# Progress report on the

# Komodo Fish Culture Project

## *A pilot project to establish a multi-species reef fish hatchery in Loh Mbongi and village-based grow-out farms in communities surrounding Komodo National Park, West Flores, Indonesia*

***Including an update on business development***

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**Report from The Nature Conservancy, Southeast Asia Center for Marine Protected Areas in collaboration with the Komodo National Park authority**

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**Executive summary**

The main objectives of the Komodo Fish Culture Project are:

- to contribute to the transformation of the live reef fish market from unsustainable, capture-based to sustainable, culture-based
- to develop sustainable fish culture of high-quality reef fish as an alternative to non-sustainable fishing practices in and around Komodo National Park.
- to provide a vehicle for outreach activities in the Komodo area, targeting local fishing communities and government agencies

The Komodo Fish Culture Project is a pilot project with an annual capacity of 25 tons of fish or marketable size. This pilot project is the predecessor for a planned fish culture business with a capacity of 200 tons of reef fish per year. This business will have a triple bottom line: profitable, socially responsible, environmentally sound. The modus operandi is that a central hatchery in the Komodo area provides inputs (fingerlings, know-how, feed, materials) to satellite fish farms deployed at nearby villages. The pilot project identifies models for technical implementation, for business development, for community involvement, for governance at the enterprise level (best practices) and for governance at the institutional / governmental level (carrying capacity studies, licensing of fish culture operations). As early as 1998 The Nature Conservancy explored models for the development of a fish culture industry, and it was concluded that hatchery production of fingerlings from captive broodstock has less negative impact on the environment than sourcing fingerlings from the wild. A preliminary business plan compiled by experts in 1999 showed that hatchery-based grow-out of fingerlings is economically viable. A study conducted in the framework of an MSc project of Rhode Island University showed that local communities and the local fish traders are likely to adopt fish culture once economic viability is proven.

The pilot project involves local communities in the grow-out of estuary grouper *Epinephelus coioides*, mouse grouper *Cromileptes altivelis*, tiger grouper *Epinephelus fuscoguttatus*, sea bass *Lates calcarifer* and mangrove jack *Lutjanus argentimaculatus*, whereof especially the grouper species can be marketed as live product to the Hong Kong - based live reef fish trade. Fingerlings are being produced from captive broodstock in a hatchery situated at Loh Mbongi (ca. 6 km North of Labuan Bajo).

The fish culture project has 3 tonnes of broodstock, which are kept in fish cages near the hatchery site at Loh Mbongi. The completed hatchery facility has a maximum production capacity of around 100,000 juvenile fish per annum, and includes facilities for the culture of algae, rotifers and *Artemia* to support this level of production. Full operational capability of the hatchery was reached by March 2003. The first batch of eggs transferred to the hatchery were of estuary grouper, collected during the night of 6 March 2003. These were hatched on 7th March 2003 and by December 2003 had been transferred to the first of four community-based grow-out units. These fish were harvested on 12$^{th}$ June 2004, and 500kg exported live to Hong Kong. Since that time, batches of all species maintained by the project as broodstock have been successfully reared in the hatchery.

The fish culture project created partnerships with institutes that can provide the necessary know-how. The main partners for technical support of the Komodo fish culture project are the Gondol Research Institute for Mariculture (Bali, Indonesia), the Department of Primary Industries, Queensland (Australia) and the Network of Aquaculture Centers in Asia (based in Bangkok, Thailand).

As part of the up-scaling phase, The Nature Conservancy plans to conduct a carrying capacity, best practices and institutional governance study. This study will determine safe environmental limits to future fish farm development and this study will also determine which regulatory instruments can be used to keep the industry within these limits. In that framework, a carrying capacity workshop, coordinated by the Network of

Aquaculture Centers in the Asia-Pacific (NACA), was held in Labuan Bajo in January 2003. This workshop resulted in a workplan for this study.

The Community Outreach team of The Nature Conservancy's Komodo Field Office assisted with the extension of the Fish Culture Project to local communities, and negotiations with target villages as well as installation of the first grow-units, was underway by September 2003. Final negotiations leading to the installation of the first grow-out unit, at the village of Warloka, took place during December 2003, and the cage unit was stocked with the first production batches produced by the hatchery at Loh Mbongi.

As mentioned above, the Komodo Fish Culture Project can only claim success after it has been transformed into a viable triple bottom line business that is replicated elsewhere in Indonesia and beyond. A first step towards the establishment of this industry is the transformation of the Komodo fish culture project into a fish culture business with a capacity of 200 tons per year. To succeed, this process must be business driven, and The Nature Conservancy is currently exploring partnerships and mechanisms for business development.

## 1 Introduction

The Komodo fish culture project was originally implemented as part of The Nature Conservancy's Komodo marine conservation program, though its significance now goes beyond the Komodo area. Komodo National Park (Eastern Indonesia, Fig. 1) is widely recognized as an exceptional storehouse of both terrestrial and marine biodiversity with global significance. Komodo National Park was established as a National Park in 1980, and declared a UNESCO Man and Biosphere Reserve and a World Heritage Site in 1986. Famous as the last remaining habitat of the Komodo dragon (*Varanus komodoensis*), the Park also harbors more than 1000 fish species, about 260 species of reef-building corals, sea turtles, manta rays and 14 species of whales and dolphins. Ca. 3,300 people live within Park boundaries, and ca. 17,000 people live around the Park. The main threats to the marine ecosystems of the Park are destructive fishing methods (blast fishing, fishing with poison, etc.), and over-exploitation. To abate these threats The Nature Conservancy's Southeast Asia Center for Marine Protected Areas has been implementing a marine conservation program together with the Indonesian Park authority since 1996. The objective of this program is to establish a marine reserve that (1) ensures long-term protection of the natural community structure, habitat and species of the coastal and marine ecosystems within and around Komodo National Park, and (2) protects a portion of the exploited reef fish stock to enhance fisheries in the traditional use zones inside the Park and in the waters surrounding the Park. The components of the conservation program are Park planning & financing, community awareness & education, surveillance, monitoring & research and alternative livelihood development. The purpose of the alternative livelihood projects is to provide coastal people with sustainable alternatives to reef fishing. The projects that are currently implemented focus on seaweed farming, pelagic fishing and fish culture. Together, they account for ca. 25% of the total budget for The Conservancy's marine conservation program in Komodo. The fish culture project is the most capital intensive of the alternative livelihood projects.

The main objectives of the Komodo Fish Culture Project are:

- to develop sustainable fish culture of high-quality reef fish as an alternative to non-sustainable fishing practices in and around Komodo National Park.
- to provide a vehicle for outreach activities in the Komodo area, targeting local fishing communities and government agencies
- to contribute to the transformation of the live reef fish market from unsustainable, capture-based to sustainable, culture-based. Currently, the live reef fish trade is rapidly depleting the Indo-Pacific stocks of Napoleon wrasse (*Cheilinus undulatus*) and groupers (*Serranidae*). The Komodo fish culture project

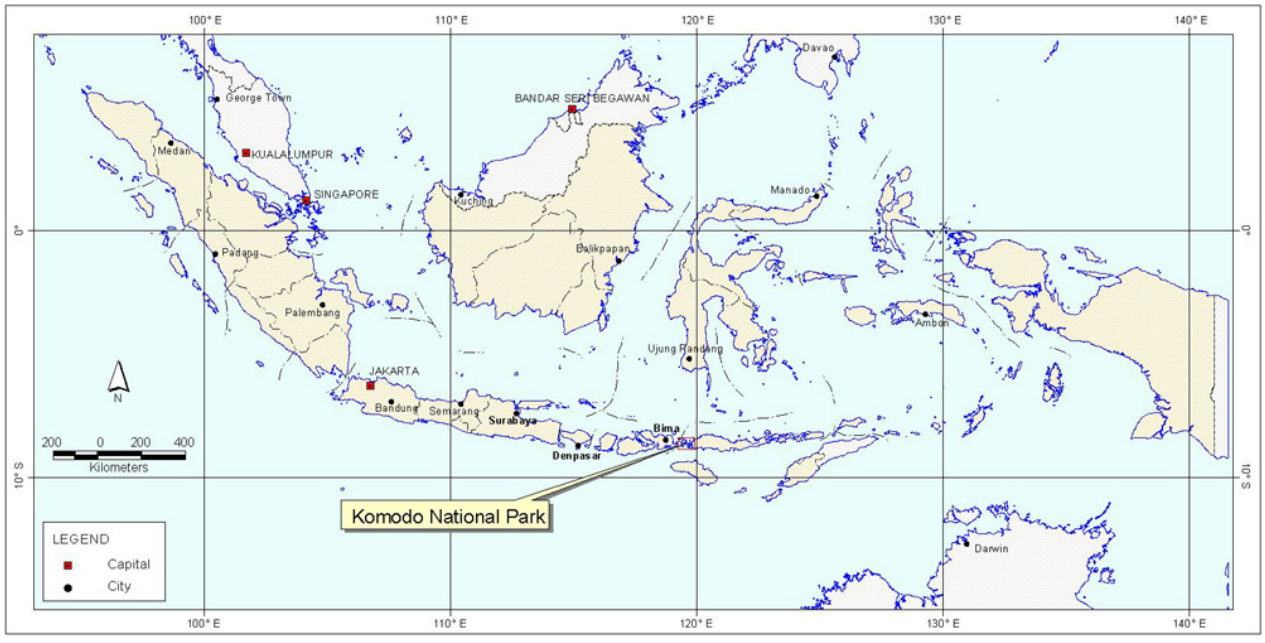


***Figure 1**. Indonesia with location of Komodo National Park.*

demonstrates how fish culture of groupers can be done in a sustainable and environmentally sound manner.

Fish culture consultants who visited the Komodo area in 1997 reported that the Komodo area was very suitable for the deployment of fish cages: water quality was excellent, there was little rainfall, and there were many locations that were sheltered from storms and waves. Also, a marketing channel for wild-caught live food fish was already in place, and local communities had already some experience with keeping wild-caught fish in cages. Therefore, it should be relatively easy to involve local communities in the grow-out phase. However, one of the main bottlenecks was found to be the availability of grouper fingerlings, the 'seed' for the culture enterprise.

Starting in 1997, a method to obtain fingerlings from the wild was tested in the Komodo area with the assistance of Philippine consultants. This method, *gango*, has already been used extensively in the Philippines. After one year of field trials in the Komodo area, it was concluded that *gango* puts additional fishing pressure on the wild stocks, both those of groupers and those of non-target fish. Therefore, it was decided not to implement *gango* but to produce fingerlings from captive broodstock.

Species cultured in the Komodo fish culture are estuary grouper *Epinephelus coioides*, mouse grouper *Cromileptes altivelis*, tiger grouper *Epinephelus fuscoguttatus*, sea bass *Lates calcarifer* and mangrove jack *Lutjanus argentimaculatus*, whereof especially the grouper species can be marketed as live product to the Hong Kong - based live reef fish trade. Fingerlings are being produced from captive broodstock in a hatchery situated in Loh Mbongi (ca. 6 km North of Labuan Bajo). The pilot project aims to produce 25 tons of live fish yearly, to be realized over 3-4 harvests per year per grow-out unit. A grow-out unit consists of a complex of 16 floating cages, varying in size between 9 and 25 $m^2$ surface area . In the pilot phase, 4 grow-out units will be deployed near the villages that are participating. The produced volume will consist of a mix of the five species of broodstock presently secured. This multi-species approach reduces risks related to species-specific vulnerability to disease and to fluctuation in consumer preference and price. The species composition of the first batch of fingerlings will depend on hatchery practicalities, as this batch will be used for training in grow-out in village-based fish farms rather than for the generation of revenue. In the pilot phase (i.e. production capacity of 25 tons annually) the project will involve ca. 20 villagers on a full-time basis, but many more will be trained in grow-out techniques. Once economic viability and environmental sustainability have been demonstrated, a carrying capacity analysis will be carried out to determine the optimal production capacity.

The project is based on full-cycle culture, meaning that impacts on wild stocks are minimal. A full cycle comprises spawning of captive broodstock, collection of fertilized eggs, larvae rearing, fingerling production, grow-out in sea cages, and marketing. A full cycle takes 11 to 22 months, depending on the species. The individual body weight of marketable fish varies between 0.4 and 1.2 kg, depending on the current market preference and on the species. The project aims to grow out fish to an individual body weight of 0.5 kg. The fish will initially be fed locally available trash fish, but will quickly be switched to a diet of commercial pelleted feeds. Feed costs ca. US$1000 per tonne, and at a feed conversion ratio of 1.7, this results in a feeding cost at ca. US$1.70 per kg of produced fish. Considering that grouper may fetch between 8 and 35 US$ per kg and that feed costs comprise the major part of the total costs for producing fish, there appears to be a good prospect for business development (see Chapter 8).

## 2 Hatchery construction

On December 21, 2000, The Tahija Foundation donated 150,000 $m^2$ of land in Loh Mbonghi to The Nature Conservancy for the purpose of construction of the hatchery (Fig. 2). Working from the 'Strategy and Action Plan' of July 2001, a blueprint for the hatchery was prepared by the fish culture team in cooperation with a local engineering company (CV Teksas). In April 2002 the contract with the Master Contractor (CV Bumi

Cakra Persada) was signed. By March 2003 construction was completed and the hatchery was operational (Fig. 3 - 7). The hatchery at Loh Mbongi was officially inaugurated in July 2003 by the Minister of Fisheries and Marine Affairs, Prof. Dr. Rokhmin Dahuri. This event was attended by senior local government officials and key stakeholders.

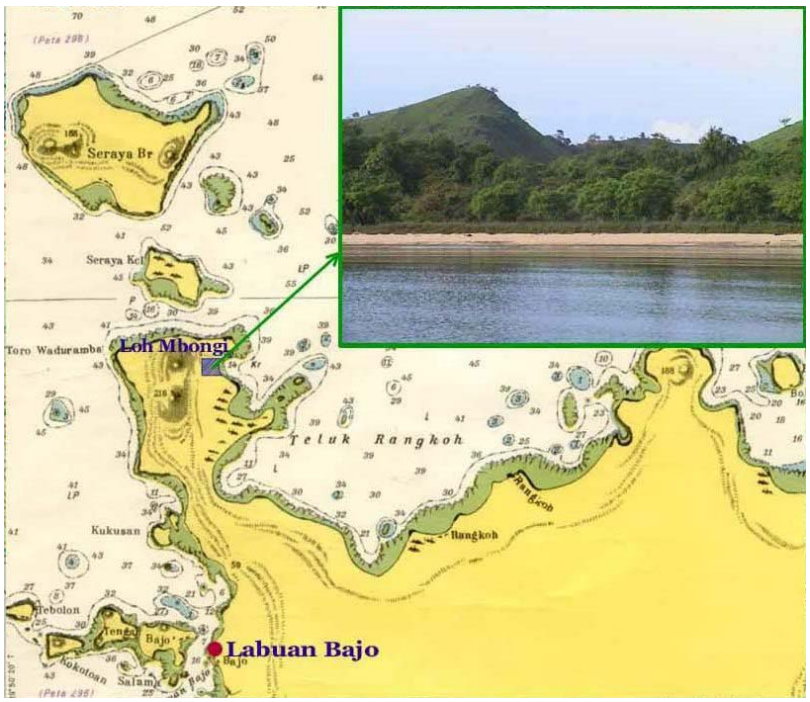


***Figure 2**. Loh Mbongi, situated on the peninsular North of Labuan Bajo, West Flores, Indonesia.*

Experts from the Gondol Research Institute for Mariculture (GRIM) have visited the construction site on a number of occasions: The Director of GRIM, Dr Adi Hanafi, visited the site on April 4 2002 and Mr Agus Priyono carried out an assessment of the mariculture complex during the period 29 July - 5 August 2002, and made a follow-up visit in mid-October. Dr. Fris Johnny and Mr. Dedi carried out a technical support visit in August 2003. Technical support visits were carried out by Dr. Fris Johnny and Mr. Dedi in August 2003, and by Dr. Eri Sutiadi in October 2004.

Two representatives of the engineering company and the master contractor visited the Gondol Research Institute of Mariculture to get first-hand insights on hatchery construction. The study trip took place on 3-5 June 2002.

Environmental impact assessments (UKL / UPL), as required under Indonesian law, have been completed and were approved by the District Planning Agency (BAPPEDALDA). In March 2002, the approval was followed by a letter of recommendation of the Bupati (District Head) of the District Manggarai The environmental impact assessments were carried out by Universitas Nusa Cendana (UNDANA) of Kupang, Nusa Tenggara Timur.

***Figure 3.*** *Aerial picture of the hatchery, taken on 5 July 2003, view from the north-east.*

***Figure 4***. *Staff accommodation at hatchery facility*

***Figure 5***. *Completed nursery building.*

***Figure 6**. Plankton production tanks at the hatchery complex.*

***Figure 7.** Hatchery-reared tiger grouper juveniles*

## 3 Hatchery production

The completed hatchery facility has a maximum production capacity of around 100,000 juvenile fish per annum. Seawater is pumped through the hatchery from a submerged pipeline, whose intake lies at a depth of 4m below low-tide level in the bay at Loh Mbongi. Three seawater pumps (two operated alternately, with one back-up) pump the water through 2 sandfilters to both hatchery and live feed facilities. Water is supplied 24 hours a day, powered by 3 electrical generators, with 3 back-up generators in case of mechanical failure. In addition, three air blowers provide the fish with oxygen and water circulation. After having passed through the facility, the seawater then returns to the sea by way of 4 large settlement ponds, which function by allowing the settlement of any particulate material in the hatchery outflow and acting as a water purification system by way of naturally occurring bacteria breaking down and consuming the low levels of nutrients present in the water.

Full operational capability of the hatchery was reached by March 2003. The first batch of eggs that were transferred from the broodstock facility (cf. Chapter 4) to the hatchery were of estuary grouper, collected during the night of 6 March 2003. These were hatched on 7$^{th}$ March and had been successfully stocked into temporary grow-out cages at Loh Mbongi by June 2003. This batch was transferred to the first grow-out unit, at the village of Warloka, in December 2003, and by June 2004 had been harvested and sold as live fish product to the Hong Kong market, at an average weight of 800g. This is a significant achievement for the fish culture project. Larval survival reached 3.7%, which is much higher than natural survival rates and also high compared by fish culture standards - an encouraging result for the first production by the Loh Mbongi hatchery.

***Figure 8**: One of the first production batch of mouse grouper (kerapu tikkus)*

Since this time, egg production by the broodstock at Loh Mbongi has been excellent, and the hatchery and nursery have been under full production now for 20 months. Hatchery production, however, has not been without its challenges, and, although all five species stocked at Loh Mbongi have been successfully reared at the hatchery, survival rates have varied considerably.

To date, the best survival rate achieved has been 7.6%, for a batch of mouse grouper produced in July 2003. During July 2003, a batch of 20,000 mouse grouper were reared in the nursery, representing the first production of a commercial-sized batch by Loh Mbongi. Unfortunately, subsequent survival was low and the improvement of nursery survival rates represents one of the many challenges to the Fish Culture Project at present.

In addition, a batch of 6,000 mangrove jack were successfully reared through the nursery phase, and transferred to the grow-out unit at Warloka by December 2003, and a batch of 6,000 tiger grouper were distributed between Warloka and the newly installed second community grow-out unit at Menjaga during May-June 2004.

Juvenile production over the dry season (May-September) of 2004, however, has been very disappointing.

The following batches showed poor survival, particularly at day 8-9 or 14-15:

| | | |
|---|---|---|
| May 2004 | mangrove jack | 6 larval rearing tanks lost at day 14 |
| June 2004 | mouse grouper | 4 larval rearing tanks lost at day 15 |
| | estuary grouper | 2 larval rearing tanks lost at day 10 |
| July 2004 | mouse grouper | 4 larval rearing tanks lost at day 18-26 |
| August 2004 | estuary grouper | 3 larval rearing tanks lost at day 8-9 |
| | Tiger grouper | 3 larval rearing tanks lost at day 8-9 |
| Sep. 2004 | Estuary grouper | 3 larval rearing tanks lost at day 3 (poor egg quality) |
| | Mangrove jack | 500 surviving juveniles |
| Oct. 2004 | Estuary grouper | 6 larval rearing tanks lost at day 10-15 |

This poor survival is thought to be due to a number of factors, including a) the low seasonal performance of broodstock during the period June-September, b) low water temperatures, which are thought to increase the incidence of VNN, c) occasional crashes of the plankton cultures and c) problems with hatchery water quality brought about by excessive corrosion of the sand filters.

Considerable efforts have been made to solve these production problems with the aim of allowing a higher and more consistent production of fish juveniles. Measures taken include:

Installation of insulation to larval rearing tanks, to maintain higher water temperatures

Adoption of husbandry measures designed to minimize the incidence of VNN

Replacement of the sand filters

Adoption of improved plankton production systems

Technical support visits from experts in VNN control and larval rearing techniques from the Gondol Research Institute for Mariculture, in Bali.

These alterations have already born fruit, with the successful production of a batch of mangrove jack juveniles during October/November 2004. 5,000 juveniles were graded and transferred to nursery tanks during early December 2004.

Future hatchery production will concentrate on tiger grouper, mouse grouper and mangrove jack. Such a production strategy will maximize hatchery output by spreading the risk of disease losses, since the mangrove jack, although of lower value, are faster growing and less prone to viral disease.

**4 Broodstock cage facility**

The fish culture project has 3.0 tonnes of broodstock (Table 2), which are kept in fish cages near the hatchery site at Loh Mbongi (Fig. 9). Broodstock was collected from the Komodo area only, to minimize the risk of disease introduction and genetic pollution. Mortality to date has been negligible.

The broodstock facility comprises 6 units of 4 cages measuring 4 by 4 m, and 4 units of 4 cages measuring 3 by 3 m. The depth of the nets are 5-6 m, except for the smallest cages that have 3 m deep nets. All cages are of simple construction, being made from locally available timber and plastic drums (acting as floats). As such, these cages can easily be built by local villagers at a minimum cost. The facility also includes a working deck, a storage shed and a guardhouse. Prior to completion of the hatchery facility, an experimental algal and rotifer culture unit was added to this floating complex, so that a start could be made with small-scale rearing of larvae. The fish culture team has successfully produced a small batch of seabass, using this unique cage-based method.

All species have already spawned in captivity. The quality of the eggs produced by the captive broodstock is variable, with an average fertilization rate of 70% and an average hatching rate of 70%. The broodstock is fed every second day with ca. 80 kg of fresh squid and small fish.

***Figure 9**. The broodstock facility at Loh Mbonghi*

***Figure 10**. Broodstock of mouse grouper at Loh Mbongi*

To produce 25 tons of fish, 2-7 million fertilized eggs are needed. As few as 2-4 females can produce this number of eggs yearly. The reason that the Komodo project maintains far more females is to reduce the risk of inbreeding and to have enough reproducing females left in case of mortality or disease. Furthermore, the present broodstock will allow for up-scaling of the project. Natural spawning of the captive broodstock takes place mostly during the rainy season (October-May) and is determined by the lunar cycle. The five species kept in this fish culture project spawn during nighttime. Mouse grouper, tiger grouper and mangrove jack typically spawn around new moon, estuary grouper and seabass about one week after full moon. Spawning of tiger grouper and estuary grouper may be limited to just 2 or 3 days per month, whilst fish such as mouse grouper and mangrove jack may continue spawning nightly for more than one week.

***Figure 11**: estuary grouper broodstock at Loh Mbongi*

The following is an eyewitness account of the spawning behavior of mouse grouper:

*On Sunday October 1 2000, 21.45 PM, for the first time in the history of the Komodo mariculture project, spawning of Cromileptes altivelis (mouse grouper) was observed to occur in one of the fish cages. The recently hired broodstock manager, Pak Sudaryanto, showed his skill by announcing on the afternoon before that he expected spawning to take place at ca. 21.30, and he also estimated that spawning would take place two or three times. I joined Sudaryanto to observe this remarkable phenomenon, and I would like to give you a brief account of the event. The mouse groupers were very active, which is quite unusual this late in the evening. At least three females, clearly gravid, received plenty of attention from the bigger and very excited males. The females were somewhat quieter, more or less being shoved around by the males. The males went frequently to the surface, splashing around, then swimming back to the bottom of the cage again. Two or three times, we observed a male and a female swimming side-by side, in an odd, jerky manner. We did not actually see the first spawning - just a splash, but somehow Sudaryanto immediately recognized it. With the flashlights we could see the eggs floating in the water. A sample was taken to observe these eggs in more detail. The eggs are fairly small (0.8 mm), their buoyancy was neutral (i.e. they do not float to the surface, nor do they sink). One female can produce hundreds of thousands of eggs. As we were really interested to see the spawning itself, we started to use the flashlights more often -in the beginning we were afraid that too much light would disturb them. We could see the second spawning in every detail. The male and the much smaller female were swimming side-by-side, then the pair rocketed to the surface, during which the female let go of her eggs. The female immediately returned, to the bottom of the cage, the male stayed behind in the clout of eggs, swimming in an erratic way while releasing the sperm. Thereafter the male also returned to the bottom of the cage. The whole event took perhaps 5 seconds or so. A successful spawning like this may result in up to 80% of the eggs being fertilized. The third spawning was similar to the second we witnessed, but this female was fairly small (perhaps 500 g body weight or so), and the males seemed to have some difficulty in persuading her. One of the bigger males seemingly made a good impression, resulting in another successful spawning. The mouse groupers were not treated with hormones, but they were given a vitamin complex 4-2 days before spawning. The night that spawning took place was 2 days before new moon. One day earlier, spawning took also place in one of the cages with tiger grouper (E. fuscoguttatus), but this was not witnessed during 'the act'. However, already days before that it was quite obvious that something would happen shortly, as one of the dominant males showed aggressive behavior, and also his colors were typical for male fish that are about to spawn: white cheeks, and a white belly (instead of the brownish colors that they normally have). Sudaryanto expects that both the tiger groupers and the mouse groupers will spawn every month from now on during new moon, possible with an off-season of ca. 2 months.*

Following the above observations, all species of fish held at the broodstock facility have spawned regularly. From 29 March to 3 April, 2003 a specialist underwater photographer successfully filmed, for the first time, the spawning behaviour of the mouse grouper at Loh Mbongi. During this 5 night filming period, natural spawning of tiger grouper, mangrove jack and seabass were also witnessed.

***Table 2.**. Characteristics of the broodstock of the Komodo fish culture project. 'protogynous' means that females change into males, whereas 'protandrous' means that males change into females. 'Number' indicates the number of fish in the broodstock facility as of February 2004.*

| Species (english, scientific and Indonesian name) | Reproduction mode | Max. length | Price per kg | Number |
|---|---|---|---|---|
| estuary grouper, *Epinephelus coioides*, kerapu lumpur | protogynous | 100 cm | 4-5 US$ | 134 |
| tiger grouper, *Epinephelus fuscoguttatus*, kerapu macam | protogynous | 120 cm | 8-12 US$ | 35 |
| mouse grouper, *Cromileptes altivelis*, kerapu tikus | protogynous | 70 cm | 30-35 US$ | 48 |
| sea bass, *Lates calcarifer*, kakap putih | protandrous | 200 cm | 3-8 US$ | 52 |
| mangrove jack, *Lutjanus argentimaculatus*, kakap merah | protogynous | 150 cm | 5 US$ | 212 |

The broodstock, being kept under natural conditions, show a seasonal variation in fecundity, such that egg production is at a minimum during the months of June to August, and seabass actually stop spawning altogether during this period. Egg production during the rainy season (November to March) reaches a maximum. Only a tiny percentage of eggs produced by the broodstock are ever collected, so that the stock of broodfish will be acting as an artificial spawning aggregation, and releasing fertilized eggs into the surrounding waters, and thus supplementing the recruitment of wild-spawned fish larvae in surrounding waters.

All existing broodstock have recently undergone a complete assessment of stock number, sex determination and health status.

The stock of broodfish has been supplemented with carefully selected first generation hatchery production estuary grouper, tiger grouper, mouse grouper, mangrove jack and seabass. This is part of a long-term selective breeding program, which aims to introduce genes for fast growth, disease resistance and optimum physical appearance into the total stock of broodfish. Selective breeding is considered the key to gaining improvements in growth rate and survival rate of hatchery-reared fish, and in the control of the viral disease VNN.

In addition, experimental stocks of leopard coraltrout, *Plectropomus leopardus,* have been secured for future research and development into the hatchery production of this species.

## 5 Grow-out and community involvement

An assessment of suitable sites for the installation of cage fish farms around the Komodo area was completed by the end of October 2002, with the most suitable sites being found close to the villages of Boleng, Medang, Sape and Menjaga. Subsequently, other suitable sites have been identified at Warloka and close to Pulau Misa. At present, no aquaculture development is envisaged within the national park boundaries.

The construction of the first two grow-out units has now been completed (Fig. 12). The Community Outreach team at The Nature Conservancy's Komodo Field Office has assisted in the development of a community model for the fish culture project, and played a key role in the socialization and extension of the project's aims to local stakeholding communities. Community members of all targeted villages have visited the facility at Loh Mbongi. To date, all have shown considerable interest in the project. In addition, staff of the Fish Culture Team frequently attend stakeholder meetings organized by the Community Outreach Team to answer questions from the local communities on the project.

***Figure 12:*** *Community grow-out unit at Warloka village*

During October and November 2003, an agreement was made to install the first of the four planned grow-out cage units at the village of Warloka. A 'member's group' of 11 community members, including the Kepala Desa, Kepala Dusun and 6 trainees, was established, and the trainees received a month of residential 'hands-on' training at Loh Mbongi. The cage unit was towed to Warloka during December 2003, and installed close to the village. It was stocked with 700 estuary grouper, 1000 mouse grouper and 5,500 mangrove jack, representing the first production batches produced by the hatchery at Loh Mbongi. Additional stocks of tiger grouper and mangrove jack were delivered during May 2004. A milestone in the project was reached on 12th June 2004, with the first harvest of grouper production to a live fish exporter, destined for the live reef fish market in Hong Kong. 500kg of fish were delivered for export, and the harvest was combined with an official ceremony, attended by a number of local dignitaries, including the Regent of West Manggarai.

Discussions were being held with the community of Menjaga by February 2004, as the proposed site for the second community grow-out unit, and the second cage grow-out unit was installed during June 2004. Batches of tiger grouper and mangrove jack juveniles were stocked, and the first harvests from this site can be expected during June/July 2005.

The operation of the above two community-based grow-out units over the last 6-12 month period has revealed some challenges, some foreseen, others quite unexpected, in operating alternative livelihood projects with stakeholder communities, and a number of valuable lessons have been learnt. The general attitude of the participants in the project has varied greatly between the two units – one group is almost totally self-reliant and diligent with respect to day-to-day fish production operations, whilst the other has required constant supervision and guidance. One group can see the future earning potential of the project, and patiently awaits the first harvest, whilst the other can only see in the short term, and sees more value in the limited monthly operational payments than the final income from harvest. Most importantly, other

factors, unrelated to the fish culture operations, may have a significant effect on the long term success of the project, including intra-community politics, tensions and rivalries, which can be exacerbated by the introduction of an alternative livelihood project to a community lacking a strong and decisive leadership, or a strong sense of cohesion within that community. Many of these factors are difficult to foresee, and underline the need for extensive and detailed community-based research and preparation for additional grow-out operations, and indeed other alternative livelihood projects of this type.

Further requests for information, and expressions of interest, continue to be received from communities requesting participation in this project, including Pulau mesa, Kukusan and Sape, and the third grow-out unit is likely to be installed in one of these locations.

## 6 Carrying capacity and development of best practices

During January, 2003 a workshop was held in Labuan Bajo to discuss the future governance of an aquaculture industry in the Komodo area, with particular emphasis on the determination of a maximum carrying capacity to allow safe environmental limits to future fish farm development. The workshop and subsequent studies will be coordinated by Michael Phillips of NACA, and involve contributions from Dr Adi Hanafi (Gondol) and Dr Bambang Widigdo, Head of Faculty, IPB (Department of Aquatic Resource Management, Bogor University).

The objectives of the workshop were:

1. To design an environmental monitoring programme for the four pilot cage sites, including the construction of a baseline study, a decision on the relevant parameters to measure, the frequency of sampling and a minimum allowable change for those parameters, and the calculation of theoretical carrying capacity values for each site.
2. To agree on recommendations on an approach to carrying capacity/monitoring guidelines for fish culture in the Komodo area.
3. To agree on a list of best hatchery and grow-out practices, at farm level, to be implemented by the Fish Culture Project.
4. To construct a list of ‘best governance practices’, eventually to be overseen by fishfarmer associations or government.
5. To review the existing governance systems and legal framework for aquaculture development in the Komodo area, and Indonesia as a whole, and to assess the possibility of zoning plans with respect to aquaculture development.
6. To devise a list of recommendations for the strengthening of governance systems for aquaculture development, including zoning systems, in the Komodo area.
7. To review existing legislation with a direct effect on aquaculture, such as use of pharmaceuticals and other chemicals, transfer of live animals and water quality/discharge regulations.

A report on this workshop is available from the project team.

## 7 Partnerships and training

As culturing of grouper still poses some technical challenges, the fish culture project created partnerships with institutes that can provide the necessary know-how. The main partners in the Komodo fish culture project are the Gondol Research Institute for Mariculture (Bali, Indonesia), the Department of Primary

Industries, Queensland (Australia) and the Network of Aquaculture Centers in Asia (based in Bangkok, Thailand).

On May 23 2002, a Memorandum of Understanding was signed between The Nature Conservancy and The Research Center Institute of Aquaculture (RCIA, the mother institute of the Gondol Research Institute for Mariculture) of the Ministry of Marine Affairs and Fisheries. The objective of the cooperation is to conduct research on the development of sustainable mariculture and to generate alternative sources of income for local communities. The agreement was signed in the presence of the Minister of Marine Affairs and Fisheries, the Honorable Dr Rokhmin Dahuri at the RCIA campus in Gondol.

As one of the first fishery research institutes in the world, Gondol succeeded in reproducing mouse grouper fingerlings from captive broodstock. Cooperation with the Queensland Dept. of Primary Industries was sought because of their extensive expertise in fish culture in general, but specifically in the culture of sea bass. This cooperation resulted in the participation of the Komodo fish culture project in the AusAID-funded Government Sector Linkage Project, which facilitated exchanges between Komodo, Gondol and the Queensland Dept. of Primary Industries.

In the framework of the aforementioned Government Sector Linkage Project, Elizabeth Cox and Julien O'Brien from the Department of Primary Industries visited the Komodo project on September 24-29 2001. They provided training on diagnosis and treatment of fish diseases to staff of the Komodo fish culture project. During the period March 18-30 2002, Mr. Gatot Wibisono (Mariculture Officer) and Primus F.S. Baru (Mariculture Assistant) attended a course at the Gondol Research Institute for Mariculture. The course focused on fish pathology, live feed production, and formulated feed production. Over the period April 12–23 2002, 2 staff of the mariculture team, Sudaryanto (Mariculture Coordinator) and Frederik G. Bataona (Mariculture Officer) were invited to receive training at the Department of Primary Industries of Queensland (Cairns, Australia). This training focused on brood-stock maintenance; induced spawning; tagging; hormone treatment, pathology, packing; and transportation of fish.

A number of technical support visits have been made by key staff members of Gondol Research Institute for Mariculture since the start of the project. A management support visit was carried out from 25-28 July by Dr Fris Johnny Ravael (senior fish pathologist) and Dedi Rohaniawan (hatchery technician), who provided valuable advice and training to mariculture staff. A technical support visit to Gondol was made during January 2004 by Mariculture Manager Trevor Meyer and Hatchery Officer Gatot Wibisono, and a further visit was made during September 2004. An additional technical support visit to the Fish Culture Project was made by Dr. Eri Sutiadi, a larval rearing expert at Gondol, in order to assist with recent problems experienced with poor larval survival rates.

The Komodo fish culture project became a member of the Network of Aquaculture Centres in Asia (NACA) to link up with aquaculture experts in Southeast Asia. During July 2003, both the Mariculture Manager and Mariculture Coordinator attended the 7$^{th}$ Technical Advisory Committee meeting of NACA, held in Bali.

The Komodo Fish Culture Project has provided regular residential training courses to the Fisheries High School at Sape. Three training courses have been completed to date, each accommodating 6 students for a period of up to 2 months. These courses were delivered from 28th July – 28th August 2003, 9th February – 9th March 2004 and 1st September to 7th November 2004. The courses include training in hatchery production techniques, production of live feed (algae, rotifers and Artemia), and grow-out in fish cages and provide valuable training to local communities who would not normally have access to such amenities, and assist in the dissemination of information to local stakeholders on the aims, methods and operations of the Fish Culture Project, The Nature Conservancy and environmental issues in general. On the strength of these training courses, the Fisheries High School of Sape has expressed an interest in joining the Fish Culture Project as the site of a community grow-out unit.

***Figure 13.*** *Training in fish hatchery techniques for students from Sape at the hatchery in Loh Mbonghi*

## 8 Business development

To get a first impression of the economic viability of a fish culture business based in West Flores, an expert team visited the Komodo area to collect data for the compilation of a business scenario for the fish culture enterprise in July 1999. The team consisted of Mr. Bill Rutledge (consultant), Dr. Mike Rimmer (Dept. of Primary Industries, Queensland, Australia) and Dr. Ketut Sugama (Gondol Research Station for Coastal Fisheries). The resulting business plan was reviewed by Dr. Stephen Battaglene, Senior Research Fellow of the Tasmanian Aquaculture and Fisheries Institute.

This business plan envisages that sea bass and estuary grouper will be used to get experience with hatchery techniques during the start-up phase of the project, after which the focus will be changed to mouse grouper and tiger grouper. The conclusion was that the hatchery, even at pilot scale, could return a profit provided that the full capacity was realized and that production would eventually focus on the most expensive grouper species, mouse grouper. Though based on incomplete data and ballpark assumptions, this analysis provided a sound basis to continue the project. As experience was gained while implementing the pilot project, it became clear that the project could only achieve profitability by up-scaling to a production capacity of 200 tons per year, and that operational continuity requires to maintain a multi-species approach. The design of the hatchery is modular, and the land on which the hatchery is located allows for further expansion. Further investment is needed for additional construction of hatchery facilities and grow-out units.

While local communities are starting to produce the first batches of marketable fish, the pilot project enters it's most critical and exciting phase: transformation into a triple bottom line business that is not only profitable but that also benefits local people and that is environmentally sound. As a global non-governmental, non-profit organization, The Nature Conservancy fully realizes that this transformation must be driven by the private sector, with The Conservancy only in a supporting and catalytic role. The approach to this process is that The Conservancy will do a final feasibility study and if this leads to positive

recommendations, support the formation of a business group that will take over and up-scale the fish culture facilities and that will operate as an independent business.

Business development is currently The Nature Conservancy's main focus for the fish culture project. The Conservancy has initiated some discussions on the formation of a business development partnership with the following potential partners:

- *Indonesia International Rural & Agricultural Development Foundation (INIRADEF),* a Bali-based foundation who has close ties with PT BPI. INIRADEF operates three eco-lodges, one of them situated in Komodo, and has experience with rural development projects that were funded by bi-lateral development aid. INIRADEF brings expertise in agriculture development, and maintains high environmental standards for its operations (for example, for its eco-lodges INIRADEF works with the environmental certifying agency Green Globe).
- *PT Bruno Phala International (PT BPI),* a private Indonesian company based in Bali. PBI is involved in community-based fish culture in Baru, South Sulawesi, and PBI has developed agriculture of corn in South Sulawesi, involving some 2000 local farmers. BPI, enabled by INIRADEF and a Dutch development aid agency, also developed a feed-mill for broilers and shrimp using state-of-the-art technology. The company set up an Industrial Development Council for South Sulawesi Province, which acts as an advisor and coordinator for the agribusiness and industrial development of the province. Divisions within this company are involved in various medium-sized businesses in Bali such as manufacturer of export quality furniture, freight forwarding company and interior design. BPI's director visited the Komodo fish culture project in February 2004.

Both INIRADEF and PT BPI offer expertise in 'green' business development and community-based agricultural business development. Although they were at this stage not in a position to make significant investments in the development of the Fish Culture Project into a triple-bottom-line business, opportunities to cooperate with INIRADEF and PT BPI may emerge in the future.

- *Asia Conservation Company (ACC).* ACC is the first investment holding company in Southeast Asia that adheres to the triple bottom line principle. ACC was incorporated on December 11, 2001 to build a bridge between private sector investment and biodiversity conservation. The goal of ACC is to construct a network of private sector investments that proactively conserve biodiversity while remaining profitable and competitive in the market place. The ACC model has been approved for a Global Environmental Facility (GEF) grant from the World Bank to be implemented by the International Finance Corporation which will give US$4.5M to conservation sites associated with ACC investments. During July 2004, senior representatives of ACC visited the Fish Culture Project as part of a fact-finding visit to the Komodo National Park, and preliminary terms of reference of their involvement in the project were drawn up. This was followed up with meetings between ACC and both PT BPI and INIRADEF over July and August 2004. During September, 2004, a member of ACC visited the Gondol Research Institute for Mariculture, in Bali, for an assessment of the current status of the grouper hatchery industry in Indonesia, and further talks were held with The Nature Conservancy in Bali. To date, ACC has decided against investment in the Fish Culture Project, pending results of further research and development with respect to the stabilization of juvenile production by the pilot hatchery at Loh Mbongi
- *Tahija Foundation*. The Tahija Foundation is a long-term supporter of The Nature Conservancy's Komodo marine conservation project. The Tahija Foundation owns the land on which the hatchery is located, and is *de facto* a partner in the development of the fish culture enterprise. However, the Tahija Foundation has indicated that it does not want to be actively involved in the development or operation of the fish culture business.

- *The Nature Conservation Southeast Asia Center for Marine Protected Areas*. As implementer of the Komodo fish culture project, The Conservancy will bring its fish culture assets into the business partnership. These assets comprise: land for hatchery development, pilot hatchery, four grow-out units, expertise and already realized investments in research and development. It is envisioned that The Nature Conservancy will not be involved in the fish culture business, but The Nature Conservancy will remain to be involved in the carrying capacity / best practices / governance study that is to be implemented as part of the up-scaling phase. Once the fish culture business is up and running, The Nature Conservancy will work with national and local government agencies to improve the regulatory framework for fish culture, to further a healthy climate for sustainable fish culture development within the boundaries of the carrying capacity of the area.
- *USAID mission in Jakarta and the Dutch Ministry of Foreign Affairs.* Before the transformation of the project into a triple bottom line fish culture business can be initiated, three steps have to be taken: (1) a feasibility study must be completed to explore under which conditions a 200 ton fish culture business can achieve its goals; (2) a business plan must be compiled to investigate how the 200 ton fish culture business will be set up, and (3) the partnership must be formalized. The USAID mission in Jakarta has offered support to help with this process. Although it is possible for the potential business group members to conduct the feasibility study, this study is better conducted by external consultants for two reasons. Firstly, prospective donors and other financial institutions will find the study credible only if it is conducted by an impartial, objective and professional agency. Secondly, the consulting agency brings in additional expertise that will supplement the expertise available in the business group members. Up-scaling can be initiated only after the studies have been completed and the business group has been formed, in the field. Financial support for the actual up-scaling phase can be obtained from various government agencies that offer bi-lateral aid for business development. One possibility is the public and private partnership program of the Dutch Ministry of Foreign Affairs.

Though formation of the business partnership and exploration of partnership scenarios is actually part of the feasibility study and the business planning process, some preliminary ideas have been developed. One option is that The Nature Conservancy and the Tahija Foundation sell off all assets after completion of the pilot phase (June 30 2005). This option is probably not feasible for two reasons: Firstly, this option would put the burden of business development and up-scaling with a buyer and it is unlikely that at this stage the buyer would choose to shoulder this burden alone. Secondly, it is unlikely that a buyer could allocate effort towards best practices / carrying capacity / governance studies, and it would also be unlikely for a buyer to internalize best practices if The Nature Conservancy and the Tahija Foundation loose all control by selling off.

A more feasible option would be for The Nature Conservancy to stay involved to (1) catalyze and find additional support for the formation of an environmentally concerned business group, and (2) to support development and implementation of best practices / carrying capacity / governance studies. Funding for up-scaling must come from investments by business partners and co-financing from bilateral agencies such as the Dutch Ministry of Foreign Affairs that are interested in small- to medium-scale business development in rural areas in Indonesia. Funding for this business development is *not* expected to come from 'traditional' conservation financing sources. The Nature Conservancy and the Tahija Foundation could stay on as partners in any future business group until up-scaling is finalized, ensuring that the business achieves its triple bottom line. One possible vehicle for The Conservancy and the Tahija Foundation to stay involved up to and including the up-scaling phase is to form a new foundation (*Yayasan*) that will be capitalized with the assets of each of the partners (hatchery and grow-out infrastructure from The Conservancy and land from the Tahija Foundation). Other ideas have been mentioned and will have to be further explored in the feasibility study and business plan.

**9 Visits to the Loh Mbongi hatchery facility**

Recent important visits to the Fish Culture Project include the following:

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| 9 April 2003 | Pk.Frans Raya , vice-chairman of the NTT parliament, visited the hatchery facility with Dr Mattheus Halim, head of TNK. |
| 27 May 2003 | Mr Buoy Roitana (Cambodian National Parks) and Mr Ouk Vibol (Cambodian Department of Fisheries). |
| 12 June 2003 | Mr Raejeong Park, journalist for 'Korean Daily' newspaper, with interpreter |
| 21 June 2003 | Mr. George Tahija, family and crew. |
| 9 Aug 2003 | Inauguration of the Komodo Fish Culture Project hatchery at Loh Mbongi, by Prof. Dr. Rokhmin Dahuri, former Minister for Fisheries and Marine Affairs |
| 20 Sep 2003 | Mr. Kazuo Saigawa and Mr. Hiroshi Yoda, Japan Fund for the Global Environment |
| 9 Oct 2003 | Edward McBride, journalist, The Economist |
| 14 Oct 2003 | Mr Euan Marshall and Feraldi Loeis, IFC |
| 1 Nov 2003 | Mr. Steve McCormick, CEO of The Nature Conservancy<br>Prof. S. Hill, UNESCO Director<br>William Freij, Director of USAID<br>David Green, Country Director, Asian Development Bank<br>Ir. Koes Saparjadi, Director, Indonesian National Parks Authority<br>Prof. Ir. Widi Agoes Pratikto, Director General, Dept. of Coastal Affairs and Small Islands |
| 28 Dec 2003 | Mr Sjakon Tahija, Tahija Foundation |
| 6 Feb 2004 | Mr Bruno Theong, potential business partner for Komodo Fish Culture Project Alan & Meryl Wilson, INIRADEF |
| 16 April 2004 | Geoffrey Muldoon, Marine Aquariumfish Council |
| 13 May 2004 | Mr. Ruud Treffers, Dutch Ambassador to Indonesia<br>Mr. Hans-Christian Kall, Belgian Ambassador to Indonesia<br>Mr. Mubariq Ahmad, Director, WWF Indonesia |
| 12 July 2004 | Ms. Leigh Ann Talmage, ACC<br>Mr. Vicente Santiago Perez, Minister of Energy, Philippines<br>Mr. Luis Miguel Vaca, ACC<br>Mr. Rafael Llamado Reyes, ACC<br>Mr. Miguel William Santiago Perez, ACC<br>Mr. Richard Raymond Balthazar Tantoca, ACC |
| 5 Aug 2004 | Mr. & Mrs. Ralph Sorensen, TNC Colorado Chapter |

21 Sep 2004 Mr. Bill Foederer, USAid

23 Oct 2004 TNC Asia-Pacific Council visit, including
Mrs. Geh Min, Consultant Eye Surgeon, Mount Elizabeth Medical Centre, Singapore
Mr. Kay Oon Kwong Kuok, Shangri-La Hotel, Singapore
Mr. James Morgan, Cisco Systems Inc.
Mr. Shinichiro Watari, Cornes & Co. Ltd

28 Oct 2004 TNC Asia-Pacific Council visit, including:
Mr. Raja Gupta, McKinsey & Co.
Mr. Hank Paulson, Goldman Sachs Group, Inc.
Mr. John Morgridge, Cisco Systems, Inc.
Mr. Douglas Hsu, Far Eastern Group
Mr. Tim Dattels, Newbridge Capital
Mr. Moses Tsang, CEO EC Investment Services Ltd.
Ms. Shirley Young, senior advisor General Motors Corp.

The list above excludes regular visits by local communities and stakeholders.

## 10 Staffing

In February 2004, the Komodo Fish Culture Project was staffed as follows:

*Mariculture Project Manager*: Mr Trevor Meyer (hired 18 August, 2002)
*Broodstock & growout Coordinator*: Sudaryanto
*Mariculture Officers*: Edi Bataona, Gatot Wibisono, Vitalis Jelanu and Primus Baru
*Mariculture Assistants*: Jamarong, Juaedi Koro, Wengking Latul, Deden Dong, Ahmad K.I., Sahruddin, Ruben Noti, Siprianus Engko, Guntur, Ramaddhan.
*Mariculture mechanic*: Martinus Sengga
*Boat crew*: Martinus Ardi (boat driver), Kasmir Kamis (boat driver), Abdullah Hasannudin (boat crew)
*Night guard*: Mustakim Ali, Gerardus, Nasrul Hasan
*Cook/housekeeper*: Imelda Sul, Rosalia Amut, Nurhayati
*Mariculture Volunteer*: Ozden Meyer

## 11 Contacts

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