghe. During the northeast monsoon from November to January in the following year, the seed density

decreased significantly. The fingerlings began to increase in March, but the density remained low (Figure 5).

## Discussion

Groupers are an economically important, popular group of food fish. Over the years there had been an emphasis on the culture of grouper species, particularly to meet the demands of the live fish restaurant trade (De Silva, 2012). Despite improvement in artificial breeding, wild caught seed still play an important role in grouper farming. Currently, grouper aquaculture uses up to 80% wild caught seed. If the growth of the industry continues, it is important that the grouper seed resources be conserved (Rimmer et al., 2006; Sadovy, 2000).

This study observed the presence of seed of three economically important species in Son Tra. Given the popularity of wild caught seed for grouper culture, these resources have been and have potential to be further exploited. We note that the density of grouper fingerlings observed was rather low compared to elsewhere (e.g. Hoi An mangrove area, author observations). If aquaculture of groupers continues to use wild caught seed, it is important that a strategy to management of wild seed resources is developed and implemented. Such a strategy requires a better understanding of migratory patterns, spawning and nursery grounds, population structure, natural recruitment rates and current fishing methods. We observed during our surveys that by-catch of grouper species other than those cultured are sold as food fish. This practice certainly needs attention from management authorities.

The present study observed seasonal differences in abundance of grouper fingerlings. However, this might not reflect the true density at the time of the surveys. November to January are winter in Danang which hinders divers from catching fish, and hence the low density observed herein.

Grouper is one of the most extensively translocated groups of fish in the Asia-Pacific region and this is also true for Vietnam (Sadovy, 2000). Aquaculture of groupers occurs outside of Danang (e.g. Hue, Quy Nhon and Khanh Hoa) and often live grouper seed caught in Hoi An or Son Tra are cultured in these

locations. The risks associated with translocations of live fish are many and well-documented. These risks need to be taken into account in development of management strategies for grouper seed resources in Vietnam as a whole.

In many areas fishing for grouper fingerlings have become part of the livelihoods of many people. It is advisable to study level of contribution of grouper seed fishing to livelihood of fishers, and incorporate such information into management strategies.

### Acknowledgements

This paper formed part of the VAST06.05/14-15 project "Investigation and assessment on the parents and their natural seeds of grouper (Serranidae) in south central coast (from Da Nang to Binh Thuan) and proposing solutions for sustainable exploitation". Data used in this paper were provided from the project: "Investigation seed of some aquatic resources mainly related to inshore reefs Da Nang, thence propose solutions to protect and manage" funded by the Department of Science and Technology, Da Nang, regarding collected samples.

### References

- Burke, L., L. Selig and M. Spalding, 2002. Reef at Risk in Southeast Asia. World Resource Institute, 72 p.
- Burrows, M. T., S. J. Gontarek, R. D. M. Nash and R. N. Gibson, 2001. Shrimp predation on 0-group plaice: contrasts between field data and predictions of an individual-based model. Journal of Sea Research. Vol. 45, No. 3-4: 243-254.
- Cesar, H. S. J. and E. Hempel, 2000. Opportunities and Constraints of Grouper Aquaculture in Asia. World Bank, East Asia Environment and Social Development Unit.
- De Silva Sena S., 2012. Aquaculture - a newly emergent food production sector - and perspectives of its impacts on biodiversity and conservation. Biodiversity and Conservation, 21 (12), 3187-3220. (DOI 10.1007/s 10531-012-0360-09).
- Haefner, J. W. and C. J. Dugaw, 2000. Individual-based models solved using fast Fourier transforms. Ecological Modelling. Vol. 125, No. 2-3: 159-172.
- Heemstra, P. C. and J. E. Randall, 1993. FAO species catalogue. Vol. 16. Groupers of the world (Family Serranidae, Subfamily Epinephelinae). An annotated and illustrated catalogue of the grouper, rockcod, hind, coral grouper and lyretail species known to date. Rome. FAO. FAO Fisheries Synopsis. 522 figs, 531 colour plates, 382 p.



- Hixon, M. A., 2011. 60 Years of Coral Reef Fish Ecology: Past, Present, Future. *Bulletin of Marine Science*. Vol. 87, No. 4: 727-765.
- Le, A. T. and J. Hambrey, 2001. Seed supply for grouper cage culture in Khanh Hoa, Vietnam. *SPC Live Reef Fish Information Bulletin* #8: 33 -36.
- Leis, J. M. and D. S. Rennis, 1983. The larvae of Indo - Pacific coral Reef Fishes. South Wales University and University of Hawaii Press.
- Leis, J. M. and T. Trnski, 1989. The Larva of Indo - Pacific shorefishes. New South Wales University Press. 371 p.
- Leu, M. Y., C. H. Liou and L. S. Fang, 2005. Embryonic and larval development of the malabar grouper, *Epinephelus malabaricus* (Pisces: Serranidae). *Journal of the Marine Biological Association of the United Kingdom*. Vol. 85, No. 05: 1249-1254.
- Lhotka, L., 1994. Implementation of individual-oriented models in aquatic ecology. *Ecological Modelling*. Vol. 74, No. 1-2: 47-62.
- Pawiro S. 2005. Trends in major Asian markets for live grouper. *INFOFISH International* 4: 20-24.
- Nakabo, T., (ed.), 2002. Fishes of Japan with pictorial keys to the species, English edition. Tokai University Press. 1750 p.
- Nguyen, N. T., 2008. Vietnam marine fish. Perch-like fish (order Perciformes) includes: grouper (Serranidae), tigerperches (Theraponidae), bigeyes (Priacanthidae), and grunts (Haemulidae). Science and Technics Publishing House. Ha Noi, 244 pages (in Vietnamese).
- Rimmer, M. A., M. J. Phillips and S. Y. Sim, Aquaculture of groupers in Asia and the Pacific in Proceedings Economics and marketing of the live reef fish trade in Asia-Pacific, Noumea, New Caledonia, 2006. ACIAR Working Paper No. 60: 116-134.
- Sadovy de Mitcheson, Y., M. T. Craig, A. A. Bertocini, K. E. Carpenter, W. W. L. Cheung, J. H. Choat, A. S. Cornish, S. T. Fennessy, B. P. Ferreira, P. C. Heemstra, M. Liu, R. F. Myers, D. A. Pollard, K. L. Rhodes, L. A. Rocha, B. C. Russell, M. A. Samoilys and J. Sanciangco, 2012. Fishing groupers towards extinction: a global assessment of threats and extinction risks in a billion dollar fishery. *Fish and Fisheries*. Vol. 14, No. 2: 119-136.
- Sadovy, Y., 2000. Regional survey for fry/fingerling supply and current practices for grouper mariculture: evaluating current status and long-term prospects for grouper mariculture in South East Asia. Final report to the Collaboration APEC grouper research and development network (FWG 01/99). December, 2000.
- Shen, S. C. and C. S. Tzeng, (eds), 1993. Fishes of Taiwan. Department of Zoology, National Taiwan University, Taipei, 960p.

## Small-scale carp seed production through portable FRP hatchery at Khanguri, Odisha: A case of technology transfer in remote and inaccessible village

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The potential of the aquaculture in producing low cost but high quality protein has been widely appreciated. It has also been proved as a useful tool for increasing rural income and employment opportunities. Looking at these potentialities, governments are making their best efforts to encourage aquaculture production. In India it is estimated that about 2.5 million ha of ponds and tanks are available, out of which only about half currently incorporate aquaculture uses. The average productivity of aquaculture ponds in India is estimated to be 3 tonnes/ha/year (DAHDF, 2013), which can easily be increased to about 5 tonnes/ha/year (ICAR, 2011).

Realising the potential of aquaculture potential requires coordinated effort in development and dissemination of technologies with consistent institutional and policy support. Making aquaculture technologies available to a wide range of farmers located over diverse locations is an important issue in aquaculture development. The domains of the adoption of these technologies are quite diverse as the ecological, social, and economic context of development varies widely across one resource or locality to another. Therefore, the dissemination of the aquaculture technologies has been a major challenge in transferring the research results to farmers' fields.

For aquaculture development the availability of an adequate quantity and quality of seed is crucial. At present more than 60% of the seed in India is produced by one state i.e., West

Bengal and in each state the areas of the seed production also tend to be concentrated in one region (Barik, 2011, Barik and Mahapatra, 2012). Hence, access to seed is a critical issue in aquaculture especially to the small and marginal farmers located in remote and inaccessible places. The seed available through seed vendors or agents often fail to reach villages at the time of stocking leading to a shortage or delay in stocking. However, these problems can be overcome by creating pockets of the seed production clusters in remote areas, near grow out sites. The local availability of the seed will contribute significantly to the aquaculture development in these areas.

An attempt has been made by Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar, to disseminate portable fibreglass enforced plastic (FRP) hatcheries along with technical support to a remote and inaccessible village in Odisha. A group of women from disadvantaged and poor section of society were taken as target group for capacity development. The results of the first two years have been highly encouraging as a successful case of seed production in combination with social empowerment. This article provides a case study of this trial and the many lessons learned in the process.





*FRP hatchery transportation for installation.*

## Portable FRP carp hatchery

The portable FRP hatchery was designed and developed by the CIFA centre of the ICAR-All India Coordinated Research Project on Application of Plastics in Agriculture. Due to the fiberglass reinforced plastic construction the hatchery can be transported from one place to another with ease for timely production of quality carp seeds (Mohapatra et al., 2003, 2004, 2005, 2007, 2008; CIFA, 2004; ICAR 2005; Sarangi et al., 2008). The hatchery has been widely adopted across India. To date, around 250 units have been installed in 27 states across the country.

The FRP hatchery is suitable for breeding of Indian major carps under field conditions for up to 20-24 kg of broodstock (females and males in equal proportion) in one operation. It consists of a breeding/spawning pool, hatching/incubation pool, egg/spawn collection chamber and overhead storage tank/water supply system. The product has an estimated lifespan of 12-15 years. It has high abrasion resistance, is maintenance free and easy to operate. Even small and marginal farmers with limited resources can also operate the hatchery with ease. With the integration of brood stock and seed rearing facilities, the hatchery is able to generate a substantial income and profit compared to cost of purchasing it.

The potential of this technology to produce spawn is very high. In one run, about 1.0-1.2 million spawn can be produced and under suitable conditions production of spawn can reach up to 30 million per year. However, actual performance of the technology in terms of net seed production and number of cycles varies due to different levels of investment, infrastructure, inputs, and management involved in the process. The pre-requisites for the successful operation of the technology is availability of facilities such as brood stock ponds, pumps, sheds and electricity; skill development through training; access to market for inputs and connectivity of the fish farmers to the hatchery; working capital; and management capabilities (Barik, 2011). Even with the lower levels of utilisation the hatchery has been of high net benefit to farmers, users and localities as it affects whole value chain from seed to consumption.

## Portable carp hatchery in Odisha State

Odisha is the state with highest number of installed FRP hatcheries. To date, the technology has penetrated to sixteen districts of the state with approximately 38 hatcheries installed so far. The Odisha Watershed Development Mission (OWDM) conducted fish breeding operations in FRP carp hatcheries under the project "Western Odisha Rural Livelihood Project"



(WORLP) in Nuapada and Bargarh districts. In its first year of operation in 2005, the hatchery supported 38 self help groups to nurse 5.5 million fish seeds, which in turn led 153 self-help groups to take up growout culture of fish in 530 ha of pond area in Western Odisha (Sudhin, 2007; Alan Casebow, 2008). Similar results were reported by Sarangi et al. (2008) and Mohapatra et al. (2012) for Tanar and Nuagaon Villages in Odisha, respectively.

To expand the benefits of the technology to the poor located in the inaccessible locations in Odisha, further, a project was undertaken by CIFA with funding support from Department of Biotechnology, Govt. of India. Under this project as many as 10 locations were chosen for the establishment of the FRP hatcheries among the poor households in Nayagarh and Mayurbhanj Districts of Odisha. Out of which one extremely resource poor and remote village viz., Khanguri in Nayagarh District is taken up as a case study to evaluate performance of the technology and its impact. This case will give an insight into the process of development and impact of hatchery technology on poor households in the rural areas.

## Study area

Khanguri Village is located 12 km away from the district headquarters of Nayagarh, Odisha. It is situated at the foothills of Panipoila Dam surrounded by Ghantalei, Rajgiri and Rasa hills. Panipoila Dam is a relatively minor irrigation

structure with mean water area of 42 ha. There are no all-weather roads to the village. During the rainy season the road becomes non-motorable and bullock cart, motorcycle, cycles and walking are the only means of access to the village. The village has access to electricity but the supply is uncertain. There are no irrigation facilities available in the village even though it is located at the foothills of the dam.

Maa Brahmanidevi Mahila Soyam Sahayak Gosthi, Khanguri is a women's self-help group (WSHG) with 14 members belonging to socially disadvantaged groups (Scheduled Castes, Scheduled Tribes and Other Backward Castes) operating since January, 2000. The group operates through a selected president and secretary with an account in a nationalised bank with an operating capital of about Rs. 25,000. The education level of the members is very low; none of them have passed high school standard and ten members have not gone to school at all. Their main occupation is agriculture with paddy cultivation as the most important enterprise in addition to small scale vegetable cultivation in their backyard. In the off-season only a few of them were involved in non-farm wage employment, but most of them remain unemployed. The annual household income ranged from Rs 8,000 to Rs 44,600. The group entered into fisheries activities by getting a lease to manage the Panipoila Dam in 2008 for a period of five years with lease rent of Rs 5,200/year. The total fish production from the dam, which has 42 ha of water area, was only 1,400 kg with average productivity of about 33 kg/



*Fiberglass reinforced plastic carp hatchery installation in Khanguri Village.*





*Carp breeding demonstration at Khanguri.*

ha which is considered to be very low. In addition, they also leased three more ponds with a water area of approximately 3 ha for fish culture.

The availability of carp seed was a major constraint for fisheries development in the dam and ponds, as the nearest hatcheries are very far away. Due to lack of communication facilities the seed vendors were not able to supplying them with seed at the right time for stocking. Considering these constraints CIFA installed a portable FRP carp hatchery to provide the SHG and other nearby localities with seed. Operation of the hatchery also provides an additional livelihood activity for the women.

## Installation of FRP carp hatchery at Khanguri

In the month of June, 2011, the components of the hatchery unit were hand carried for about two kilometers (from the nearest all weather road site) to reach to the village. From the village, the hatchery components were again carried across the rice fields to a pond site for installation, where it was placed on a pond embankment and hooked up to a temporary power connection some 500 meters from the village.

## Training-cum-demonstration

The first attempt at carp breeding in the hatchery was made on 8 August, 2011 as a training-cum-demonstration programme. Training began with the identification of male and female carp broodstock at the pond site. After catching broodstock via drag netting, the broodstock were carried to the hatchery in a hammock. The fish were acclimatised for one hour before injection in the breeding pool. Male and female brooders were selected in 1:1 ratio, and injected with Ovaprim, a product commonly used as an inducing agent @ 0.5 ml/kg for females and 0.2 ml/kg for males. Injection was given at the intraperitoneal region of the fish. After injection they were released into the breeding pool. Circular moment of the water in the pool was started four hours after injection and first egg release was observed approximately five hours after injection. Egg release continued for around 35 minutes with a total of about 200,000 eggs gathered in the rectangular egg collection chamber with the help of a cotton hapa. Eggs were transferred to the hatching pool for incubation using a mug and bucket. A total of around 150,000 spawn were collected from hatching pool on the fourth day from egg release. In the afternoon of 11 August, 2011, one more breeding programme was conducted in the established hatchery to demonstrate the fish breeding operation again to the people of the village. From the breeding operation, 300,000 spawn were collected and released to the second hatching pool of the hatchery





*Fish sampling at Khanguri Village.*

unit. Within a week two training programmes in carp breeding had been conducted with the women of the self-help group and they were capable of handling the facility themselves afterwards.

Along with the spawning techniques in hatchery, they were also trained on the aspects of the seed rearing so as to complete the process of seed production. The seed rearing techniques comprising rearing of spawn to fry in nursery and further fry to fingerling in rearing pond were demonstrated in the village.

Carp seed are delicate and their growth and survival largely depend on the environment in which they live. The survival and growth of seed in the rearing system largely depended upon the presence or absence of aquatic weeds, aquatic insects and predatory and weed fishes; water and soil quality; availability of natural feed; population density; supplementary feed and rearing period. At Khanguri one earthen tank of 0.2 ha was used as nursery pond with water depth of 1.0-1.5 m. The shallow pond depth in summer made it easy to eradicate predatory and weed fishes. Pre-stocking management measures were undertaken following standard procedures in the pond. Phase manuring was done with raw cow dung which was available from self-help group member's households. Five baskets (25 kg) of cow dung were applied as basal dose three days prior to stocking. After stocking,

cow dung was applied based on the availability of plankton population in the nursery pond. Dry feed mixture of ground nut oil cake and rice-bran at 1:1 (w/w) was used as supplementary feed. The dry feed mixture was applied at 400% of initial spawn biomass for the first 5 days and 800% of the initial spawn biomass for the subsequent days. The daily ration was supplied in the pond dividing it to two equal parts during morning and evening. After 15 days of rearing 28% fry survival was recorded.

Fry measuring 20-25 mm were raised for three months to produce fingerlings. The same nursery pond was further used as a rearing pond due to non-availability of other facilities. Standard pond management practices were followed during the rearing period. Fry were fed rice bran and ground nut oil cake in 1:1 ratio @ 8-10 % of body weight per day in first month, and 6-8 % and 4-6 % per day during the second and third months respectively. After 85 days of rearing in pond, the fry had reached fingerling stage and measured 36-74 mm length and 0.6-8 g weight. They were harvested and released into the Panipoila Dam for grow out production.



## Economics of operation

In Khanguri Village two trials of induced breeding of rohu were conducted in 2011, and 500,000 spawn were harvested and reared in a 0.2 ha pond until they reached fingerling stage. After 15 days of spawn rearing, 140,000 fry were harvested and survivability rate was 28%. Out of this, 70,000 fry were sold @ Rs. 200/ per 1,000 fry and the self-help group received Rs. 14,000 revenue. The same nursery pond was further used as a rearing pond for fingerlings production. After three months of rearing, 37,000 fingerlings (value Rs. 74,000) were harvested and transferred to Panipoila Dam for grow out production. Net profit from these seed rearing practices was calculated to be Rs. 68,988 (Table 1). Each self-help group member received Rs. 4,928 to their annual income in 2011.

## Conclusions and lesson learned

The installation of portable hatcheries in remote areas with women self-help groups as a target has delivered a new and positive experience. It is generally believed that hatchery operators need to be belong to better-off socio-economic groups in order to be successful with minimum facilities of ponds, houses and other capital. But in this case, a poor group of women with no ownership of such assets was able to produce fish seed in a remote area. Technical support needs to go beyond training and demonstrations to the extent

**Table 1. Economics of seed production and rearing at Khanguri Village in 2011-12.**

Items	Units	Unit price	Cost
<b>Recurring cost</b>			
Pond lease value	1	1,000	1,000
Spawn (lakh)	5	400	2,000
Kerosene (lt)	30	20	600
Feed (kg)	525	15	7,875
Lime (kg)	110	10	1,100
Cow dung (kg)	1,800	0.50	900
Wages (labour/day)	30	100	3,000
Miscellaneous			500
Sub total of recurring cost			16,975
12% interest on rec. cost			2,037
<b>Total expenditure (A+B)</b>			<b>19,012</b>
<b>Gross Income</b>			
Fry sold	70,000	0.20	14,000
Fingerling	37,000	2.00	74,000
Total income (Rs)			88,000
<b>Net profit (Rs)</b>			<b>68,988</b>

of providing necessary infrastructure and other facilities. Providing an enabling environment contributed to the group having sufficient confidence for successful operation of the hatchery. The case study demonstrates that the twin objectives of seed production and livelihood support for poor can



*Beneficiaries of Khanguri Village.*



be achieved simultaneously through the FRP hatchery. The Maa Brahmanidevi Mahila Soyam Sahayak Gosthi, Khanguri women's self-help group adopted under the project was given the Felicitation Award for Better Adoption of Aquaculture Technology in the Field on the occasion of the "National Fish Farmers' Day" held at CIFA, Bhubaneswar on 9 July 2013. After installation and operation of the hatchery in 2011, the self-help group has taken lease of three more small ponds with a total area of 0.6 ha for fish seed rearing. It is expected that in future the group will operate successful seed production enterprise to supply fish seed in the nearby localities.

### Acknowledgement

The support provided Director, CIFA during the work is deeply acknowledged. Authors also acknowledge the financial assistance of the Department of Biotechnology, Govt. of India and the facilities provided by CIFA, Bhubaneswar.

### References

- Alan Casebow, 2008, Outreach Abroad. Operation Agri., p 11.
- Barik, N. K., 2011. Aquaculture in Rainfed areas of India: emerging possibilities for food and nutrition security in Mishra, P. K., Osman, M., Satendra and Venkateswarlu, B (eds). 2011. Techniques of water conservation and rainwater harvesting for drought management, SAARC Training programme, 18-29 July, 2011. Central Research Institute of Dryland Agriculture (CRIDA), Hyderabad, India, p 695-71.
- Barik, N. K., 2011. Socio economic context of impact of Portable hatchery in India. Mahapatra B.C, Sarkar. B, Barik N.K & Jayasankar. P(edited) (2011) Application of Plastics in Aquaculture. Published by Director CIFA. Central Institute of Freshwater Aquaculture, Bhubaneswar. 97-112.
- Barik, N. K. and Das Mahapatra, K. 2012. Impact of Improved Carp Strain in India, pp. 88-97. In: K. Das Mahapatra, P. Routray, N. K. Barik, P. Jayasankar (eds). Quality fish seed production through brood fish management in SAARC countries. CIFA, Bhubaneswar, India. 2012. 200 p.
- CIFA, 2004. Portable FRP carp hatchery. In: CIFA Technologies, Central Institute of Freshwater Aquaculture (ICAR), Bhubaneswar: 22-23.
- DAHDF, 2013. Annual report 2012-2013. Department of Animal Husbandary, Dairy and Fisheries, Ministry of Agriculture and Cooperation, Government of India.
- ICAR, 2005. Portable plastic carp hatchery. In: Aquaculture technologies for farmers. Indian Council of Agricultural Research, New Delhi: 55-58.
- ICAR, 2011. Handbook of Fisheries and Aquaculture. Publication Division, Indian Council of Agricultural Research, New Delhi, 2nd ed., p 100.
- Mohapatra, B.C., Sarkar B. and Singh S.K. 2003. Use of plastic in aquaculture. In: Satapathy, K.K. and Ashwani Kumar (Ed.) Plastics intervention for agriculture development in North East region. ICAR Research Complex for NEH region, Umiam, Meghalaya: pp 290-305.
- Mohapatra, B.C., Singh S.K., Sarkar B. and Majhi D. 2004. Portable carp hatchery for carp seed production. In: Technologies on livestock and fisheries for poverty alleviation in SAARC countries. SAARC Agricultural information center, Dhaka: pp 132-135.
- Mohapatra, B.C., Singh S.K., Sarkar B. and Sarangi N. 2005. Portable FRP Carp hatchery: An aid for rural aquaculture. Proceedings International Conference on Plastics and Precision Farming, 17-21 November, 2005, New Delhi, India: pp 515-522.
- Mohapatra B.C., Sarkar B., Singh S.K. and Majhi D. 2007. FRP carp hatchery and its economics. In: Workshop on portable hatchery for better carp seed production. 31 August-1 September 2007, Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar, Odisha, India : pp 11-18.
- Mohapatra, B.C., Sarkar B. and Sarangi N. 2008. Portable FRP carp hatchery technologies: Successful adaptation in India. Fishing Chimes, 28(4): 48-52.
- Mohapatra, B.C., Mahanta S.K., Majhi D. and Eknath A.E. 2012 Seed production of Rohu (*Labeo rohita* H.) in FRP hatchery in Nuagaon block, Nayagarh district of Orissa. e-planet, 9(1): 35-39.
- Sarangi, N., Das B.K., Mohapatra B.C., Patnaik P., Ghosh S., Swain D.K. and Mallick A. 2008. Carp seed production under extreme temperatures: An experience at Tanar Village, Odisha, India. Fishing Chimes, 28 (3): 42-44 and 49.
- Sudin, K. 2007. Pisciculture as a viable livelihood option for poor: issues, experiences and lessons from Western Orissa Rural Livelihoods Project (WORLP). In: Workshop on portable hatchery for better carp seed production. 31 August - 1 September, 2007, Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar, Odisha, India, pp: 4-10.

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## Regional consultation on culture-based fisheries developments in Asia

A regional consultation was held to discuss culture-based fisheries development in Asia from 21 to 23 October 2014 in Siem Reap, Cambodia. The consultation was funded by the Australian Centre for International Agricultural Research (ACIAR) as part of the project Culture-based fisheries development in Lao PDR and Cambodia. The consultation provided the opportunity to discuss the outcomes of a series of successful projects that have been implemented over the past decade in the Asian region by both Deakin University and NACA with financial support from ACIAR.

The consultation was welcomed by His Excellency Mao Vuthy, Vice Governor of Siem Reap Province and opened by His Excellency Nao Thuok, Director General of the Fisheries Administration of Cambodia. Introductory remarks were made by Dr Chris Barlow, Fisheries Programme Manager of ACIAR, Dr Cherdasak Virapat, Director General of NACA, Dr So Nam, Coordinator of the Fisheries Programme of the Mekong River Commission, and Dr Chumnarn Pongsiri, Director General of the Southeast Asian Fisheries Development Center.

The consultation began with a session on the general considerations to be taken into account in culture-based fisheries activities. Presentations addressed general aspects of stock enhancement, site selection and genetic considerations. This was followed by a series of presentations on the project's outcomes in Lao and Cambodia, including both technical aspects, profit sharing models developed by participating communities, induced breeding and broodstock management,

and the use of reciprocal exchange visits and communication centres to help sharing of experience both between countries and individual communities.

The following sessions were dedicated to presentations and discussions on stock enhancement practices in Mekong riparian countries and on culture-based fisheries experience from other Asian countries, including China, Sri Lanka, Myanmar and Vietnam. Participants spent the last day of the meeting visiting the Great lake (Tonle Sap) to observe fisheries practices and the way of life of the fishing communities living out on the water.

From the discussions it was evident that culture-based fisheries are very much seen as a valuable and environmentally friendly development option for rural communities. It was noted that culture-based fisheries has gained significant momentum over the past few years and recently become something of a hot issue, being taken up in Sri Lanka, Vietnam, Thailand, Lao PDR and with the first steps having been made to introduce it to Cambodia under the present project. Participants strongly requested both NACA and ACIAR to pursue follow up activities to consolidate the gains that have been made.

The proceedings of the consultation are in preparation and scheduled for publication by May 2015. In the meantime, audio and video recordings of the technical presentations from the meeting are in preparation and will shortly be made available for download / viewing on the NACA website shortly. Please check <http://www.enaca.org/modules/podcast/>.



Participants in the Regional consultation on culture-based fisheries developments in Asia.



## Gender Assessment Synthesis Workshop

During 29 September to 1 October 2014, the NACA/USAID MARKET Gender Project organised a Gender Assessment Synthesis Workshop, which was attended by the MARKET gender project teams from Cambodia, Thailand and Vietnam, as well as the regional gender focal point of the Network for Gender Promotion in Fisheries in the Lower Mekong Basin countries, and the Coordinator of the Gender in Fisheries Programme of the Mekong River Commission. Other participants included USAID and MARKET project team staff, India Gender Expert, and NACA core staff. A total of 20 participants attended the three-day workshop held at Centara Grand Hotel, Central Plaza Ladprao, Bangkok.

The objectives of the Synthesis Workshop were to:

- Assess the status of work on the in-country gender assessment reports and the case studies, including make a start on writing of case studies.
- Participate in a one-day training on gender in aquaculture and fisheries tools.
- Contribute ideas to the regional gender practitioners' network action plan.

- Discuss future work activities / plans to achieve expected project outcomes.

After the three day workshop, these objectives were met and participants evaluated the workshop as excellent and most useful for their project work especially in achieving their target deliverables. The one day training on gender dimensions framework and tools was also assessed as useful and participants appreciated the learnings they gained from the training. The exchange of experiences from various practitioners from India, Lao PDR, MRC, NGF and Thailand on how gender is integrated in their own workplaces and projects provided the participants with some ideas and skills on gender integration.

The expected outputs from the workshop were submitted by the participants, such as the status reports and drafts of the in-country gender assessment reports, case study status reports and abstracts, country – specific work and activity plans and ideas for the Regional Gender Practitioners Network Action Plan. A “write shop” during the workshop provided the country teams with the opportunity to discuss the data collected for the gender case studies, to create an outline and write a rough draft of the case studies. A half-day session was also conducted for status reporting and preparation for the Special Workshop on NACA/USAID/MARKET during the 5th Global Symposium on Gender in Aquaculture and Fisheries in Lucknow, India in November 2014 (see separate article below).

## NACA participation in the 5th Global Symposium on Gender in Aquaculture and Fisheries, Lucknow, India

The Network of Aquaculture Centres in Asia-Pacific team participated actively during the 5th Global Symposium on Gender in Aquaculture and Fisheries (GAF5) held during 12-15 November 2014, in Lucknow, India. This event was held simultaneously with the 10th Indian Fisheries and Aquaculture Forum and the International Workshop on Aquatic Animal Disease Surveillance, wherein NACA was also represented.

Dr Cherdsak Virapat, NACA Director General, in his speech at the 10 IFAF and GAF5 opening ceremony, introduced NACA's programmes with gender as one of the cross cutting themes, and giving acknowledgement to various organisations providing support, both local and international. The major international supporters were NORAD for GAF5 organisation, and USAID for the MARKET Special Workshop and MARKET Gender Project as a whole.

Dr Meryl Williams, NACA Gender Mentor and the main organiser of GAF5, presented how interest in the then women in fisheries initiatives has evolved through the years into what is now known as the gender in aquaculture and fisheries.

The half-day Special Workshop on MARKET Project on 14 November 2014 presented the initial results of the gender assessments in each country (Cambodia, Lao PDR, Thailand and Vietnam) and the various case studies prepared by the country teams. The case studies highlighted the gender aspects in selected aquaculture value chains. The Special



Workshop was chaired by Dr Cherdsak Virapat, Ms Galdys Villacorta (USAID/MARKET), Dr Nikita Gopal (CIFT/ICAR) and Dr Arlene Nietes Satapornvanit (NACA).

The following presentations were given during the special workshop:

- NACA/USAID Thematic Studies on Gender in Aquaculture in Cambodia, Lao PDR, Thailand and Vietnam by Dr Arlene N. Satapornvanit, NACA.



- Success story of a woman in aquaculture, Cambodia by Mr. Kao Sovityea, Cambodia Fisheries Administration.
- Small-scale marine shrimp culture in Chanthaburi, Thailand by Dr. Amonrat Sermwatanakul.
- Small-scale tilapia cage culture in Sakhon Nakhon, Thailand by Dr. Kanit Naksung, Department of Fisheries.
- Red tilapia cage culture in Tieng Giang, Vietnam by Dr. Truong Hoang Minh, Cantho University.
- Rice-shrimp rotation farming in Soc Trang, Vietnam by Ms. Nguyen T.K. Quyen, Cantho University.

These presentations were also made into posters so the information could be disseminated to a larger audience and for the whole duration of the conference, which was held

simultaneously with the 10th Indian Fisheries and Aquaculture Forum. Dr. Yuan Derun (NACA Education and Training Coordinator) also chaired a GAF5 session on Global Innovations.

The final session was the GAF Network meeting, wherein issues on how networking among interested gender stakeholders could be sustained through the years. Details were asked about the regional gender practitioners network being coordinated by NACA/USAID/MARKET.

In addition, Dr. Eduardo Leano (NACA Aquatic Animal Health Programme Coordinator) shared his experiences and the mechanisms within the Fish Health Section network of the Asian Fisheries Society (AFS-FHS).



## Broodstock Management in Aquaculture: Long term effort required for regional capacity building

Asia produces nearly 90% of world aquaculture output. However, growth of the industry is increasingly constrained by various factors, including poor broodstock quality and genetic deterioration of domesticated stock. This has arisen in part from a general lack of planning, knowledge and skills in broodstock management. Capacity building across the region is urgently required for hatchery operators at different scales through information exchange, experience sharing and training.

The United Nations University Fisheries Training Programme (UNU-FTP), Network of Aquaculture Centre in Asia-Pacific (NACA) and Nha Trang University jointly initiated a project on "Development of a Regional Training Course for Capacity Building on: Finfish Broodstock Management in Aquaculture Broodstock Management in Aquaculture" in collaboration with Deakin University and Fisheries Victoria (Australia) and Holar University (Iceland) in 2012. The objective was to develop and test a training course on principles and practices

of broodstock management with hatchery managers and key in-service personnel associated with hatchery operations. To date, a set of training materials have been developed, covering most aspects of broodstock management including broodstock nutrition, genetic maintenance and improvement, disease and health management and hatchery operation. The training materials have been continuously evolving through consultation in various expert workshops and accumulation of practical knowledge.

Two pilot training courses were conducted in 2013 and 2014 respectively in Nha Trang University, Vietnam, for some 80 professionals from 19 countries in Asia and Africa. The training courses took a learner-centred approach, encouraging active participation of trainees in learning process, emphasizing practical experience and problem solving skills of participants.



Broodstock management is an important part of general aquaculture practice and interrelated to all other segments of aquaculture production cycle. It is however often considered to be difficult by some hatchery operators due to lack of know-how or simply overlooked by others. The issue is further complicated by lack of overall planning, little collaboration among seed producers, insufficient financial input for R&D, and lack of institutional support.

Efforts to maintain and improve broodstock quality of any major cultured species requires long-term strategic planning at national and regional level and practical approaches involving public sectors, breeding centres, and private hatcheries at various operational scales. Capacity building for all stakeholders through training is therefore fundamentally important to raise awareness, update knowledge and enhance skills.

Participants considered that the training courses were highly relevant and important in addressing the issue of deteriorating broodstock quality. They were satisfied with the course organisation and logistic support and voiced their continuing effort to amplify the course impacts upon return to their work through application of knowledge and skills they acquired during the training.

Development and successful implementation of the training course on broodstock management in aquaculture by UNU-FTP, NACA and Nha Trang University turned over a new leaf for regional capacity building in broodstock management in aquaculture. Admittedly this is just a start and there is still long way to go.

## Urgent appeal to control spread of the shrimp microsporidian parasite *Enterocytozoon hepatopenaei* (EHP)

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### What is EHP?

*Enterocytozoon hepatopenaei* (EHP) is a microsporidian parasite that was first characterized and named from the giant or black tiger shrimp *Penaeus monodon* from Thailand in 2009 (Tourtip et al. 2009. *J. Invertebr. Pathol.* 102: 21-29). It was discovered in slow growing shrimp but was not statistically associated with slow growth at that time. EHP is confined to the shrimp hepatopancreas (HP) and morphologically resembles an unnamed microsporidian previously reported in the HP of *Penaeus japonicas* from Australia in 2001. Together, these studies suggest that EHP is not an exotic pathogen but that it is endemic to Australasia. Later, it was found that EHP could also infect exotic *Penaeus vannamei* imported for cultivation in Asia and that it could be transmitted directly from shrimp to shrimp by the oral route (Tangprasittipap et al. 2013. *BMC Vet Res.* 9:139). This differed from the most common microsporidian previously reported from cotton shrimp, where transmission required an intermediate fish host, allowing disruption of transmission by exclusion of fish from the production system.

### Why is EHP important?

Although EHP does not appear to cause mortality, information from shrimp farmers indicates that it is associated with severe growth retardation in *P. vannamei*. Thus, we began to warn Asian farmers and hatchery operators after 2009 to monitor *P. vannamei* and *P. monodon* for EHP in broodstock and post

larvae (PL). However, the warnings were not heeded because of the overwhelming focus on early mortality syndrome (EMS) or acute hepatopancreatic necrosis disease (AHPND). We feared that lack of interest in EHP would lead to its build up in production systems and that its spread would be masked by EMS/AHPND because it kills shrimp before the negative effects of EHP on growth are apparent. We feared that solution of the EMS/AHPND problem would probably lead to succeeding widespread problems with slow growth. Indeed, this seems to have happened in the past year or so. We now have information indicating that EHP outbreaks are occurring widely in China, Indonesia, Malaysia, Vietnam and Thailand. Very recently, we have also received samples PCR-positive for EHP from slow growing shrimp in India. Thus, EHP is an emerging problem that is under urgent need of control.

### How to control international spread of EHP

A nested PCR detection method and a LAMP method are available to check faeces of broodstock and to check whole PL for the presence of EHP (Tangprasittipap et al. 2013. *BMC Vet Res.* 9:139; Suebsing et al. 2013. *J. Appl. Microbiol.* 114: 1254-1263). The pathogen can also be detected by light microscopy using a 100 times objective with stained HP tissue sections or HP smears, but this is based on finding the characteristic spores that are extremely small (less than 1 micron in length) and are sometimes produced only in small numbers, even in heavily infected specimens. Thus, the PCR detection method is preferred.

We have data indicating that most SPF stocks of *P. vannamei* imported to Thailand are negative for EHP but that they often become contaminated in recipient maturation facilities and hatcheries because of poor biosecurity. One serious fault in biosecurity is the widespread practice of using live animals (e.g., polychaetes, clams etc.) from local sources or as imports to feed broodstock shrimp, despite our constant warnings against the practice. We have firm data that some live polychaetes from local and imported sources in Asia can give positive PCR test results for both AHPND bacteria and EHP. However, there is also a possibility that some imported stocks of *P. vannamei* labeled SPF may also be positive for EHP, since it is not on the OIE list that is used by many SPF suppliers or quarantine agencies responsible for confirming SPF status. This problem could be rectified by adding EHP to the SPF list of both suppliers and quarantine agencies. The faeces of the broodstock can be tested for the presence of EHP by nested PCR.

The best approach for maturation and hatchery facilities to avoid EHP is to never use live animals (e.g., live polychaetes, clams, oysters, etc.) as feeds for broodstock. If this advice is ignored, at the very minimum, such feeds should be frozen before use since this would at least kill AHPND bacteria and EHP. Better would be pasteurization (heating at 70°C for 10 minutes) since it would also kill major shrimp viruses (which freezing would not). Another alternative would be to use gamma irradiation with frozen feeds.

### How to control EHP in hatcheries

EHP and AHPND bacteria have both been found in broodstock from China, Vietnam and Thailand. Both have also been reported from living polychaete samples used to feed broodstock shrimp. EHP can be suspected if post larvae from any hatchery grow slower than would be expected.

Therefore, the first issue is to ensure that broodstock maturation facilities and hatchery facilities are CLEAN! To achieve this goal, all shrimp must be removed from the hatchery and it should be washed followed by cleaning using 2.5% sodium hydroxide solution (25 gms NaOH/L fresh water) with the solution left on and washed off after

3 hours contact time. This treatment should include all equipment, filters, reservoirs and pipes. After washing to remove the NaOH, the hatchery should be dried for 7 days. Then it should be rinsed down with acidified chlorine (200 ppm chlorine solution at pH <4.5).

The next issue is the broodstock. As indicated above some SPF shrimp broodstock gave positive PCR test results for EHP but none for AHPND bacteria. Thus, purported SPF broodstock should also be checked for EHP while in quarantine and before being admitted to a cleaned maturation and hatchery facility. Our work in Thailand revealed that locally pond-reared broodstock derived from imported SPF stocks initially free of EHP showed very high levels of prevalence for EHP infection. As stated above, broodstock faeces may be checked for EHP by nested PCR using DNA extracts from feces as the template. Confirmation should be conducted on HP tissue after the usefulness of the broodstock has expired.

### How to control EHP in farms

For farmers, there are two main issues to contend with. The first issue is to ensure that the PL used to stock ponds are not infected with EHP. This can be done most easily by PCR testing. If DNA has already been extracted from the PL to check for AHPND bacteria by PCR, a portion of the same DNA extract can be used to test for EHP. A farmer should not use batches of PL positive for either of these pathogens for stocking ponds.

The second issue for farmer concerns appropriate preparation of ponds between cultivation cycles, especially when a cultivation pond has previously been affected by EHP. The spores of EHP have thick walls and are not easy to inactivate. Even high levels of chlorine alone are not effective. In addition, potential environmental carriers are currently unknown. Both may remain in a pond after harvest and it is important that both be inactivated before the next cultivation cycle.

To disinfect earthen ponds of EHP spores, apply CaO (quicklime, burnt lime, unslaked lime or hot lime) at 6 Ton/ha. Plow the CaO into the dry pond sediment (10-12 cm) and then moisten the sediment to activate the lime. Then leave for 1 week before drying or filling. After application of CaO, the soil pH should rise to 12 or more for a couple



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of days and then fall back to the normal range as it absorbs carbon dioxide and becomes CaCO<sub>3</sub>.

### A special warning for Mexico

There are rumors that the outbreaks of AHPND in Mexico originated from contaminated broodstock of *P. vannamei* illegally imported to Mexico from Asia for production of PL to stock rearing ponds. If these rumours are true, given the high prevalence of EHP in Asia, it is quite probable that the imported shrimp would also have been infected with EHP. Thus, it is urgent that the Mexican quarantine authorities check their current and archived DNA samples used to monitor for AHPND bacteria by PCR to also check for the presence of EHP target DNA by PCR. If they find it, it would support the hypothesis that AHPND bacteria were imported from Asia. It is also possible that timely preventative measures or continued surveillance of imported, living shrimp.