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

September 2003

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

Compiled by:
Peter J. Mous PhD, Science, Training and Partnerships Manager
Sudaryanto, Mariculture Coordinator
Trevor Meyer MSc, Mariculture Manager
TNC Southeast Asia Center for Marine Protected Areas
Jl Pengembak 2, Sanur, Bali, INDONESIA
phone +62-(0)361-287272, fax +62-(0)361-270737

Contents

Executive summary

The main objective of the Fish Culture Project is to provide sustainable fish culture as an alternative livelihood to non-sustainable fishing practices in and around Komodo National Park. The project aims to involve 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 in Loh Mbongi (ca. 6 km North of Labuan Bajo).

The fish culture project has 2.4 tons of broodstock, which are kept in fish cages near the hatchery site in 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 and by September 2003 had reached an average weight of 150g.

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).

From 23 to 26 January, 2003 a carrying capacity workshop, coordinated by NACA, 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 safe environmental limits to future fish farm development. The Community Awareness and Education team at the The Nature Conservancy's Komodo Field Office have completed Phase 1 of their extension of the Mariculture Project, and Phase 2, involving negotiations with target villages and installation of the first grow-units, was underway by September 2003.

Ringkasan Umum

Tujuan utama dari Proyek Budidaya Ikan adalah membantu budidaya ikan berkesinambungan sebagai alternative mata pencaharian dari pada penangkapan ikan yang tidak berkesinambungan di dalam dan di sekitar Taman Nasional Komodo. Sasaran proyek adalah untuk mengikutsertakan masyarakat setempat dalam berbudidaya kerapu lumpur *Epinephelus coioides*, kerapu tikus *Cromileptes altivelis*, kerapu macan *Epinephelus fuscoguttatus*, kakap putih *Lates calcarifer* dan kakap merah *Lutjanus argentimaculatus*, yang mana khususnya jenis ikan kerapu dapat dipasarkan dalam keadaan hidup ke Hong Kong – pusat perdagangan ikan hidup. Ikan seukuran jari tangan akan dihasilkan dari induk yang dipelihara di lingkungan hatchery Loh Mbongi (lebih kurang 6 km sebelah Utara Labuan Bajo).

Proyek budidaya ikan mempunyai induk seberat lebih kurang 2,4 ton, yang dipelihara dalam karamba jaring apung dekat hatchery di Loh Mbongi. Seluruh fasilitas hatchery mempunyai kapasitas produksi maksimum 100,000 benih per tahun, dan termasuk di dalamnya fasilitas kultur alga, rotifer dan artemia untuk menjamin tingkat produksi. Hatchery beroperasi secara penuh dimulai menjelang bulan Maret 2003. Telur pertama yang dipelihara di hatchery adalah kerapu Lumpur, yang dipanen pada malam hari tanggal 6 Maret 2003. Telur ini menetas pada tanggal 7 Maret dan sampai dengan bulan September 2003 ikan mencapai berat rata-rata 150gram.

Proyek budidaya ikan membangun kerjasama dengan lembaga yang dapat membantu untuk memecahkan beberapa masalah. Mitra teknis utama Proyek budidaya ikan komodo adalah Balai Besar Perikanan Budidaya Laut Gondol (Bali, Indonesia), the Department of Primary Industries, Queensland (Australia) dan Network of Aquaculture Centers in Asia (berkedudukan di Bangkok, Thailand).

Pada tanggal 23 sampai 26 Januari, 2003 lokakarya daya dukung lingkungan yangdikoordinar oleh NACA, telah dilaksanakan di Labuan Bajo untuk mendiskusikan penataan ke depan industri budidaya ikan di sekitar perairan Komodo, dengan penekanan pada penelusuran ambang batas aman bagi lingkungan bagi pengembangan budidaya ikan di masa yang akan datang. Tim Pendidikan dan Penyadaran Masyarakat The Nature Conservancy Komodo Field Office telah menyelesaikan fase ke-1 untuk penjelasan tentang Proyek budidaya ikan kepada masyarakat. Fase kedua yang sudah dan sedang berlangsung pada bulan September 2003 ini melibatkan proses negosiasi di desa-desa target dan pemasangan unit pembesaran ikan yang pertama.

1 Introduction: Fish culture as an alternative livelihood for coastal people in 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 Indonesia Coastal and Marine Program 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 objective of the fish culture project is to provide sustainable fish culture as an alternative livelihood to non-sustainable fishing practices in and around Komodo National Park. A secondary objective relates to the Hong Kong based trade in live reef fish. Currently, the live reef fish trade is rapidly depleting the Indo-Pacific stocks of Napoleon wrasse (*Cheilinus undulatus*) and groupers (*Serranidae*). It is hoped that the Komodo fish culture project can demonstrate how fish culture of groupers can be done in a sustainable and environmentally sound manner, thereby contributing to the market transformation of the live reef fish trade from unsustainable, capture-based to sustainable, culture-based. Fish culture consultants who visited

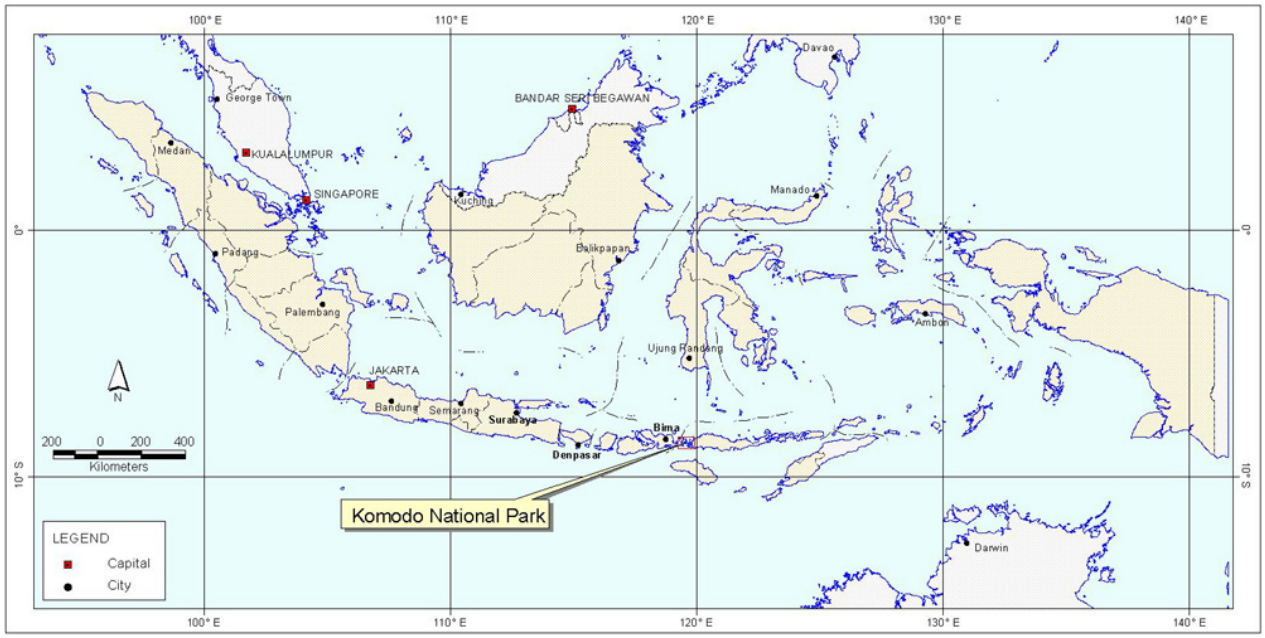

Figure 1. *Map of Indonesia with location of Komodo National Park.*

the Komodo area in 1997 reported that the Komodo area is very suitable for the deployment of fish cages: water quality is excellent, there is little rainfall, and there are many locations that are 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.

The Komodo fish culture project aims to involve 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 will be 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 whereof broodstock is 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, and the project will be handed over to another group under the condition that 'best practices' will be adhered to. This group may be a fishery cooperative or a local business partner.

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 commercial pelleted feeds. At a cost of approximately US$1000 per tonne, and at a feed conversion ratio of 1.7, this results in a feeding cost at ca. US$1.70 per kg of produced fish. This is not much, considering that grouper may fetch between 8 and 35 US$ per kg. To get a first impression on the economic viability, 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 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. Mouse grouper is more profitable, but its culture also poses more technical challenges. The business plan concludes that to start up a hatchery-based grow-out enterprise in two years, with a capacity of 27 tons / year, capital requirements amount to US$ 280,000. Operational costs in the first three years would amount to US$ 460,000, and the enterprise would break even after 5 years. After the

facility is fully operational, annual profits would amount to US$ 435,000. The business plan was reviewed by Dr. Stephen Battaglene, Senior Research Fellow of the Tasmanian Aquaculture and Fisheries Institute.

More details on the fish culture project are in the 'Strategy and Action Plan for the TNC Komodo Fish Culture Project', which can be downloaded from the 'Reports' section at www.komodonationalpark.org.

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.

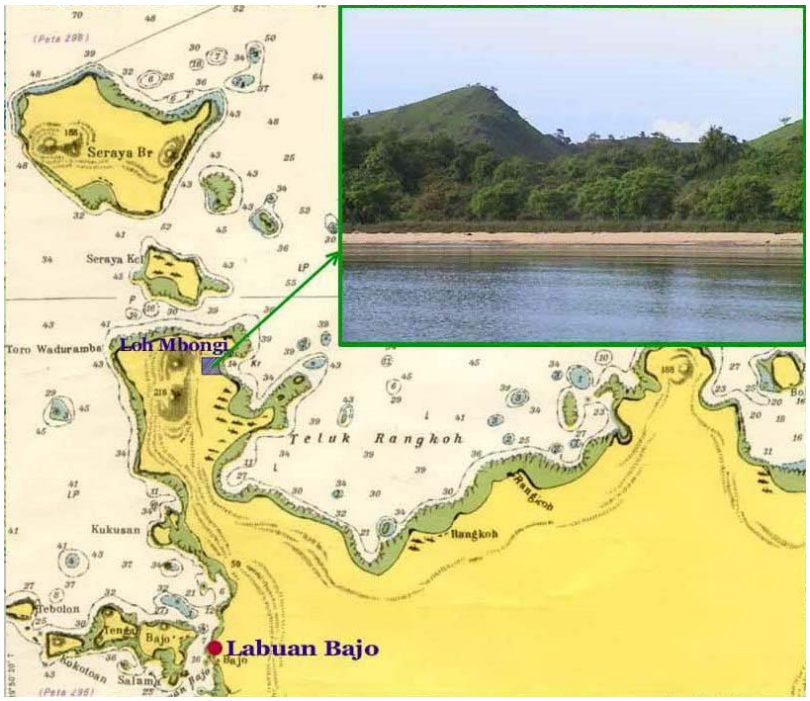

***Figure 2**. Loh Mbongi, situated on the peninsular North of Labuan Bajo, West Flores, Indonesia.*

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.

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*. Aerial picture of the hatchery just after completion, March 27, 2003. viewed from the north.*

Figure 5*. Completed nursery building.*

***Figure 6**. Algae and rotifer tanks at the hatchery complex.*

***Figure 7**. Staff mess at the hatchery complex.*

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 7th March and had been successfully stocked into temporary grow-out cages at Loh Mbongi by June 2003. By September, this batch of fish had reached an average weight of 150g. This is a significant achievement since most of the highest risk periods of mortality encountered in fish larval culture have been passed by this stage. Larval survival reached 3.7%, an encouraging result for the first production by the Loh Mbongi hatchery.

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

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 almost 6 months. Hatchery production, however, has not been without its challenges, and , although four of the 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.

By September 2003, one batch of estuary grouper and two small batches of mouse grouper had been transferred to temporary grow-out cages at Loh Mbongi. A batch of 5,000 mangrove jack juveniles have been transferred from larval rearing tanks to the nursery, and are expected to be transferred to the grow-out cages during November 2003.

Table 1.. *Stocking of the larvae rearing tanks during September 2003.*

Tank	Species (english, scientific and Indonesian name)	Age of larvae (days)	Number (estimated)	Remarks
1	tiger grouper, *Epinephelus fuscoguttatus*, kerapu macam	1	100,000	Stocked 23 September 2003
2	mouse grouper, *Cromileptes altivelis*, kerapu tikus	5	100,000	Feeding on SS rotifers
3	tiger grouper, *Epinephelus fuscoguttatus*, kerapu macam	1	100,000	Stocked 23 September 2003
4	mouse grouper, *Cromileptes altivelis*, kerapu tikus	5	100,000	Feeding on SS rotifers
5	tiger grouper, *Epinephelus fuscoguttatus*, kerapu macam	1	100,000	Stocked 23 Septemebr 2003
6	mouse grouper, *Cromileptes altivelis*, kerapu tikus	9	50,000	Feeding on S rotifers

4 Broodstock cage facility

The fish culture project has 2.4 tons of broodstock (Table 2), which is kept in fish cages near the hatchery site in Loh Mbongi (Fig. 8). Broodstock was collected from the Komodo area only, to minimize the risk of disease import 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.

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

***Figure 10**. Mouse grouper broodstock at Loh Mbongi*

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

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 or small fish.

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. All fish spawn during the night. 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.

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.

***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 August 2002.*

Species (english, scientific and Indonesian name)	Reproduction mode	Max. length	Price per kg	Number
estuary grouper, *Epinephelus coioides*, kerapu lumpur	protogynous	100 cm	8-10 US$	170
tiger grouper, *Epinephelus fuscoguttatus*, kerapu macam	protogynous	120 cm	8-10 US$	50
mouse grouper, *Cromileptes altivelis*, kerapu tikus	protogynous	70 cm	30-35 US$	40
sea bass, *Lates calcarifer*, kakap putih	protandrous	200 cm	3-8 US$	70
mangrove jack, *Lutjanus argentimaculatus*, kakap merah	protogynous	150 cm	6-10 US$	260

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.

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. In these circumstances, egg production can be stimulated, and increased, by the use of hormones, either injected or introduced to the fish via their feed.

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

5 Grow-out and community involvement

Now that the hatchery has started producing fingerlings local communities are becoming involved in grow-out. Two grow-out units have now been completed (Fig. 12), and are presently on temporary moorings at Loh Mbongi, awaiting installation at the first grow-out sites. The Community Outreach team at The Nature Conservancy's Komodo Field Office have completed Phase 1 of their socialization and extension of the Mariculture Project, and have now started discussions with the chosen villages leading to installation of the first grow-out units. Community members of all targeted villages have visited the facility at Loh Mbongi and discussed the aims of the Fish Culture Project. 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 Awareness and Education Team and by the Community Development Team so that they can answer questions from the local communities on the project. Phase 2 of the socialization and extension project, involving visits to the target villages, has begun, with a visit to the first planned grow-out unit site at the village of Warloka.

***Figure 12**. Grow-out unit under construction, to be deployed near a local village (March 25, 2003).*

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.

6 Carrying capacity and development of best practices

From 23 to 26 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 Johhny Ravael (senior fish pathologist) and Dedi Rohaniawan (hatchery technician), who provided valuable advice and training to mariculture staff.

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 7th Technical Advisory Committee meeting of NACA, held in Bali.

8 Visits to the Loh Mbongi hatchery facility

Recent visits to the Fish Culture Project include the following:

9 April, 2003	Pk.Frans Raya , vice-chairman of the NTT parliament, visited the hatchery facility with Pak Halim, head of TNK.
12 April	Media Visit II, with Pk.Endang Sukendar of GATRA, and Pk.Pandaya of the Jakarta Post visiting Loh Mbongi.
15 April	Pk.Sudaryanto arranged and supervised a visit for more than 25 local teaching staff of a local school, SLTPN.
25 April	Ms Tanya Burnett and Mr Kevin Palmer of Island Exposure Inc., a travel journalism company, visited the facility at Loh Mbongi, along with Pak Gede and Mark Heighes of TNC.
27 May	Mr Buoy Roitana (Cambodian National Parks) and Mr Ouk Vibol (Cambodian Department of Fisheries).
11 June	Pak Pius Mahdi, tv journalist with RCTI.
12 June	Mr Raejeong Park, journalist for 'Korean Daily' newspaper, with interpreter.
17 June	Pak Marsel Ali, journalist from Kupang (Wartawan Pos)
21 June	Mr. George Tahija (a major donor of the Mariculture Project), family and crew.
31 July	A delegation of senior government officials from Wakatobi National Park, and the Kabupaten Buton, including: Pk. Syihabudin, Kepala Taman National Kelautan Wakatobi Pk. Nasir Baso, Kepala Dinas Pariwisata Kabupaten Buton Pk. .Abidin Baso, Kepala Dinas Kehutanan Kabupaten Buton Pk. Ibrahim Udu, Kepala Dinas Perikanan Kabupaten Buton Ibu Waobe Nurjana, Staf Dinas Perikanan Kabupaten Buton
4 August	5 members of Dept. of Forest Protection & Nature Conservation (PHKA), from Jakarta and Bogor, to discuss aspects of KCMI.
9 August	Visit of the Minister of Marine Affairs and Fisheries: Prof. Dr. Rokhmin Dahuri, Minister for Fisheries and Marine Affairs Bpk. Drs. Frans Lebu Raya, Wakil Gubernur NTT Bpk. Adi Pasaribu, PR of Secretary General of MFMA Dr. Tony Ruhimat, Director of Coastal and Small Island Ir. Endroyono, Director Fisheries Infrastructure Drs. Anthon Bagul, Bupati Manggarai, Ruteng Fidelis Kerong, District Fisheries Service Rafael Kasor, Ass. For Admin to Bupati Manggarai Liber Habut, Camat Komodo Blasiur Janu Pandur, Stakeholder, Fisher Association (HNSI)

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

9 Staffing

In September 2003, the Komodo Fish Culture Project was staffed as follows:

Mariculture Project Manager: Mr Trevor Meyer (hired 18 August, 2002)
Mariculture Coordinator: Sudaryanto
Mariculture Officers: Edi Bataona, Gatot Wibisono and Marda Mulyawati
Mariculture Assistants: Jamarong, Juaedi Koro, Wengking Latul, Primus, Deden Dong, Ahmad K.I., Sahruddin and Martinus Sengga.
Boat crew: Abdul Wahab (boat driver, Manta), Martinus Ardi (boat driver, KMP2)
Night guard: Siprianus Engko, Mustakim Ali.
Cook/housekeeper: Imelda Sul, Rosalia Amut, Nurhayati
Mariculture Volunteer: Vitalis, Ozden Meyer

10 Contacts

Network of Aquaculture Centers in Asia (contact person Dr Michael Phillips)
PO Box 1040; Kasetsart Post Office; Jatuchak, Bangkok; 10903; Thailand
phone +66-(0)2-5611728/9, fax +66-(0)2-5611727

Gondol Research Institute of Mariculture (contact person Dr. Adi Hanafi)
PO Box 140, Singaraja 81101; Gondol, Bali; Indonesia.
phone +62-(0)362-92278, fax +62-(0)362-92272

Department of Primary Industries, Queensland (contact person Dr Mike Rimmer)
PO Box 5396, Cairns; Queensland 4870; Australia
phone +61-(0)7-40350109, fax +61-(0)7-40351401

TNC Southeast Asia Center for Marine Protected Areas
Jl Pengembak 2, Sanur, Bali, INDONESIA
phone +62-(0)361-287272, fax +62-(0)361-270737, www.komodonationalpark.org

Appendix. Income and expenses for the Komodo fish culture project over FY02

Income:		**Expenses**	
Foundations and private donors		Personnel	8,363
Gerbode Foundation	US$ 25,000	Fringe Benefits	25
David and Lucile Packard Foundation	US$ 38,000	Contractual [3]	120,154
Tahija Foundation	in kind [1]	Communications	15,207
Anonymous	US$ 42,000	Travel	9,017
Anonymous	US$ 25,000	Supplies	52,539
Institutions and agencies		Occupancy	257
TNC Coastal and Marine Program	US$ 100,000	Other Expenses	2,205
AusAID[2]	US$ 7,000		
Total income	**US$ 237,000**	**Total expenses**	**US$ 207,767**

(1) The Tahija Foundation donated the land on which the hatchery is constructed.

(2): In collaboration with the Department of Primary Industries, Queensland, Australia and the Gondol Research Institute for Mariculture, Bali, Indonesia. Used for financing a personnel exchange between the The Conservancy, Dept. of Primary Industries and the Gondol Research Institute.

(3): This includes a payment of US$ 38,000 to the construction contractor CV Bumi Cakra; the total contract sum amounts to US$ 126,000. This also includes a payment of US$ 2,000 to the engineering company CV Teksas, as part of a total contract of US$ 4,000. The outstanding contract amounts will be partly paid the carry-over to FY03.