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The Financial Feasibility of Small-Scale Grouper *Cromileptes altivelis* Aquaculture in Indonesia

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Abstract

This paper presents the results of a financial analysis of the aquaculture of *Cromileptes altivelis* (mouse grouper, barramundi cod, polka dot or high-finned grouper) in Indonesia. The analysis provided financial information on individual broodstock, hatchery/nursery, and grow-out stages. The findings of the analysis indicate that, based on the assumptions, all three scenarios are financially feasible. However, the capital requirements for the broodstock and hatchery/nursery may be beyond the financial means of many small producers. These stages of grouper culture may need to be developed as a larger project by private investors or government. The capital investment requirements for grow-out (not including purchase of transport boxes) is within the financial means of small producers. Loans or other incentives will need to be made available for the small producer, but the cash flow indicates that these loans can be repaid in the first year of production.

Introduction

Among the threats to coral reefs in the Indo-Pacific region, the live reef fish trade (LRFT), which involves the capture and culture of living reef organisms (fish, coral), is currently the most destructive and unsustainable. Aquaculture is being increasingly cited as a priority solution for reducing the pressures on coral reefs arising from over- and destructive fishing associated with the trade in wild-caught live reef organisms (Barber and Pratt 1997; Weber 1998; Johannes and Riepen 1995; USCRTF 2000; Graham 2001). For example, the argument has been raised that if live reef fish and ornamental fish could be cultured, it would decrease the demand for species captured in the wild. Additionally, if technologically and economically viable, aquaculture could provide an alternative or supplemental livelihood for fishers using destructive fishing practices; thus reducing or eliminating destructive fishing.

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If aquaculture is to be taken seriously as a solution for reducing the pressures on coral reefs arising from over- and destructive fishing in the trade in wild-caught live reef organisms, there is a need to comprehensively and objectively assess the biology, technology, economics and socio-cultural feasibility of aquaculture. This involves critically evaluating the production and marketing of live reef fish for food and aquariums and selected invertebrates in coral reef environments prior to the broad scale prescription of this intervention.

To address this issue, a team of researchers undertook a research study called "Farming the Reef". The purpose of the project was to provide information and policy recommendations for the application of aquaculture for live reef organisms in developing country tropical nearshore waters as a priority solution for reducing the pressures on coral reefs arising from over- and destructive fishing associated with the trade in wild-caught live reef organisms (Pomeroy et al. 2003). The project focused on the biology, economics and markets for several live reef organisms including live reef food fish (grouper: *Epinephelus* and *Cromileptes*), ornamental fish (clownfish: *Amphiprion ocellaris*), and marine invertebrates (live rock and live coral: *Scleractinia* and *Alcyonacea*).

Study focus

The focus of this paper is on one output of the Farming the Reef project, that is, a financial feasibility analysis for small-scale grouper culture in Indonesia. This paper will focus on *Cromileptes altivelis* (mouse grouper, barramundi cod, polka dot or high-finned grouper).

The paper will provide information to determine if the aquaculture of *Cromileptes altivelis* has economic potential as an alternative or supplemental livelihood for fishers and their families in rural fishing communities in Indonesia. Many aquaculture enterprises have large investment costs or operating costs or may take several years to produce a profit. The economic analysis provides basic operational and financial information for making investment decisions concerning grouper aquaculture enterprises.

The study focus is on a small-scale culture technology/system that would be suitable for rural fishing communities in Indonesia. This was the project's target audience as fishers from these communities are the individuals primarily engaged in the live food fish trade and those who would undertake aquaculture as an alternative to overfishing and destructive fishing. While this study has a geographic focus on Indonesia, it is felt that the conclusions may be applicable to other countries in the Indo-Pacific region.

Status of grouper aquaculture in Indonesia

Grouper culture is expanding in many areas of Indonesia. While there is no statistical data available on grouper culture in Indonesia, national aquaculture statistics show brackish water and cage culture growing at 8 and 16 percent, respectively, during the 1990's. The primary areas for grouper grow-out culture in Indonesia are Aceh, North Sumatra (Nias and Sibilga), Riau islands, Bangka islands, Lampung, West Java, karimunjawa islands (Central Java), Teluk Saleh (West Nusa Tenggara), South Sulawesi, North Sulawesi, and Southeast Sulawesi. Grouper culture is generally characterized in Indonesia by the use of wild-caught seed and use of trash fish for feed. There is limited use of hatchery-reared seed, although this is growing. Grouper are primarily grown-out in net cages. There is some limited pond grow-out culture, particularly for small size classes, but a general shortage of land for ponds has been identified (Sadovy 2000).

There has been a good deal of research on hatchery production of grouper. This has been stimulated by the development of a large number of milkfish hatcheries near the Gondol station and by increased interest from these private hatcheries in Bali and throughout Indonesia to produce grouper seed on a commercial basis. At the Gondol Research Institute for Mariculture on the north coast of Bali, there has been success in the mass seed production of *Cromileptes altivelis*. Broodstock have been able to spawn naturally all year round, although the survival rates of larvae are low at the early stage. There is slow growth rate and disease problems at the grow-out stage. Some private hatcheries have succeeded in seed production applying technologies learned from the Gondol station. In addition, humpback grouper seed has been provided from the station to many aquaculture operations in Bali and elsewhere in Indonesia and Southeast Asia for grow-out. The Gondol station has also succeeded in full-cycle culture of *E. fuscoguttatus*. The spawning period for this species in the hatchery has been found to be very short, only 3-4 days a month, and not all year round. Survival rates are low due to high levels of cannabalism, although survival rate and growth rate in cages is high. Many of the hatcheries in Bali culture several species of fish in addition to grouper such as sea bass, milkfish and humphead wrasse (*Chelinus undulatus*).

Research on a variety of species have also been undertaken at the Regional Brackish-water Aquaculture Development Center in Situbondo in eastern Java.

At the Marine Finfish Production and Research Center (MAFPREC) in Besut, Terengganu, natural spawning of *E. fuscoguttas* was achieved in 1995 in a 150 ton tank. Research at MAFPREC continues to improve spawning and larval culture. Other research work has been carried out at Research Institute for Coastal Fisheries in Sulawesi and the Mariculture Development Center at Lampung.

The Nature Conservancy has developed a full-cycle mariculture operation in the area of the Komodo National Park in western Flores. The project was originally started as an alternative enterprise for local fishers who were utilizing destructive fishing practices. Fingerlings were obtained from the wild, but after a trail period it was decided to enter into full-cycle grouper culture. A number of species are being used as broodstock, including *E. coioides, E. fuscoguttas, Cromileptes altivelis,* and *Lates calcarifer*. The first spawning of *Cromileptes altivelis* and *E. fuscoguttas* occurred at the project in late 2000 (Mous 1999).

There are currently some problems with expansion of grouper culture in Indonesia. The number of grow-out operations has not expanded at the same rate as hatcheries. This has resulted in an cycle of oversupply of grouper seed at times, leading to a sharp decline in seed prices, which has caused hatcheries to stop producing seed. Thus, there is a need for improved market information for hatcheries on seed demand and on wholesale and retail prices and markets for grow-out operations. There is also a need for extension assistance to potential and existing small culturists, as many lack the technical skills to grow grouper. In some areas, water quality is emerging as a serious problem (Dr. Ketut Sugama, pers. Comm. 2001). It is important to note that the Indonesian government has given aquaculture development a high priority for support.

Methods

A mix of primary and secondary data was used for this analysis. A substantial amount of biological and technological research and industry development has been completed and is ongoing on grouper (Ruangpanit 1993; Rimmer et al. 1998; Rimmer 1999, 2000; Duray et al. 1995; Ali et al. 1994, Tucker 1998). Much less economic information was found to be available (Cesar and Hempel 2000). This project was not meant to undertake new biological or technological research, but rather to make use of the best available data and information to undertake a financial analysis for aquaculture of each selected species. As such, the analysis relied on secondary information and interviews with scientists and industry specialists currently working on grouper culture in the Indo-Pacific region. Contact and visits were made with scientists and industry in Japan, Taiwan, Thailand, Philippines, Indonesia and Malaysia. The analysis will focus on culture techniques felt by the experts to be the most technologically feasible for transfer to Indonesia and other developing countries.

Primary data was made available from research at the Gondol Research Institute for Mariculture in Bali. Interviews were conducted with three hatchery/nursery operations and two grow-out operations located on the north coast of Bali to obtain additional primary data. The operation size used in the analysis is based on recommendations from staff at the Gondol station and on the current scale of operations in Bali and Eastern Java.

This analysis focused on full cycle aquaculture, that is, the use of hatchery-reared fingerlings. The culture scenario analyzed was for an individual broodstock, hatchery/nursery, and grow-out. Only cage culture grow out techniques were analyzed.

The financial analysis includes initial capital investment requirements, capital asset addition schedule, fixed costs, annual operating costs, enterprise budget and a cash flow statement (five year).

Technological overview of culture production: Broodstock management and spawning

Initial broodstock can be caught from the wild using fish traps or young fish can be captured and grown to broodstock size. To grow to brood stock size can take three years, or longer, depending upon the species (particularly waiting for males) (Ruangpanit 1993; Ali et al 1994; Nelson 1996; Quinito 1999; Rimmer et al 1998; Seng 2001). New broodstock are introduced at 10 to 20 percent of total spawners per year to maintain genetic diversity and desired sex ratio.

Broodstock are maintained in tanks, ponds or cages. Round, cement broodstock tanks are most common and are used not only for maintaining the fish but also for spawning. Stocking density is 1 to 5 kg of fish per cubic meter. A daily exchange rate of more than 200 percent (and up to 400 percent) of water volume in each tank is maintained. Tanks may have a built in egg collection tank with a net (0.3-0.4mm mesh). Tanks may be roofed with non-transparent or transparent materials, to keep down the growth of seagrass and algae.

The conditioning of broodstock for spawning is done by providing plentiful and high quality feed, favorable environmental conditions, and adjusting the stocking density and sex ratios. Chopped trash fish, including sardines, are used as the basic feed. Fish are fed at 3 to 5 percent of their body weight. At the Gondol station, one week before spawning the grouper are fed a trash fish diet mixed with squid to enhance the quality of their eggs (Sugama et al. 2001). Fish may be fed 4-5 times per week.

At the Gondol station, 40-60 *Cromileptes altivelis* broodstock are kept in a 100 cubic meter tank with a sex ratio of one male to two female.

Spawning patterns follow a lunar rhythm. Natural spawning occurs in most months of the year, however, there may be less natural spawning activity in the period of May to August. The spawning duration for *Cromileptes altivelis* is 4-8 days (Sugama et al. 2001). Natural spawning may be stimulated by the manipulation of temperature, water flow or complete water change in the tank. Spawning may also be induced using hormones. Fertilization rates above 70 percent are widely reported. Average production of eggs is approximately 500,000-2,000,000 per female.

Hatchery and larval culture

Collected eggs are transferred into a transparent polycarbonate tank and separated into three groups – floating eggs, suspended eggs and sunken eggs. Floating eggs are transferred to another tank and treated with an iodine bath for the prevention of diseases. The eggs are transferred to an incubation tank and dead or unfertilized eggs are removed (Toledo nd.; Duray et al. 1995; Rimmer 1999, 2000).

Survival rate of groupers to metamorphosis is generally low and variable, usually < 10 percent and averaging around 3 to 5 percent. Hatching rates average between 40-85 percent, but usually above 50 percent. The larval-rearing period, from metamorphosis to 25 to 30 mm juvenile stage, lasts for approximately 45-50 days (Sugama et al. 2001). Success or failure of larval rearing depends on the control of Viral Nervous Necrosis (VNN) and cannabalism.

Larvae are generally reared in tanks of approximately 5 to 30 cubic meters in volume, with a depth of 1.2m. Larval rearing tanks should be roofed and covered with transparent plastic sheet to control water temperature. Stocking density depends upon egg quality and species, but range from 10 to 30 fry per liter to as high as 50 to 100 fry per liter. Water quality is maintained by daily water exchange (about 10 to 50 percent) and cleaning of tank bottom.

Grouper larval-rearing tanks are supplied with microalgae (generally *Nannochloropsis oculata*) at a density of around 100,000-500,000 cells per ml. This is known as a "green water" system. The microalgae can serve as a food for live prey organisms added to the tank (rotifers), it may be ingested by the larvae, and it provides a shading effect for homogeneous light intensity and water turbidity. Generally 10 to 30 ton tanks are used for the mass culture of green water. The starter preparation for green water of either *Chlorella* sp. or *Tetraselmis* sp. is produced in a laboratory under controlled conditions. Green water should be supplied to the tank for several hours in each day, especially when water exchange rates are increased.

Three kinds of feed are used for larval rearing: rotifers (two strains, namely SS-type rotifer and S-type rotifer), artificial diets, and *Artemia* (Rimmer 2000).

Nursery

After 45 to 50 days of larvae rearing, the grouper, which are approximately 25 to 30 mm in size, are transferred to nursery culture tanks. Nursery culture is conducted to grow the grouper to a size of 50 mm before transfer to nursery net cages and to grade them for size in order to reduce cannabalism. The nursery stage is about 21 to 25 days.

The nursery stage can be carried out in cement tanks, netcages, hapas (nylon netting enclosures), or earthen ponds. Five to 10 ton cement tanks are normally utilized. The tanks are covered by a shed.

The juveniles are stocked at 300 to 600 per cubic meter. The major causes of mortality during the nursery stage are VNN and cannibalism. If VNN does not break out, an 80 to 100 percent survival rate can be expected in nursery culture.

The juveniles are fed minced trash fish or shrimp-meat diet. The fish are fed to satiation two to six times a day at approximately 10 percent of their body weight. Artificial diets have been formulated and are being used in some places for nursery culture. A high water exchange rate of 300 to 500 percent a day is used at high stocking rates.

Grow-out

Grouper may be grown-out in cages or ponds. The focus of this analysis is on grouper grow-out in floating net cages. Floating net cages should be sited in calm, sheltered waters with good water flow (Baliao et al. 2000).

Two types of floating net cages are used for grow-out. Nursery net cages are used when fry are 5 to 10 cm in size. Production net cages are used when stock size is 10 to 15 cm in size and larger. A floating net cage module usually has 4 to 12 compartments supported by a galvanized iron, bamboo or wood frame. One compartment has dimensions of 5m x 5m x 3m or 75 cubic meters. Plastic drums or containers are used as floats for the cage module. Nursery net cages use “B” net of 0.5 to 1 cm knotless mesh. Production net cages use 2 to 5cm mesh netting. Hides and shelters of sawed off bamboo or PVC pipe are sunken and placed inside the net cage. These shelters have been shown to allow for increased stocking density and overall production (Teng and Chua 1979).

The juveniles are usually stocked at 10 to 20 (but can be stocked at up to 50 to 100) fish per cubic meter. Sorting is done every two or three days during the nursery stage to separate larger fish and reduce cannibalism. The fish are minimum size graded as they grow during the production stage. Cage-reared grouper harbor more species of parasites with a higher prevalence and intensity of infection than pond-cultured groupers (Marte 1999). Cage maintenance is necessary to control biofouling and to maintain good water flow (Baliao et al. 2000).

Trash fish are the preferred feed for grow-out in Indonesia. Chopped trash fish are fed two times a day at 7-8 percent of body weight and gradually reduced as fish grow to one to two times per day at a rate of 3-5 percent of the total body weight. Feed conversion ratios (FCR) ranges from 5:1 to 7:1 for trash fish and 2:1 to 2.5:1 for pellet feed. Dry formulated feed has limited availability and is generally not well accepted by farmers in Indonesia. In some areas, there is a seasonal scarcity of trash fish. It takes approximately 16 months to reach a marketable size of 600 grams in Indonesia. Survival rates of above 80 percent can be achieved unless there is a disease problem. The whole culture period for *Cromileptes altivelis* from egg to market size grouper of 600 g takes about 18 months (Sugama et al. 2001).

Marketable size grouper are placed inside plastic bags with water and oxygen. The plastic bags are placed inside styrofoam boxes with ice on the top to maintain coolness for water during transport (Baliao 2000).

Results

Baseline assumptions for the financial analysis

The financial analysis is conducted using a specific set of descriptive, operational and financial baseline assumptions (Sugama et al. 2001). More specific technical assumptions are presented for each individual stage in production.

- All loans (i.e. capital and operating) are at 18 percent per year.
- Initial start-up capital expenses assumes that 50 percent of cost is financed (i.e. 50 percent is owner financed).
- Initial start-up operating expenses assumes that 50 percent of cost is financed (i.e. 50 percent is owner financed). An operating loan covers all cash shortfall.

- Each system is managed by owner-operator, whose cost of management skills is not included. Therefore, final returns are to owner-operator's management and risk. Additional labor requirements for each system are presented in the analysis.
- Returns are before taxes.
- General overhead of 3 percent of total variable costs is included. These are "catch-all" costs including telephone, fax, e-mail, and contingencies.
- Repair and maintenance costs are 3 percent of total capital investment costs.
- Miscellaneous costs are 3 percent of variable costs. These include general expenses for operating the system but which were unexpected during the production period.
- Land is purchased (1000m^2 broodstock; 1000m^2 medium scale hatchery/nursery; 150m^2 small scale hatchery/nursery).The land charge of US$276.20 per hectare represents an opportunity cost.
- Insurance is not included. The purchase of insurance, except for vehicles, is not common practice in Indonesia.
- Harvest volumes, revenues and operational expenses are assumed to be constant across the years (costs and prices are for 2001).
- Capital assets are depreciated using the straight-line method. Salvage value is zero for all capital assets.
- The cost of land is assumed to be the same in all locations.
- Construction will take six months. Production will begin in month seven.
- One US dollar equals 11,000 Indonesian rupiah.

Broodstock: Technical assumptions

This is a stand-alone analysis for egg production only. The analysis is based on Sugama et al. (2001) and Kawahara and Ishiyama (2000).

The breeders are stocked at a ratio of one male to two female fish. Male fish weigh 6 kg and female fish weigh 3 kg. Total stocking density in the 100 ton breeding tank is 36 fish with 12 males and 24 females with a total body weight of 144 kg. Fish are purchased at $55 per fish. In order to maintain genetic diversity of the stock, 20 percent of the breeder stock is added each year. For this analysis, starting in year 3, seven new fish from the original breeder stock are replaced with 2 new male breeders and 5 new female breeders. Seven fish are replaced in each subsequent year. It is assumed that there are 12 runs or production periods per year or one per month.

Cromileptes altivelis spawn all year. Spawning duration is 4 to 8 days per month. Spawning frequency for each female is two times a month. The average fecundity per female per month is 2,000,000 eggs. The selling price for the eggs is 3 Rupiah or $0.0003 per egg.

The egg collection rate is 90 percent. The egg fertilization rate is 90 percent. Viable egg production is 65 percent. The average viable egg production per female breeder per month is 1,053,000. The total viable egg production per month for 24 female breeders is 25,272,000.

The feeding regime for the broodstock utilizes mixed trash fish with sardines for feed. Trash fish are enriched with a commercial food supplement containing vitamins and fatty acids. Squid or cuttlefish are added to the diet before spawning to improve the quality of the eggs. The fish are fed an average of four percent of body weight on alternate days or 15 days per month. The trash fish is purchased for $1.00 per kilogram. Water in the tank is exchanged at the rate of 300 percent per day.

Hatchery/nursery: Technical assumptions

The production or culture period from the hatched larva stage to the juvenile stage (5 cm) is 65 days.

There are five culture periods per year.

The total production per culture period is 25,920 juvenile grouper. To meet this production target will require 3,200,000 viable eggs. The hatching rate is assumed to be 45 percent, producing 1,440,000 larvae. It is assumed that 90 percent of the larvae are normal, producing 1,296,000. The survival rate of larvae to juvenile is two percent over the culture period.

During the larval stage, the feeding regime utilizes rotifer (SS-type and S-type) for days 1 to 29. An artificial diet is used for days 17 to 43. Artemia is used for days 20 to 44. During the nursery stage, days 45 to 65, the fish are fed a pelleted feed as suggested by Sugama et al. (2001).

Water is exchanged daily at 50 percent of the total tank volume during hatchery stage and at 400 percent during the nursery stage.

A 5 cm fry sells for $0.82.

A financial analysis is conducted for the hatchery/nursery at two scales of production. The medium scale has a total production per culture period of 25,920 juvenile grouper. The small scale has a total production per culture period of 3,050 juvenile grouper.

A second financial analysis of hatchery/nursery operation was conducted for a smaller scale operation. This operation only has two, 10 ton larval rearing/nursery tanks producing 3050 juvenile grouper.

Grow-out: Technical assumptions

This analysis assumes that the grow-out system in floating net cages is stand-alone, i.e., hatchery and nursery systems are not in the operation. Therefore, fingerlings are purchased for stocking. The grow-out system has two net cage modules. A nursery net cage module of four units to raise fingerlings from 6 to 12 cm in size. A production net cage module of six units to raise fingerlings from 12 cm in size to a marketable size of 600 grams. Each net cage unit is 5m x 5m x 3m in size or 75 cubic meters.

- The stocking rate is 15 fish per cubic meter or 1125 fish per net cage unit.
- The size of the initial stock is 4-5 cm at $0.82 per piece.
- Each 5 cm fingerling weights approximately 7 grams.
- The total number of fish stocked in the production module (6 net cages) is 6750 fish.
- The culture period is eighteen (18) months from 5 gram fingerling to 600 gram market size fish.
- The survival rate is 50 percent.
- The average body weight at harvest is 600 grams.
- The number of fish harvested is 3375 with a total harvest weight of 2025 kg.
- The feed conversion rate is 5:1.
- Trash fish is used for feed at a cost of $0.15 per kg.
- The selling price is $6.00 per piece at the farm.

Table 1. Capital investment for broodstock, Indonesia

	Year				
	1	2	3	4	5
Total initial investment in US$	15366	-	1720	870	1570

Note. Equipment includes breeders (12 male/24 female), land (1000 m^2) , site clearing, perimeter fencing, 1-100 ton breeder tank, 1-1 ton holding tank, roof and frame, plumbing, electrical, air blower-1000w, 2-seawater pump-5hp, freshwater pump-2.5hp, pump house, staff house, 5000w generator, and miscellaneous equipment (scoop net, brush, pail, scraper, siphon hose, water quality test kit, cathater pipe).

Table 2. Fixed costs for broodstock, Indonesia

New Cost	Average Investment	Annual Depreciation
10516	5258	1716

In US$
Interest on investment: 5258 x .18 = 946.00
Fixed cost: 1716 + 946 = 2662.00
Fixed cost per run (12 runs): 222.00

Table 3. Enterprise budget for broodstock, Indonesia

Item	Unit	Price or cost/unit	Quantity	Total
Gross receipts:				
Sale of eggs	Egg	0.0003	25,272,000	6982
Variable costs:				
Feed	Kg	1.00	200	200
Vitamins	Kg	6.00	12	24
Electricity	Kwh	1500	0.09	135
Labor:				
Technician	1 month	80	1	80
Aide	1 month	36	2	72
Fuel/oil	-	20	1	20
Marketing	-	40	1	40
Supplies/medication	-	50	1	50
Repair/Maintenance	-	39	1	39
Misc. expenses	-	20	1	20
Total variable costs				680
Income above variable costs				6212
Fixed costs				222
Total of above costs				902
Net returns to land, management, risk and overhead				6080
General overhead				20
Land charge	hectare	267.20	.10	27
Total costs				949
Net returns to management and risk				6033

In US$
Variable costs for one year or 12 runs: 8160.00
Gross receipts for one year or 12 runs: 82,704.00
Total cost per one million eggs: 35.00

Table 4. Cash flow (five year) for broodstock, Indonesia

	Year				
	1	2	3	4	5
Beginning bank balance	19446	35522	110066	182890	256564
Cash receipts/Income	41352	82704	82704	82704	82704
Cash outflows/Costs: Operating expenses	4080	8160	8160	8160	8160
Net cash income	37272	74544	74544	74544	74544
Capital equipment purchase	15366	-	1720	870	1570
Long term/Capital loan payment	9066	-	-	-	-
Operating loan	2040	-	-	-	-
Operating loan payment	2407	-	-	-	-
Ending cash balance	35522	110066	182890	256564	329538

In US$

Table 5. Capital investment (medium scale) for hatchery/nursery, Indonesia

	Year				
	1	2	3	4	5
Total initial investment in US$	38795	-	2300	835	2300

Note: Equipment includes land (1000 m2), site clearing, perimeter fencing, 17-10 ton larval rearing/nursery tank with sand filter, 6-10 ton rotifer/phytoplankton tank, 6-1 ton rotifer enrichment tank, 4-200 liter artemia tank, harvesting canal and drain pit, 30 ton water reservoir, roof and frame, 17 tank cover frame, black plastic siding, harvest/work area constructed of cement, pump and power building, technician quarters/office/lab, plumbing, electrical, air blower (2000 watt), 4-seawater pump (5 hp), 2-freshwater pump (5 hp), 5 KVA generator, truck, egg incubation system, and miscellaneous equipment (nets, bucket, brushes, siphon hose, filter pack).

Table 6. Fixed costs (medium scale) for hatchery/nursery, Indonesia

New cost	Average investment	Annual depreciation
33995	16998	5175

In US$
Interest on investment: 16998 x .18 = 3060
Fixed cost: 3060 + 5175 = 8235
Fixed cost per culture period: 1647

Table 7. Enterprise budget (1 culture period) (medium scale) for hatchery/nursery, Indonesia

Item	Units	Price or cost per unit	Quantity	Total
Gross receipts	-	0.82	25,920	21254
Variable costs:				
Eggs	Egg	0.0003	3,200,000	873
Artificial Feed	Kg	50	8.00	400
Rotifer	-	40	-	40
Artemia	Kg	120	5	600
Pelleted feed	Kg	6.82	17	116
Chemicals and medication	-	300	1	300
Electricity	Kwh	0.09	3000	270
Labor:				
Technician	2.2 months	100	1	176
Aide	2.2 months	60	2	238
Fuel/oil	-	100	1	100
Supplies	-	75	1	75
Repair/Maintenance	-	1164	1	1164
Marketing/Harvest	-	400	1	400
Misc. expenses	-	143	1	143
Total variable costs				4895
Income over variable costs				16359
Fixed costs				1647
Total of above costs				6542
Net returns to land, management, risk and overhead				14712
General overhead				147
Land charge	hectare	267.20	.10	27
Total costs				6716
Net returns to land, management and risk				14538

In US$
Gross receipts per year: $106,270
Total variable costs per year: $24,475
Net returns to land, management and risk per year: $72,825
Total cost per piece: $0.26

Table 8. Cash flow (annual) (medium scale) for hatchery/nursery, Indonesia

	Year				
	1	2	3	4	5
Beginning bank balance	48585	28345	110140	189635	270595
Cash receipts/ income	42508	106270	106270	106270	106270
Cash outflows/Costs: operating expenses	9790	24475	24475	24475	24475
Net cash income	32718	81795	81795	81795	81795
Capital equipment purchase	38795	-	2300	835	2300
Long term/ capital loan payment	22890	-	-	-	-
Operating loan	4895	-	-	-	-
Operating loan payment	5776	-	-	-	-
Ending cash balance	28345	110140	189635	270595	350090

In US$

Table 9. Capital investment (small scale) for hatchery/nursery, Indonesia

	Year				
	1	2	3	4	5
Total initial investment	3258	-	350	145	350

In US$

Note: Equipment includes land (150 m2), site clearing, perimeter fencing, 2-10 ton larval rearing/nursery tank with sand filter, 1-10 ton rotifer/phytoplankton tank, 1-1 ton rotifer enrichment tank, 200 liter artemia tank, harvesting canal and drain pit, 30 ton water reservoir, roof and frame, tank cover frame, black plastic siding, harvest/work area constructed of cement, pump and power building, technician quarters/office/lab, plumbing, electrical, air blower (2000 watt), seawater pump (5 hp), freshwater pump (5 hp), 5 KVA generator, truck, egg incubation system, and miscellaneous equipment (nets, bucket, brushes, siphon hose, filter pack).

Table 10. Fixed costs (small scale) for hatchery/nursery, Indonesia

New cost	Average investment	Annual depreciation
2530	1265	440

In US$

Interest on investment: 1265 x .18 = $228

Fixed cost: 228 + 440 = $668

Fixed cost per culture period: $134

Table 11. Enterprise budget (1 culture period) (small scale) for hatchery/nursery, Indonesia

Item	Units	Price or cost per unit	Quantity	Total
Gross receipts	-	0.82	3050	2501
Variable costs:				
Eggs	Egg	0.0003	384,000	115
Artificial Feed	Kg	50	1.00	50
Rotifer	-	10	-	10
Artemia	Kg	120	.6	72
Pelleted feed	Kg	6.82	2	14
Chemicals and medication	-	300	.2	40
Electricity	Kwh	0.09	360	32
Labor:				
Technician	2.2 months	100	1	176
Supplies	-	75	.12	10
Repair/Maintenance	-	98	1	98
Marketing/Harvest	-	50	1	50
Misc. expenses	-	20	1	20
Total variable costs				687
Income over variable costs				1814
Fixed costs				134
Total of above costs				821
Net returns to land, management, risk and overhead				1680
General overhead				20
Land charge	hectare	267.20	.015	4
Total costs				711
Net returns to land, management and risk				1790

In US$

Gross receipts per year: $12505

Total variable costs per year: $3535

Net returns to land, management and risk per year: $8970

Total cost per piece: $0.23

Table 12. Cash flow (annual) (small scale) for hatchery/nursery, Indonesia

	Year				
	1	2	3	4	5
Beginning bank balance	4672	832	9802	18422	27247
Cash receipts/ income	5002	12505	12505	12505	12505
Cash outflows/Costs: operating expenses	1414	3535	3535	3535	3535
Net cash income	3588	8970	8970	8970	8970
Capital equipment purchase	3258	-	350	145	350
Long term/ capital loan payment	1922	-	-	-	-
Operating loan	707	-	-	-	-
Operating loan payment	834	-	-	-	-
Ending cash balance	832	9802	18422	27247	35867

In US$

Table 13. Capital investment for grow-out, Indonesia

	Year				
	1	2	3	4	5
Total Investment	5010	-	-	4950	-

In US$

Note: Equipment includes nursery 1-floating net cage module, 1-production floating net cage module, outrigger boat, net maintenance equipment (brush, bucket, scoop net, netting needle, line), harvest equipment (scale, measuring rule, bucket, basket, harvest net), water quality test equipment (pH meter, dissolved oxygen kit, thermometer, salinity test kit), and 200-transport boxes (91cm x 61cm x 61cm, reusable, styrofoam in wood frame and hold 10-12 fish).

Cost of 200 transport boxes: $4000

Table 14. Fixed costs for grow-out, Indonesia

New Cost	Average Investment	Annual Depreciation
5010	2505	1657

In US$

Interest on investment: 2505 x .18 = 451

Fixed cost = 1657 + 451 = 2108

Table 15. Enterprise budget for grow-out, Indonesia

Item	Units	Price/cost per unit	Quantity	Total Cost
Gross receipts	Piece	6.00	3375	20250
Variable costs:				
Fingerlings	Piece	0.82	6750	5535
Feed	Kg	0.15	10125	1519
Medication	-	100	1	100
Supplies	-	40	1	40
Repair/Maintenance	-	125	1	125
Caretaker wages	Man/month	40	18	720
Harvest labor	Man/day	3	10	30
Transportation	-	50	1	50
Miscellaneous: Supplies	-	244	1	244
Total VC				8363
Income above VC				11887
Fixed costs				2108
Total of above costs				10471
Net returns				9779
General overhead				251
Total costs				10722
Net returns to management and risk				9528

In US$

Medication for parasites, bacterial and/or viral disease.

Harvest labor includes two persons for five days each during harvest period.

Transportation includes hiring of a vehicle for two days.

Total product weight: 2025 kg

Total cost per piece: $3.18

Total cost per kg: $5.29

Total variable cost per piece: $2.48

Total variable cost per kg: $4.13

Table 16. Cash flow (annual) for grow-out, Indonesia

	Year				
	1	2	3	4	5
Beginning bank balance	10530	(6468)	7098	21828	11358
Cash receipts/ income	-	20250	20250	-	20250
Cash outflows/Costs: operating expenses	5520	5520	5520	5520	5520
Net cash income	(5520)	14730	14730	(5520)	14730
Capital equipment purchase	5010	-	-	4950	-
Long term/ capital loan payment	2956	-	-	-	-
Operating loan	2760	6468	-	-	-
Operating loan payment	3259	7632	-	-	-
Ending cash balance	(6468)	7098	21828	11358	26088

In US$

Discussion

The financial feasibility analysis for the culture of *Cromileptes altivelis* in Indonesia provided financial information on individual broodstock, hatchery/nursery, and grow-out stages. The findings of the analysis indicate that, based on the assumptions, all three scenarios are financially feasible. However, the capital requirements for the broodstock and medium size hatchery/nursery scenarios may be beyond the financial means of many small producers (Tables 1 and 5). The broodstock scenario has capital investment costs of $15,366 and a medium size hatchery/nursery scenario of $38,795 (Tables 1 and 5). The small size hatchery/nursery scenario has approximately one-tenth the capital investment cost ($3,258) (Table 9) of a medium size scenario. The capital investment cost for grow-out ($1,010) (not including purchase of transport boxes) is within the financial means of many small producers (Table 13). The high cost of transport boxes (200 boxes at US$4000.00) is a potential problem for the small producer, but could be shared with the fish buyer or the fish buyer could provide the boxes.

The total cost per fry from the hatchery/nursery (medium size: $0.26 and small scale: $0.23) was less than the average selling price in Indonesia (Tables 7 and 11). A 5cm fry in Indonesia sells for $0.82. The total cost per market size fish from grow-out ($3.18) was also less than the average selling price ($6.00) in Indonesia for a 600 gram market size fish (Table 15).

The five-year cash flow for both size hatchery/nursery operations was positive (Tables 8 and 12). The five-year cash flow for grouper grow-out in Indonesia indicates a negative cash flow in year one but a positive cash in subsequent year (Table 16). If loans or other incentives will be made available for the small producer, the cash flow indicates that these loans can be repaid in the first or second year of production. The cash flow analysis should encourage small producers and lenders to consider investment in grouper grow-out systems.

When a sensitivity analysis is conducted for changes in price (+ or – 20%), yield (+ or – 20%), and variable costs (+ or – 20%), all stages of production remain financially feasible.

Policy recommendations

Several potential problems will need to be overcome with grouper aquaculture in Indonesia. The future of the industry will depend on having a regular supply of hatchery raised seed and fry. The collection of seed and fingerlings from the wild is not sustainable in the long-term and the export of wild-caught grouper seed needs to be regulated or prohibited. Markets for seed and fry show periodic over- supply problems and resulting decline in price as the industry has not fully developed to utilize all the available *Cromileptes altivelis* seed and fry which can be produced.

There is a need to shift from using trash fish as feed to the development and availability of cost-effective formulated feed. The use of trash fish is unsustainable if the industry is to continue to expand (Sadovy and Lau 2002). A number of diseases at various stages of production are affecting the grouper industry. Vaccines will need to be developed, as well as improved health management methods.

Grouper aquaculture in coastal areas will need more regulation to address real and potential problems of pollution from nutrient and organic matter and the use of medications and chemicals. In Indonesia, as in other countries in Southeast Asia there is a lack of regulations and enforcement to site and manage coastal aquaculture, both pond and cage culture.

Certification and production standards need to be put in place for cultured fish.

Cultured grouper can be certified for quality and good culture practices. Grouper grown from hatchery reared seed, as compared to wild-caught seed and fingerlings, can be certified.

Supporting infrastructure for grouper culture needs to be made available including credit, productive inputs (feed, chemicals), extension services, and markets. The supply of the necessary inputs (seed, feed) are often overlooked but are essential components of grouper culture development. The research being undertaken and transferred to aquaculturists in northern Bali by the Gondol Research Institute for Mariculture is a good example of technical assistance to develop the industry.

Economic recommendations

The broodstock (initial capital investment $15,366.00) and medium scale hatchery/nursery (initial capital investment $38,765.00) scenarios may be beyond the financial means of many small producers. The small scale hatchery/nursery scenario has a much lower initial capital investment ($3,258.00) and may be within the means of some small producers. It may be more feasible, however, if the broodstock and hatchery/nursery operations are developed as a larger project by private investors or government. One such model is to have a central hatchery/nursery which can supply fry to small producers who do grow-out in the area. This central facility (whether governmental or private), can supply technical assistance to the small producers. There is a need to develop advanced nursery phase for grouper fingerlings as the current industry in Bali had not taken up this sector of the industry (Siar et al. 2002).

The initial capital investment for grow-out ($5,010.00 with transport boxes; $1,010.00 without transport boxes), especially if transport boxes are not included and can be supplied by the buyer, is within the means of many small producers.

In addition, government support and intervention may be necessary to improve the marketing system, for example, the establishment of a cooperative to organize small producers, render technical assistance, and provide credit and inputs. Regional markets for grouper need to be more fully developed to stimulate growth in the industry.

A drawback of backyard multispecies hatcheries was found to be the demand for grouper fingerlings, which was not recurrent. A key factor for expansion of the industry is the development of a larger grow-out sector.

Management recommendations

To achieve the results presented in this analysis, producers will need to maintain high levels of management, have access to markets, and prices will need to be stable. A critical mass of small producers should exist so that they can exchange information and learn from each other. Success as a producer will require the producer to balance financial and marketing management skills with production ability.

Conclusion

Although there are still some technical and marketing problems in the culture of *Cromileptes altivelis* in Indonesia, such as high mortality rate of grouper during early life stages and availability of seed, the development of grouper culture looks promising. Grouper culture is an option which can be used to manage and protect grouper populations in the wild, and at the same time provide a livelihood source to live grouper fishers. This will reduce the market's dependence upon wild stocks. Economic incentives will need to be put into place for the industry to grow. There are also concerns about environmental problems due to pollutants and the use of wild caught fish for feed.

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