

Regional Review on Livelihood Opportunities Related to Mariculture Development
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1 Introduction

The United Nations Millennium Development Goals called for a reduction in the proportion of people living on less than US\$ 1 per day (economic or income poverty) to half the 1990 levels by the year 2015. Global poverty is considered one of the major causes of food insecurity, and poverty eradication is seen as essential in improving access to food (Tacon, 2001). It is expected that global poverty rates will fall to 13%, meaning that the goals will be met and there will be 360 million less people living in abject poverty. However, progress in eradicating hunger has been slower with the situation actually worsening in regions such as South Asia.

This report from the Network of Aquaculture Centres in Asia-Pacific (NACA) Support to Regional Aquatic Resources Management Initiative (STREAM) draws on secondary literature, media reports and country reviews from STREAM Communications Hub Managers in India, Indonesia, Myanmar, Pakistan and the Philippines. It examines the role mariculture could play in reducing poverty and providing alternative livelihood opportunities for people living in coastal areas. This includes a review of the current status of coastal poverty, coastal livelihoods and vulnerabilities within the Asia-Pacific region and the experiences and examples of sustainable economic development through mariculture. This review then identifies key follow-up actions and recommends strategies for future pro-poor mariculture development.

1.1 Food security and the role of fisheries in Asia-Pacific

Fish and aquatic products contribute massively towards food security and currently supply around 7% of the global food supply (Haylor et al, 2003). As fish is generally more affordable to poorer members of society, a greater amount of this protein source is consumed on a per capita basis than any other type of animal protein (Tacon, 2001). As a result, fish and aquatic products are the primary source of animal protein for over one-sixth of the global population. In the Asia-Pacific region, fish makes up more than 50% of animal protein intake (Haylor, 2004) with China dominating consumption (36%); India and Southeast Asia account for another 17% (Delgado et al, 2003).

The demand for fish is also increasing, not only due to an increasing population but also to a greater awareness of the importance of fish in the diet (Delgado et al, 2003; IMM et al, 2005). There is a general consensus that traditional sources of fish such as global capture fisheries have peaked (FAO, 2002) and the future of wild-caught fishery production appears to be uncertain. Currently 47% of fish stocks are described as being fully exploited or close to their maximum sustainable limits (Delgado et al, 2003; FAO, 2002; IMM et al, 2005). Others are in a state of decline, or are completely exhausted. Recent studies based on trawl surveys in eight Asia-Pacific countries by the WorldFish Centre indicate that the situation may be far more serious than these figures suggest, and that substantial degradation and over-fishing have occurred. According to the surveys, coastal stocks have declined by as much as 40% in five years (Silvestre et al, 2003). Consequently it is believed that the amount of fish available for the region's fishers is now only a fraction of what was available before the industrialization of fishing (Sugiyama et al, 2004).

Coastal populations that were once almost entirely dependent on inland or coastal capture sources of fish have therefore seen their resources decline, and once cheap and plentiful wild fish has become less available and less affordable (Wilfredo et al, 2006). In some locations around coral reefs, fishers are turning to lucrative yet destructive practices such as the use of explosives (so-called blast fishing) and cyanide to stun and capture fish (Burke et al, 2001). There are also numerous reports of conflicts over diminished fishery resources and increased illegal fishing activities as fishers from one community, region or country encroach into the territories of their neighbors (Bulcock and Savage, 2005).

1.2 The international fisheries trade

Despite the apparent crises in global fisheries, the international trade in aquatic products has grown significantly over the last few decades, supported by improvements in technology, transport, communications and increased demand (FAO, 2003). Consequently, fisheries export values have increased from US\$ 15 billion in 1980 to US\$ 56 billion in 2001 (Macfadyen et al, 2003), and a large percentage of fisheries and aquaculture production now enters international marketing channels and chains, with more than 37% exported in 2000 in various forms. Once again, developing countries, predominately in Asia, play a major role in this trade (Macfadyen et al, 2005) and fisheries and aquaculture are therefore significant contributors towards national economies across the region, particularly Small Island Developing States (SIDS) (Table 1) (Sugiyama et al, 2004).

Table 1 Contribution of capture fisheries and aquaculture to Gross Domestic Product

Production value as % of GDP			
Capture fisheries		Aquaculture	
Kiribati	33.549	Lao PDR	5.775
Marshall Islands	28.378	Vietnam	3.497
Maldives	17.294	Bangladesh	2.688
Cambodia	10.030	Philippines	2.633
Solomon Islands	7.787	China PR	2.618
FSM	6.603	Thailand	2.071
Samoa	4.239	Indonesia	1.662
Vietnam	3.702	Cambodia	0.893
PNG	3.306	Kiribati	0.752
Vanuatu	3.294	India	0.540
Tonga	2.865	Sri Lanka	0.468
Indonesia	2.350	Malaysia	0.366
Philippines	2.184	Nepal	0.345
Fiji Islands	2.046	Taiwan POC	0.324
Thailand	2.044	New Zealand	0.189

(Sugiyama et al, 2004)

2 Coastal communities

2.1 Poverty status

It is estimated that about 1.9% of the world's population derive their livelihoods from fishing and fishing-related activities, in both inland and marine environments (FAO, 2004), with the vast majority found in Asia (Table 2) (FAO, 2002). The majority of these fishers are small-scale, artisanal, coastal operators and among the poorest in society, depending on open access to fisheries resources as a last resort (IFAD, 2002). Income generated by fisheries is generally lower than those from other sectors and within the sector itself small-scale fishers earn the lowest incomes (Silvestre et al, 2003). Within Asia, poverty in coastal areas is a defining characteristic of countries such as Bangladesh, India, Indonesia, Myanmar, Pakistan, Philippines and Vietnam (Table 3) (IFAD, 2002). The extent of poverty in coastal communities is difficult to measure (FAO, 2002) and while there have been many studies on poverty in farming and urban areas there have been few that have concentrated on the fisheries sector. Most studies that have been conducted focused on an assessment of income rather than more broad-based approaches to the livelihoods of fishers themselves (FAO, 2002). Reviewing literature on the subject Macfadyen and Corcoran (2002) found that there had been few studies and analyses on the extent, nature, causes and dynamics of poverty in fishing communities, and limited study on the extent to which the fisheries sector and its various associated activities (e.g., fish processing, marketing and distribution) contribute to poverty alleviation and food security.

Table 2 Poverty estimates in small-scale fisher communities in Asia

Category	Estimate for Asia
% of population on <US\$ 1 per day	25.6%
Inland fisheries	514,023
Marine coastal	95,837
Marine other	551,133
Unspecified	3,660,428
Total	4,821,421
Number of related income-poor jobs	14,464,262
Total number of income-poor (FAO 2002)	19,285,683

Table 3 Poverty status in country reviews

Country	Poverty status
India	The vast majority of India's poor people live in rural areas (Mohan et al, 2006). Rural poverty is estimated at 42.7%, with 43.3% of India's rural poor people belonging to Scheduled Tribes and Castes (Mukherjee, 2006).
Indonesia	Over 70% of fishers are poor. In some areas it may be over 80%. Poverty levels in coastal communities are generally considered to be around 80% of the population (Suspita, 2006). In total, there are 36 million poor people in Indonesia (Jaya, 2006).
Myanmar	Of the population of 54 million, 22.9% are described as income-poor (Maung Soe, 2006).
Pakistan	No poverty profile dealing with the specific aspects of poverty in coastal communities of Pakistan has been developed (Wattoo, 2006).
Philippines	Of the Philippines 88 million people, 22.78% are living below the annual poverty threshold of US\$ 220.64. The three regions with the highest percentage of income-poor families are found in Mindanao (Gonzales, 2006).
Vietnam	Income poverty has been reduced by 50% between 1991 and 2000. However, the poorest communities are still those reliant on coastal fisheries (Nguyen, 2006).

2.2 Livelihoods¹

The fisheries sector provides employment to a large workforce, though they represent only a small proportion of the region's population. Asia has a total of some 25 million fishers and fish farmers, which is more than double the number in the 1970s, and 80% of the world's total (IFAD, 2002). In South and Southeast Asia, 10.4 million people work as full-time or part-time fishers, with about 8.6 million employed in marine fisheries and the remaining 1.7 million employed in inland fisheries (IFAD, 2002). Coastal fisheries provide employment to two million people in Indonesia, 1.55 million in Bangladesh and 1.4 million in Vietnam (Silvestre et al, 2003). The types of livelihoods are complex and vary tremendously (IMM et al, 2005), from full-time small-scale operators to those involved in seasonal and migratory positions in the processing and marketing industries (Box 1). Where the diversity of systems and species remains high, such as in Cambodia, aquatic resources offer considerable opportunities to coastal people to "diversify their livelihoods" to suit changing needs (IMM et al, 2005). Aquatic resources provide an important social and economic safety net (IMM et al,

¹ A livelihood is defined as comprising the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain the natural resource base (DFID, 1999).

2005), particularly for poorer members of society. Estimated incomes (Table 4) vary considerably with coastal communities.

Box 1 Coastal livelihoods in Pakistan

The dominant livelihoods in coastal areas of Pakistan can be categorized as follows: fishing and related activities which employ an estimated 90% of the population; agriculture and forestry, in which 8% of the population is involved; and the services sector which employs 2% of the population. The fisheries sector employs the majority of the population of coastal villages (talukas) in a number of ways, as fishermen, boat owners, helpers (khalasis), boat captains (nakho), workers in ice factories, transporters and drivers of fish carrier vehicles (IUCN Pakistan, 2003; Wattoo, 2006).

Table 4 Estimated income levels in coastal communities of Olango and Batasan Islands, Philippines

Livelihood	Estimated income in US\$/month
Ornamental fish collector	9-233
Odd job worker	18
Packers of ornamental fish	3.6-7.2
Fishers	36-144
Shell gleaners	2.7-4.5
Vendors of seafood products	43-50
Store owners	144
Carpentry work	54 (2.7 per day)

(Gonzales and Savaris, 2005)

Country reviews collated in this study from India, Indonesia, Myanmar, Pakistan, Philippines and Vietnam are widely diverse but identify distinct characteristics of coastal livelihoods across the region, particularly of poorer members of society. These include (i) a tendency towards reliance on natural “key-stone resources” (Box 2), (ii) a diversified livelihoods approach, and (iii) shifting, often seasonal, balances in resource use and the division of labor (Haylor et al, 2003; Gonzales, 2006; IMM et al, 2005; Mohan et al, 2006; Nguyen, 2006; Suspita, 2006; Wattoo, 2006; Whittingham et al, 2003).

Box 2 Role of coral reefs in the livelihoods of coastal communities in Asia-Pacific

Around half a billion people live within 100 km of a coral reef and many of these are dependent on fishery-based livelihoods which are in turn dependent on coral reefs. The diversity and productivity of coral reef resources in these areas also act as sinks for such people, providing a range of livelihoods strategies (Whittingham et al, 2003). Therefore coral reefs are vital to the livelihoods of millions worldwide and particularly within Southeast Asia. In some areas, for instance the coastal regions of major archipelagos including Indonesia and the Philippines, and small Pacific island states, this dependence is extremely high (Burke et al, 2002; Whittingham et al, 2003). Reefs are known to act as a “key-stone resource,” i.e., one ensuring that people just manage to escape poverty. They are described as “interstitial poor”, in that they are often overlooked in coastal development projects, many groups do not have the resources to undertake alternative development options, and they are extremely vulnerable to any decline in reef condition (Whittingham et al, 2003).

Associated post-fishery activities such as processing and the trading of aquatic products also generate employment and income to millions of people around the world (Macfadyen et al, 2005). At the local level, wealth generated through trade can make significant contributions to rural development through income and employment multiplier effects. At the household level, the catching or harvesting of fish

and associated post-harvest activities such as processing and trading generate livelihoods, employment and income (Box 3) (Macfadyen et al, 2003; Nguyen, 2006; Tuan, 2003).

Box 3 Fishery and aquaculture-based livelihoods in Vietnam

It is estimated that there are more than three million people in Vietnam who depend either directly or indirectly on fisheries for their income. Ninety percent of all fishers are artisanal and small-scale and most of them are poor. The fisheries sector is a significant source of income, not only in the case of full-time fishers, but also for households that combine fishing as a component of their wider livelihood strategies. The biggest source of fishing and aquaculture income is generated from the Mekong Delta, where between 60% and 70% of households are involved in aquaculture. In this area, the average income from aquaculture ranges from US\$ 36-79 per month. Almost all aquaculture producers are small-scale in their activities and belong to private households, although some cooperatives have recently been established. The aquaculture sector provides employment for 668,000 workers, and shrimp aquaculture accounts for more than half of this (Nguyen, 2006; Macfadyen et al, 2003; Tuan et al, 2003).

2.3 Coastal livelihood trends

Throughout Asia, coastal populations are increasing due to a combination of local population growth and migration (Haylor et al, 2003). There has also been an increase in overall fishery production and trade over the last few decades and a corresponding increase in employment in the fishery and aquaculture sector. In 2000, an estimated 38 million people were directly engaged in fishing and fish-farming as a full-time, or more commonly part-time, occupation, compared with 28 million a decade earlier (Table 5) (FAO, 2002; IMM et al, 2005). Despite the peaking of capture production, wild caught fisheries are still considered a profitable livelihood, particularly for the owners of commercial fishing vessels (Silvestre et al, 2003), and the number of fishers has been growing at an average rate of 2.2% per year since 1990 (FAO, 2002). The number of aquaculture workers has also increased by an average of 7%, with growth particularly marked in Asia (FAO, 2002). However, it is suspected that these positive figures disguise the plight of small-scale subsistence fishermen throughout the region. In general, it is thought that while owners of commercial vessels can and do earn large sums of money, small-scale fishers barely make a living (Silvestre et al, 2003). Across the region, small-scale fishers are believed to be increasingly marginalized by a growing number of commercial fishing boats which often fish over quota and use illegal fishing practices; there is increasing disparity within the fisheries sector (Mohan et al, 2006).

Table 5 Number of fishers and farmers (in 1,000s) by region

Continent	1990	1995	2000	2001	2002
Africa	1,917	2,238	2,585	2,640	2,615
North and Central America	767	770	751	765	762
South America	769	814	784	760	770
Asia	23,654	28,552	30,770	31,493	32,821
Europe	654	864	821	796	746
Oceania	74	76	86	80	81
World	27,835	33,314	35,797	36,534	37,795
Of which fish farmers					
Africa	...	105	112	115	111
North and Central America	53	74	74	69	65
South America	16	88	92	92	93
Asia	3,698	6,003	8,503	8,720	9,502
Europe	11	36	37	39	39
Oceania	neg	1	5	5	5
World	3,778	6,307	8,823	9,040	9,815

(FAO, 2002)

2.4 Vulnerability

Although communities are often relatively cash rich – in that they are able to sell their products more frequently and consistently than can land-based farmers (FAO, 2002) – they often remain vulnerable to sudden and seasonal variations in earnings (FAO, 2002), along with many other factors, the outcome of which may be income-poverty (FAO, 2002). These include climatic and severe weather events, storms, seasonally-adverse weather conditions and natural disasters, e.g., exceptionally in 2004 there was a devastating tsunami in the Indian Ocean (Box 4) (CONSRN, 2005; Gonzales, 2006; Suspita, 2006). Because of its scale and severity, the tsunami focused the world's attention on the plight of poor coastal communities. They are vulnerable to economic factors such as debt, fluctuations in market price and access to markets, health issues such as ill health and accidents leading to a loss of income, and environmental factors such as pollution, over-exploitation of natural resources and destructive fishery practices (FAO, 2002; Gonzales, 2006; Maung Soe, 2006; Mohan et al, 2006; Silvestre et al, 2003; Suspita, 2006; Wattoo, 2006; Nguyen, 2006). Poor coastal communities are also under the increasing threat of marginalization in the face of increasingly competitive commercial fishing enterprises (IFAD, 2002). Unfortunately, it appears that the vulnerability of coastal communities is increasing (FAO, 2002). This often forces poor individuals to develop short-term survival strategies such as destructive and over-fishing practices which further increase a community's vulnerability (IFAD, 2002; Wattoo, 2006).

Box 4 The Indian Ocean tsunami

The Indian Ocean tsunami event of 26 December 2004 demonstrated vividly the vulnerability of coastal communities throughout Asia-Pacific and eastern Africa. Estimates put the human cost of the tsunami at just under 300,000 people killed and a negative impact on the livelihoods of around five million people, particularly in Indonesia and its region of Aceh, and Sri Lanka. The majority of those affected followed agricultural or fisheries-based livelihoods or were employed in associated enterprises. The degree of damage to lives and property varied within and between countries and communities, with some suffering a complete loss of villages, homes, fishing and aquaculture infrastructure (including port and post-harvest facilities), fishing vessels and gear, aquaculture facilities (including ponds, cages, hatcheries and brood stock), markets, and other livelihoods assets (CONSRN, 2005).

In Sri Lanka, at least one million people were directly affected, with the worst affected areas being the underdeveloped coastal regions in northeast, east, south and southwest coastal areas of the country. The majority of job losses were in the service sector, followed by fishing, agriculture and industry. Up to 100,000 fishermen are now unemployed and 18,500 fishing vessels have been lost or badly damaged (<http://www.ilo.org>).

In Aceh Province, Indonesia aquaculture is a significant livelihood for many coastal dwellers. The tsunami destroyed or severely damaged more than 50% of all brackishwater aquaculture ponds (tambaks), the main farming systems for milkfish (*Chanos chanos*) and shrimp (*Penaeus monodon* and other species). Aquaculture production has effectively stopped in the major farming areas of the east coast. As the economy in these areas is heavily dependent on aquaculture and fisheries, farmers and laborers are also faced with few opportunities for alternative employment (Suspita, 2006).

The extent to which international trade can benefit poor rural and coastal communities is also vulnerable to key factors and trends. These include changing demand for different types of fish products, increasing moves towards Corporate Social Responsibility (CSR) certification and traceability, increasingly strict health and hygiene regulations, and requirements of the regulatory framework for international trade, including trade barriers and subsidies. All these factors, while offering opportunities for poor people, also present certain risks in terms of their exclusion from the market chain and the benefits of increased trade (Macfadyen et al, 2005).

3 The current status of aquaculture and mariculture in Asia-Pacific

Since yields from capture fisheries are not expected to increase, an emphasis is being placed on the aquaculture sector's ability to provide increasing quantities of aquatic products. Production from inland aquaculture and marine and brackishwater-based aquaculture (mariculture) are both increasing (FAO, 2002, 2003, 2004; Sugiyama and Funge-Smith, 2003; Sugiyama et al, 2004) and now account for 30% of total aquatic production (Delgado et al, 2003). Low-income food deficit countries (LIFDCs) lead the way in this growth, dominated by China and other Asian countries (FAO, 2003). As a result, the Asia-Pacific region (including China) is the largest contributor towards world aquaculture, producing 46.9 million tons or 91% of total global aquaculture by volume and 82% by value (Wilfredo et al, 2006). Aquaculture production within the region is diverse, but in terms of volume it is still dominated by freshwater fish production (39%), followed by aquatic plants (29%), crustaceans (13%), marine and diadromous fish (13%) and mollusks (7%). In terms of value, crustaceans such as the tiger prawn (*Penaeus monodon*) dominate, accounting for 49% of production, followed by freshwater fish (35%) (Wilfredo et al, 2006).

3.1 The potential role of mariculture in poverty reduction and food security

The shifting emphasis in production from fishing to aquaculture and mariculture, and the growth in the international trade in aquatic products, are often believed to offer the potential to contribute towards poverty reduction and food security through the creation of jobs and alternative sources of food. They may also provide a way to encourage those involved in destructive fishing practices to adopt a more sustainable form of livelihood (Gonzales, 2006; Haylor et al, 2003; Mukherjee, 2006; Nguyen, 2006; Suspita, 2006). From the country reviews undertaken for this study, mariculture practices considered potentially "pro-poor" were identified in every country except Pakistan, which currently has an extremely limited and mostly experimental mariculture industry focusing on shrimp (Wattoo, 2006) (Table 6).

Table 6 Mariculture practices identified in country reviews

Country	Mariculture activity
India	Mud crab fattening Shellfish culture
Indonesia	Shrimp processing Traditional milkfish production in tambaks (ponds) Traditional prawn culture Mud crab fattening Shellfish culture Sea cucumber Seaweed culture Shrimp and finfish hatcheries
Myanmar	Traditional shrimp farming Mud crab fattening
Philippines	Marine finfish seed supply Shellfish farming Milkfish production in cages and pens Backyard grouper production in cages Seaweed culture
Vietnam	Integrated shrimp-mangrove farms Marine finfish culture and fattening in cages Lobster culture and fattening in cages Shrimp processing Shrimp and finfish hatcheries

(Gonzales, 2006; Maung Soe, 2006; Mukherjee, 2006; Nguyen, 2006; Suspita, 2006)

Livelihoods from mariculture include:

- **Fry collection and supply** for milkfish, grouper and shrimp; small-scale trading and middlemen for mariculture products and inputs
- **Production** of milkfish, groupers, mud crabs, and lobsters in cages and pens, seaweed production (including family-owned and operated seaweed farms), mussel and oyster production
- **Waged labor** for hatcheries such as feeders and tank cleaners
- **Waged labor in production**, caretaking of fish cages and pens, and shrimp ponds; seasonally-hired pond and cage work and hired labor for cage construction and fish harvesting, and
- **Waged labor** (cleaning and laboring) in processing facilities such as shrimp and other seafood product packing and processing facilities (Gonzales, 2006; Mukherjee, 2006; Nguyen, 2006; Suspita, 2006; Wattoo, 2006) (Appendix I).

3.2 Examples of pro-poor mariculture in Asia-Pacific

3.2.1 Finfish farming

Throughout the region Groupers (*Epinephelus sp*) and other marine finfish such as Milkfish (*Chanos chanos*) are typically farmed in ponds or cages (which can sometimes offer the opportunity for landless individuals and fishers to become involved in mariculture activities). Marine finfish culture comprises an increasingly well-known set of technologies. However, the fattening of wild caught fish and juveniles needs to be conducted within the context of sustainable management of the capture fishery. Nursing fish seed, production and processing may provide employment or small-scale business opportunities for poor people in coastal areas. Table 7 illustrates the opportunities that small-scale Grouper culture is thought to possess, as perceived by poor coastal villagers in Khanh Hoa province, Vietnam.

Successful examples of where small-scale finfish culture has benefited poor coastal communities exist in Tubigon, Bohol, Philippines, where the small-scale cage culture of Grouper was introduced by local government as an alternative to destructive fishing practices. There are now 141 Grouper farmers organized into nine groups throughout several villages (Gonzales, 2006). Another Philippine example is the so-called “backyard type of Grouper culture” such as in Day-asan, Surigao City. Here each farmer owns between two and four 3x3-m cages, each stocked with around 100 fish. Where these are fed wild caught fish as feed and cultured for a period of five to six months, there are question marks over sustainability. Production costs are estimated at PhP 200 (US\$ 3.88) per kilogram, with farmers claiming it is more profitable than more familiar livelihoods such as backyard pig production. The average selling price ranges from PhP 400-1,000 per kilo (US\$ 7.77-19.42) depending on the type of grouper and season (Gonzales, 2006).

However, there are also many potential constraints to finfish culture and its suitability as an alternative livelihood for poor fishers. These include the high-technology, capital-intensive and long-term payback characteristics of finfish farming, and the difficulty of uptake of mariculture, including breaking the cycle of debt among poor fishers, and persuading people to change vocations (Haylor et al,2003). In the Ilocos region of the Philippines, where the milkfish industry is concentrated, the production costs per cage are reported as US\$ 23,504 although a profit of just over US\$ 3,000 is expected (Gonzales, 2006). Such high costs have deterred small-scale fishers from investing in these technologies and the cages are owned by wealthier individuals (Gonzales, 2006). There are also environmental considerations, for example, the proliferation of fish-pens and fish-cages in shallow and narrow water bodies has resulted in occasional but severe fish kills (Gonzales, 2006; Rosario, 2006). In Indonesia, the tambak culture of finfish is also thought to have led to environmental degradation in some instances (Suspita, 2006).

Table 7 The potential of small-scale cage aquaculture to improve livelihoods

Problem and constraint as identified by villagers	Rating	Comment
Low income	high	Cage aquaculture generates high returns compared with alternative activities.
Dense population and lack of land	high	There are many available sites for cage aquaculture in Khan Hoa.
Poor and/or impoverished soils	high	
Shortage of freshwater	neutral	This is an infrastructure issue.
Forest fires and mangrove destruction	medium	Cage aquaculture development could take the pressure off mangrove systems.
Shrimp disease	medium	Cage culture offers an alternative.
Flooding	high	Cage aquaculture is not vulnerable to flooding.
Erosion	neutral	
Overexploitation of fisheries	low-medium	Development of cage aquaculture could take the pressure off inshore fisheries – although feed and seed supply are a problem in this regard.
Use of destructive fishing gears (e.g., cyanide, electric fishing push-nets)	low-medium	Unsustainable with efforts impacted by punitive measures as well as alternative livelihoods, which could include cage culture (see Philippines example below).
Degradation of coral reef	medium	Fishing for seed does not involve habitat destruction.
Pollution from shrimp farming, shrimp hatcheries, and animal husbandry	neutral	Cage aquaculture may cause similar pollution problems, although far less concentrated.
Poor roads	neutral	This is an infrastructure issue.
Access to markets	high	Cage aquaculture generates high-value products and marketing channels are well developed.

(Hambrey et al, 2001)

3.2.2 Crab and lobster fattening

Mangrove crab production or the fattening of mangrove crabs (*Scylla sp*) in earthen ponds and simple cages have a long history in the region. The crabs are attractive for the growing export market as they can be easily packed and shipped live (Wilfredo et al, 2006). Small but successful mangrove crab industries exist throughout Asia-Pacific, for instance in Indonesia where hatchery technology is now available (Suspita, 2006), and Myanmar where fattening is common along the coasts of Rakhine, Ayeyarwady and Tanintharyi and is being extended by research institutes (Maung Soe, 2006). Mangrove crab culture also has the advantage of being able to integrate within mangrove systems and therefore is often seen as a way to promote sustainable forms of aquaculture to be of benefit to income-poor groups.

Other crustacean species under culture include the fattening of lobsters, which once again relies on wild caught seed. Species such as the spiny lobster (*Panulirus sp*) can fetch a value of US\$ 25 per kilogram (Wilfredo et al, 2006) and are cultured throughout the region. Vietnam in particular is a major producer, with 17,000 lobster cages recorded along the south central coast alone (Nguyen, 2006). However, operating costs are high, for example lobster farming in Nha Trang Bay, Vietnam, has operating costs of almost US\$ 1,750 for seed and feed (IUCN, 2003) which is a deterrent to uptake by poorer members of communities who often have extremely limited access to credit. However, within Vietnam, the pro-poor culture of lobster, finfish and a range of aquatic species is being investigated under the SUMA (Support to Marine and Brackishwater Aquaculture) component of the DANIDA-funded FSPS (Fisheries Sector Program Support) project. SUMA has already

introduced sustainable breeding and culture technologies adapted to Vietnamese conditions for a range of species including Top Shell (*Trochus niloticus*), Abalone (*Haliotis asinina*), Mud Crab (*Scylla serrata*), Swimming Crab (*Portunus pelagicus*), Hard Clam (*Meretrix meretrix*), Sea Cucumber (*Holothuria scabra*), and Oyster Clam (*Lutralia philippinarum*). Demonstrations have also been carried out in Quang Ninh, Nam Dinh, Nghe An and Ha Tinh provinces for species such as Shrimp, Seabass, Rabbit Fish, Abalones, Sea Cucumber, Green Mussels and Grouper in ponds and cages.

3.2.3 Extensive seaweed and shellfish production

In contrast to these semi-intensive systems is the extensive or traditional culture of seaweed and shellfish. Due mainly to their low input requirement and extensive nature, these are regarded as environmentally sustainable (Suspita, 2006) and another potential “entry point” for the inclusion of poor coastal communities in mariculture activities. Seaweed in particular is thought to be a particularly promising culture method and is the focus of government promotional campaigns in Indonesia and the Philippines (Suspita, 2006; Gonzales, 2006). It is of interest to other governments in the region, including Cambodia. Indonesia has a rapidly growing seaweed industry and the Directorate General of Aquaculture (DGA) views seaweed production as an opportunity to reduce poverty in areas such as West Nusa Tenggara, Bali and Lampung. Seaweed technology is considered as relatively easy to implement, with a short life cycle and an existing market, and the DGA is currently promoting seaweed culture through collaboration with local banks that provide the capital needed for start-up operations (Box 5). It also has the potential to involve various household members including women, which makes seaweed culture particularly attractive as a poverty reduction strategy (Suspita, 2006). Such approaches have resulted in farmers reporting incomes of around US\$ 300-500 per month. Although culture itself may be less capital intensive, depending on the seaweed type and the production objective, processing may be a particular issue, especially facilities or processes for drying prior to transport and particularly in remote areas.

Box 5 Seaweed culture in Sembilangan Village, Java, Indonesia

Sembilangan Village is situated in the northern part of Bekasi District, Java, Indonesia, where villagers earn a living from the sea and through brackishwater pond culture of milkfish and shrimp. Environmental degradation has led to the collapse of shrimp farming while the culture of milkfish was erratic and unpredictable. Any income from harvests often went towards paying back loans and many would lose ownership of their ponds. Polyculture in the form of integrated seaweed and milkfish or shrimp culture has recently been introduced. Through improved organization and planning within the village, producers began to receive a regular income (every two months) from the production of dried seaweed. Seaweed production has also improved the quality of the water and once again shrimp is being produced. In 2004 a group from the village known as KBTT won first prize in the seaweed category of a national aquaculture competition held by the Marine and Fisheries Department (Mauksit et al, 2005).

In the Philippines, where seaweed contributes the majority of the total mariculture production (Gonzales, 2006; Rosario, 2006), it is viewed by the government as one of the main species, along with milkfish and tilapia, that has the potential to generate both food and income for poorer groups (Box 6) (Gonzales, 2006).

The traditional or extensive culture of shrimp is also considered to hold potential in countries such as Myanmar (Maung Soe, 2006). However, these so-called “low-input extensive” and “extensive plus” systems rely on the stocking of shrimp from natural sources, with associated sustainability issues (Maung Soe, 2006). In India, shrimp are often cultured on a rotational basis in rice fields known as *khazans* in Karnataka and *bheri* in West Bengal (Mohan et al, 2006; Mukherjee, 2006) and result in production volumes of up to 0.5 tons per hectare. Upon the establishment of these farms, employment is reported to have increased by between 2 and 15% with the average income rising by between 6 and 22% and were reported as particularly important employment opportunities for women (Mohan et al, 2006).

Box 6 Seaweed (*Eucheuma*) culture in Guimaras Island, Western Visayas, Philippines

In 2001, the local government unit of San Lorenzo requested BFAR Region 6 to introduce seaweed farming in Nadulao Island as a potential alternative to blast fishing in the area. A fishers' organization with 17 members was formed to be responsible for four seaweed farms. Under the GMA, or Ginintuang Masaganang Ani, program, the Seaweed Culture Project was created in collaboration with the Office of the Provincial Agriculturist and the Office of the Municipal Agriculturist. The site was expanded to include three other villages in San Lorenzo and 19 additional villages in the municipalities of Buena Vista, Nueva Valencia and Sibunag.

In April 2004, a Provincial Seaweed Development Council (PSDC) Technical Working Group (TWG) was formed, composed of representatives from government and commercial institutions. The PSDC-TWG then created the Seaweed Growers and Traders Association (SGTA) which now sells their products directly to Cebu exporters. There are now 16.65 hectares under cultivation and benefiting 162 farmers. In 2005, the beneficiaries sold over 6 tons of fresh seaweed and 22 tons of dry seaweed valued at US\$ 14,977. Farmers who were interviewed reported that the supplementary income from seaweed culture kept them away from their illegal fishing activities and enabled them to send their children to school (Gonzales, 2006).

However, extensive systems are subject to particular constraints, in particular the access to and availability of sites. Due to their extensive nature, such practices require access to relatively large areas of near-shore and coastal land and therefore exclude landless individuals and can also lead to resource use conflicts.

3.3 Mariculture market chains and coastal communities

Mariculture is constrained as a livelihood option for resource-poor people by lack of access to capital capacity-building and resources, high capital investment costs, access to sites and markets, and processing infrastructure, and the potential for resource use conflicts. However, the increasing international trade and exports from LIFDCs offer other opportunities. The market chains of the supply, production and export of aquatic products such as live reef fish, ornamental reef fish, shrimp and seaweed are typically defined by their complexity, which facilitates the inclusion of a wide range of stakeholders involved in the supply of inputs, production and harvesting, and product marketing and consumption. Many of these stakeholders are classified as income-poor and many are women who are heavily involved in the processing of aquatic products throughout Asia, for example in Vietnam where women account for 90% of the labor force (Macfadyen et al, 2003; Nguyen, 2006). Appendices II and III demonstrate this complexity and describe a typical market chain for shrimp production in Vietnam and, although not strictly a mariculture activity, a market chain for the collection and export of ornamental fish from Mindanao, Philippines, to the UK.

3.4 Risks to mariculture development

Pollution and environmental degradation have the potential to impact heavily on mariculture and poorer stakeholders who are often less well equipped to deal with risk and livelihood shocks. Other risks, such as mariculture's reliance on wild seed collection and the use of fish in feed sources, demand solutions some of which may provide opportunities for the inclusion of poorer groups.

3.4.1 Ecosystem degradation

One of the main risks to mariculture development is the degradation of the ecosystems that provide key environmental goods and services. Prime among these are the services that coral reefs and mangroves provide (UNEP, 2006). These are a valuable resource for coastal communities and often act as a nursery for many fish species (Haylor et al, 2003; NACA and FAO, 2003; UNEP, 2006), including mariculture species such as Grouper. In purely monetary terms, recent estimates have placed the value of coral reefs at between US\$ 100,000 to 600,000 per hectare per year and the value of mangroves at between US\$ 200,000 to 900,000 per hectare per year (UNEP, 2006). Increasingly these systems are under the threat of degradation from a range of anthropogenic factors (Burke et al, 2002; Chou, 2000; FAO, 2003; Haylor et al, 2003; NACA and FAO, 2003; Silvestre et al, 2003;

UNEP, 2006). This is particularly severe in Southeast Asia which accounts for 27% and around 43% of the world's reefs and mangroves respectively (Burke et al, 2002; UNEP, 2006). Ecosystems that can no longer provide their full ecological services have an economic and social cost that often can be felt both locally and many miles away (UNEP, 2006). The degradation of corals and mangroves may cause:

- Reduced fish catches and tourism revenues in coastal communities and potentially a loss of food security;
- Loss of export earnings;
- Increased coastal erosion and destruction.

3.4.1.1 Coral reefs

The main threats to coral reefs are coral bleaching and death, due to climate change and increased El Niño events, over-fishing and unsustainable and destructive fisheries practices such as dynamite and cyanide fishing. Other factors include habitat destruction and sedimentation through coastal development (Table 8).

Table 8 Anthropogenic threats to coral reef bio-diversity in selected Southeast Asian countries

Country	Over-exploitation	Destructive fishing	Sedimentation	Pollution
Cambodia	X	X		
Indonesia	X	X	X	
Malaysia	X	X	X	X
Philippines	X	X	X	X
Thailand	X		X	X
Singapore	X		X	
Vietnam	X	X	X	X

(Chou, 2000)

There is regional diversity in the state of reef decline but the situation in Southeast Asia is described as serious and probably under the greatest threat from human activities (Burke et al, 2002). Some 88% of Southeast Asia's reefs are severely threatened with the situation especially severe in Cambodia where 100% of reefs are at a medium or higher level of threat², followed by China (92%), Indonesia (88%), Malaysia (88%), the Philippines (98%), Singapore (100%), Taiwan (100%) and Vietnam (96%).

3.4.1.2 Mangroves

Global trends in mangrove systems indicate a similar pattern of decline (Silvestre et al, 2003; UNEP, 2006), and the total area covered by mangroves worldwide has now fallen from 19.8 million hectares in 1980 to below 15 million hectares (FAO, 2003b), or 25% of the extent found in 1980. Mangrove deforestation continues, although at a lesser rate than in the 1980s (1.1% per year compared to 1.9% per year) (FAO, 2003b). Many fish species use mangroves as nurseries or make use of these systems in some part of their life cycle; mangroves also provide sources of feed and act as a buffer to the impacts of severe weather events (FAO and NACA, 2003; UNEP, 2006). The disturbance and alteration of mangrove habitats therefore lead to a departure of fish populations and other nekton which will not easily return to the impacted zone (FAO, 2003b; FAO and NACA, 2003) and ultimately to impoverished livelihoods for those who depend upon the fishery sector.

² Based on the RRSEA model and the Reefs at Risk Threat Index. The index is designed to highlight areas where, in the absence of good management, coral reef degradation might be occurring or where it is likely to happen in the near future, given ongoing levels of human activity. The threat indicators therefore gauge current and potential risks associated with human activities, not actual reef condition (Burke et al, 2002).

The main threats to mangroves include clearance for industrial and coastal development, salt production and shrimp pond construction. However, due to an increased awareness of the important roles mangroves play in the marine food web and in providing wood and non-wood forest products and coastal protection, most countries in the region have long since restricted or banned the conversion of inter-tidal mangrove into shrimp pond culture. Where the demand for land for agriculture or aquaculture (e.g., to increase production of rice and fish for local consumption) or for infrastructure development necessitates the conversion of mangrove areas, the decision should be based on the results of a thorough environmental impact assessment, including a valuation of all the direct and indirect benefits mangroves provide to livelihoods and the environment. Therefore, the use of these systems must seriously consider the value of the services they already provide to ensure the regional sustainability of fisheries production and the ecosystem services on which they rely. At the minimum, decisions on the use of reefs and mangroves must be based on ecological and livelihoods-based research to ensure that returns from an activity introduced into mangroves (such as aquaculture) are far greater than the opportunity costs of the services that the targeted mangroves provide (FAO and NACA, 2003).

3.4.2 Wild seed collection verse small-scale hatcheries

The reliance on wild caught seed for mariculture purposes is another potential constraint, since not only do such activities have the potential to cause over-fishing and ecosystem degradation, but discarded by-catch from seed collectors also impacts upon future fisheries and fishers' livelihoods (Suspita, 2006). The development of small-scale or backyard hatcheries, however, can help alleviate this risk and still involve poor stakeholders in mariculture activities (Gonzales, 2006; Sim et al, 2005; Suspita, 2005). Small-scale hatcheries are those where the capital costs are relatively low, technologies are accessible, and which focus on the larval rearing and nursery aspects of fingerling production. They do not hold broodstock; instead they purchase fertilized eggs from larger hatcheries. They offer the advantages of low capital costs, simple construction, ease of operation and management, flexibility and use for a range of marine fish species, and they offer quick economic returns (Sim et al, 2005).

3.4.3 Fish feed

Mariculture, particularly the production of marine finfish and lobster, still relies heavily on the supply of "trash fish" which can be considered inappropriately named as this protein source would never be wasted but used for other purposes (Sim et al, 2005b). The increased use of this resource in mariculture therefore has the potential to lead to resource use conflicts and impact on people's food security and livelihoods (Suspita, 2006). An increased demand for trash fish could also encourage over-fishing, destructive fishing practices and environmental degradation. Other problems with its suitability for mariculture use include a short storage life, seasonal variation in supply, wastage due to disintegration and the pollution from these causes. It has the potential to act as a disease or parasite vector (Sim et al, 2005b). Significant progress has been made in the development of partial or full feed alternatives (Sim et al, 2005b; Suspita, 2006) and like small-scale hatchery production, small-scale feed production provides an opportunity for poorer stakeholders to become involved in mariculture activities (Sim et al, 2005b; Suspita, 2006).

3.4.4 Intensification and consolidation

New aquaculture technologies are likely to accelerate the intensification of inland and coastal aquaculture that has already occurred. Environmental legislation is likely to contribute significantly towards this, as controlling pollution requires capital investment. In addition, if developing countries adopt aquaculture subsidies similar to those already present in China and industrialized countries, which include cheaper land, lower taxes and tariffs, then the large-scale, capital-intensive model of aquaculture is likely to emerge at the expense of small-scale systems (Delgado et al, 2002). Weak legislative frameworks for the promotion or protection of access rights for rural and coastal communities and people will also aggravate this issue. In addition, growing international markets and the increasing power of export markets will likely cause market chain consolidation, which could force out smaller operators (Macfadyen et al, 2005).

3.4.5 Trade barriers

The risks inherent with international trade are often passed on to the poorest stakeholders (Macfadyen et al, 2005) and aquaculture processing countries in Asia have to address a wide array of trade issues (Bueno, 2004), including tariff and non-tariff trade barriers.

The aquaculture industries of Asia-Pacific are susceptible to the imposition of tariffs by importing countries and over the last few years the US has successfully placed import tariffs on Vietnamese catfish (tra and basa) and on shrimp from a range of Latin American and Asian countries (Bulcock and Savage, 2003, 2004, 2005). Such measures can have a dramatic effect on national aquaculture industries and often can lead to poorer stakeholders becoming marginalized (Box 7).

Box 7 The impact of shrimp trade tariffs in Vietnam

In 2004, under the direct impact from an anti-dumping case, Vietnamese shrimp export and processing activities declined, with some fish export-processing companies ceasing operations. The case has seriously affected the export turnover and trading activities of shrimp companies, especially those with established market ties to the US. Prices of shrimp dropped quickly (by at least VND 10,000/kg (US\$ 0.67/kg) for every size of shrimp. Those most affected were collectors of shrimp as processing companies not only reduced the quantity they required but also stopped informing collectors of the purchase price. In addition, when prices fall, shrimp farmers' incomes are also reduced and as a consequence farmers find it difficult to prepare their finances for the next culture cycle. The fall in prices also has had knock-on effects for others involved in the market chain, such as those working in shrimp hatcheries, as the demand for seed is lower (Macfadyen et al, 2005; Nguyen, 2006).

It is also becoming increasingly important for producers to assume responsibility for the quality of the product and the actions taken in producing it (Bueno, 2004). In a recent poll in the EU by the Seafood Choices Alliance on consumer attitudes towards seafood and the state of the world's ocean, 79% said that the environmental impact of seafood is an important factor in their purchasing decisions (Bulcock and Savage, 2005). Environmental and social responsibility issues are therefore joining food safety and quality as requirements to market access and can sometimes be used as so-called non-tariff trade barriers by importers. As most farms in Asia are small and producers are sometimes not well organized, it is difficult for farmers to comply with international standards (Bueno, 2004). There have been several recent and high profile trade conflicts, including a zero tolerance policy by the EU, over the use of prohibited antibiotics (Bueno, 2004; Bulcock and Savage, 2003, 2004). However, this growing awareness and demand for environmentally-sensitive aquaculture also presents opportunities (Bueno, 2004; Macfadyen et al, 2005). In the same Seafood Choices Alliance poll, 86% of consumers would prefer to buy seafood that is labeled as "environmentally responsible". Consumers added that reassurances that the product was environmentally sound were more important than price. In fact, 40% were willing to pay 5-10% extra for seafood identified as eco-friendly (Bulcock and Savage, 2005). Environmentally-sensitive aquaculture makes good business sense and has helped push efforts to promote the adoption of environmentally and socially responsible farming practices through appropriate standards or codes of conduct and the discussion of suitable certification programs (Bueno, 2004).

4 Way ahead

4.1 Actions needed

4.1.1 Livelihood diversification

The diversification of economic activities is seen an important part of the development of economies. With respect to poverty reduction, diversification is considered as:

- i) a coping strategy of poor people to deal with increasing competition, and therefore is a familiar strategy within coastal communities, and
- ii) as a development strategy enabling poorer members of society to graduate out of poverty (IMM et al, 2005).

Therefore, it is not surprising that the rural development strategies of governments sometimes focus on the role of livelihood diversification as a way of reducing poverty (IMM et al, 2005). In addition, government and NGO agencies that are concerned with the sustainable use of natural resources are promoting livelihood diversification as a way to encourage people to move away from exploitative and destructive use of those resources (IMM et al, 2005). Mariculture presents an opportunity to diversify coastal livelihoods and provide an alternative income-generating activity for coastal communities and those involved in destructive fishing practices (Haylor et al, 2003). It also has the benefit of being an alternative source of fish protein. However, before promoting pro-poor mariculture activities, there are many specific issues that must be addressed. These vary according to the type of activity, and must be considered in a context-specific manner, but typically they include:

- The relatively high capital costs and skills required for mariculture
- The right focus of mariculture activities with respect to gender and age and its ability to integrate with existing aspects of coastal management, livelihoods and resource uses
- The willingness and ability of people to adopt alternative livelihoods (to diversify their livelihoods)
- The ability of farmed products to replace wild-caught products in markets
- The environmental footprint of the activities
- Seed, broodstock and feed supply, and
- Unproven economic, technical and environmentally sustainability factors (Briggs, 2003).

In some countries, there are also questions regarding access to technology, extension support, capital and security (FAO and NACA, 2003).

Therefore, key issues with respect to the development of pro-poor mariculture in the region include the introduction and extension of appropriate mariculture technologies and activities, the provision of support services, and the development and implementation of sustainable mariculture practices based on an analysis of the goods and services provided by ecosystems and their carrying capacity.

4.1.2 Pro-poor international trade

The opportunities presented by domestic and international trade and their market chains should also be recognized, and effective and equitable ways of linking coastal communities into regional, national and global markets found to achieve long-term livelihood improvements (Macfadyen et al, 2005). In some cases, the building of the capacity of fisheries administrations to deal with international trade issues is required. There is also the need to focus on issues regarding the reliability and quality of the product. However, once again there is limited access to credit and therefore pro-poor trade initiatives could include support for micro-finance programs (Macfadyen et al, 2005).

4.2 Strategies for development

4.2.1 Pro-poor mariculture policies

The opportunities that the growth in aquaculture and mariculture production and the international trade in their products present for livelihoods diversification, and the actions needed to achieve this, have been recognized by regional governments, and this recognition is now being voiced through government policies and statements.

For instance in Vietnam in January 2006, Decision 10/2006/QD-TTg was issued by the Prime Minister, approving a Master Plan for the fisheries sector development until 2010 with perspectives for 2020 (Bulcock and Savage, 2005; Nguyen, 2006). In this legal document, the need to develop fisheries into a major commodity was detailed along with a call for increased productivity, production and competitiveness, characterized by product diversity, to meet the increased demand from domestic consumption and foreign trade. The decision also outlined the importance of ensuring the sustainable development of the aquaculture and fisheries sector (Nguyen, 2006). In the Philippines in response to the president's recent "10-Point Agenda," which focuses on job generation, the Bureau of Fisheries and Aquatic Resources (BFAR) has begun to identify areas in which mariculture could contribute towards providing small-scale fishers and coastal communities with alternate types of employment (Gonzales, 2006). The Government of Pakistan is currently emphasizing the importance of the fisheries sector in creating food security and income-generating opportunities and national fisheries policy is currently being formulated (Wattoo, 2006).

4.2.2 Adopting a livelihoods-based approach

Livelihoods in coastal areas and the factors that affect them are complex (IMM et al, 2005). Therefore, interventions that intend to help reduce poverty in these areas need to understand this complexity and how it evolved (IMM et al, 2005). However, the majority of efforts to support livelihoods diversification have tended to be supply-driven and focused on single-issue solutions. Services such as mariculture have been offered to communities to address perceived needs without any real understanding of the underlying causes of the lack of livelihood diversification (IMM et al, 2005). As a result, rural development efforts tend to be well supplied with development initiatives, but lack the corresponding level of livelihood improvement (IMM et al, 2005).

Therefore, to implement effective pro-poor mariculture strategies, an acknowledgement and understanding of the complex nature of livelihoods in poor coastal communities is essential. The use of mariculture as a potential livelihood option for poor rural and coastal communities must be based on a careful and realistic assessment of communities' needs, priorities, access to resources and the vulnerabilities people and communities face (Gonzales, 2006; Suspita, 2006; NACA/FAO, 2000). Due to the complex and shifting nature of coastal communities and livelihoods, it is possible that mariculture may actually adversely affect the livelihoods of rural and coastal communities by diverting food resources, degrading the environment, disrupting access to common resources and therefore disrupting already vulnerable livelihood strategies. Therefore, for research and development in mariculture to support poor people's livelihoods, people and communities must be placed at the center of development planning, where an understanding of their livelihoods will require a comprehensive and broad-based approach that goes beyond a focus on assessments of locally available resources and technologies.

The adoption of livelihoods-based approaches is one such method. These involve learning about the resources that people and communities command, the choices they make, and the circumstances of their livelihoods. They are therefore better able to identify poor people and understand the contexts of poor rural and coastal communities' lives. Such approaches are increasingly becoming endorsed by international organizations (such as FAO), development organizations, donors (including DFID) and governments, notably in Asia-Pacific. The Network of Aquaculture Centers in Asia-Pacific and its

Governing Council of 17 Asia-Pacific governments recently endorsed a regional consensus on the value of livelihoods approaches,³ calling for:

- Investment in livelihoods approaches that go beyond a focus on resources and technology alone
- The participation and shared understandings of all stakeholder groups to build community capacity, trust and ownership, and
- Livelihoods approaches and analysis to be a bridge between communities and policy-makers in the assessment of the impact of decision-making processes and policies on people.

4.2.3 Identifying appropriate entry points

Through a consideration of people's needs and priorities, livelihoods-based approaches can therefore help better identify:

- i) whether mariculture interventions are appropriate, and
- ii) if so, can they help identify appropriate low-risk, entry-points where coastal communities including women can become involved in mariculture activities and where they can receive maximum benefits (Gonzales, 2006; Maung Soe, 2006; Mukherjee, 2006; Nguyen, 2006; Suspita, 2006).

They can also help identify the most suitable livelihoods along the mariculture market chain, and can often recognize potential income-generating opportunities such as backyard hatcheries and feed production.

4.2.4 Integrated coastal management approaches

The increase in mariculture production and trade of marine products also presents a challenge to ensure sustainable development and that a balance is preserved between valuable ecosystems and reducing poverty is preserved (Macfadyen et al, 2003). The Indian Ocean tsunami has brought issues such as coastal planning, resource use and potential resource use conflicts into the spotlight and there is continued interest in the issues concerned with coastal management. As a result, it is widely accepted that the introduction of mariculture practices should be part of a coherent wider program of intervention in coastal resources management, and that these programs should involve the participation of resource users in the design of interventions along with partnerships with relevant institutions (Haylor et al, 2003). Effective management is key, though sometimes inadequate across the region. Improved community-based coastal resources co-management is encouraged in collaboration with government and private sector and aimed at addressing the lack of integration of mariculture in development plans. Such approaches can be consolidated under well-managed Marine Protected Areas (MPAs) (Box 8). MPAs are internationally recognized and in operation throughout Asia-Pacific (Briggs, 2003; IUCN, 2003b; Gonzales, 2006; Santos et al, 2003; Suspita, 2006; Nguyen, 2006).

4.2.5 Pro-poor trade approaches

It is clear that the international trade in seafood products and the associated seafood market chains within each country offer many opportunities for the inclusion of poor people and the improvement of their livelihoods. However, there is a low level of awareness regarding this key finding. The importance of the seafood trade needs to be much more widely appreciated along with a greater awareness of the role it can play in poverty reduction (Macfadyen et al, 2005). Trade issues and market chain analyses need to be incorporated into poverty reduction strategies, including those focused on mariculture development. The capacity of development of country governments and

³ The FAO-NACA Regional Workshop on Aquatic Resources and Livelihoods: Connecting Policy and People, 17-19 March 2005 in Los Baños, Philippines.

fisheries administrations also needs to be supported for them to be more proactive in engaging with international trade issues to ensure that trade is beneficial to small-scale and poor producers, rather than being reactive to problems once they have occurred. Such capacity-building could involve improvement in trade negotiation skills, product quality issues, developing and following through marketing strategies and promotional tools, analysis and understanding of people's livelihoods and how best to support them and improve policies, how to adapt to health and safety measures in export markets, and monitor and respond to on-going developments in trade, methods of dissemination of trade-related information and support to all links in the market chain. Other key recommendations for improved pro-poor trade in Asia-Pacific are given below (Box 9).

Box 8 Mariculture parks

Promotion of mariculture parks is one strategy through which BFAR intends to create livelihood opportunities for coastal communities and increase fish production. A mariculture park is described as "an industrial estate put in the sea for the fishing industry?" where infrastructure (a pre-developed area complete with a road network, power, water and communication lines) and utilities (mooring system) are provided by the government and mooring space is leased to investors. The first mariculture park was formally inaugurated in August 2001 in Samal Island in Davao Region (Gonzales, 2006).

Box 9 Key policy recommendations for improved pro-poor trade in Asia-Pacific

- The importance of trade in aquatic products needs to be more widely appreciated.
- The capacity of Fisheries Departments should be developed on issues such as trade negotiations, promotion and extension.
- Capacity in local-level organizations should be developed.
- Traceability of products must be encouraged.
- Development of fishery policy and trade policy must be participatory and include poor stakeholders and their representatives.
- Support improved communications regarding international trade including raising awareness on the impacts of trade barriers.
- Pro-poor trade policy implementation must be backed up by wider local management of resources and good governance initiatives.
- Greater support for pro-poor trade research.
- Establish preferential tariffs for socially certified products.
- Focus on quality and reliability of supply.
- Support detailed studies on the impacts of certification schemes and the potential of poor stakeholders to be marginalized by these needs to be recognized.
- Governments and donors should work through NGOs and their associated networks to reach poor stakeholders.
- Governments in Asia should examine whether parts of the international market chain can be encouraged to relocate to Asia.
- Support the increased availability of micro-finance.
- Complementary activities of those engaged in trade who remain poor should be investigated.
- Occupational health and safety issues should be incorporated in any eventual certification schemes.

(Macfadyen et al, 2005)

5 Conclusion

In conclusion, small-scale fishers and poor coastal communities in Asia-Pacific that traditionally relied on coastal capture fisheries as a cheap source of animal protein are faced with an increasingly competitive and declining capture fisheries sector, associated with increased food insecurity and unsustainable fishing practices. Therefore, there is a need to support diversified coastal livelihoods and promote alternative and sustainable income-generating activities and sources of affordable fisheries products. Mariculture and the international trade in fishery products hold a great deal of

potential towards achieving this. There are a wide range of small-scale mariculture-based technologies and practices available and in operation throughout the region. However, the livelihoods of poor coastal communities and people are complex and subject to particular vulnerabilities and risks which often lead to an increased level of marginalization, and the failure of mariculture activities. For mariculture and the international trade in aquatic products to be truly pro-poor, a broad-based, people-centered approach is needed to:

i) understand coastal livelihoods more completely, and

ii) identify context- specific and appropriate mariculture entry-points that could be adopted as alternative income-generating activities. These livelihoods-based approaches could be incorporated into recognized and established integrated coastal management plans and policies such as MPAs to reduce resource use conflicts and encourage sustainability. Finally, although the international seafood trade has been recognized as an important source of employment and income for poor coastal communities and in particular women, there needs to be more awareness generated regarding its pro-poor potential and more focus in this area by development strategies, government policy and institutions. This could include building the capacity of government and local-level institutions in understanding and dealing with issues specific to the trade in aquatic resources.

Appendix I Target communities and stakeholders identified by the country reviews

Country/Commodity	Target Communities	
India⁴		
Shrimp culture	Farmers and workers, feed and seed suppliers	West Bengal, Kerala, Andhra Pradesh, Tamil Nadu and Karnataka states
Traditional rice-shrimp culture	Small-scale farmers and fishers and women	Coastal lowlands (Pokkali fields in Kerala, Khar lands in Goa, Khazans in Karnataka State and Bheri in West Bengal)
Green mussel farming	Small-scale farmers and fishers and women	
Lobster fattening	Small-scale farmers and fishers and women, seed and feed suppliers	
Crab farming	Small-scale farmers and fishers and women	
Edible oyster culture	Small-scale farmers and fishers and women	
Seaweed culture	Small-scale farmers and fishers and women	
Indonesia⁵		
Tambak mariculture	Ethnic groups	
Intensive mariculture	Migrant workers	
Seed collectors		
Seaweed culture	Farmers, women	Beksi District, Bali (US\$ 0.30-0.60 month per household), Palu Bay, Central Sulawesi
Pearl culture	Low-paid cleaners	
	Crafters of discarded shells	
Mud crab culture	Farmers	
Mussel culture (<i>Perna spp.</i>)	Farmers	
Fisheries extension	Women in extension, research and education	
Myanmar		
Shrimp fry collection	Fry collectors, women and children	Rakhine State
Mud crab and grouper cage farming	Cage farmers	Rakhine State
Shrimp culture (extensive, extensive plus and semi-	Small-scale operators, caretakers, pond preparation laborers, harvest and post-harvest laborers, sorters, buyers, traders and exporters	Rakhine State, Yangon, Tanintharyi Division

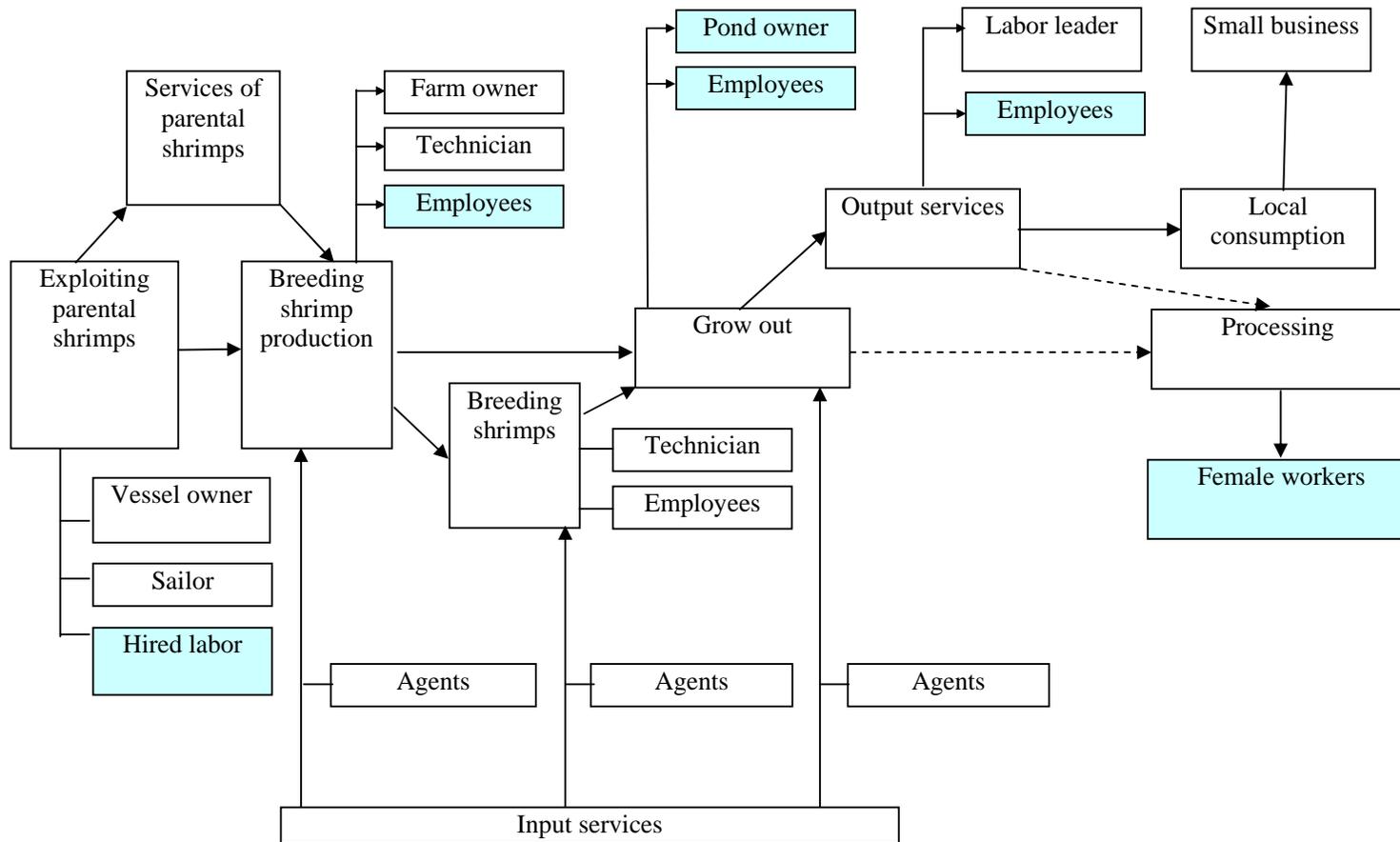
⁴ Coastal communities of Tamil Nadu, Chennai, Pondicherry, Andhra Pradesh, Orissa and West Bengal and scheduled castes and tribes

⁵ Many people not listed as fishers are at least part-time harvesters of marine organisms

intensive)		
Shrimp hatcheries	Operators, caretakers, tank cleaners	27 shrimp hatcheries, 12 run by DoF and 15 private
Grouper cage culture	Small-scale operators/farmers and grouper fry collectors (700 to 800 fishers)	Southern, western parts of Myanmar: Myeik archipelago and Gwa township Ayeyarwady and Tanintharyi divisions
Sea bass (<i>Lates calcarifer</i>) pond culture		Ayeyarwady and Rakhine states
Mud crab fattening in ponds and cages and feed preparation	Farmers and women	Myeik
Collection of live lobsters (<i>Panulirus</i>) and <i>squilla</i> or mantis shrimp	Collectors and buyers	
Mother of pearl culture	Hired laborers, divers and cleaners	Myeik and Tanintharyi divisions
Post-harvest activities	Women	
Philippines		
Milkfish cage operation	Small-scale cage operators, caretakers, extra feeder, pre-operation workers/laborers, small-boat operators delivering farm inputs, fish vendors and viajeros	Bolinao, Anda na Sual in Western Pangasinan, Central Pangasinan, Masinloc-Palauig areas in Zambales; Santo Tomas in la Union, Quezon, Cavite, Negros Occidental, Samal Island in Davao
Seaweed farming in coastal waters	Small-scale farmers, women, farmers associations, producers and traders association, seed suppliers, buyers, processors and exporters	Tawi-tawi in ARMM, MIMAROPA, Zamboanga Guimaras Island, Panagatan and Caluya in Antique in Western Visayas
Oyster and mussel farming	Farmers and women	
Fish and seafood trading	Fish vendors, peddlers and women peddlers	
Grouper cage culture	Small-scale operators, small buyers and seed suppliers	Day-asan, Surigao, CARAGA in northeastern Mindanao, Eastern, Western and Central Visayas, Pangasinan, Cavite, Mindoro, Quezon, Masbate, Bulacan, Cagayan, General Santos, Zamboanga del Sur and Bais City in Negros Oriental
Wild fry collection	Fry collectors, concessionaires and other middlemen	Cabangan, Botolan in Pangasinan, Cavite, Mindoro, Quezon, Masbate, Bulacan, Cagaya, General Santos, Zamboanga del Sur and Negros Oriental

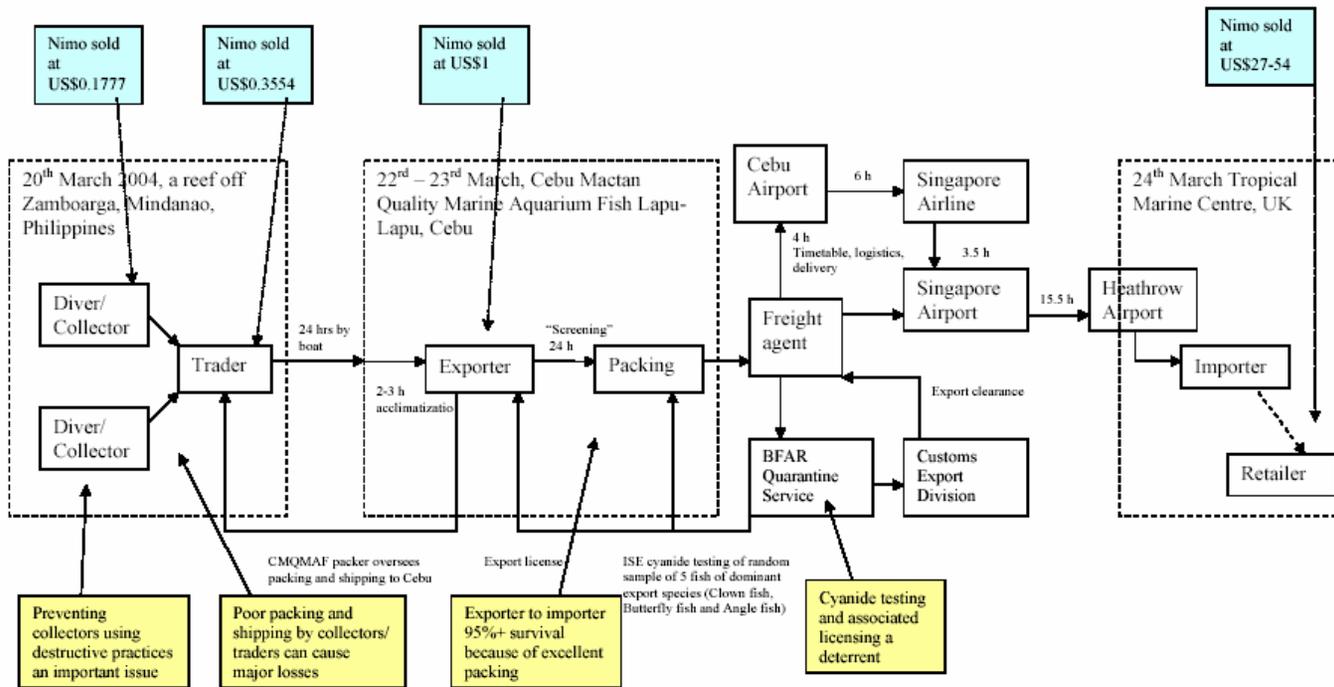
Shellfish gleaners and seafood vending	Women and children	
Live fish, ornamental fish collection	Grouper collectors, ornamental fish collectors, abalone, sea horse, sea cucumber collectors (seasonal), seasonal octopus fishers, packers, women packers and children running errands in 'financiers' facilities	
Commercial fishing	Captain and crew	
Vietnam		
Agriculture and animal husbandry	Crop farmers, migrant workers, hired laborers, livestock and poultry raisers	
Aquaculture products processing	Women	
Commercial fishing	Hired workers	Receiving US\$ 13.33 per trip
Hatcheries	Hired workers	Income = US\$ 33.33-40
Shrimp farming (<i>P monodon</i> and <i>vannamei</i>)	Small-scale operators, shrimp farm employees, feed suppliers, fry suppliers	Income = US\$ 33.33-40
Shrimp processing factory (seasonal; working 12-15 hours per day during peak season)	Hired factory workers and women workers	Income = US\$ 1.67 per day State-owned = US\$ 23.33-80
Fish and lobster sea cage farming	Small-scale farmers, landless people	Khanh Hoa benefited
Shrimp-mangrove farms	Farmers	Mekong Delta
Cage culture		Bai Tu Long and Ha Long bays
sMollusks, crab, seaweed farming		Long An to Ca Mau

Appendix II The market chain for shrimp in Thua Thien Hue, Vietnam⁶ (From Macfadyen et al, 2005)



⁶The blue shaded areas indicate potential roles for income-poor stakeholders.

Appendix III Trading *Nimo* - the market chain of marine ornamentals from Mindanao to Manchester



From Macfadyen et al, 2005

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