Fisher Livelihoods in Southern Thailand: Sustainability and the Role of Grouper Culture

By

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Abstract

The sustainability of grouper culture as an alternative livelihood option for coastal fishers was investigated in the southern provinces of Thailand. A sequenced approach using qualitative and quantitative research methods was used to explore factors that could undermine the potential for grouper culture to contribute to a sustainable livelihood.

A study was initially conducted in 28 villages in 6 provinces in southern Thailand to provide baseline information on grouper aquaculture and fisheries, focusing on culture practice, the actors and institutions involved in grouper culture and beneficiaries. Factors contributing to the variation in levels of uptake of grouper culture between provinces was explored. This initial overview facilitated the description of the grouper culture system in terms of its boundaries, hierarchies, interconnections and processes and the development of a framework for the assessment of the sustainability of the grouper culture system.

A case study approach was used to investigate in-depth the role and sustainability of grouper culture at the community and household level. Three communities were selected for study in Trang and Satun provinces. Research was guided by the sustainability assessment framework, which comprised five components: Livelihoods, Institutions, Environment, Markets and Production Systems. Data was collected using qualitative, participatory methods and a quantitative survey.

The research found that grouper culture has the potential to contribute to a sustainable livelihood for coastal fishers in southern Thailand, although problems with fish disease and mortality, fluctuations in the availability of seed fish and water quality undermine the ability of most farmers to obtain the maximum benefit from grouper culture. Non-technical factors including motivation and incentive, access to financial capital and levels of social capital were also observed to influence sustainability of grouper culture. Grouper culture was found to be an activity in which members of all wealth groups could participate with institutional support, access to credit, and access to wild sources of seed and feed. It is unlikely to provide a suitable *alternative* to fishing, as the two activities contribute in different ways to the livelihoods of coastal households, but may support livelihood diversification.

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Abbreviations

AIT	Asian Institute of Technology, Pathum Thani, Thailand
BAAC	Bank of Agriculture and Agricultural Cooperatives, Thailand
BOBP	Bay of Bengal Programme. Regional technical and management advisory programme established by the FAO in 2003
DOCD	Department of Community Development
DOF	Department of Fisheries, Thailand
FAO	Food and Agriculture Organization of the United Nations
FIGIS	Fisheries Global Information System provided by: Fishery Information, Data and Statistics Unit (FIDI) of the FAO
HH	Household
INFOFISH	Intergovernmental Organization providing marketing information and technical advisory services to the fishery industry of the Asia-Pacific region and beyond. Launched in 1981 by FAO.
IUCN	International Union for the Conservation of Nature and Natural Resources or 'World Conservation Union'
LIC	Low Income Country
LRFT	Live Reef Fish Trade
NGO	Non-Governmental Organisation
NICA	National Institute of Coastal Aquaculture, Songkhla, Thailand
NOS	National Office of Statistics, Bangkok
PRA	Participatory Rural Appraisal
RIT	Rajamangala Institute of Science and Technology, Trang
SARS	Severe Acute Respiratory Syndrome
SCAT	Social Capital Assessment Tool
SEAFDEC	Southeast Asian Fisheries Development Center
SSFD	Small-Scale Fisheries Development Programme
SL	Sustainable Livelihood
THB	Thai Baht
TL	Total Length
WCED	World Commission on Environment and Development

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Introduction and Literature Review

1.1 Introduction

In recent years, the potential impacts of aquaculture industries upon the environment and associated social systems, notably the salmon and shrimp producing sectors, has called into question the 'sustainability' of this expanding industry. As economic sectors are responding to the call for greater convergence of economic and environmental interests coming from the Brundtland report (WCED, 1987) and the subsequent development of Agenda 21, researchers and practitioners are now facing the challenge of defining and implementing sustainability in aquaculture.

Defining the concept of sustainability has been a major stumbling block in the practical application of the concept to new and existing projects and economic activities. The original concept of sustainability and 'sustainable development', as espoused by the World Commission on Environment and Development (1987) arose in response to an increasing awareness that economic development is having deleterious impacts on the environment, with subsequent negative impacts on human health, social well-being and the ability of future generations to meet their needs. Consequently, definitions of sustainability have sought to capture the multi-faceted nature of the concept primarily by encompassing economic, environmental and social considerations.

Sustainability in aquaculture is receiving increasing attention. Emphasis is placed on policy development and the production of guidelines for sustainability, based on general definitions of what sustainable aquaculture might mean. The majority of approaches and discussions may be divided in to three principal categories: those that focus on the negative environmental impacts of aquaculture; those that place emphasis on the sustained economic viability of production systems based on the continued appropriation of input resources, and on the growth of the commercial aquaculture sector; and most recently a more holistic approach which addresses the integrated nature of the components which make up an aquaculture system, which is more closely allied to the multi-dimensions attributed to sustainability itself.

In a development context, the concept of 'sustainable aquaculture' is often to be found associated with that of 'sustainable livelihoods', as development agencies and national governments seek to conserve natural resources whilst simultaneously improving the livelihoods of fishers. In the tropical coastal environment, sustainable aquaculture is promoted as a solution to alleviate pressure on reef fisheries by providing an alternative livelihood for coastal fishers engaged in destructive fishing practices.

Throughout South East Asia, both governmental and non-governmental organisations have promoted, and continue to promote, the development of marine cage aquaculture, particularly of the groupers. Grouper aquaculture has also undergone expansion in recent years in response to increasing demand for fish to supply the international trade in high value live reef fish. The live reef fish trade (LRFT) is widely regarded to have led to declines in coral reef fish and concomitant degradation of coral reef environments. 'Sustainable aquaculture' is therefore proposed as an alternative source of fish for the LRFT and as a means to reduce the extent to which destructive fishing practices are used to supply the trade. However, the sustainability of grouper culture as an alternative livelihood to fishing has not been evaluated although a number of characteristics of grouper culture, including the dependence of culture on wild seed and the nature of the international live reef fish trade which drives production, could undermine the sustainability of grouper culture, and with it the livelihoods of those who depend upon it, in the long-term. Furthermore, little is understood of the role that aquaculture could play in fisher livelihoods and hence the appropriateness of its promotion.

This study aims to address these issues by assessing to what extent grouper culture is 'sustainable' and whether it has the potential to provide a *sustainable* livelihood option for coastal fishers.

The study was conducted in Thailand, one of the top producers of grouper in the world. Production is reported to be growing rapidly in Thailand(Pomeroy et al. 2002) although it remains small scale, providing fish for a primarily regional market, particularly in Hong Kong, Malaysia, Singapore, Taiwan and the domestic market in Thailand (Ruangpanit 1999). Statistics show that Thailand was the third most important producer of grouper in 2001, after Taiwan, where production includes hatchery produced seed, and Indonesia. Thailand is also one of the top ten fishery nations in the world. In 1997, 530 401 people were involved in the primary sector of the

fisheries industry in Thailand (FAO 2001). The Thai government has promoted grouper culture as a livelihood option for fishers in coastal communities, in order to discourage the practice of destructive fishing activities, and to provide an additional livelihood option for households. Thailand therefore provides a suitable location in which to explore the way in which grouper culture has developed, the role it plays in the livelihoods of coastal fishers and its sustainability.

This chapter begins by reviewing the concept of sustainability and its application to aquaculture (Section 1.2). Then follows an overview of aquaculture and the driving forces for and interpretation of sustainable aquaculture, presented in Section 1.3. Section 0 introduces the concept of sustainable livelihoods followed by a review of the key issues in fisher livelihoods and the potential role of aquaculture. This is followed by an introduction to the geography, demographics and back ground to the fishing industry in Thailand (Section 1.6) together with an overview of grouper culture and the LRFT. The review is summarised in Section 1.8 before the research objectives are presented in Section 1.8.2.

1.2 Sustainability and aquaculture

1.2.1 Sustainability: a meaningful definition?

> *'Sustainability has emerged as an umbrella under which a large number of movements with widely disparate reform agendas have been able to march while avoiding confrontation over their often mutually inconsistent agendas.'*
>
> (Ruttan 1994)

Understanding sustainability

One of the principal criticisms of the concept of sustainability, which hinders its ability to provide practical guidance for environmentally and socially aware development, is the lack of a clear definition over which consensus can be reached. As such, its interpretation remains context specific, an attribute that some authors find to be in its favour (e.g. Sneddon 2000). As Sneddon (2000) notes, 'context specificity forces the crucial questions: what exactly is being sustained, at what scale, by and for whom, and using what institutional mechanisms?', going on to comment that sustainability, as opposed to sustainable development, 'has not yet suffered the same degree of co-optation by solidifying into a unilinear, mainstream interpretation.' However, the contrary argument might also be presented, as evidenced by the proliferation of projects and corporate-imaging that

incorporate some notion of sustainability, as by doing so creates an image of environmental and social soundness that is often lacking in substance.

Yet, despite the ambiguity of the sustainability concept, if 'sustainable aquaculture' is a goal to be achieved, the goal must be defined, and thus requires some interpretation of what sustainability is.

Costanza and Patten (1995) point out that the basic idea of sustainability is relatively straightforward, requiring that something persists or survives. Furthermore, any definitions are essentially no more than predictions of what one might hope will lead to sustainability, assessment must wait until after the fact (Costanza and Patten 1995). There is, however, scope to learn from past and current activities, with the possibility of providing informed guidance and predictions for the future.

Sustainability as a multi-dimensional concept

Temporality lies at the heart of the sustainability debate. If a system is to persist or survive, over what time scale will it be considered to be sustainable? As some would argue that sustainability means 'sustainability forever' an alternative argument suggests that sustainability means a lifespan that is consistent with the systems time and space scale. It is therefore important to differentiate between changes due to normal life span limits and changes that cut the life span short (Costanza and Patten 1995.

Temporality is one dimension of what is acknowledged as the multidimensional complexity of sustainability. The appreciation of the numerous factors to be considered for an understanding of sustainability has arisen primarily as a result of the ecological focus of the sustainable development debate and the subsequent recognition of the role of social and economic factors in environmental degradation.

Sustainability in the context of sustainable development is characterised by its many dimensions. These dimensions are often described in terms of capital stocks. In an economic context, in which the term has its origins, 'capital' is 'human-made' or 'manufactured' generated by economic activity. The concept has now been extended to incorporate 'natural capital' and 'cultural capital'.

'Capital'

Capital comprises the stock of man-made capital – machines and infrastructure such as housing and roads – together with the stock of knowledge and skills, or human capital. But it also comprises the stock of natural capital including natural resources (oil, gas, coal), biological diversity, habitat, clean air and water and so on. Together, these capital stocks comprise the aggregate capital stock of a nation. (Pearce 1993p.15)

'Natural Capital'

Consists of three major components: (1) non-renewable resources such as oil and minerals that are extracted from ecosystems, (2) renewable resources such as fish, wood and drinking water that are produced and maintained by the processes and functions of ecosystems, (3) environmental services such as maintenance of the quality of the atmosphere, climate, operation of the hydrological cycle including flood controls and drinking water supply, waste assimilation, recycling of nutrients, generation of soils, pollination of crops, provision of food from the sea, and the maintenance of a vast genetic library.(Berkes and Folke, 1992)

'Cultural Capital'

Refers to factors that provide human societies with the means and adaptations to deal with the natural environment and to actively modify it: how people view the world and the universe; environmental philosophy and ethics, including religion; traditional ecological knowledge; and social/political institutions. Cultural capital includes the wide variety of ways in which societies interact with their environment; it includes cultural diversity.(Berkes and Folke, 1992)

The most commonly cited definition of sustainable development, which pushed the notion of sustainability into the global arena in 1987, is that given by the World Commission on Environment and Development in the Brundtland Report, '*development which meets the needs of the present without compromising the ability of future generations to meet their own needs'*. As Pearce (1993) notes 'sustainable development is about ensuring that some measure of human well-being is sustained over time'. The mechanism by which this may be achieved is through the transfer of capital bequests, leaving the next generation a stock of capital no less than the present generation has now (Pearce 1993).

Strong and weak sustainability

The degree to which different forms of capital are interchangeable in the context of sustainability is described by the concepts of 'weak' and 'strong' sustainability. Weak sustainability is based upon the 'constant capital rule', which requires that, unless there are special reasons for singling out one form of capital, sustainable development can be achieved by passing on to the next generation an aggregate capital stock no less than that which exists now (Pearce 1993). Weak sustainability means that we are not concerned with the form in which we pass on capital stock, and assumes that the forms of capital are completely substitutable. As long as the overall aggregate of natural and man-made capital does not decline between one generation and the next, the stock of natural assets can

decline because the growth of man-made capital will compensate for it (Pearce 1993). Within the weak sustainability interpretation of sustainable development the environment is simply another form of capital.

An alternative approach suggests that natural capital should not decline with time and that the next generations should inherit at least a similar natural environment. 'Strong' sustainability has an environmental focus, highlighting the limited nature of substitution between natural and man-made assets. In reality, the notion of substitutability is limited. Many environmental services provided by natural capital are essential to human survival, the ozone layer for example, and are not substitutable. Pearce (1993) has suggested that essential ecological assets are designated as critical natural capital, and supports the adoption of the strong sustainability view. Uncertainty, promoting a precautionary approach, and irreversibility of loss of capital, are also important considerations in support of strong sustainability.

Sustainability – a brief summary

In summary, there can be some agreement on the general nature of the sustainability concept:

- it is context specific, and requires that questions should be answered with regard to what is to be sustained, why, for how long and how will sustainability be measured?
- Sustainability is a temporal concept. Consideration should be given to the time-scale of sustainability.
- Sustainability is predictive, rather than prescriptive.
- It is multi-dimensional, incorporating a minimum of three components: social, economic and environmental
- Weak and strong sustainability advocate varying degrees of capital substitutability

1.2.2 Aquaculture and the driving forces for sustainability

Aquaculture, as it is practiced today, is the legacy of a long history dating back more than 2500 years. Its origins can be traced back to the flood-prone environments of China, and to Egypt, where fish were associated with rebirth and the life-giving forces of the Nile (Beveridge and Little

2002). Aquaculture has, since these ancient beginnings, developed on every continent, and includes the culture of more than 210 species, raised in a diverse number of culture systems in every type of aquatic environment.

Aquaculture defined

Aquaculture may be defined as 'the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants with some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated.' (FAO). Boyd and Schmittou (1999) put forward a slightly more straightforward definition, stating that 'aquaculture is simply farming in water. It is the science and art of farming or managing aquatic ecosystems to produce crops of animals and plants for profit'.

Current state of aquaculture production

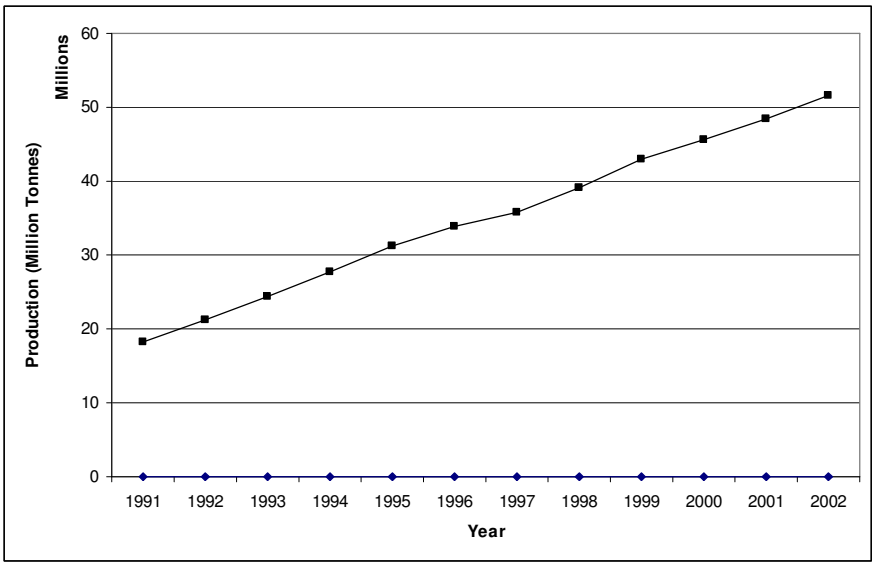
Aquaculture is currently one of the fastest growing food producing sectors in the world. In 2000, the sector was growing at a rate of more than 10% per year, surpassing both terrestrial livestock meat production and capture fisheries, which increased at rates of 3% and 1.5% respectively (FAO 2000). Together, production from capture fisheries and aquaculture provides more than 15% of total animal protein for the global population. Total aquaculture production in 2002 reached 51.6 million tonnes (Figure 1-1). Although marine and brackish water aquaculture production receives the majority of media and public interest, production from freshwaters accounts for 44.5% of aquaculture production (Table 1-1). Asia dominates production of the aquaculture sector, with China the largest aquaculture producer. In 2002, 36.6 million tonnes of aquatic animals were produced by Chinas aquaculture producers (Table 1-2).

Aquaculture: the costs and the benefits

Aquaculture has the potential to make an important contribution to society in a number of ways:

- As a contributor to food security
- As a provider of employment
- As a means of income generation
- As an alternative to capture fisheries for a source of fish protein

Figure 1-1 World Aquaculture production of fish, molluscs and crustaceans, 1991-2002



Source: FAO, provided by FIGIS 2002

Table 1-1 Aquaculture production by aquatic environment, 2002

Environment	Production (million t)	% of total production	Growth rate 1992-2002	Major species types
Freshwater	23	44.5 %	61.4%	Silver carp, grass carp, other carps
Brackishwater	2.4	4.7%	37.7%	Shrimp and milkfish
Marine	26	49.8%	58.3%	Seaweeds (Japanese kelp) and molluscs (Pacific cupped oyster)*
Total production	51.6			

Source: FAO (FIGIS)

* Production given in live weight (high water content of seaweeds and heavy shells) so gives a impression they are greater sources of food and employment than they are (FAO 2000)

Table 1-2 Aquaculture production -major producing countries 2002 (Source: FAO (FIGIS))

Country	Production (thousand tonnes)	Value (million US$)
China	36 576	32 827
India	2191	2538
Japan	1386	4600
Philippines	1338	695
Indonesia	1137	1455
Korea Rep.	794	778
Bangladesh	786	1126
Thailand	644	1436
Chile	617	1681

The Brundtland report by the World Commission on Environment and Development, published in 1987, recognised that food security arises not as a result of insufficient food production – between 1950 and 1985 cereal production outstripped population growth reaching over 1,800 million tonnes – but as a result of regional differences in production, and a lack of policies which ensure that food

is produced where it is needed and in a manner that sustains the livelihoods of the rural poor (WCED 1987, p118). Global food security relies also on employment, to ensure that all people can either produce or purchase food. Unemployment and underemployment are recognised as important factors at the heart of the hunger problem in many countries (WCED 1987, p129). Aquaculture represents one strategy put forward by the WCED (1987), and endorsed through Agenda 21 (Chapter 17, sections 17.79 and 17.85), to tackle issues of food security, as it has the potential to provide both protein and employment.

In developing countries, aquaculture provides an increased supply of affordable fish on the market or to producing families (Ahmed and Lorica 2002; Bailey 1997). In many countries in Africa and Asia, fish provide at least 14% of dietary animal protein (Edwards 2000). Based on studies carried out in countries where aquaculture has been adopted on traditional agriculture farms, such as Bangladesh, China, India, Indonesia, Thailand and Vietnam, Ahmed and Lorica (2002) identified linkages between the adoption of aquaculture and positive income and consumption benefits. In providing income, food and employment, aquaculture contributes directly to the livelihoods of the poor (Edwards 2000). However, there remains the issue of whether emphasis should be placed on a luxury, export oriented market (producing high incomes for producers and hard currency from exchange earnings) or to meet the nutritional needs of the population (Bailey 1997).

1.3 Sustainable aquaculture

In comparison to agriculture, its terrestrial counterpart, both aquaculture as an industry and the associated interest in sustainable aquaculture are relatively recent developments and the growth of the industry has been coincidental with increased social awareness of the environmental consequences of development (Pillay 1997). In the last two decades, as both aquaculture and sustainability have grown in importance, the way in which the concept of sustainable aquaculture is interpreted has developed from a relatively narrow focus on the environmental interactions between aquaculture and the wider environment, to a more holistic approach to sustainability in which social issues are receiving progressively more attention. Interpretations of sustainable aquaculture can therefore be classified according to three principal approaches:

1. Environmental approach to sustainable aquaculture

2. Bio-economic approach to sustainable aquaculture
3. Holistic approach to sustainable aquaculture

1.3.1 Environmental sustainability

The need for a 'sustainable' approach to aquaculture has arisen primarily from the perceived impacts of aquaculture on the wider environment. The boom and bust years of shrimp aquaculture during the 1980's and early 1990's led environmental groups to call for a complete ban on shrimp farming, which was held responsible for the destruction of large areas of mangroves (Beveridge et al. 1997; Phillips et al. 1993, in Beveridge et al 1997) and impacts on local communities, small farmers and food security (Bailey 1988; Primavera 1991). Salmon farming, another form of industrial aquaculture, also came under public scrutiny as farms altered the physical, chemical and biological properties of their surrounding environment, and came into conflict with other resource users. Approaches to sustainable aquaculture frequently emphasise *environmental* sustainability or, more simply, the relationship between aquaculture activities and the natural environment, which can be categorised as:

1. environmental impacts of aquaculture on the surrounding environment
2. environmental impacts of aquaculture upon aquaculture
3. environmental impacts of other economic activities and resource use upon aquaculture

(Barg and Phillips 1997)

The goal of environmental sustainability differs from that of sustainable development, in that it does not seek economic growth but merely a sustained level of production and consumption within the limits of the ecological carrying capacity and the indefinite maintenance of global life support systems (Goodland 1995; Goodland and Daly 1996). According to the definition of environmental sustainability put forward by Goodland (1995), environmentally sustainable aquaculture can be said to be concerned with the maintenance of environmental sink and source capacities, keeping waste emissions within the assimilative capacities of the environment without impairing it and maintaining the supply of required inputs for the future of the production system. Aquaculture is said to be unsustainable when the environmental goods and services that the environment provides are over-exploited (Beveridge et al 1997).

1.3.2 Bio-economic approach to sustainable aquaculture

Aquaculture is essentially an economic activity, carried out in order to generate a financial benefit for the operator. Economic benefits are considered in every aquaculture venture, whether the principal purpose of the systems creation is for social or economic purposes (Pillay 1997). Successful aquaculture requires attention and skills, which families in many developing countries cannot afford to devote to an activity which does not provide some economic return (Pillay 1997). The concept of environmental sustainability is therefore insufficient for most farm operations where economic sustainability is also a goal.

Economic sustainability is concerned with the maintenance of a continued benefit to aquaculture producers, and is inextricably linked with environmental sustainability when productivity is dependent upon the appropriation of environmental goods and services. The relationship between good farm management to reduce negative impacts on the environment, and the subsequent economic benefits which can result is therefore a key topic in sustainable aquaculture. For Boyd and Schmittou (1999), economic viability based on sound environmental management is the only valid objective of a sustainable aquaculture system. Defining a sustainable aquaculture system as 'an adaptable production technology system whose ecological and economic viability can persist indefinitely', they reject interpretations which include psychological, social and political factors. Proponents of this approach would argue that as long as the systems are profitable and maintain the environment, sustainability will eventually be achieved and humankind will automatically benefit, without the necessity of including a specific social objective within the development plan (adapted from Altieri 1989, p40).

Using an environmental approach to sustainability, strong sustainability favouring the preservation of natural capital in its original form would most likely be adopted. However, from a bio-economic perspective, aquaculture operators are likely to implement measures mitigating environmental impact only if it is economically worthwhile to do so. A position of weak sustainability might therefore be adopted which assumes that financial capital based on system productivity is a suitable substitute for the natural capital the system consumes. In reality, a trade-off is likely to be sought by policy makers and governments who seek to find a balance between a strong and weak sustainability approach, which exist along a continuum.

1.3.3 Holistic approach to sustainable aquaculture

A holistic, multi-dimensional approach seeks to incorporate the values encapsulated by the sustainable development paradigm within the concept of sustainable aquaculture. Based on the FAO definition for sustainable development (1998) (See Box 1), Insull and Shehadeh (1996) propose a framework for sustainable aquaculture which incorporates the following principles:

- Maintenance of ecological systems
- Improvement in economic and social well-being
- Inter-generational equity
- Intra-generational equity
- Adoption of the precautionary approach

Intended to be adopted at the level of national policy, these principles should promote the optimization of the aquaculture sector to the economic and social well-being of the nation (Insull and Shehadeh 1996). The incorporation of such principles therefore moves the sphere of interest from a production/profit driven interpretation of the interaction between aquaculture and its environment to a broader perspective which recognizes the inter-linkages between society, environment and economic activity. It contains within it a moral objective to manage the environment for the well-being of current and future generations, and steps beyond the boundary of the production system.

Box 1. Sustainable development defined.

'*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*'

WCED 1987

'*development which improves the quality of human life, within the carrying capacity of the earth's life support system'*

World Conservation Strategy (IUNC/UNEP/WWF 1991)

'Sustainable development is the management and conservation of the natural resource base, and the orientation of technological and institutional change in such as manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable'.

FAO 1998

The multi-dimensional nature of sustainability is therefore dictated by the defined goals for sustainable development. The definitions of sustainable development given in Box 1 assert that social objectives are of equal importance to economic and environmental concerns, in terms of well-being and equity for present and future generations. Addressing sustainable development from this broad perspective requires a move away from the traditional reductionist approach to aquaculture, which places emphasis on the scientific aspects of the production system, namely the aquatic environment and the animal or plant under cultivation (Edwards 1998), to a systems based approach. The study of the inter-linkages between environmental management, productivity and economics shows how aquaculture activities cannot be considered in isolation.

1.3.4 Sustainable aquaculture - summary

It is apparent from the points raised above that only a holistic approach to sustainability, and hence sustainable aquaculture, can meet the aims of sustainable development as set out by the WCED. The aim of sustainable development as given in Box 1 is in essence an aim to protect society, both now and in the future, from the potentially damaging impacts of economic development. Thus, to disregard any of the three principal components of sustainable development, social, economic or environmental, cannot adequately address sustainability. For this reason, the holistic approach to sustainable aquaculture will form the basis for the assessment of grouper culture sustainability in this study.

1.3.5 A systems approach

The discipline of 'systems' evolved out of Bertalanffey's generalised organismic thinking in the mid 1940s (the system theory of the organism) and the concept of 'organised complexity'. This theory is based on the existence of hierarchical levels of organisation within a given system, with each level being more complex than the one below, and possessing emergent properties which were not evident at the lower level of complexity (Checkland 1981).

Systems have been defined as 'groups of interacting, interdependent parts linked by exchanges of energy, matter and information' (Costanza et al. 1993). As such, systems science focuses on function and links, rather than individual organisms and processes. This approach was developed as a reaction to the nature of science, which 'assumes that the components of the whole are the same

when examined singly as when they are playing their part in the whole, or that the principles governing the assembling of the components into the whole are themselves straightforward'. In a systems view, the widest boundaries for practical purposes are set by the globe, which is essentially a closed system. Within this system, all subsystems are essentially open, to a greater or lesser extent. In order to be operational at an assessment level, the global system must be divided into subsystems, whilst acknowledging that this separation may affect the operation of these parts.

Approaching sustainability from this perspective permits the identification of subsystems, whilst still acknowledging the interlinkages which are absent from a reductionist approach. The difference is rooted in the three basic features which characterise systems:

- emergence – there are properties at a given level of complexity which can not be explained solely by reference to properties at lower levels of complexity (subsystems).
- Hierarchical control – higher levels of systems exert controls over lower level systems.
- Communication – material, energy and information – between higher and lower levels, in the form of information from lower to higher levels and feedbacks.

  (Stewart, 1995)

However, it cannot be denied that a systems approach may also be open to the criticism levelled at reductionism: simplification is inevitably required and any assessment of the component parts of a whole will never truly represent or predict the complex reality.

The systems concept has its origins in engineering, where it was developed as an approach to problem-solving in the development and management of complex engineered processes. This approach is described as a 'hard' systems approach and is characterised by the formulation of a system in terms of quantifiable relationships between component parts, in which communication and control (feedbacks) are deterministic and can be mathematically described (Stewart, 1995). The approach aims to provide a solution to a defined problem, and the study is goal-directed.

In many situations, particularly in social systems, the goal of sustainability may be ill-defined and obscure. Interlinkages may be non-linear and unpredictable. This lack of a clear definition of the problem in a 'soft'system made a hard systems approach inappropriate, and thus required the

development of a 'soft'systems methodology. The emphasis here is on learning, creating a cyclical process which is iterative, participatory and ongoing (Bell and Morse 1999).

Many features of sustainability place it within a 'soft' systems framework as 'there are never totally clear cut answers to any specific decision, but simply an ongoing process of resource management, and economic and social change' (Stewart, 1995). A soft systems framework is essentially ongoing in its process of re-evaluation and adaptation and lends itself well to sustainability assessments. For any system, multiple stakeholders can be identified, each with their own views and objectives for the development of the system (Chambers and Conway 1992). This is in accordance with a 'soft' systems concept, which must be defined ultimately by competition and consensus outside the relationships and processes that are scientifically and technologically grounded (Muir, 1996).

The definition of the system is essential to permit the identification of the components interacting within the system and the external factors that influence the system. The definition of the system in a sustainability context also allows us to determine what it is we are trying to sustain. As (Muir, 1996) states 'sustainability can be defined as the ability of a chosen system to persist in a given form (in terms of structure and behaviour) for a specified time period according to defined criteria.' Thus for aquaculture, at the level of the production unit and its methods of production various system characteristics can be defined and required to continue, both for existing activities and for future activities of the particular type (Muir, 1996). Muir (1996) has defined an aquaculture system as 'the interdependent elements of environment, physical structure, rearing process, resource use and socio-economic context which form the entity from which farmed aquatic organisms are produced.' The system is described using three key elements of the systems approach:

- Boundaries – which define the system and describe its context and nature. Elements inside the boundary interact to provide the system characteristics
- Interconnections and hierarchies – refer to the scale of the system and may comprise systems 'nested' within one another. Scale units are interconnected vertically, smaller units within larger ones, and horizontally, between system classifications e.g. socio-economic or bio-ecological classifications.
- Processes - the features which determine the behaviour of the system

The nature of systems analysis implies that interpretations of sustainability will differ according to the scale at which it is assessed. As Webster (1999) notes with reference to agricultural systems, when viewed as part of a global system, it is apparent that agricultural systems are embedded within a hierarchy ranging from the level of the enterprise, to the farm, regional/community level, national and global levels. As a result of interactions between different levels of the hierarchy, 'any operational definition of sustainability can only be regarded as an emergent property of a particular level within the hierarchy of agricultural systems' (Webster 1999). What is deemed to be unsustainable at the farm level may be sustainable when all farms are taken as aggregate at the national level (Webster 1999). The importance of scale is reflected in the agricultural literature, in which spatial scale has been presented as a hierarchy of enterprises, farms, plantations, regional and national agricultures (Spedding 1979, in Smith and Macdonald 1998), as a hierarchy of agro-ecosystems (Conway 1985), from the level of the cropping system to the supra-regional system (Izac and Swift 1994), and farm, regional, national and global scales (Smith and McDonald).

There are few examples of the application of systems in aquaculture, which has been put forward primarily by Muir (1996). Muir (1996) presents a review of the concepts of systems perspectives concerning aquaculture and draws on the concept of sustainability as a basis for a systems framework for aquaculture. Taking the notion of a continuum between weak and strong sustainability as a starting point, Muir (1996) describes a basic system comprising natural, cultural and manufactured capital. The tradeability between environmental goods and economic output, which may possibly be damaging, may still allow the overall criterion of sustainability to be met, which provides the 'overall theme on which a systems approach can be developed, and in which the role and potential of aquaculture might be discussed' (Muir 1996). To this basic structure is added a consideration of scale, from the specific (e.g. locality, community, or project-based) to macro-level (global, national, or ecosystem) suggesting that capital may be traded at a range of levels (Muir 1996). Table 1-3 shows the various scales which may be considered for aquaculture and water resource systems, grouped according to the processes within the system.

Nordone (1999) have grouped approaches to sustainability into two broad paradigms which are particularly relevant to the application of systems thinking, and which will be important concepts in the development of this thesis: resource sufficiency and functional integrity. Resource sufficiency

stipulates that a practice is sustainable when the resources needed to carry on the practice are available in the foreseeable future (Thompson and Nordone 1999).The functional integrity approach views production activities within a broad, complex system containing ecological and

Table 1-3 Scale hierarchies for systems related to aquaculture and water resources (Muir 1996)

Scale level	*Physico-chemical*	*Bioecological*	*Socioeconomic*	*Production*
Geo	Oceanic/climate system Hydrological cycle Ocean biogeochemical cycle	Biosphere Oceanic ecosystem Global species population	Global population Global economy International agency	Global food production Global fishery sector Global aquaculture
Macro	Catchment/watershed Coastal zone Large aquifer Large island or archipelago	Major biomass Large scale species assemblage	Region/large nation National political structure Major religion/ethic Major communications	Regional/national food, fishery, aquaculture sectors Species/system subsector Major producer group
Median	Main river section Lake, reservoir Smaller aquifer Coastal segment Small island	Community groups Populations General environmental change/impact	Small nation Governmental institution Large corporation Generic market	Producer organisation Production entity Production site Integrated equipment/ management assembly
Small	Stream, bank, bed unit Lake compartment/ mixing cell Sediment area	Family Inter-species Specific environmental impact	Small business Specific market Club,association	Holding unit/small site Equipment item Stock group
Micro	Local mixing cell	Individual	Family	Individual stock, feed Equipment sub-assembly
Nanno	Sediment particle Molecular process	Cell	Individual	Feed particles Equipment parts

social components. The system is sustainable when feedback mechanisms prevent the reproduction of crucial elements from increasing without limit or from disappearing from the system altogether (Thompson and Nordone 1999). The authors suggest that the latter approach is better able to represent the problems of spatial and temporal scale and the relationship between society and ecology and this in keeping with a systems approach. As such it presents a useful way in which to understand the critical thresholds of systems. Feedback mechanisms working within the system are identified through the development of an understanding of the inter-linkages and processes at work within the system. Potential perturbations in the system can then be determined and managed for the maintenance of system function. Under the functional integrity interpretation of sustainability,

which is adopted for the purposes of the current study, sustainability is not a static concept. Sustainable Livelihoods

1.4 Sustainable livelihoods and the livelihoods framework

As mentioned in Section 1.1, the promotion of sustainable aquaculture often goes hand in hand with that of sustainable livelihoods.

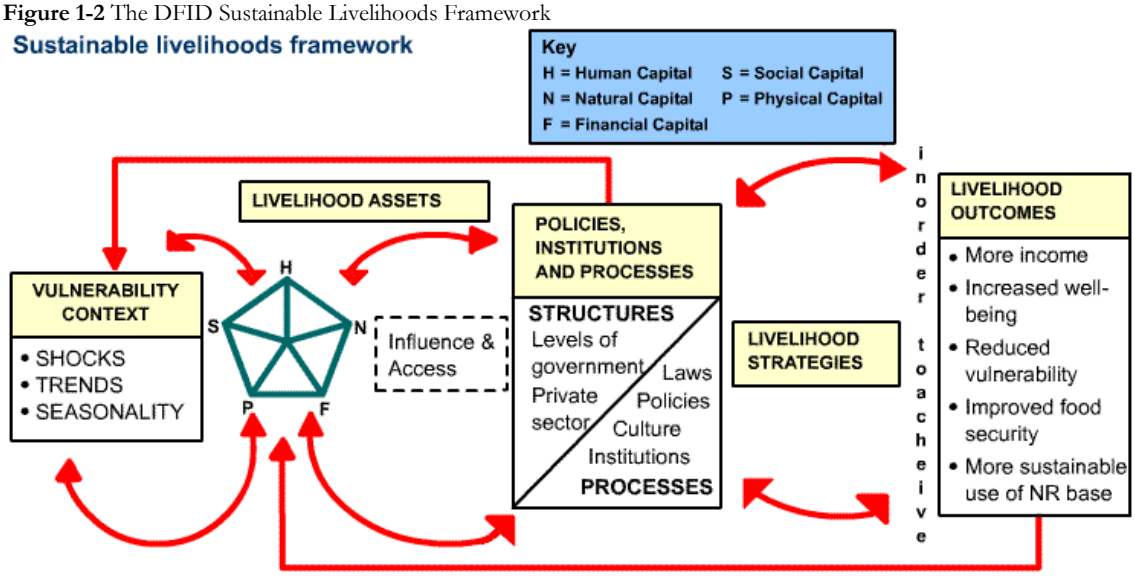
The term 'livelihoods' represents a relatively recent development in the understanding of what was previously referred to as 'socio-economics', and aims to incorporate the non-economic attributes of survival (Ellis 2000), recognising that income is only one aspect of poverty, as reported by the poor themselves (Chambers 1987, in Farrington et al. 1999). Poverty may also include: a sense of insecurity or vulnerability; lack of a sense of voice vis-à-vis other members of their household, community or government; and levels of health, literacy, education, and access to assets (Farrington et al. 1999). The Sustainable Livelihoods (SL) approach to poverty eradication therefore grew out of this awareness of the multi-faceted nature of poverty and aimed to address these problems holistically.

The concept of sustainable livelihoods (SL) originally grew out of an understanding of famine and food security in the 1980's (F. Ellis, in Hussein 2002), and has since been adopted by many agencies and organisations seeking a pathway to appropriate and sustainable development interventions (Hussein 2002). Chambers and Conway (1992) provide a popular definition of the concept, defining a livelihood as 'the capabilities, assets (including both material and social resources) and activities required for a means of living' (Chambers and Conway 1992). A livelihood is sustainable when 'it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base' (Chambers and Conway 1992).

At the core of the SL approach, as illustrated by the DFID framework and interpretation of the SL concept, are the key livelihood assets (human, natural, financial, social and physical); transforming structures and processes governing access to, and mobilization of assets; and the vulnerability context. The capability of a household to reduce vulnerability through livelihood and income

diversification is influenced by asset availability and factors influencing access to resources and uptake of new activities. These factors determine the livelihood strategies of the household, and may also dictate the success or failure of development intervention.

Figure 1-2 The DFID Sustainable Livelihoods Framework



Source: DFID Sustainable Livelihood Guidance Sheets (http://www.livelihoods.org/info/dlg/sect1/2/2_03.htm)

The framework describes a system in which aquaculture is one component, connected to other household activities, structures, processes, assets and resources through a series of inter-linkages.

An important distinction must therefore be made between sustainable grouper culture and the contribution of grouper culture to sustainable livelihoods in the context of the present study. The principle factor which distinguishes the two approaches is the scale of analysis. *Grouper culture sustainability* encompasses social, economic and environmental factors at a defined level in the system hierarchy. The unit of analysis when understanding the role of *grouper culture in sustainable livelihoods* is primarily the household. Here, the sustainability of grouper culture is assessed in terms of its contribution to asset maintenance and accumulation, impact on household vulnerability and the viability and continuance of grouper culture at the household and community level. Grouper culture as part of a sustainable livelihood therefore essentially represents one dimension of the concept of sustainable grouper culture.

1.5 Fisher livelihoods and the potential role of aquaculture

1.5.1 Challenging assumptions

Small-scale fisheries receive relatively limited attention in the fisheries science literature. However, amongst the literature that does exist, a number of key issues can be identified which appear to characterise and define the nature of small scale fisheries:

- Poverty
- Marginalisation
- Uncertainty
- Mobility

That small scale fishers are poor has long been expounded in the literature. For example, in 1974, FAO, with reference to fisheries, reported that 'the people engaged in these activities and their families continue, with few exceptions, to live at the margin of subsistence and human dignity' (FAO 1974).More recently, FAO (2002) presents data indicating that approximately 28 million people were employed in capture fisheries worldwide in 2000 (FAO 2002), of which 95% are reported to be small scale fishers (McGoodwin 2001). Approximately 20 percent of this total, or 5.8 million people, are reported to be small-scale fishers earning less than US$1 per day. FAO (2002) suggests the total number of income-poor people involved in the small scale fishery is approximately 17.3 million people if related activities such as boatbuilding, marketing and processing are also included, suggesting a figure of 23 million income-poor people, plus their household dependents, reliant upon small scale fisheries (FAO 2002). Income poverty is particularly high in Asia, where 84% of the world's poor fishers try to make a living.

This level of poverty has traditionally been ascribed to what Bene (2003) calls the 'old paradigm' of poverty in small scale fisheries, which is based on the perception that poverty in fisheries results from the over-exploitation of the natural resource base, due to its open access nature, where declining productivity leads to a reduction in fishery income and also food supply (Bene 2003). Thus, factors *endogenous* to the fishery are responsible for poverty (Bene 2003). An alternative view suggests that *exogenous factors* are responsible. This view attributes poverty to the lack of alternative occupations outside of the fishery sector, which force fishers to remain within the fishery. These

views have perpetuated one interpretation of poverty in fisheries, namely 'they are poor because they are fishers'. Fisheries are frequently also presented as an 'occupation of last resort' or as a 'safety valve' for the poor, allowing the landless poor, not traditionally involved in fisheries and pushed out of their own traditional occupations, to enter the fishery. This view thus generates the supposition that 'they are fishers because they are poor' (Bene 2003).

Allison and Ellis (2001) argue that solutions advocated to reduce problems of poverty and resource degradation in small scale fisheries 'have centred on the necessity to make small-scale fisheries more economically efficient, while finding means to conserve fish stocks through a combination of management to limit access and incentives for current participants to leave the fishery.' The adaptive responses of fishers to fluctuating resources and uncertainty have not been taken into account in fisheries management. Based on a review of the adaptive strategies of fishers, Allison and Ellis (2001) find that flexibility within fisheries, geographical mobility and livelihood diversification are key strategies for fisher livelihoods. Fishing households show a high degree of occupational mobility that has frequently been overlooked by policy makers, who seek to increase fisher incomes through an emphasis on increased fishing efficiency. The key to successful fisheries management, and the provision of appropriate strategies for improving fisher livelihoods, may therefore lie in an understanding of fisher adaptability and an emphasis of 'occupational pluralism' and the support of 'enabling institutions' (Allison and Ellis 2001).

Furthermore, the perception that fishing is a last resort and an occupation that fishers would leave if they were able is contested by McGoodwin (2001) and Pollnac et al. (2001). McGoodwin (2001) focuses attention on the culture of small-scale fishing communities, reporting that fishing as an occupation is often closely tied to fishers' personal and cultural identities. Fishing is regarded 'not merely as a means of ensuring their livelihoods, but as an intrinsically rewarding activity in its own right – as a desirable and meaningful way of spending one's life…prompting many fishers to tenaciously adhere to the occupation and to continue fishing even after it has become economically unrewarding.'(McGoodwin 2001). Pollnac et al (2001) present evidence in support of this view. In a study conducted in the Philippines, Indonesia and Malaysia, they found that, in all three countries, fishers like their occupation and only a minority would change to another occupation, with a similar income, if it were available. In the Philippines, 95% of fishers surveyed reported that they would

choose to become fishers again if they had to live their life over again. They also cited pleasurable aspects of the job as reasons for staying in the fishery, including the beauty of the sea and not having to work for a boss. Fishers in the three countries who would choose to leave the fishery were characterised by a higher level of education and a lower income from fishing. The results do not support the view that fishers are the poorest of the poor, as fishers cite income as one of the reasons for choosing not to change their occupation. The level of satisfaction with fishing as an occupation suggests that fishers will not necessarily change to an alternative occupation and leave the fishery (Pollnac et al 2001).

Tietze et el. (2001) also challenge the assumption that fishermen are the 'poorest of the poor' and that fishing is an 'occupation of last resort', finding that the annual household income of fisherfolk households was significantly higher that that of households in neighbouring agricultural villages.

Thus, efforts to reduce destructive fishing practices by encouraging fishers to leave the fishery may not be appropriate if fishers do not want to leave the fishery or if they are able to generate greater benefits from fishing than from alternative occupations such as aquaculture. Fishing also permits fishers to retain their occupational flexibility. Investment in a static aquaculture farm which requires regular maintenance and harvesting may reduce flexibility and mobility. However, aquaculture may have the potential to contribute to overall livelihood diversification.

1.5.2 Applying the livelihoods approach in a fisheries context

Allison and Ellis (2001) propose that livelihoods analysis may lead to a better understanding of the nature of small-scale fishery production systems, permitting the identification of appropriate entry points for development intervention or policy support for poverty reduction in small scale fisheries. However, the livelihood concept and its associated methodologies have so far been applied to only a limited degree in the fisheries context (Allison and Ellis 2001). In general, development efforts which apply the livelihoods concept to coastal fishing communities are still lacking.

However, an important point to have emerged from the literature on inland fisheries in Africa is the advantage of adopting a livelihoods based methodology to facilitate a multi-sectoral approach. Studies by Sarch and Allison (2001), Sarch and Birkett (2000) and Bené et al (2000) have shown that fishers participate in a wide range of activities that cross sectoral boundaries. According to Sarch

and Allison (2001) the SL framework provides 'the means of moving beyond these narrowly sectoral, production oriented and equilibrial views of small-scale fishers' and to assist in the 'understanding and interdependency of fishing and other livelihood sources.' The SL framework also draws attention to the institutional context in which the fisheries are set, permitting the investigation of institutional factors, including governance and policy and social networks, which may constrain or enhance mobility and diversification.

1.5.3 Contribution of aquaculture to household livelihoods

As described earlier, aquaculture may provide a number of benefits to households. However, few studies exist which provide specific evidence of the role of aquaculture in household livelihoods, and given the already restricted number of studies relating to fisher livelihoods, the specific role of aquaculture in fisher livelihoods appears to have not yet been investigated.

On the Lo River in Vietnam, the culture of grass carp was found to provide an important livelihood option for the poorest groups in six communes living on the banks of the Lo.A key finding of the study was the importance of grass carp culture as a source of savings for the household, which allowed resource poor, landless fishers to accumulate assets. The significance of grass carp culture was therefore the opportunity ot created for two open access resources, water and grass, to be used to produce a source of food and means to accumulate capital (AIT Outreach 2000). Similarly, in Tam Giang lagoon, Hué, Vietnam, farmers raising a variety of fish species in both brackish and freshwater environments reported that aquaculture provided a means of accumulating long-term savings which were used to improve the standard of living of the household and the wider community. Fish were also sold to provide a source of income to support daily lives if necessary (Crumlish and Sheriff, unpublished). The study took place shortly after the worst floods in Hué for a century. Farmers reported that although the losses were greater from aquaculture than from fishing during the flood, the savings earned from aquaculture allowed them to recover quickly. Mobile fishers[1] did not have the financial resources to replace their losses easily after the flood. However, aquaculture in the lagoon had also led to conflict between net enclosure farmers and

[1] Mobile fishers are here distinguished from fishers who harvest fish from net pens. The net pen enclosures in Hué represent a form of combined aquaculture and fishing. Fish are stocked into large net enclosures, from which both stocked fish and self-recruited fish are harvested.

fishermen in the shallow waters of the lagoon. The latter were excluded from a previously open access fishery resource with the development of aquaculture in net pens.

A study to investigate the social impact of aquaculture in communities in Bangladesh found that stakeholders reported benefits including the generation of alternative sources of income, food and employment. Aquaculture was also believed to have contributed to social capital, as aquaculture generated curiosity and interest and increased interaction between community members (Brugere et al. 2001).

These studies therefore suggest that aquaculture may not be able to replace fishery activities, but rather contribute to fisher livelihoods by providing an additional livelihood option to increase opportunities for diversification and asset accumulation. They also suggest that aquaculture may have an important role to play in the reduction of household vulnerability, although negative consequences for other resource users must also be addressed.

1.6 The study area – Thailand

1.6.1 Geography and demographics

Thailand occupies a geographically central position within South East Asia. To the north, it shares its border with Myanmar and Lao PDR, to the east with Cambodia, and to the south Malaysia. Its population of 60 300 000 (1998) is divided amongst four geographical regions, the Central Region, Northeast, North and South, of which the Northeast is the most populous. The Kingdom is further subdivided into 76 provinces (see Figure 1-3). Economically, Thailand is not far behind its wealthier neighbours, Malaysia and Singapore, and is on the verge of becoming one of the newly industrialized countries. Between 1985 and 1995, the country enjoyed one of the world's highest economic growth rates, averaging almost 9% annually until the financial crisis of 1997. However, due to a strong export market on computers and electrical appliances, Thailand's GDP growth in 2002 reached 5.2%. A summary of general economic and geographical data is summarised in Table 1-4.

Table 1-4. General economic and geographical data for Thailand

Area	514 000 km^2
Shelf Area	394 000 km^2
Length of coastline	2 624 km
Population (1998)	60 300 000
Population average annual growth rate	
(1980-1990)	2.7%
(1990-1998)	1.4%
GDP (1996)	US$ 114 956 million
Average annual growth rate (1985-	8.4%
1995)	5.2%
Average annual growth rate (2002)	
Agricultural GDP	US$ 12 695.8 million
Agricultural labour force (1980)	71%
Agricultural labour force (1990)	64%
Life expectancy at birth (1997)	
Male	66 years
Female	72 years
Adult illiteracy (1995)	33%

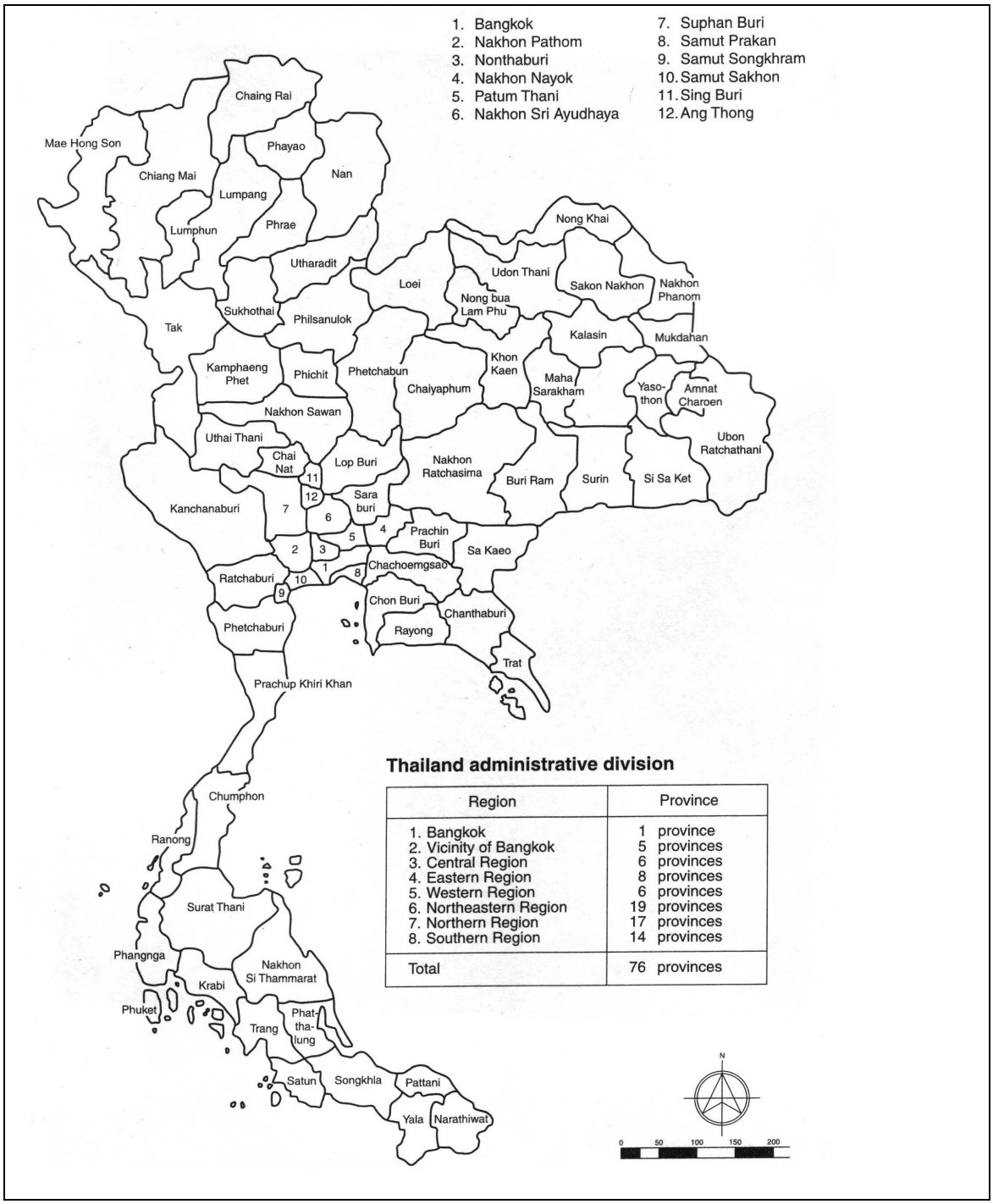
Source: Poonnachit-Korseiporn (2000) ; CIA Factbook : (http://www.cia.gov/cia/publications/factbook/geos/th.html#Intro)

1.6.2 Industry and Economics

Thailand's economy is based on a rich endowment of natural resources, a strong export market and industry. Thailand is the world's second largest producer of tungsten, and the third largest producer of tin. The country is endowed with considerable natural resources, notably: tin; rubber, natural gas, tungsten, tantalum, timber, lead, fish, gypsum, lignite, fluorite, and arable land (CIA World Fact Book Thailand).

The manufacturing sector outstripped agriculture in relative importance until the economic crisis of 1997. However, as production, consumption, trade investment and economic growth all decreased in the aftermath of 1997, agriculture became the country's only high-performing sector (UN Thailand Country Profile 2002). Rice is Thailand's most important crop with cassava (tapioca), rubber, corn, sugarcane, coconuts and soybeans also produced in significant amounts.

Figure 1-3 The provinces of Thailand (Source: Thailand in figures 1995-1006 by Alpha Resarch Co., Ltd, in Poonnachit-Korsieporn 2000)



The economic crisis led to the re-migration of approximately 1.2 million people, who returned to rural areas following dismissal from their jobs. This resulted in a reduction of remittances flowing into rural communities, an increase in rural youth who would otherwise seek employment in urban centers, increased poverty in some areas, a decline in real wages by 13% since 1997 and an increase in seasonal unemployment (UN Thailand Country Profile 2002). Pressure on natural resources also increased, as returning workers cleared land for agriculture, encroaching on forest areas.

1.6.3 The fisheries sector in Thailand

Thailand has been ranked as one of the top ten largest capture fisheries in the world since 1972 (Phasuk 1992). Fisheries in Thailand play a major socio-economic role. In 1996, the fisheries sector contributed US$2 195 million (1.9%) to GDP (FAO country profile 2001). Fish provides an important, affordable source of protein for most Thai people, who consumed on average 28kg fish per caput during 1990-1998. The seafood industry generates a major income for Thailand, particularly frozen shrimp and canned tuna (FAO 2001). The industry is also a significant employer. In 1996, fishery related industries included 144 cold storage plants, 50 canneries, 159 fish fermenting plants, 81 fish steaming plants and 28 fish smoking plants. These industries employ approximately 200 000 people, in addition to the 530 400 employed directly in capture fisheries and aquaculture (FAO 2001).

Fishery activities in Thailand are categorised into three groups: marine capture fisheries, inland fisheries and aquaculture. Marine fisheries dominate the fish catch, representing 79% of total fisheries production in 1996 (2.8 million t). Inland fisheries provide a traditional occupation for the rural Thai population, and contributed 208 400t to total fisheries production in 1996. Aquaculture has expanded rapidly, primarily through the explosion of shrimp farming since the 1980's. In 1996, aquaculture contributed 15.6% to total national fisheries production, of which 59% came from coastal aquaculture, primarily shrimp (FAO 2001).

Despite the apparent significance of fisheries to Thailand's economy, a relatively small number of individuals are directly employed within the industry. Of an estimated population of 60.3 million[2] (1998), 530 401 individuals are reported to work in the primary fishery sector (FAO 2001), although this figure underestimates those who obtain benefits through part-time or indirect employment in the industry. This represents less than 1% of the total Thai population, and may be compared with more than 20 million individuals engaged in agriculture activities (FAO 1999). This can be explained by the relatively small number of provinces which make up the coastal zone of Thailand. The coastal zone, as defined by the Economic Statistic Division of Thailand comprises 24 provinces, of a total of 76.

[2] Of which 45 million economically active (defined as members of the population above 15 years old, by the NSO)

1.6.4 History of fisheries development policy in Thailand

Following World War Two, development in south and South East Asia placed emphasis on the promotion of mechanisation in industry and agriculture. As fisheries were, and in many cases still are, classified under agriculture, and regarded as extractive industry, development was identified with increasing extractive capacity (Panayotou 1985). Asian governments promoted the mechanisation and rapid expansion of fisheries which created a dualism of small scale fisheries alongside large scale commercial fisheries. It was anticipated that the benefits accruing to the commercial fishery would trickle down to small scale fishers, but instead the gap between commercial fishers and the relatively poorer small scale fishers widened. In an attempt to lessen the gap, and improve conditions for small scale fishers, programs were introduced to upgrade the gears and boats used in small scale fisheries, the rationale being that larger, faster more efficient vessels would allow fishers to take a larger share of the common fishery resources and hence have a higher income. However, after initial successes, production began to level out, but the mechanisation programs continued, otherwise fishers who had not yet mechanised would be left even further behind (Panayotou 1985). Since the 1970's fisheries development in Thailand has included the introduction of fishing gears such as the purse seines, gill net and trawl net. The trawl net fishery operates off the coasts of Cambodia, Vietnam, Malaysia, Indonesia, Myanmar, Bangladesh, India, Oman and Saudi Arabia (Nagalaksana 1989). Developments in the efficiency of fishing gears has of course been accompanied by an increase in the fish catch, which increased from a catch of approximately 200 000 mt in 1960 to 1.5 million mt in 1972 (Nagalaksana 1989). Although the oil crisis of 1974 reduced production in the mid-1970's, by 1977 the catch rate had reached 2 million mt. In 1996, marine fisheries contributed 2.8 million mt to total fisheries production in Thailand (79%) (FAO 2000).

The marine capture fishery has experienced difficulties since the establishment of Exclusive Economic Zones (EEZ) by neighbouring countries in 1977, 200 nautical miles (370km) offshore, limiting the potential fishing grounds available to Thai fishers. Thailand as a distant water fishing fleet did not establish an EEZ and did not recognize those of neighbouring countries (Flaherty and Karnjanakesorn 1993) . Estimates suggest that Thailand lost 300 000km^2 of fishing grounds and catches of 400 000-600 000 tons of fish annually (Nagalaksana 1988). The increased fishing effort

of trawlers within the boundaries of the EEZ has not only put greater pressure on fishing stocks in the Gulf of Thailand and the South China Sea, but has also brought the commercial fleet into conflict with small-scale fishers, as commercial fishers encroach on the fishing grounds of small scale fishers and in so doing damage or destroy fishing gears, although legislation was passed in 1972 prohibiting trawlers from entering waters within 3km of the shoreline. Nevertheless, trawlers often operate within this zone to capture demersal fish and prawn (Flaherty and Karnjanakesorn 1993).

1.7 Grouper culture and the trade in live reef fish

1.7.1 Grouper culture in Thailand

The development of grouper culture is a priority for Thailand, with a number of research institutions working on grouper production technology, with particular emphasis placed on seed production. The literature pertaining to the culture of grouper in Thailand is limited. The few papers that exist focus primarily on general culture practices, details of which are summarised in Table 1-5.

Table 1-5. General characteristics of grouper culture in Thailand. Source: Ruangpanit (1999) and Yashiro (1996)

Culture system	Primarily in floating netcages in waters of salinity range 12 to 30 ppt. Limited culture in earthern ponds.
Seed supply and stocking practices	Most grouper seed from wild stock.
Status of hatchery production	Hatchery seed production limited and unstable
Culture locations	Grouper culture is conducted in the southern and eastern coastal areas of Thailand, although majority of production in the south.
Species cultured	*Epinephalus malabaricus* and *E. coioides* are most commonly cultured species
Nutrition and feeding	Fish are primarily fed trash or fresh fish i.e. Yellowstripe trevally (*Selaroides leptolepis*), Sardine or Fringescale sardinella (*Sardinella fimbriata*) and Round scad (*Decapterus russelli*)
Disease	Disease is a major cause of mortality in hatchery and grow-out production. Groupers susceptible to bacterial, viral and parasitic disease

Reports state that grouper culture is concentrated along the Andaman coast, in the provinces of Trang, Phangnga, Krabi, Satun, Phuket and Ranong, and the Gulf provinces of Chantaburi and Trat (Yashiro 1996; Ruangpanit 1999). These reports indicated that grouper are cultured primarily in intensive systems of floating or fixed cages, although some grouper production in ponds does take place (Runagpanit 1999; Yashiro 1996; Tokrina 1990). The source and size of fry fish is also briefly described. Smaller size fish of 1-2.5cm TL are collected from nursery grounds in the Gulf of

Thailand, off the coast of Songkhla and Pattani during March to October, whilst larger fry (7.5-10cm TL) are caught between May and December in coastal waters of the Andaman sea (Ruangpanit 1999).

The extent and nature of grouper culture is not well described in the literature. Information about the people who are engaged in grouper culture and fry fishing activities, the principal beneficiaries of these activities and other 'actors' in the grouper culture system is lacking.

1.7.2 Grouper aquaculture – an overview

Status and distribution

Grouper aquaculture refers to the culture of fish of the Family Serranidae, Sub-family Epinephilae, which are variously referred to as groupers, coral trout, rock cod and gag. Widely distributed in tropical and sub-tropical waters, and represented by approximately 159 species worldwide (Heemstra and Randall 1993), the groupers are economically valuable, making up an important part of the catch of sport and artisanal fishers throughout their distribution (Seng 1998). Grouper culture is, however, largely confined to Asia, where the demand for live grouper for the life reef fish trade (LRFT) drives production (See Table 1-6, Fig. 1-4). Producing countries include Thailand (Yashiro 1996); Malaysia (Ali 1996; Subramaniam 2002); Philippines (Rosario 2002); Taiwan (Chu 1996); Singapore (Chao and Chou 1996; Mee 1996); India (Devaraj 1996); Indonesia (Ramelan 2002); Hong Kong (Pomeroy et al. 2002) and Vietnam (Son 1996). Grouper culture is also being developed in Kuwait, according to Al-Thobaity and James (1996), and Saudi Arabia (Al-Thiabity and James, 1996; James et al 1998). Australia also has an established wild capture fishery for grouper. The Queensland Department of Primary Industries (DPI) is now keen to develop grouper aquaculture and have undertaken a feasibility study to assess the potential to develop a farmed tropical fish industry in Queensland (Rimmer 1996). Statistical information available from the FAO also indicates that grouper are cultured in Korea, Brazil, Tunisia and United Arab Emirates, although production is low (Table 1-6).

Table 1-6 Production of grouper by all producing countries, 1991-2002 (tonnes). Source: FIGIS, FAO

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Brazil	-	-	-	-	-	-	-	1	2	3	4	3
Hong Kong	265	55	632	627	620	1110	1036	312	280	523	910	325
Indonesia	-	-	-	-	-	-	-	-	1759	1159	3818	7057
Korea, Republic of	-	-	-	-	-	9	.	.	5	6	20	33
Kuwait	.	.	.	.	.	.	.	.	5	6	3	3
Malaysia	153	288	1006	931	834	857	799	465	948	1217	1101	1399
Philippines	6765	349	772	2129	715	595	654	135	151	167	136	115
Saudi Arabia	-	-	-	-	-	-	-	1	-	-	-	0
Singapore	198	233	147	133	101	93	82	97	94	111	157	64
Taiwan	1229	1125	3942	1841	2104	1883	2525	3471	4122	5053	5386	12367
Thailand	355	965	755	1.078	674	774	795	1390	1143	1332	1442	1442
Tunisia	.	2	1	1	<0.5	<0.5	<0.5	-	-	-	-	0
United Arab Emirates	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0
TOTAL	8920	3017	7255	6740	5048	5321	5882	5872	8509	9577	12907	22808

Figure 1-4. Aquaculture production of grouper (Family Serranidae), Asia-Pacific region, 2002 (Source: FIGIS)

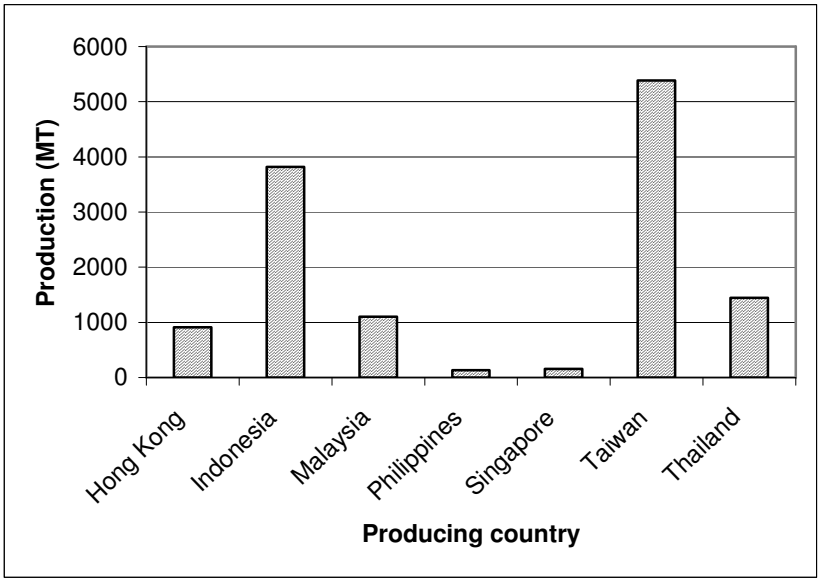


Table 1-7. Status of grouper production in countries of the Asia-Pacific region

Country	Species produced	Summary of production status[3]	Level of production 2001 (MT)[4]
Australia	*Epinephalus coioides*	Hatchery production at the research stage. No significant grow-out production	Insignificant
Philippines	*E. malabaricus ; E. amblycephalus ; E. tauvina ; E. sexfasciatus ; E. megachir ; E.bleekeri*	Grow-out in floating and fixed cages and ponds. Increasing numbers of farmers engaged in grouper culture. Dependent upon wild seed. Lack of commercial hatcheries.	136
Indonesia	*Cromileptes altivelis; E. fusciguttatus; E. suellis; E.malabariensis; Plectrofomus leopardus*	Expanding although no statistics available. Grow-out primarily in net cages. Limited use of hatchery seed although significant amount of research on hatchery production has been carried out.	3818
Singapore	*E. tauvina; E. malabaricus; E. fuscoguttatus; Cromileptes altivelis*	Primarily in floating net cages. Most fish seed are wild caught. Trash fish feed main source of feed.	157
Taiwan	*E. amblyephalus; E. molabaricus; E. swillus; E. tauvina; E. rivalatus; E. akaara; E. fario; E, fuscoguttatus; E. lanceoratus; C. altivelis*	Hatcheries produce seed from more than 40 species of marine fish. Full.cycle grouper culture of *E.coioides* and *E. malabaricus* achieved in 1980's. Now 15 species produced.	5386
Malaysia	*E. coioides; E. tauvina ; E. fuscoguttatus; E. aerolatus; E. bleekeri; C. altivelis*	Over 2000 farmers involved in marine aquaculture in Malaysia. Grouper make up 30% by weight of marine finfish production. 85% seed imported from Thailand and Taiwan. Few private hatcheries exist. Trash fish used but feed mills producing formulated feed as trash fish decreasing.	1101
Hong Kong	*E. tauvina; E. lanceolatus; E. malabaricus; E. aerolatus; E. bleekeri*	Culture began 30 years ago. Floating cages in designated culture zones. No hatchery production. Moist pellet fed has been introduced to reduce use of trash fish. Production has decreased in recent years. Annual production approx 1000 t a year.	910
Thailand	*E. coioides; E. malabaricus; E. lanceolatus ; E. aerolatus ; C. altivelis*	Primarily in floating cages in southern and eastern provinces. Major supplier of wild seed. Government has made grouper culture a priority. Several research institutions working in development of hatchery seed production.	1442
Vietnam	*E. coioides; E. malabaricus; E. bleekeri*	Relatively new enterprise although growing. Culture in floating cages, fixed cages and ponds. No private hatcheries. RIA-1 in North Vietnam maintains research program to produce seed fish.	Statistics unavailable

[3] Adapted from Pomeroy et al. (2002)

[4] Source: FISHSTAT+, FAO statistical software for fisheries and aquaculture production data, 1950-2001

Scale of production

Although rarely explicitly stated in the literature, there is some indication to suggest that the majority of grouper culture take place in small scale, family run farms, with a small number of commercial companies producing grouper in Asia (Kongkeo and Phillips 2002). Sadovy (2000), for example, refers to 'small-scale' enterprises in Indonesia, Vietnam and China, although the scale of operations Thailand, Philippines, Malaysia and Taiwan are not discussed. Farms comprising between 2 and 74 cages were maintained primarily by fishers and middleman in Indonesia, while most farmers in Vietnam had 1 or 2 cages (Sadovy 2000). Sulaiman (1996) comments that fish farmers in Negara Brunei Darussalam are usually self-employed, pensioners, retired civil servants and army personnel, usually operating a family run business. However, in North Sumatra, commercial enterprises appear to dominate due to the high cost of investment required for grouper culture, and Chao and Chou (1996) describe grouper culture operations in Singapore as 'commercial'. Although there is interest in the development of larger scale, offshore systems in the region, most farms in the region are small scale operations (Kongkeo and Phillips 2002).

Culture practice

According to a comprehensive review of grouper culture provided by Seng (1998), grouper culture was first introduced in the early 1970's in Singapore, Malaysia, Hong Kong, Thailand and Taiwan, and now occurs throughout Southeast and East Asia. Culture is primarily carried out in floating net cages in sheltered coastal regions, although Chen (1990) reports that fingerlings are stocked into ponds as well as cages in Taiwan. Abandoned shrimp ponds in Thailand, Taiwan and Malaysia have also been adapted for use as fish ponds (Liao et al. 1995; Ruangpanit and Yashiro 1995, in Seng 1998; Ruangpanit et al. 1993).

The principal characteristics of grouper aquaculture are summarised in Table 1-8.

Table 1-8 Summary table of principal characteristics of grouper culture. Source: Hambrey and Dato-Cajegas (1997)

Cultured species	Groupers belong to the Family Serranidae. The majority of cultured groupers belong to the sub-family Epinephelinae *Epinephalus coioides* and *E. malabaricus* are the most commonly cultured species.
Production	Most grouper production comes from capture fisheries, approx. 168,934 mt were landed in 2002 Major producers of captured grouper are the Philippines, Indonesia and China Total aquaculture production of grouper in 2002 was 20,966 mt
Seed supply and hatchery production	The majority of seed supplied to grouper culture is wild caught. Seed are mainly collected by artisanal fishermen Major exporting countries of fry are Sri Lanka , Indonesia, Philippines, Thailand, China and Taiwan. Hatchery prodction sporadic. In Thailand, NICA has achieved some success in production of *E.malabaricus* and *E.lanceolatus*.Limited intereste from commercial hatcheries. Commercial production currently limited to Taiwan.
Culture: larval rearing; nursery and grow-out	Research into the hatchery production of grouper seed began in the 1970's. Significant survival rates over 5% achieved in the 1980's Major problems in hatchery production include low survival rate in early stages and high rates of cannibalism in later stages. Provision of appropriate feed at the right time of development is critical. Small fry of 1-5 cm nursed in hapas, netcages or ponds for 1 to 3 months Grow-out primarily carried out in net cages and brackish water ponds. Market size varies from 600g to 1.2kg. Grow-out may take up to a year Survival rates of up to 80% achievable
Nutrition	Rotifer, brine shrimp and shrimp or fish meat common feeds during larval rearing Trash fish most common type of feed used during grow-out Use of moist feeds (trash fish with other ingredients such as fish meal, soybean meal, rice bran etc) also popular Typical nutritional requirements of grouper are 40-60% protein, 13-14% lipid, about 3300kcal kg-1 energy content. Essential vitamins include ascorbic acid (AA or vitamin C) Optimum feeding 4-6 times per day at a ratio of 2-5% bw in young grouper (*E.akaara*, 1.4g). Feeding once every two days was found to be optimum in larger size fish.
Disease	Disease problems which affect grouper have been classified as follows (taken from Bondad-Reantaso et al. 2002, adapted from Arthur and Ogawa 1996): Environmental: Pollution, toxic plankton blooms Management: Acclimitzation/adaptation mortalities (juveniles) ; handling mortalities (Juveniles and grow-out transport mortalities (juveniles) Nutritional: Spinal curvature Viruses: Golden eye disease ; red grouper reovirus ; sleepy grouper disease (iridovirus) ; spinning grouper disease (picorna-like virus) Bacteria: Red boil disease, streptococcosis (Streptococcus sp.), Vibriosis, haemorrhagic septicaemia (*V. alginolyticus, V. parahaemolyticus*) Parasites: Protozoa (Amyloodinium, so., Brooklynella sp., Cryptocaryon irritans, Trichodina sp.) Fungi: Ichthyophonus sp. Disease of unknown etiology: Popeye, blindness, swimbladder syndrome
Markets	Three markets for grouper dominate: live fish; frozen or chilled fish; fry fish Major markets in Asia are Hong Kong, China, Japan and Singapore Demand for grouper and other reef fish expected to grow with expanding economies in the region Prices of grouper range from US$3-68 per kg depending on the species

Seed supply is a crucial factor contributing to the potential sustainability, in environmental terms, of grouper culture. Commercial production of grouper seed in hatcheries is currently limited to Taiwan, where 300 private grouper hatcheries produce 20 million grouper fry of *Epinephalus coioides* and *E. malabaricus* species annually (Chu 1996). Production is, however, irregular and the low level of survival (7% survival is considered good) means the price of grouper fingerlings is high (Rimmer 1999). As yet, methods for the small-scale method of production of most groupers are not available (Sadovy 2000), although techniques for the intensive production of the humpback grouper, *Cromileptus altivelis*, have been developed at the Gondol Institute for Mariculture, Bali, (Suguma et al. 2001). This technology has also been applied to the production of tiger grouper (*Epinephalus fuscoguttatus*) and is reportedly now being used in 67 hatcheries in Indonesia, the majority of which are 'back-yard' facilities (Suguma 2003). The total production of humpback grouper and tiger grouper seed in 2002 from these hatcheries was estimated at 3,350,200 fish (size 5cm-10cm TL) (Suguma 2003).

As hatchery production of grouper fry remains sporadic, with final survival of grouper juveniles (2.2cm) still less than 5% (Marte 2003), the majority of grouper farmers currently depend on seed fish from the wild for grow out, which are either caught by the farmer or purchased from a fisherman or fish trader. The dependence of grouper culture on wild fish has implications for the wild fish stock, which are believed to be in decline either as a direct result of capture to supply aquaculture, or due to other factors including habitat degradation and capture as bycatch by commercial fishing vessels. Johannes and Riepen (1995) consider the practice of using wild-caught grouper juveniles to supply grouper culture to be unsustainable, as grouper populations on coral reefs are believed to be limited by recruitment rather than by competition or predation. Grouper populations are therefore relatively low, below the carrying capacity of the reef environment, and removal of juveniles who do recruit to the reef may jeopardise the ability of the adult stock to sustain itself if numbers reaching maturity are not sufficient to maintain the population. However, while it is known that early natural mortality rates of pelagic spawning fish such as the groupers are extremely high, it is not known whether the bulk of mortalities occur between egg production and settlement, or whether mortality remains high after settlement (Sadovy and Pet 1998). If mortality

continues after settlement, then the removal of grouper juveniles during this phase may not have a great impact on adult stocks. As Sadovy and Pet (1998) note, however, grouper taken for maricuture range in length from 20mm to 120mm total length (TL), which means fish may be up to one year old when they are taken, far exceeding the short period of high mortality of approximately three months following settlement, which has been observed in reef species such as the gag grouper (*Mycteroperca microlepis)* (Koenig and Colin, in Sadovy and Pet 1998) and other non-grouper species. Sadovy and Pet (1998) conclude that the development of hatchery-based mariculture is a possible solution to replace wild fish as a source of grouper juveniles.

1.7.3 The market for grouper – the Live Reef Fish Trade (LRFT)

After grow-out, fish are destined for sale to supply the demand for live reef fish trade, which began in China in the 1960's, when a few marine species were to be found in the live fish markets of Hong Kong, but has expanded rapidly since the early 1990's. The preference for keeping fish alive until minutes before cooking and consumption has been popular for centuries in Chinese culture, and until recently this demand for live fish was supplied by locally caught species. A preferred species for consumption was the red grouper, *Epinephalus akaara*, until overfishing of both adults and later fingerlings for culture in Hong Kong waters led to severe depletion of local stocks, forcing fishermen and the LRFT industry further afield to seek out supplies to meet local demand for market size fish. In the mid-1970's fishing boats began to exploit Philippine waters, and later the islands of Indonesia, before moving onto The Pacific Islands, Papua New Guinea, Australia's Great Barrier Reef, the Solomon Islands and the Maldives (Johannes and Riepen 1995). Thailand is now also an important contributor to the LRFT.

The environmental impacts of the LRFT trade are reported to include the effect of the destructive fishing practices commonly employed in the capture of LRF, including the use of cyanide and the dramatic reductions in individuals of the slow growing, long lived fish species targeted by the trade, including the giant grouper and humphead wrasse, both listed as "Vulnerable" in the IUCN Red List of Threatened Animals (Lau and Parry-Jones 1999). There is also a human health concern, as foreign shipments of live fish can potentially introduce ciguatera poisoning into major consumption centres (Sadovy 2000).

A wide variety of species are targets for LRF operations, including species of groupers, wrasses and snappers. Highly prized species such a *Cheilinus undulates*, common name humphead wrasse, command an exorbitantly high price in the restaurants of Hong Kong, where they provide a means of demonstrating the status of the host who provides the fish. A humphead wrasse can fetch a price of up to $200 per kg (Lau and Parry-Jones 1999). Thus the trade in live reef fish is a lucrative one, and one from which some can derive considerable benefits.

Hong Kong is the largest consumer of reef fish in the region, in 1997[5] accounting for 60 % (by weight) of the total annual regional trade in LRF. The total imported weight in 1997 was 21,066,363 kg, with a value of US$132,324,000 (Lau and Parry-Jones 1999). Indonesia, the Philippines and Thailand respectively were the main sources of LRF imports in 1997, with Thailand representing the source of 31% of the annual total imports recorded for Hong Kong. According to data gathered by Lau and Parry-Jones (1999) Indonesia is recorded as the sole supplier of High finned grouper and Giant grouper to Hong Kong, although this is unlikely to be the case. Thailand dominated the trade in 'other groupers'[6], representing 50% of the total imports in 1997 (2,611,626 kg). Information presented by Lau and Parry-Jones indicated that the majority of green grouper (*E.coioides*) is imported from Thailand, and mostly from aquaculture sources. Over half of imports of *E.bleekeri* and *E aerolatus* from Thailand were also from aquaculture[7].

The market for live grouper is, however, sensitive to regional and global events. The market declined following the economic crisis which struck Asia in 1997 and the value of grouper in the face of reduced demand has also declined (Pawiro 2002; Ridmontri 2003). In 1998, consumption of live marine finfish in the principal market of Hong Kong was 23 603 MT, a drop of 15% on consumption in 1997. Imports of live seafood into Hong Kong subsequently also declined by 41.7% in volume in 1999, compared to the same period in 1998.

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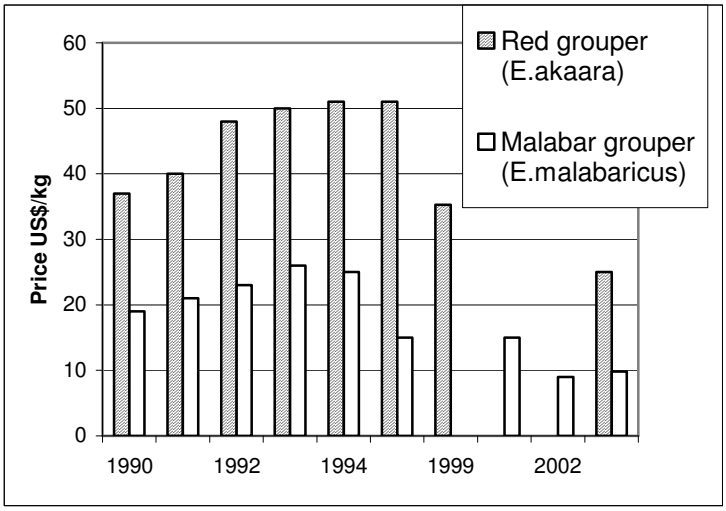
[5] 1997 figures are currently the most up-to-date available.

[6] *Epinephalus spp.,* and not including High-finned grouper, Giant grouper and coral trout. Epinephalus spp. Include *E. polyphekadion* (flowery grouper), *E. malabaricus* (malabar grouper), *E. fuscoguttatus* (tiger grouper), *E. akaara* (red grouper), *E. bleekeri/E. aerolatus* (brown spotted grouper), *E. coioides* (green grouper).

[7] However since 1997 the market for *E.bleekeri* (fry or market size) has collapsed due to disease problems with this species in Hong Kong and its slow growth in Thailand.

The market also declined following the attacks on the World Trade Center and the Pentagon in September 2001, when importers noticed a downturn in business by 45 per cent as a result of global economic decline (McGilvray and Chan 2003). Most recently, the outbreak of SARS during the first half of 2003 also had a significant impact on the trade in live reef fish in the Asia Pacific. According to a report in the Marine Finfish Aquaculture Newsletter April-June 2003, Thai and Vietnamese farmers were unable to sell tonnes of market size grouper.

Figure 1-5. Wholesale value of two species of grouper in Hong Kong, 1990-2003 (Source: Riepen (1997; Li (2002); McGilvray and Chan (2003); Pawiro (2002)



The market for grouper is therefore highly sensitive, as illustrated byFigure 1-5, and liable to sudden and sustained decline in demand and value in times of economic uncertainty and crisis, with potentially severe consequences for the small-scale producer. Farmers do report, however, that grouper production remains profitable despite the economic downturn of recent years (Ridmontri 2003; Tan 2003).

1.8 Conclusions

1.8.1 Summary of key points

The above review has shown that the concept of sustainability is multi-dimensional, context specific and must be considered in terms of what should be sustained, why and for how long. When applied to aquaculture, it was concluded that a holistic approach to sustainable aquaculture is the most appropriate with which to assess the multi-dimensional nature of sustainability. Within this approach to sustainability functional integrity, which draws on the systems approach, was considered to be a useful tool with which to investigate the processes and interlinkages in the

grouper culture system and their potential to undermine the sustainability of grouper culture in the long-term. Following this approach, sustainability is not a static concept. It is here interpreted as the maintenance of system equilibrium and the continued generation of benefits for stakeholders through the active management of potential perturbations in the system.

The potential contribution of aquaculture to household livelihoods was also discussed. It was shown that aquaculture may provide a means of saving and the conversion of open access resources into assets and food. However, aquaculture may therefore play a greater role in livelihood diversification than as an alternative livelihood to fishing, particularly in light of McGoodwin's findings (2001) which suggest that fishers would not necessarily leave the fishery if alternative options were available.

Grouper culture has been identified as a priority by the Thai government with several research institutions working on the development of grouper culture (Pomeroy et al. 2002) although the sustainability of the activity is unknown. Key sustainability issues include the current dependence on wild seed and trash fish. However, little is know of the social implications of grouper development.

These issues form the basis of the current study.

1.8.2 Research objectives

The review has shown that efforts to promote grouper culture as an alternative livelihood option in Southeast Asia do so in the absence of an understanding of the sustainability of grouper culture, or the appropriateness of its promotion as part of a sustainable livelihood. The review also reports that there is a lack of information regarding the social, economic and environmental aspects of grouper culture, as emphasis in the available literature is placed on technical aspects of production.

The overall aim of the current study is therefore to assess to what extent grouper culture is 'sustainable' and whether it has the potential to provide a sustainable livelihood option for coastal fishers. The specific objectives of the study are:

1) To provide baseline information with which to place grouper culture in southern Thailand in its social, economic and environmental context.

2) To assess the sustainability of grouper culture using a holistic, multi-dimensional approach. The assessment will draw on systems theory, beginning with the identification and definition of the grouper system in terms of its boundaries, hierarchy, inter-linkages and processes.

3) To evaluate the role of grouper culture in fisher livelihoods in southern Thailand and the extent to which it contributes to a sustainable livelihood, by analysing fisher livelihood strategies, the impact of grouper culture on asset status and vulnerability.

4) To evaluate the appropriateness of grouper culture as an alternative livelihood to destructive fishing practices.

1.8.3 General Research Method

Both qualitative and quantitative methods were applied in the present study in an approach described by Marsland et al (2000) as 'sequencing'. Qualitative methods were used in a series of exploratory studies from which hypotheses were developed. The studies also formed part of a phased sampling regime, conducted at different hierarchical levels, in order to increase the representativeness of the communities ultimately selected for in-depth case study analysis.

The study was carried out in four phases:

Phase One: Preliminary overview of fisher based aquaculture in seven provinces in southern Thailand. Identification of characteristics of grouper culture activities and sustainability issues at the provincial level using semi-structured interviews. Selection of provinces from which communities would be selected for case study analysis based on defined criteria. Provisional selection of communities for analysis. Development of a research framework for sustainability assessment.
Phase Two: Characteristics of coastal communities raising grouper in Trang and Satun provinces in southern Thailand. Carried out to ensure that the communities provisionally selected for analysis during Phase One were representative of communities raising grouper in the two provinces, qualified for analysis based on predefined criteria and would therefore represent different contexts in which grouper culture is carried out. Data gathered using semi-structured interviews based on a topic check-list, analysed quantitatively. Phase Two is described in detail in Chapter Two.

Phase Three: Case study analysis of three fishing communities in southern Thailand (Qualitative). In-depth research to determine the role of grouper culture in household livelihoods and the sustainability of grouper culture. Qualitative methods drawn from participatory methodologies were the principal methods used to gather information.

Phase Four: Case study analysis of three fishing communities in southern Thailand (Quantitative). Testing of hypotheses developed during Phase Three using a sample survey to gather quantitative data from a representative sample of households in each of the communities studied. The structure, content and response fields of the questionnaire were informed by the information gathered in Phase Three.

Participatory methods were used during the study in addition to traditional interviews and focus groups employed in social science research. Participatory methods were used to facilitate the development of an understanding of the temporal contexts (seasonal calendars, timelines, daily activity charts) and spatial contexts (resource mapping, village mapping) of peoples' livelihoods, and to provide a structure for discussions with groups and individuals. The techniques used brought to the fore issues and information that may not have arisen during straight forward interviewing, as the activities brought to mind issues or events otherwise forgotten by participants. They also allowed a rapport to be created with members of the community and encouraged participants to think about and discuss their opinions, facilitating the ranking of activities and issues in order of importance according to criteria discussed amongst the group, or by creating categories of household groups, for example.

Sampling

Site selection for case study analysis was carried out using a phased sampling at hierarchical levels. Qualitative methods were used to improve the extent to which findings were representative at the macro level (Phase Two) and the micro level (Phase Three and Phase Four). Secondary data obtained from Provincial government offices were used to generate an initial sampling frame for Phase Two, containing communities which qualified for inclusion in the study (i.e. households in the community raised grouper, or had done so in the past). This information was supplemented by snowball sampling, a method by which new respondents are suggested by initially identified subjects.

Research activities in the case study communities required that the sample population was stratified to ensure representative access to different groups within the community (aquaculture producers, non-producers, fry fishers, pond farmers, cage farmers) from which further sub-groups were created (wealth groups). The identification of members of each of these groups was facilitated by interviews with key informants and access to the community register, wealth ranking, and village mapping. Village mapping was an important tool for identification of a representative sample of households for the quantitative sampling, in addition to assisting in the planning of the division of data collection amongst enumerators.

Analysis

Qualitative and quantitative methods were 'merged' in order to analyse the information generated by both the qualitative and quantitative methods of data collection. Interview responses were coded in Excel. Ranking and scoring methods were used to create wealth rank indicators, which were used in the analysis of quantitative data collection. Survey data was analysed in SPSS using the Chi-square test for association.

1.8.4 Structure of the thesis

The structure of the thesis follows the development of the research from the initial exploratory stages at the provincial level to the case studies at the community and household level:

Chapter 2 comprises the preliminary research conducted prior to the selection of case studies for analysis and the way in which the decision to conduct case study analysis was reached. Chapter 2 provides a preliminary overview of grouper culture and associated fisheries activities in six provinces in the south of Thailand. At this stage the research approach is also evaluated, the grouper system defined and a framework for the assessment of sustainability is presented. The information gathered during this first phase of the study and the new research framework then forms the basis of the remainder of the study. The findings of the preliminary overview inform the research presented in the second part of the chapter, which describes how three communities were selected for case-study analysis and the degree to which they are representative of coastal communities in Trang and Satun provinces.

Chapter 3 and Chapter 4 comprise the case study analysis, which explores the issues raised in the earlier chapters at the community and household level, paying specific attention to the role of grouper culture as a sustainable livelihood option for coastal fishers. Chapter 3 presents the case study sites and a detailed account of the method used to gather and analyse information. Chapter 4 is divided into six parts, which reflect the principal areas of investigation and outcomes of the study:

1. Understanding livelihood strategies in the case study communities
2. Grouper culture and fishery activities in the case study communities
3. Access and participation
4. Vulnerability and fisher livelihoods
5. Long-term viability and conditions for successful grouper culture
6. Grouper culture and the environment

Chapter 5 comprises a discussion which brings together the findings of parts one and two of the thesis to address the issues raised in section 1.8.2, and an evaluation of the research approach and methodology.

Chapter 2
Preliminary overview of fisher-based aquaculture in six provinces in southern Thailand

2.1 Introduction

In Chapter One it was shown that available literature on grouper culture gives a broad overview of grouper culture activities, focusing primarily on technical aspects of grouper culture, and constraints to its further development. The extent and nature of grouper culture is not well described. Information about the people who are engaged in grouper culture and fry fishing activities, the principal beneficiaries of these activities and other 'actors' in the grouper culture system, is also lacking. Furthermore, statistics suggest that grouper culture has not developed to a uniform extent throughout the southern region, nor are culture systems identical (Yashiro 1996; Ruangpanit 1999). This would suggest that regional variations exist which have shaped the development of grouper culture in the provinces of southern Thailand. It is possible that variations exist which may perhaps be attributed to social, environmental or economic factors.

This chapter aims to contribute to existing knowledge about grouper culture, providing information about grouper culture and fry fisheries activities in the southern provinces of Thailand where grouper culture is practiced and, where possible, identifies characteristics which may have differentially influenced the development of grouper culture in this region of Thailand. It provides baseline information, the development of an analytical framework, and the selection of case study sites through which to address the research objectives set out in Section 1.8.2.

2.2 Research Approach

As described in Chapter Two, a phased approach was adopted to address the research question, descending hierarchical levels from the provincial to the household level. In this chapter, the findings of two studies are presented. The first study, or 'preliminary overview', explored the characteristics of grouper culture and fishery activities which can be distinguished at the provincial

level. The findings of the preliminary overview informed the development of the second study, which comprised a survey designed to explore in more detail important issues identified during the first phase of research at the provincial level. The survey was conducted in two provinces, Trang and Satun, with emphasis placed on the comparison of grouper culture and fishery activities at the community level. Communities were selected for case study analysis based on the synthesis of results generated by these two studies.

2.3 Part One - Preliminary overview of fisher based aquaculture in six provinces

2.3.1 Research questions and hypotheses

The preliminary overview sought to address four research questions, originating from the review presented in Chapter One, and the gaps in current knowledge of the grouper culture system outlined above:

Research question 1:

How do grouper culture and fishery activities differ between provinces, and why do such variations exist?

Research question 2:

Who are the principal actors and beneficiaries of the grouper culture system?

Research question 3:

What factors affect the environmental, social and economic sustainability of grouper culture?

Research question 4:

How can the grouper culture system be defined, in terms of boundaries, hierarchies, inter-linkages and processes, to facilitate the development of a sustainability assessment framework?

2.4 Research Methods

2.4.1 Research Area

Southern Thailand covers an area of 511,770 sq km. It is culturally and geographically distinct from its northern neighbours from whom it is relatively isolated, and bounded on both sides by the sea. Inhabitants of this region have an average income which places them in the middle income range when compared with Thailand's other four regions. The Northern and Northeastern regions of the Kingdom, with the largest populations, have relatively lower average incomes (Table 2-1). The dominant religion in the area is Buddhism, but Islam dominates in the most southerly provinces, particularly in the provinces of Pattani, Yala and Satun which previously belonged to the Malay kingdom. Many Muslims in Thailand live in coastal communities, where fishing is their principle occupation. Twenty-four percent of households in the southern region are reported to be in fishing villages (National Statistics Office, Bangkok).

Table 2-1 Village and household statistics, by region, 2000

	Whole kingdom	Greater Bangkok	Central Region	Northern Region	North-eastern Region	Southern Region
Basic statistics						
No. of households	9,965,954		2,575,054	2,422,586	3,628,260	1,340,054
% of total households	100	18	19.1	19	31.2	12.7
Ave. household size	3.6	3.2	3.5	3.4	3.9	3.8
No. of villages	69,324		15,987	14,912	30,249	8,176
No. agricultural villages	67,910		15,149	14,751	30,022	7,988
No. villages producing rice	58,539		11,322	14,049	28,257	4,911
No. villages producing para rubber	11,323		1,311	111	3,249	6,652
Average monthly income and expenditure 2000						
Ave. monthly income per household (THB)	12,167	24,690	13,301	8,649	7,853	11,407
Ave. monthly expenditure Per household (THB)	9,910	19,178	10,411	7,559	6,702	9,491
Ave. monthly expenditure on food and beverage (THB)	3,173	5,475	3,381	2,471	2,350	3,195

Source: National Statistical Office, Office of the Prime Minister, Thailand

The region is rich in natural resources, with mining of minerals and the metals industry being important industries. Agricultural production is particularly important in Songkhla, whilst Trang is a major producer of rubber. Less rice is produced in the region than it is elsewhere in Thailand, with Para rubber[8] being of more importance.

Shrimp and fish aquaculture are important in the region, with shrimp culture being particularly important in Trang and Songkhla provinces, which have the highest number of aquaculture farms in the region.

Table 2-2 Summary statistics, by province

	Satun	Phangnga	Trang	Phuket	Krabi	Songkhla
Population*	247,900	234,200	595,100	249,500	336,200	1,255.7
No. of households*	58,100	61,800	150,389	70,500	81,800	315,700
No. households in fishing villages	22,678	19,186	23,087	32,731	23,315	59,612
Municipal population (% of total)*	16.1	14.6	20	36.7	16.5	32.4
Religion*						
Buddhist	31.9%	76.3	86	81.6	65.2	76.6
Muslim	67.8%	23.2	13.7	17.1	34.7	23.2
Malay speaking	9.9%	1.7		0.7	0.2	4.6
Distance of provincial town from Bangkok (km)	973	788	828	862	814	950
Land area (square km)*	2,7478.98 (incl. 105 islands)	4,170	4,941.439	538.72	4,709	7,393.9
Land Use:						
Forest (% total land)	23	28	19	0.4	0.7	8
Para rubber (sq m)			2,136,825	186,016		2,660,198
Rice paddy (sq m)	182,240	41,690	208,680	2,960	121,370	703,890
Length of coastline	144.80 km*					

* Source: Population and Housing Census 2000, National Statistics Office, Bangkok Thailand. http://web.nso.go.th/pop2000/indiregion/wholetab1.htm
** Source: Royal Forest Department, Thailand, http://www.forest.go.th/stat41/tab62.htm

[8] Pará rubber is produced from the tree Hevea brasiliensis, a large tree native to tropical South America. Most pará rubber is now produced from plantations grown in Asia ("Para rubber tree." Wikipedia. Wikipedia, 2005. Answers.com GuruNet Corp. 25 Jul. 2005. http://www.answers.com/topic/para-rubber-tree). The species was introduced to Thailand from Malaysia in 1911.

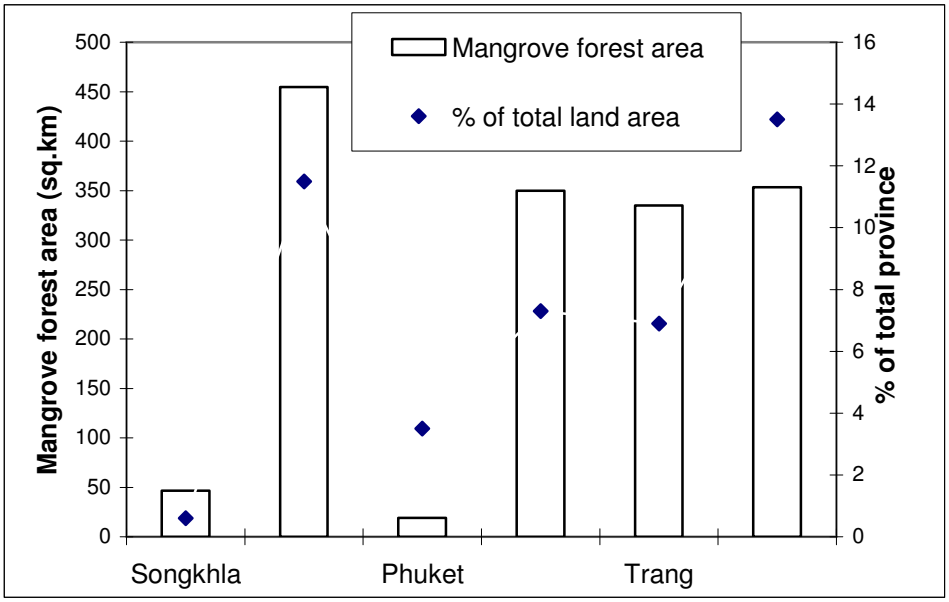
Table 2-3 Number of coastal aquaculture establishments, by province, 2000

	Total no. Aquaculture farms	Shrimp	Fish	Mollusc	Others
Satun	766	483	248	2	33
Trang	1,349	1,248	70	4	27
Phangnga	969	574	299	93	3
Songkhla	2,614	1,892	706	14	2
Krabi	968	848	100	12	8
Phuket	167	87	41	29	10

Source: National Statistical Office, Office of the Prime Minister, Thailand

The development of shrimp culture in Songkhla may have had an impact on the provinces mangrove resources, which are amongst the lowest in the region. Phangnga has the largest total area of mangrove forest of the six provinces in the study, and Satun the largest area of forest as a percentage of total land area. Krabi, Trang and Satun provinces have roughly comparable areas of mangrove forest.

Figure 2-1 Mangrove forest area, by province, 2000 (Source: Forest resources assessment division, Royal Forest Department. Thailand)



2.4.2 Research framework

The literature review, presented in Chapter One, concluded that grouper culture is an activity which is embedded within a complex system comprising ecological, social, economic and technological dimensions. These four dimensions form the basis of the research approach adopted for the preliminary overview, and the core of the research framework, shown in Figure 2-2.

2.4.3 Method

Brief summary of method

A rapid appraisal methodology was adopted for the preliminary overview at the provincial level. Semi-structured interviews were the principle method of data collection used. Interviews were conducted using a topic check-list.They were not constrained by the use of a structured survey, but rather flexible and open to the exploration of new issues and topics as they arose. Interviews were carried out in villages in 7 provinces in the south of Thailand. Provinces were selected that represented significant areas of grouper culture or grouper fry fisheries. A total of 36 interviews were conducted in 10 days between May and July 2000 from which information was drawn to meet the objectives described above.

Figure 2-2 Preliminary Research framework

SOCIAL The social subsystem focuses on the people involved in the grouper system, primarily those reliant upon grouper culture and its associated activities for their livelihoods.	**ECONOMIC** The economic subsystem incorporates any aspect of the system which relates to the profitability of grouper culture and the grouper fisheries on which it depends, and the market of grouper from the local production level, through middlemen, exporters, wholesalers to customers, market trends and influences.
ECOLOGICAL The ecological subsystem includes all activities which have an influence upon the ecology of the coastal zone. In the context of grouper culture, this includes the fisheries for grouper and the fishery for trash fish. Activities external to the grouper system but which in some way affect the fisheries directly or indirectly must also be considered.	**TECHNICAL** The technical subsystem refers to the technical aspects of grouper culture. It also includes issues relating to developments in the hatchery production of grouper and pelleted food, and the likely uptake of new technology by farmers.

Selection of provinces for the appraisal

Provinces were selected based on the following key criteria:

- Number of grouper farms – provinces were selected where grouper production is concentrated
- Type of culture system (fixed or floating cages, ponds) – provinces selected represented the variety of culture systems in which grouper are produced
- Importance of fry fishing – provinces selected included those where grouper fry fishing was reported to be significant

Data from the National Office of Statistics, Bangkok, indicated that grouper is cultured in 10 provinces in the southern region of Thailand (Table 2-4)). Grouper culture was of minor importance, 33 farms or less, in the provinces of Chumporn, Surat Thani, Nahkon Si Thammarat and Narathiwat. These provinces were therefore excluded from the study. Pattani and Songkhla provinces, although having little or no grouper culture according to DoF statistics, were selected for study due to the importance of the fry fishery that was reported for these provinces.

The provinces selected for study included:

- Satun
- Phangnga
- Ranong
- Trang
- Phuket
- Krabi
- Songkhla
- Pattani

Table 2-4 Number of grouper farms by province,1986-1998 (Source: National Office of Statistics, Bangkok, Thailand)

Province	1986	1990	1998
Chumporn	0	10	20
Surat Thani	0	1	33
Nakhon Si Thammarat	0	0	16
Phattalung	0	0	0
Songkhla	0	0	0
Pattani	19	0	0
Narathiwat	0	1	10
Ranong	6	48	241
Phangnga	129	552	691
Phuket	10	7	61
Krabi	68	51	86
Trang	16	54	62
Satun	251	730	418

Rationale for selection of provinces

- According to statistics from the Department of Fisheries, Thailand, grouper farms were concentrated in the provinces of Satun and Phangnga. In Satun, production had declined between 1990 and 1998. Production was increasing in Phangnga province, where production was highest in 1998.
- Statistics from Ranong showed a relatively rapid increase in grouper culture during the 1990's, when compared with other provinces in the region.
- Trang, Phuket and Krabi, with substantially fewer farms than Satun or Phangnga, were showing a gradual increase in production, following a decline in the early 1990's. An earlier visit to Trang province in 1999 had revealed that Trang was also an important source of grouper fry fish for the region.
- Songkhla and Pattani were also included in the list of provinces selected for study as they had been identified as sources of small size (1-2.5cm TL) grouper fry, in contrast to the larger fry caught by fishers on the Andaman coast.

Data collection

Data was collected in two phases, in May 2000, and in June-July 2000. The first phase was conducted in collaboration with the Department of Fisheries (DoF), Bangkok and the National Office of Statistics (NoS), Bangkok, who devised the research schedule. The influence of the

involvement of a policing institution (DoF) during this phase of research is acknowledged. Trang, Satun, Phangnga and Ranong provinces were visited during this initial phase of field research.

The second stage of data collection was conducted with the assistance of an independent translator from Trang province, who had previous experience working with fishermen whilst working with the Trang based NGO 'Yadfon'. Songkhla, Krabi and Phuket provinces were visited during the second stage of data collection.

Selection of study villages

A total of 28 villages were visited during the appraisal (Table 2-5).

Table 2-5 Number of villages visited in each province

Province	No. of villages	No. of interviews
Trang	4	5
Satun	5	8
Phangnga	4	4
Ranong	2	2
Songkhla	5	7
Krabi	4	6
Phuket	4	4
Total	28	36

The sample population included villages which appeared on the records of grouper culture of the DoF, or which were known to staff of the local District DoF offices. Grouper culture was practiced in all of the villages visited. Interviews were also conducted with the Provincial Fisheries Officer, and the Assistant Provincial Fisheries Officer of the Department of Fisheries, Trang.

For the second phase of the study, records were obtained from the Provincial and District offices of the Department of Fisheries from which the target population was drawn i.e. villages where grouper were currently being raised, where grouper had been raised in the past, or where fishers fished for grouper fry. This information provided a starting point for data collection for a 'chain sampling' method.

Selection of respondents

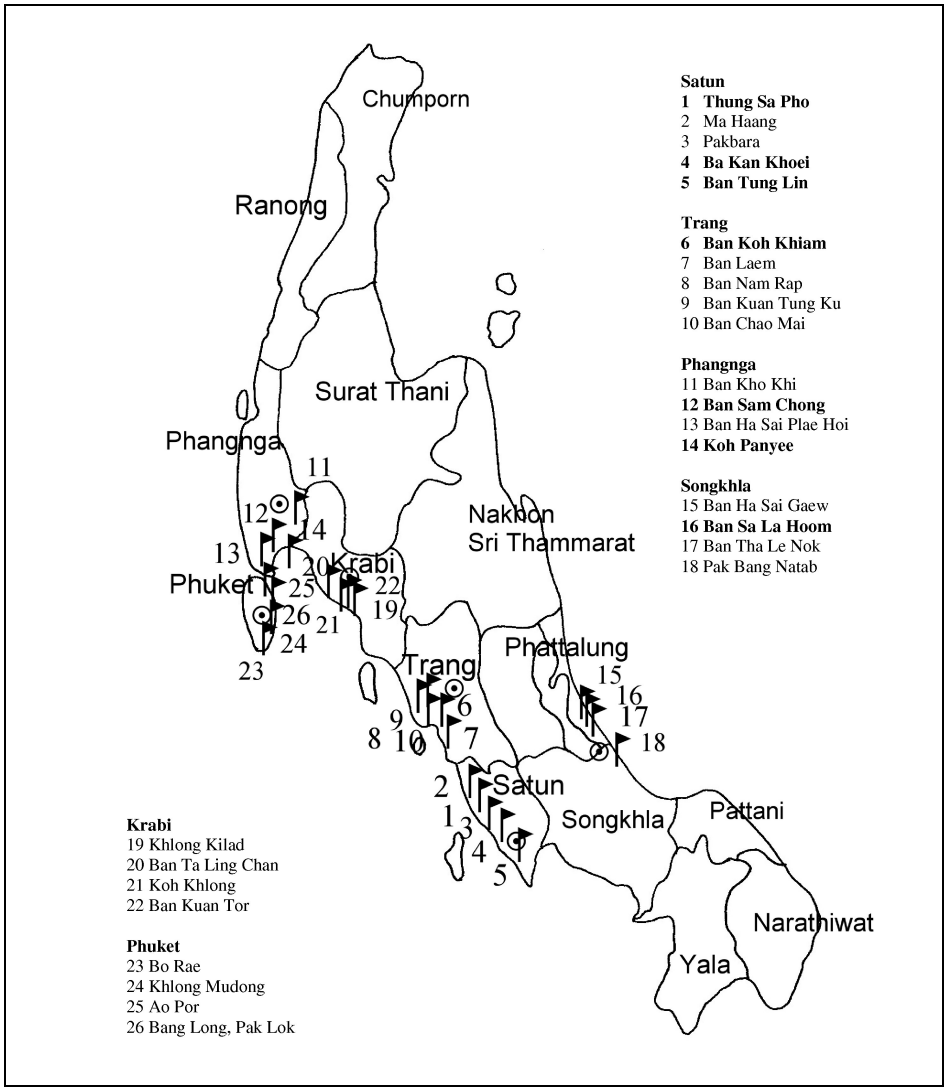
One or two respondents were interviewed in each village. Where possible, key informants were sought who could provide an overview of grouper culture and fishery activities in their own village and, if possible, about activities in the surrounding area. For this purpose, middleman/fish traders

were ideal respondents. The Village Head was often sought for interview, as their role as a spokesperson and leader of the village requires that they are familiar with the people and activities of the village. The Village Head was in many cases also a grouper farmer. Interviews were also sought with grouper farmers, ex-farmers, fry fishers and representatives of the Department of Fisheries.

Table 2-6 Number of respondents interviewed in each respondent group

Respondent group	No. of respondents interviewed
Grouper farmers – total	22
Fish trader/farmers	5
Fisher/farmers	10
Pond farmers	3
Discontinuers	2
Fish traders (Excl. Trader/farmers)	3
Fishers (Excl. Fisher/farmers)	1
Fisheries Officers (DoF)	5
Total	33

Figure 2-3 Villages in which interviews were conducted during the preliminary overview. Flags indicate the location of villages. Villages highlighted in bold indicate locations where the DoF initiated fish culture projects.



Topic checklist

Information was sought using a semi-structured interview technique based on the following topics:

1. Culture systems
2. Culture management and husbandry
3. Origins and motivation for grouper culture
4. Uptake and beneficiaries of grouper culture
5. Feed and seed resources
6. Fishery activities
7. Status of the grouper fry fishery
8. Problems experienced by farmers and fishers, and constraints to grouper culture

Data analysis

Interview transcripts were analysed using Excel. Statements made by respondents were coded according to province and topic. The coded data in each category was then summarised for presentation.

2.5 Findings of the study

2.5.1 Grouper culture in context

According to respondents in the provinces studied, grouper culture began in the region approximately 20 years ago. The experience of farmers raising grouper varied between 1 and 20 years. A small number of respondents reported that they had been raising grouper for 30 years.

Grouper culture is an activity which households undertook in addition to a range of other activities. Fishing was the main occupation in all the villages visited and many grouper farmers were also fishers themselves, or fish traders. As the Village Head in Ban Kho Khi, Phangnga commented, he '*needs to have another business as well as grouper culture to provide a daily income as I have to wait for profit from culture.*'

In contrast, grouper farmers in Phuket had primarily land-based occupations in addition to grouper culture, e.g plantations and shops. Culture of green mussel was also a common activity in Phuket.

While fishing provided the household with a daily income, grouper farming acted as a form of saving.

'*One person here started to raise grouper 10 year ago- he mainly fishes and harvests fry to sell and to stock his own cages. Most people here have other occupations – like rubber plantations. Grocery is main income for daily expenses. Sometimes have income from rubber, grouper provides a saving.*' (Cage farmer (Grouper, Red Snapper), Ban Bor Rae, Phuket)

'*We support our daily lives by pushing nets (fishing), we raise grouper because we can feed them on trash fish. Grouper is the main income, in terms of accumulation for saving money.*' (Net pen farmer (Grouper), Ban Had Sai Gaew, Songkhla)

'*We divide into two categories – they make their daily living by using the net, gill net or something like that. But grouper culture is a kind of saving, when we need a big amount of money, this is a kind of deposit to the bank, something like that.*' (Net pen farmer (Grouper, Seabass), Ban Sa La Hoom, Songkhla)

Other activities reported by respondents included harvesting rubber, making cigarettes from Nipa palms, shrimp culture, providing tourism services (boat hire), oyster or mussel culture, selling food and making shrimp paste.

2.5.2 General overview of culture systems

Culture systems

Where data was not available from interviews regarding the specifics of system construction, information is supplemented from Yashiro (1996), to provide a more complete picture.

Grouper culture, in the provinces visited during the study, is practiced in three different types of culture system[9]:

- Floating net cages
- Fixed net cages
- Ponds

[9] See Appendix 6 for illustrations

Floating cages are the most common type of culture system, and found in the majority of villages visited. Cage systems comprised roughly comparable constructions throughout all 6 provinces, wooden or bamboo poles supported by Styrofoam floats or empty plastic containers from which nets are hung. Cages were generally within the size range of 4 by 4 m to 5 by 5 m. Cage systems were situated in sheltered, coastal waters. Mangrove canals, or '*klongs*' , were the preferred location for grouper culture in cages.

Fixed net cages were seen to be used by farmers in Songkhla, where a lower tidal range and shallow coastal waters permit their use. Fixed cages, as the name indicates, are secured to the bottom substrate and comprise strong posts to which nylon nets are attached. They are generally approximately 3m (Baliao 2000). The constructions cannot withstand a large tidal range and therefore can only be used in regions with a where the tidal range does not exceed 50-60cm (Yashiro 1996).

Grouper farmers using pond systems were encountered in Krabi and Satun. Ponds varied in size and construction, from simple earthern ponds in Thung Sa Pho village in Satun of approximately 0.1 ha, to reinforced structures where disused shrimp farms had been modified for fish culture. Some pond farmers thought that pond culture was preferable to cage culture as they felt they had more control over the pond environment than cage farmers, particularly in terms of water quality, which they could control to a greater degree than cage farmers.

'*In cage culture we have to worry about security, storms, puffer fish that make holes in the net. Not a problem in ponds.*' (Pond farmer (Grouper), Ban Ta Ling Chan, Krabi)

Some also believed that the pond environment could cure some grouper diseases,

'Sometimes the body of grouper has red spots, like wounds. If these fish are put in the pond, the wound goes. No disease in pond fish. Get red spots in the cages. Usually during the dry season the water is hot, fish become 'wounded'. Sometimes people take the fish to the pond then. The fish like to stay at the bottom on the soil, seem to itch on the soil.' (Pond farmer (Grouper), Ban Ta Ling Chan, Krabi)

The size of farm systems varied from 2 cages to 30 cages per farm.

Species raised

Although farmers indicated that they raised many different species of grouper, three species were encountered most frequently during the study:

English name*	Local name	Scientific name
Orange-spotted grouper	Red spot grouper, 'Dork daeng'	*Epinephalus coioides*
Malabar grouper	Black spot grouper, 'Dork dam'	*E. malabaricus*
Duskytail grouper	Orange spot or 'beetle nut flower', 'Dork maak'	*E. bleekeri*

* Lau and Li (2000)

E. coioides is the most commonly cultured species of grouper on both the Gulf and Andaman coasts of Thailand. *E. malabaricus* is cultured primarily on the Gulf coast, and was reported in villages visited in Songkhla province. *E. bleekeri* was raised by some farmers, but many reported that it grew slowly and did not fetch a high price (200-270 THB, $4.5-$6[10]) when compared to *E. coioides* and *E. malabaricus* (approx. 350 THB, $8).

Many farmers also raised seabass (*Lates calcifera*), in separate cages from grouper. Seabass culture alongside grouper culture appeared to provide a more secure income than grouper alone, as seabass could be sold on the local market for cash when required. Seabass fry are also readily available from private and government hatcheries. However, seabass culture was reported to generate a lower profit than grouper culture. Seabass also require more feed, according to farmers interviewed. A further advantage of grouper culture which farmers found attractive was the trade in grouper fry, which enable farmers to sell fish below the preferred restaurant size of 1.2kg. Seabass must be sold at the preferred market size of 700g and cannot be sold at a lower weight.

'Seabass and red snapper eat a lot compared to grouper, and the price is lower. Narrower profit margin.' (Cage farmer (Grouper, Seabass, Red Snapper), Khlong Mudong, Phuket)

'The seabass is very low price. He doesn't know exactly because he doesn't grow seabass. Price of seabass about 80 THB per kg, but grouper more than 200 THB, so grouper is better.' (Net pen farmer (Grouper), Ban Had Sai Gaew, Songkhla)

In Phuket and Phangnga, farmers stocked red snapper (*Lutjanus argentimaculatus*) as a lower investment alternative to grouper. The profit generated by red snapper culture was also lower than

[10] Conversion 44.7 THB = 1 US Dollar. Source: OANDA.com

that for grouper. However, grouper culture was found to be particularly limited in Phuket province, where the culture environment is not suitable for grouper culture due to low salinity. Red snapper appear to be more tolerant to freshwater and to fluctuations in environmental conditions and are therefore a lower risk alternative to farmers in this province.

'The people like to raise red snapper here, as red snapper are tolerant to freshwater. Grouper culture has problems because of the low salinity here. DoF supplies fry for red snapper raising. Red snapper is less risky than grouper in terms of disease.' (DoF Officer, Phuket)

Stocking and harvesting practices

Grouper farmers did not adhere to a clearly identifiable regime of stocking and harvesting, primarily as a result of the variability in availability of grouper seed. Juvenile fish were generally preferred within the size range of 4-5 inches (TL) or 8-9 inches (TL)[11]. Some farmers preferred to stock the larger fish of 8-9 inches in order to reduce the length of the grow-out period, although this required a greater initial investment. Grouper are most commonly raised to a size of 1.2kg, the standard market size for grouper, although fish were also harvested at smaller sizes of 7 to 9 inches or as kilo fish (200g) in some villages. The culture period may last for more than a year, if 4-5 inch fish are stocked and raised to full market size. The culture cycle in cages and ponds is illustrated in Figure 2-4.

Farmers do not operate a single, annual stocking and harvesting cycle, but stock and harvest continuously as long as juvenile fish are available. As one farmer reported, the culture cycle cannot be planned, as different size fish reach market size at different times and are harvested when they reach 1.2kg. They are therefore unable to manage the culture cycle in such a way that harvesting coincides with Chinese New Year in January, when demand and value of grouper reaches its peak. As grouper culture is dependent upon wild caught fish, it is not possible to purchase seed fish of a standard size which would reach harvest size simultaneously. The financial cost of such a practice of a single cycle stock and harvest system would also be more than many grouper farmers could afford. Instead, the costs and benefits of grouper culture are distributed over time,

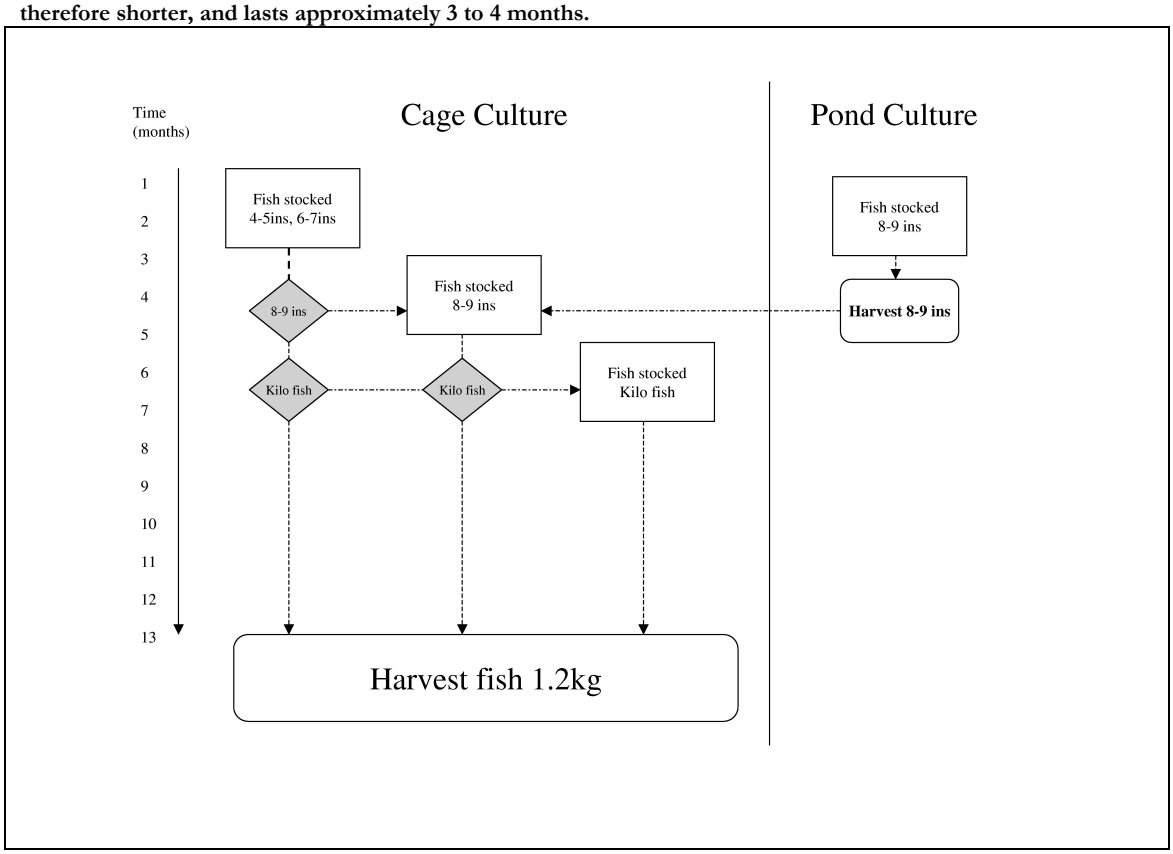
[11] Fishers, farmers and middlemen referred to grouper seed within these size increments.

'He doesn't harvest fish in January, when the price is highest, as he doesn't like to plan the culture cycle. To harvest the fish at the same time need to stock the same size of fish. Can't find all the same size. Stocks different sizes and sell when they reach 1.2kg. Also needs a large amount of money to buy the same size fry all at the same time. He distributes the costs over time.' (Head of village/Cage farmer (Grouper, Seabass), Ban Kho Khi, Phangnga)

Two types of management system could be identified during the study:

a. short culture cycle (advanced nursing – 3 to 6 months)
b. long culture cycle (fattening – 6 to 13 months)

Figure 2-4 Grouper culture cycle in cage and pond systems. Pond systems are primarily used for nursing grouper to a size of 8-9 inches, before they are sold or moved to cages for on-growing. The culture cycle is therefore shorter, and lasts approximately 3 to 4 months.



Farmers took advantage of the possibility of selling grouper at less than the market size by harvesting fish after a shorter grow-out period, 3 to 6 months, and selling fish at 8 to 9 inches (approx. 100-150g) or as 'kilo' fish i.e. 200g[12]. This system allows farmers to generate a benefit from grouper culture within a relatively short period of time, reduces the risk of losing fish stock to disease and requires a lower, total feed input than over a longer grow-out period.

[12] ,Kilo' fish are sold per kg, rather than per fish, as the 1.2 kg fish are. Fish approx. 200-250g each.

'Stock for a very short period of time, in one water, then call middleman to come and buy, if they stock longer greater risk of the fish dying.'(Cage farmer (Grouper), Ban Kuan Tung Ku, Trang)

This system essentially adds value to small size fish, and could be described as 'advanced nursing'. The longer culture cycle, where fish are fattened for market, lasting approximately 12 months, yielded greater financial benefits if the fish stock survived, as the value of fish is higher for larger fish (THB/kg).

'Previously he harvested fry from the wild. But very low profit, so would like to raise in a cage to get more profit.' (Cage farmer (Grouper), Bang Long,Phuket)

Scale of production

Two types of culture system were encountered during the study, which could be described as 'small-scale' and 'commercial'. Small-scale systems were the most common. These farms were family-owned and comprised approximately 2 to 4 cages, although farms with as many as 30 cages were seen. Commercial farms were found primarily in Phangnga and Satun (at Pakbara). These farms were larger than the small-scale farms. Owners came from outside the village in which the cages were situated and employed a caretaker, also from outside the village, who lived in a small house above the cages. Commercial farm owners were usually absent from the area and caretakers were unwilling to speak in the absence of the owner, thus information regarding commercial systems is lacking from the study. For small scale farmers, grouper culture provides a supplementary income in addition to other livelihood activities in which the household is engaged. In contrast to the capital intensive commercial systems, financial capital investment is kept to a minimum in small scale systems through the harvest of feed and seed inputs from the wild.

2.5.3 Factors motivating uptake of grouper culture

Influential institutions

A number of institutions were identified as having been influential in promoting the uptake of grouper culture and its development in the region, these included:

- The Department of Fisheries (DoF)

'DoF in collaboration with the FAO introduced cage culture 19 years ago (1981) as a supplementary income for fishermen. Chose this village and one other (Ko Chiam). Six fishermen selected and given 6 cages between them, and

600 THB for fry.' (Imam, district fisheries officer and cage farmer (Grouper), Koh Panyee, Phangnga)

- Middlemen and fish traders

'When grouper culture first began, a middleman came from Satun, and told them they should do grouper culture, then he would come back to buy from them' (Head of Village/Cage farmer (Grouper farmer, Ban Kho Khi, Phangnga)

'About 18 years ago, a middleman told them he would buy grouper if they cultured it. Fishermen pleased as grouper previously worthless to them.' (Imam, district fisheries officer and cage farmer (Grouper), Koh Panyee, Phangnga)

- Bay of Bengal Program (BOBP)

'The village has a Fishery Collecting Group. The BOBP set up the project to enable fishers to get a high price for their shrimp. Removing middlemans control of prices. Now have a number of middlemen come to the village to auction and bid for the shrimp.Currently only operates for shrimp. The group began one year ago. The village is now taking over control of the group itself. They are thinking of including grouper in the auctions, but are not sure how to do this as the fish are sold live.' (Head of the Fishery Group, Ban Had Sai Plae Hoi, Phangnga)

Of these institutions, the influence of the DoF was most apparent. Provincial officers of the DoF had been instrumental in the development of grouper culture in 7 of the villages visited during the study, shown in Figure 2-3.

Table 2-7 Villages in which fish culture was promoted by the Department of Fisheries

Village	Province	Project information
Koh Panyee	Phangnga	The DoF, together with financial support from the FAO introduce cage culture to the village in 1981. Gave cage materials and money to purchase fry
Ban Sam Chong	Phangnga	DoF gave seabass fry and materials to construct cages for fish culture
Thung Sa Pho	Satun	The DoF introduced mud crab culture and later also provided training for grouper culture
Ba Kan Khoei	Satun	The DoF provided 10,000 THB per household for cage materials in 1998, for 20 households. Seabass seed was also provided. Each household involved in the project must return 6000 THB to a central fund in the village.
Ban Tung Lin	Satun	Fish culture introduced by the DoF in 1985. Originally began as seabass culture, but farmers changed to grouper culture a year later.
Ban Sa La Hoom	Songkhla	The DoF advised villagers to raise grouper

'DoF promoting grouper culture through extension, for lowest class in the fishing villages. We supply cages and fry, but villagers must organise themselves into a group to receive funds and supplies.' DoF Officer, Krabi

'Started cage culture in 1982. DoF gave seabass seed and cages. Cultured seabass until 5years ago then began grouper culture.' (Fry trader, Ban Sam Chong, Phangnga)

Respondents reported that the DoF had provided materials for cage construction and seed fish for the cage culture of seabass, to which farmers later added grouper seed also. Some farmers had also received grouper seed from the DoF, but the seed fish were reported to be too small for culture and the majority of fish died,

'Previously the DoF supplied fry, but stopped now so have to find our own. They gave us fry twice, of size 2 inches. The growth rate was less than wild fry.' (Cage farmer (Grouper), Bang Long, Phuket)

In Thung Sa Pho village, Satun, villagers began to raise mudcrab in ponds with the assistance of the DoF, but later introduced grouper culture when they discovered that grouper can be nursed relatively easy in ponds and showed a fast growth rate. In other villages, the DoF had suggested to villagers that they raised grouper, but did not provide materials or support to enable them to do so.

The Department of Fisheries instigated the development of cage culture in Ban Ba Can Khoei village, Satun, where farmers primarily raised seabass. Fish culture was offered as an alternative livelihood to encourage fishers to stop using destructive fishing gears such as push nets. Without an alternative option, continued fishing with these gears was a necessity for the fishers, who lacked money for investment in other methods. The DoF provided a loan to allow 20 households to begin fish culture or to take up alternative fishing methods. Each household was given 10000 THB for cage materials and seed, of which 6000 THB was a repayable loan. The farmers in the village reported that they would prefer to culture grouper when they have paid back their loans, but at the time of the study they could not afford seabass seed and grouper seed were difficult to obtain.

However, DoF policy requires that villagers form groups in order to participate in the fish culture project. This policy is not always successful,

'When cage culture began, the DoF gave money for the project. But have conflict as fishermen don't return the money. Group is supposed to share responsibilities, but not honest and do not work together. Usually select the poorest to give

cage culture, but have many problems and when they sell fish have no money to return to the group. So now have to select the middleclass to raise fish. The money was given by the DoF as part of a project to offer alternatives to destructive fishing. Only seven people took up grouper culture, the others chose other types of fishing, as cannot find fingerlings. Policy of DoF is to try to encourage change from pushnets and destructive gears.'(Head of Village/cage farmer (Grouper), Ban Tung Lin, Satun)

'DoF would like to give money for fish culture, but we have to form a group. Don't want to do this.' (Cage farmer (Grouper, Seabass, Red Snapper), Klong Mudong, Phuket)

Some villagers preferred to raise grouper with their own capital,

'DoF come here sometimes and take a look at the water and give us advice about the fish. They tell us they have funds if we want to borrow money, but villagers don't want it. They would have to take things seriously. More relaxed with their own investment.' (Pond farmer (Grouper), Ban Ta Lin Chan, Krabi)

Independent ideas

However, in many villages, grouper culture has developed without the assistance or influence of institutions external to the village. In these villages, respondents gave the following reasons for taking up grouper culture:

- Grouper are high value fish and can generate a high income. The value is sufficiently high, that even if half of the fish die, the farmer can still make a good income.
- Groupers believed to be easy to raise with a fast growth rate.
- They had seen other people who were successful and could generate a benefit so began to raise grouper also
- Raising grouper provides an alternative income to fishing as the wild stock has declined. It enables fishers to add value to the small fish which dominate the catch.
- Grouper culture began incidentally, as fishers were holding fish in cages before selling them. They found that grouper could grow well in cages, and as fishers were also catching fry fish, they added them to the cages too.

'*Began culture about 5 years ago. At the beginning because we use the gill net, and then the fry comes along so we just put in the cage.*' (Net pen farmer (Grouper), Ban Sa La Hoom, Songkhla)

- The waste from the processing of anchovy could be used to feed grouper culture, and thus allow fishers to generate a benefit from waste that would otherwise have been discarded

'*Went to buy fishes from the fishing pier. We don't know where to put the fishes head so we use the head of fishes to feed grouper. We buy fish to make dried fishes, when we process the raw fish, we have fish heads and intestines which we don't know where to put so we buy grouper fry to eat the leftovers'* (Net pen farmer (Grouper), Ban Tha Le Nok, Songkla)

- In Songkhla, grouper were believed to have a good future for export, facilitated by ease of transport as a new road was built for the port in 1983.

Local institutions

In Krabi, one grouper farmer had formed an informal producers group amongst other grouper farmers operating on the klong. The group was established in 1998 with 10 members. Membership has since increased to 18 villagers. The group has accumulated 100,000 THB from deposits made by each group member into a central fund. Each member initially deposits 1000 THB, followed by 100 THB per month. The group sells fish together to a fish trader at a price agreed by the group. The groups savings are used to buy fry and repair cages. The existence of the group has allowed villagers who could not otherwise afford the investment to participate in cage culture. The savings provide some degree of security against potential risks.

2.5.4 Access and participation

Level of uptake of grouper culture

The level of uptake of grouper culture varied widely between villages, from 1 household to a reported 80% of households. The proportion of households raising grouper in each village, according to estimates by respondents, is shown in Table 2-8. Uptake was influenced not only by wealth status and institutional involvement but also by the situation of the village, and the prevailing environmental conditions of the culture location.

The highest level of uptake was observed in villages in Phangnga, for example Ban Koh Khi village where 120 of 200 households raised grouper, together with red snapper, seabass and oyster. The Head of the village commented that no-one wants to raise seabass as the market price is low. However, if farmers lost as much as half of their grouper stock, they were still able to make a profit.

'Price of seabass is low so no one wants to culture it. Little profit from seabass compared to grouper. Even if 50% loss (mortality) from grouper, still make a profit.' (Head of Village/Cage farmer (Grouper, Seabass), Ban Kho Khi, Phangnga)

A large number of cages were observed at Ban Sam Chong village, Phangnga. However, the majority of these cages, 300 of 400 units, belonged to commercial farmers. Only ten households in the village raised grouper, whilst 120 of 150 households fished for grouper seed. Fishing in general provided the most important source of income for the community. Fish culture had been of more importance in the past, however, an outbreak of disease in 1991 was reported to be responsible for the reduction in the number of fish cages from 1000 to 400 units.

Factors constraining uptake of grouper culture

Cost of investment

One of the most significant factors constraining the uptake of grouper culture by many people in the region was the high cost of investment required for start-up of grouper culture. The estimated costs for materials and the first stock of fry fish was calculated based on information provided by grouper farmers to be approximately 20 000 THB for two cages. Thus, in many villages, grouper culture was an activity undertaken primarily by the less poor and the wealthier members of the community. Respondents reported that members of poorer households could not afford the investment needed to raise grouper.

'*Fishermen who catch fry have no money to invest in grouper culture.*' (Head of village/Cage farmer (Grouper, Seabass), Ban Kho Khi, Phangnga)

However, with the support of the DoF, some poorer households were able to raise grouper as projects to initiate fish culture in coastal communities removed the chief obstacle to participation by providing materials and seed fish for fish culture. Ba Kan Khoei village, Satun, and Ban Saam Chong village, Phangnga, appeared to be having some success as a result of the scheme.

Poorer households were also able to benefit indirectly from grouper culture by providing juvenile fish for farmers. Some producers indicated that they regularly buy from the same fishers and thus support them in their livelihood.

'He (grouper farmer) has a group of fishermen who catch fry for him. The fishers who fish for him fish for grouper only, using the trap. His group of fishers mainly catches Dork Maak (E.bleekeri), so he has to buy them. He only buys from this group. Other people raising grouper also have their group of fishers. He cannot stop raising grouper, as his fishers will have to go elsewhere, and some depend on the fry fishery. He effectively supports the people who fish for him. They support one another.' (Cage farmer (Grouper), Ban Kuan Tung Ku, Trang)

Table 2-8 Village characteristics and uptake of grouper culture. The figures provided are estimates given by respondents.

	Total. No. households	No. raising grouper	% of total HHs	Wealth status of farmers	DoF initiative in village?	Commercial production in village?
Satun						
Thung Sa Pho	68	50	73	Poor-middle	Yes	No
Ma Haang	100	10	10	Middle-wealthy	No	No
Pakbara	-	-	-	-	-	Yes
Ba Kan Khoei	80	20	25	Poor	Yes	No
Ban Tung Lin	142	20	14	-	Yes	No
Trang						
Ban Koh Khiam	400	70-80	17-20	Poor-middle	Yes	No
Ban Laem	160	40	25	Poor	(Yadfon)	No
Ban Kuan Tung Ku	140	4	3	Middle-wealthy	No	No
Ban Nam Rap	80	1	0.1	Wealthy	No	No
Phangnga						
Ban Kho Khi	200	120	60	-	No	No
Ban Saam Chong	150	10	7	-	Yes	Yes
Ban Had Sai Pla Hoi	50	30	60	-	(BOBP)	No
Koh Panyee			80	-	Yes	Yes
Songkhla						
Ban Had Sai Gaew	15	Most	-	Poor	No	No
Ban Sa La Hoom	10	10	100	-	No	No
Ban Tha Lae Nok	-	-	-	-	No	No
Pak Bang	200	70	35	Middle-wealthy	No	No
Krabi						
Khlong Jilad	-	-	-	-	-	-
Ban Ta Ling Chan	330	200	60	-	No	No
Koh Khlong	800	18	0.2	Poor	(Village co-op	No
Ban Kuan Tor	230	70	30	-	No	No
Phuket						
Khlong Mudong	-	6	-	Middle-wealthy	No	No
Ao Por	-	10	-	Wealthy	No	Yes
Bang Long	200	8	4	Wealthy	No	No

In Songkhla, the number of people able to participate in grouper culture was reported to be decreasing due to the high cost of investment and the limited availability of grouper seed. People who were taking up fish culture were opting to raise seabass rather than grouper.

'Grouper culture began in the village about 20 years ago. The number of people raising grouper has now decreased as it is a big investment. People who are starting now are raising seabass.' (Middleman, Pak Bang, Songkhla)

Culture location and environment

Uptake of grouper culture was influenced not only by household wealth and ability to invest in grouper culture, but also by such factors as village location, and the local, environmental conditions. In Ban Nam Rap, Trang, for example, a low level of uptake may be explained by the distance of the village from the coast or mangrove canals and the primarily land-based occupations of the villagers. At 6km, the village is situated further from a suitable culture location than any of the other villages visited during the study. In Phuket, grouper culture is limited by the low salinity of the water surrounding the island of Phuket, which is more favourable for the culture of red snapper.

2.5.5 Problems contributing to declines in grouper culture

Disease

Fish disease and mortality were the most commonly reported problems associated with grouper culture. Respondents described symptoms such as spinning behaviour, skin lesions, a black mouth, yellow eyes and 'wounds' on the skin. Diseased fish in Songkhla had a white appearance. Disease was most often associated with the dry season in Phangnga, Phuket, Krabi and Trang. Respondents in Songkhla attributed mortality to parasites that attacked the gills, which caused problems during the months of January to March. Fish brought from the Andaman coast and stocked in cages on the Gulf coast were thought to be particularly susceptible to disease. Disease problems were also associated with hot water during the summer season, and high turbidity. Farmers in Trang believed that fish disease could be attributed to poor water quality and pollution from the local town of Kantang, local fish processing factories and shrimp pond effluent.

Farmers in Satun appeared to experience fewer problems with disease than reported by farmers in other provinces. Pond farmers in Thung Sa Pho village reported losses of approximately 10%.

Some respondents gave accounts of incidents of water pollution, for which local processing factories were thought to be responsible. On one occasion, effluent released from a shrimp farm was blamed for the loss of two cages of seabass. Poor water quality and associated fish disease and mortality were described by respondents in Pakbara, Satun and Saam Chong, Phangnga, both areas of high levels of grouper culture. In both locations, respondents related how the number of farms in the area was dramatically reduced, by hundreds of cages, following a disease outbreak associated with poor water quality. It is possible that disease and mortality arose as a result of overcrowding

and self-pollution as the culture environment was densely packed with cages. Alternatively, the close proximity of cages may have facilitated the rapid spread of disease amongst the cages.

Respondents in Krabi seemed to feel that risks were to be expected, and when managed properly, grouper raising could generate a relatively stable income.

Other problems experienced by grouper farmers included:

- theft of grouper
- lack of fry
- price instability
- lack of experience and knowledge
- high cost of investment

Respondents also described two problems which indirectly posed problems for grouper farmers. The first was described by DoF officers, who related how small scale fishers in the area frequently come into conflict with the commercial fishers, who encroach on the fishing grounds of the small scale fishers by failing to comply with regulations which prevent them from fishing within 3 km of the coast. Respondents in Thung Sa Pho village, Satun had told how the artificial reefs offshore prevented encroachment of trawlers as the structures ripped the nets of the trawlers

A lack of community cohesion had created problems in a village in Satun, where the DoF tried to initiate a cage culture project. Conflict arose when farmers failed to return the money they had borrowed to the fund established by the DoF. The group was required to share responsibilities but could not work together or trust one another. It is part of the policy of the DoF that farmers form groups in which to raise fish before money for cage culture is given to the community. The account given above suggests that this is not always a successful policy and worthy of further investigation.

2.5.6 Seed resources and the fishery for grouper fry

At the time of the study, grouper seed were obtained almost entirely from the wild although farmers have, on a very limited number of occasions, received seed fish from the DoF. Farmers who had received fish from the DoF often reported, however, that the quality of the fish was often too poor for on-growing. Villagers in every village visited during the study were targeting grouper

fry using traps either for their own farms or to sell to grouper farmers and middlemen. At this stage, based on the data gathered, it was not possible to determine whether a strong association between locally available grouper fry and uptake of grouper culture exists.

Fry fishing – gears used and location

In villages on the Andaman coast, fishers used traps, known as '*sai*' or '*lob*' to catch fry of 2-3 inches or more[13]. The traps used by fishers were mostly rectangular in shape and approximately 25cm wide and 50 cm in length, and comparable to those described by Yashiro (1996). They are made of bamboo or mangrove wood and covered with a nylon mesh. *E. bleekeri* were targeted with a hook and line gear, rather than the fish trap used for catching other grouper fry.

Fishers use approximately 50-70 traps at a time, which are baited and lowered onto the substrate of mangrove channels or stony areas. Respondents pointed out that grouper fry are found primarily in muddy or stony areas, depending on the season, and not, as often stated in the literature, on coral reefs. Ornamental fish and larger grouper are caught on coral reefs. Fishers do not fish for grouper fry every day, but only during the 'dead' or neap tide – representing a period of 12 to 15 days per month. During the spring tide they use other gears, particularly crab traps, shrimp push nets and gill nets. Fishermen reported that they could catch grouper fry all year round, but fishermen have to travel further during the rainy season.

In Trang, fisherman fished with an average of 70 traps per boat, which may catch an average of 30 fish per trip, increasing to up to 100 during the peak season. In Trang, this was reported to be before the west monsoon in April. The middleman reported that fry collectors in Koh Khiam village, Trang, can buy 300-400,000 fish in one month during the peak season.

Fry of 1-2 cm are caught in seagrass beds. Fishermen in Koh Khiam, Trang, reported that they do not consider it to be financially wothwhile to fish in these areas. However, in Ban Chao Mai village, Trang, fishermen fished for fingerlings of 4-5 inches in the seagrass beds close to the village. This area represents the largest seagrass area in Trang and is home to a population of approximately 40 dugong.

[13] For illustrations, see Appendix 6

Fishers on the Gulf Coast in Songkhla catch 'cm' fish between January and March using a bag net set in the mangrove channel. Reports of catches of up to 10,000 fry in one night were reported. These tiny fish are destined for the export market, as farmers in Thailand prefer to stock larger fish of 4-5 inches.

Species caught

Red spot grouper (*E.coioides*) and orange spot grouper (*E.bleekeri*) were the most commonly caught grouper fry on the Andaman coast of Thailand. Black spot grouper (*E. malabaricus*) were more commonly cultured on the Gulf Coast, although one respondent in Pak Bang, Songkhla, reported that Malabar grouper were usually sent from the Andaman coast of Thailand to be raised in Songkhla, as *E.coioides* often dies during culture. The Malabar grouper was also reported to grow faster than other species. A key informant in Koh Khiam village, Trang, reported that grouper are often categorised as 'real grouper', which refers only to *E.coioides*, and 'other' groupers i.e. 'not real' groupers, which include all other groupers.

Factors influencing fry availability

The type of gear used by fishers in a village may influence the number of fry fish that fishers are able to catch. For example, in Ma Haang village, Satun, fishers primarily used fixed nets and gill nets. These gears are not suitable for fry capture. Fishers reported that they could catch fingerlings using shrimp push nets.

Geographical location, particularly proximity to *klongs*, where grouper seed are primarily found, would appear to be a possible determinant of local availability of grouper fry. However, Trang, Satun and Krabi have relatively equal areas of mangrove forest (see Figure 2-1), yet Trang acts as source of grouper seed, respondents in Satun reported that there was a shortage of seed fish. Farmers in Krabi relied primarily on local sources of seed, suggesting that sufficient seed fish were available for culture in Krabi province.

Status of the grouper fry fishery

Respondents in every province believed that the number of grouper fry was decreasing. The problem seemed particularly pronounced in Satun province, where many respondents indicated that fry fish were bought from other provinces to supplement the local catch. Artificial reefs were

thought to have improved the grouper fry stock, whilst destructive gears such as push nets and large commercial anchovy nets were blamed for the decline. One respondent in Satun also suggested that the demand for grouper had increased as a result of increased numbers of people using disused shrimp ponds as grouper ponds.

'I buy 4-5 inch grouper fry from Trang. There are not enough fingerlings in Satun.' (Pond farmer (Grouper), Thung Sa Pho, Satun)

'Grouper and seabass fingerlings are disappearing in this area. Don't know why they can't find them. Have a lot of grouper ponds from failed shrimp culture. Many people need fingerlings so they are scarce. Maybe only looks like there are fewer because there is a greater demand.' (Fish trader, Ma Haang, Satun)

Trang is a relatively important source of grouper fry both to local grouper farmers and to the neighbouring provinces. Mr Supot Chungyampin (Fisheries Biologist at Trang Coastal Aquaculture Fisheries Station) reported in November 1999 that 'few large fish [grouper] are caught [in Trang]', and that 'fish are mainly exported from this area, there is not much culture' (See Table 2-10). In Trang, fishers reported that they use locally caught seed for culture, whilst three villages of five visited in Satun reported that they obtain their fry supply from Trang (See Table 2-11). The remaining villages in Satun sourced their fry outside of their own village, although the source was local. It was not determined whether fry obtained locally were wild caught in the area or whether they had been brought from other areas and nursed before being sold for grow out. One middleman in Pakbara also bought fry in Pattanee. Villagers in Thung Sa Pho village, Satun, nursed fry in ponds, which they obtained from Trang. These fry were then sold for on-growing at a size of 8-9 inches throughout the province. A middleman in Koh Khiam village, Trang, reported that the number of red spot grouper (E. coioides) had decreased recently, due to the use of destructive gears such as push nets and the commercial fishery for anchovy. This had increased the price of red spot grouper.

Respondents in Ban Kho Khi village, Phangnga, reported a decrease in the number of fry available, which was attributed to an increased number of fishermen using the resource.

'Number of grouper fry has decreased. Maybe because there are many fishermen using traps and catching a lot of grouper.' (Head of Village/Cage farmer (Grouper, Seabass), Ban Kho Khi, Phangnga)

Fishermen previously caught adult grouper. In Ban Sam Chong village, Phangnga, where a greater proportion of the village is dependent upon fishing for a livelihood, 80% of the households catch fry and fingerlings with traps. 70-100 traps are used per trip, catching 10-120 fry per trip, for 15 days each month. Shrimp push nets and crab traps are also used in the village. The peak season for fry capture is May when fishers catch on average 100 fish per trip. In one week, the middleman reported that he could collect 10,000 fry. He also indicated that the number of available fingerlings has decreased in recent year, although sometimes there are a lot fish. Compared to five years ago both the number and size of fry has decreased.

'Number of fingerlings has decreased. Some years do get a lot of fish, maybe because of high water levels. Average size of the fish caught changes depending on the month. Compared to five years ago, the number and size of fry has decreased. Maybe due to exploitation.' (Fry trader, Ban Sam Chong, Phangnga)

In Thung Sa Pho and Ban Ba Kan Khoei villages in Satun, fry were obtained locally and were not caught in the village as the type of gears used in the village were not suitable for the capture of grouper. Shrimp nets are used in Ba Kan Khoei, where they are reported to provide a higher income than would be obtained from the grouper fishery. For farmers in Ba Kan Khoei, it is more cost effective to catch shrimp and buy fry from a neighbouring village.

2.5.7 Feed resources

Grouper, like seabass and red snapper, are carnivorous and are fed with trash fish, comprising sardines, mackerel, small size shrimp and other small sized economic fish. Respondents reported few problems with regard to obtaining feed inputs for grouper culture, which was generally obtained either from the producers own fish catch or from other local sources, including fishers in the village, local villages or landing piers. Fixed nets were reported to provide a plentiful supply of trash fish. The availability of trash fish appeared to be most limited in Phangnga province, where respondents reported that feed was brought from Krabi and Phuket. The cost of purchased trash fish varied between villages, and according to quality and composition (Table 2-9).

Table 2-9 Cost of trash fish (Source: interview data)

Type of fish or source	Price (THB/kg)
Fish processing factory, Trang	12 THB per kg
Sardines in dry season, Trang	5 THB per kg
Small sardines, Krabi	5-6 THB per kg
Large sardines, Krabi	10-15 THB per kg
Whole mackerel, Phuket	6 THB per kg

2.5.8 Markets and fish trade

Grouper seed trade and networks

The study revealed the existence of a series of fish trade networks crossing the southern provinces of Thailand. These networks have arisen as a result of variation in fry fish availability between different provinces. These networks are illustrated in Appendix 1.

Satun province was primarily a 'sink' for grouper fry, and was the most dependent of all the provinces upon fry imported from other provinces. Krabi and Trang provinces appeared to be entirely self-sufficient, with fisher/farmers providing grouper fry fish for stocking from their own catch, or buying fry from local villages. Farmers in Phangnga, Songkhla and Phuket harvested grouper fry to stock their farms, but also had to supplement their catch with fry bought from other provinces. In Songkhla, fishers catch mostly 'cm' fry, and purchase fry fish imported from other provinces.

Table 2-10 Sources of fry for grouper culture, by province, as reported by respondents raising grouper

Province	Sources of fry fish for on-growing									
	Own catch/ in village	Local village	Ranong	Phangnga	Phuket	Krabi	Trang	Satun	Pattanee	Songkhla
Phangnga	X	X	X	X		X	X	X		
Phuket	X	X		X	X					
Krabi	X	X				X				
Trang	X	X					X			
Satun	X						X	X	X	
Songkhla	X						X	X	X	X

Trang appears to be an important source of grouper fry for the region, as most respondents, particularly in the more southerly provinces, reported that they had bought fry from Trang province. Middlemen in Trang reported that grouper juveniles are regularly transported to Satun.

Table 2-11 Destination of traded grouper fry, as reported by fry traders

Province	Destination of traded grouper fry									
	Direct to exporters	Local Middleman	Ranong	Phangnga	Phuket	Krabi	Trang	Satun	Pattanee	Songkhla
Phangnga			X	X	X	X				
Phuket					X	X				
Krabi										
Trang				X			X	X		
Satun		X						X		
Songkhla	X	X		X		X		X		

Two principal grouper seed networks appear to be in operation in the provinces visited during the study. One network comprises the more southerly provinces of Trang, Satun and Songkhla, a second the northerly provinces of Phangnga, Krabi, Phuket and, to a lesser extent, Ranong. It is possible that this division can be attributed to differing environmental characteristics along the Andaman coast. For example, one respondent in Phuket commented that environmental quality is comparable between Phangnga and Phuket, but differs from Krabi. Transferring fry between Phangnga and Phuket is therefore preferable to buying fry from Krabi. A respondent in Songkhla commented on a similar problem when buying fry from the more saline waters of the Andaman coast to raise in the Gulf of Thailand, where salinity is lower,

'For example, water quality in east and west of Thailand different. Higher salinity on Andaman side, so problem for transition of fry brought from Andaman provinces.' (Net pen farmer, (Grouper), Ban Sa La Hoom, Songkhla)

'Because here if we find locally, the water quality is the same salinity. So that means we can save our investment. The other thing is the fish is stronger, healthier.' (Net pen farmer (Grouper), Ban Sa La Hoom, Songkhla)

Grouper market

Consumption of grouper in Thailand is minimal, as the price is too high for local people to afford. Although some grouper, sold dead and primarily from capture fisheries, is sold to local restaurateurs for the tourist market, the market for cultured grouper is directed towards the more lucrative export market. The market chain is therefore relatively short. In general, farmers sell cultured grouper to a middleman, who may sell to a secondary middleman or, more frequently, directly to an exporter. Most exporters are based in Bangkok, but there was evidence of a significant export market from Had Yai, in Songkhla province. Both locations have major international airports. The shortest market chain was operating in Songkhla province, where some farmers sold grouper directly to exporters. The close proximity of the deep sea port to some

farmers in Songkhla, allowed them to sell fish to exporters from Taiwan, who transport the fish in well-boats. Exported fish were destined for markets in Hong Kong and Taiwan, Malaysia and Singapore. The principal links in the market network are illustrated in Figure 2-5.

At the time of the appraisal, grouper fetched an average price of 330 THB per 1.2kg fish (US$ 8). There appeared to be little variation between provinces, with respondents quoting figures in the range of 300-400 THB for a fish of 1.2kg in all provinces.

Respondents in Krabi, Phangnga, Phuket and Songkhla commented on the fluctuations in market value of grouper. Price instabilities were reported as one of the problems they experienced with grouper culture, with prices fluctuating during the year and between years. Respondents in these provinces also gave accounts of prices reaching a high of 500-550 THB in 1997. An illustration of price changes, as reported by respondents, is presented in Figure 2-6..

Figure 2-5 Grouper market network structure

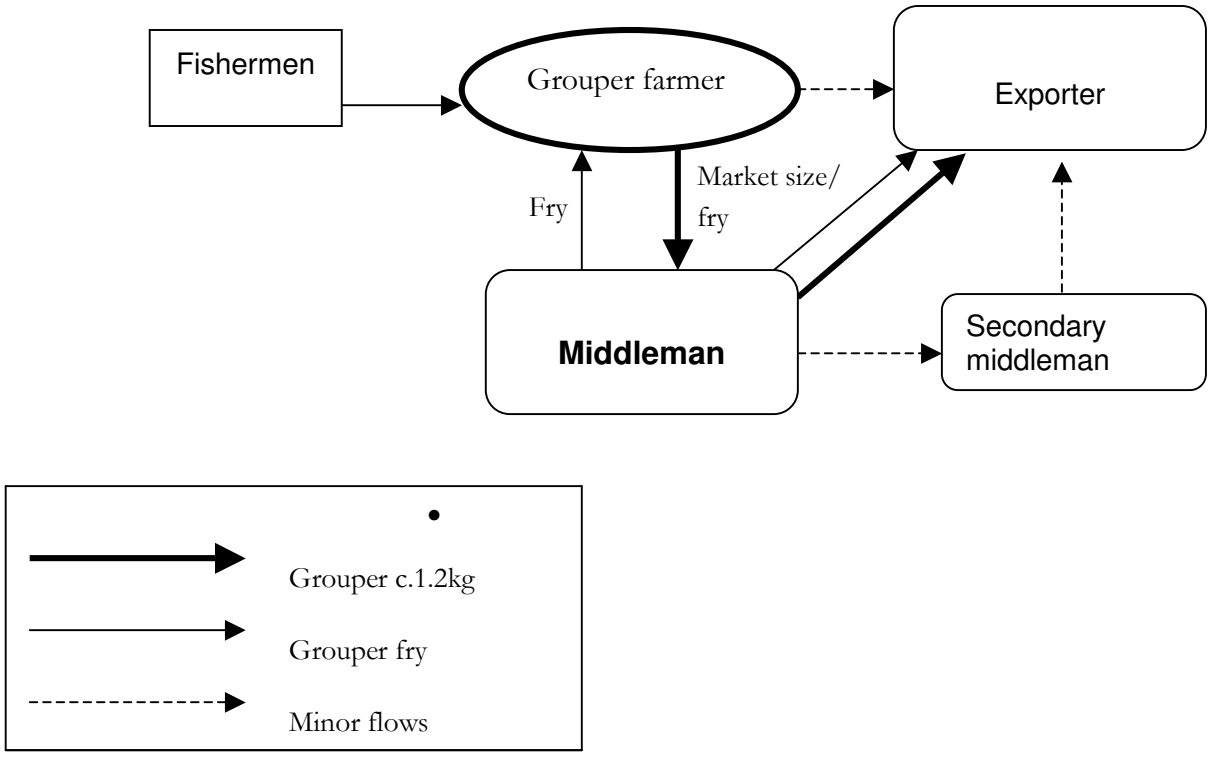
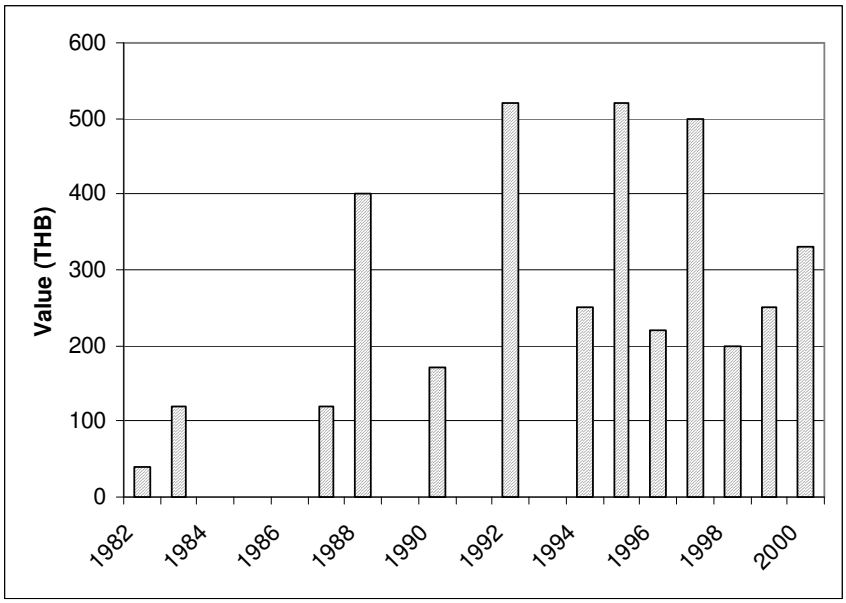


Figure 2-6 Trend in value of grouper, in Thai Baht per 1.2kg fish, 1982-2000



2.6 Summary of findings

2.6.1 Provincial variation in fish culture and fishery activities

Satun

- Satun is one of the most important producers of grouper in southern Thailand, with farms particularly concentrated in the region of Pakbara. DoF statistics for 1997 suggest that Satun has the highest number of grouper farms in southern Thailand.
- Culture is practiced in cages, predominantly 3 by 3 m, although a substantial amount of production takes place in ponds. Pond culture of grouper is practiced at the fry nursery stage with fish of 8-9 inches being sold for grow out.
- Respondents indicated that fry shortage was a constraint, with many being dependent upon fry brought from other provinces, particularly Trang. This was attributed to both diminishing fry stocks and the type of fishing gear used, fixed nets and shrimp pots, which are not appropriate for fry capture. Fry was obtained from Pattanee, Trang and locally in Satun. There are a number of artificial reefs along the coats of Satun, which are said to contribute to the productivity of the grouper fishery.
- Fixed nets provided feed for culture, at a cost of 3-4 THB. The catch also included sardines, and other economic fish. Fishers expressed concern for the small size of fish in their catch.

- Few problems were reported with culture in Satun. Disease and loss of fish in Pakbara were attributed to poor environmental quality.

Trang

- Trang has a limited amount of cage culture, with the fishery for grouper fry being of greater importance. The main area for grouper production is Koh Khiam, where 70-80 families currently raise grouper. Production was greater in the past until the villagers were affected by bank debts, the low price of grouper in the early 1980's and disease outbreaks.
- The fishery for orange spot grouper (*E.bleekeri*) used to be a major source of income for the fishers in the province. However, the price has now fallen dramatically and many fishers have had to adopt alternative gears.
- Seed and feed for culture is obtained locally at a cost of 12 THB per kg.
- Culture is primarily in cages.
- Disease is a major problem for cage farmers in Trang.

Phangnga

- Phangnga was the main area of grouper culture in southern Thailand until 1995. 1997 figures suggest that there has been a significant decline in farms although production remains high, and is apparently increasing. A high proportion of households in each village visited were participating in grouper culture. Red snapper and seabass are also produced.
- Seed was available locally, with many fishers fishing for grouper fry in the villages visited. Cage farmers did not indicate that fry availability was limited, although a decrease in the fry stock was reported.
- Feed was obtained locally from fixed net fishers, from Krabi and Phuket at a price of 7-9 THB/kg.
- Disease was reported to be a problem in one village. No other problems were indicated.

Krabi

- Cage culture in Krabi has been in existence for over 20 years, although according to DoF statistics production is low.
- Fishers used a wide variety of gears, in addition to fishing for grouper fry. All respondents fished for their own fry for stocking. There was little evidence of fry trade in the province.
- Feed was obtained locally or from Krabi town at a cost of 5-10 THB per kg.
- Disease was reported to be the main problem in fish culture.

Songkhla

- Few grouper farms are to be found in Songkhla, with production concentrated in two areas: close to the deep sea port in Songkhla, and Nathap, Jana district. Seabass is of more importance in Songkhla due to the more favourable environmental conditions for this species. The east coast has a substantial freshwater input creating unfavourable conditions for grouper raising.
- Grouper are primarily cultured in net pens, with a small number of floating cages evident.
- Fishers reported that fry for stocking were difficult to find in the wild, requiring the input of supplementary fry from Satun and Pattanee. Fry fishing is concentrated on the capture of 'cm' fry, which are trapped for three months at the beginning of the year, for export to Hong Kong and Taiwan. Fishers reported catching 300,000-1 million fry per month during this period.
- The DoF had supplied fry on occasion from their hatchery facility at NICA. However, survival was negligible as the fry were 1 inch in size and therefore too small for farmers to raise.
- Black spotted grouper were more common in culture than in other provinces. Humpback grouper, which fetches a very high price and is one of the most valuable of the live reef fish, was reported to have no price and was often thrown back if caught.
- Feed is bought locally at a cost of 5 THB.

Phuket

- Few grouper farms were in evidence in Phuket, although islands where production may have been concentrated, such as Ko Yao, were not visited. The DoF reported that there are a total of 770 fish cages in Phuket. This figure includes cages for seabass and red snapper.
- Raising grouper was said to be problematic due to fluctuating salinity levels. The DoF were promoting red snapper production, with fry supplied from a hatchery in Phangnga, as an alternative.
- In the areas visited, cages were primarily owned by non-fishers who used grouper raising to generate a substantial income. Many also owned rubber plantations, and other businesses, such as groceries.
- A number of farmers used fish processing waste for feed, at a cost of 30 THB for a 10kg bag. Other fishers were able to catch their own fry using the sardine gill net.
- Fry were reported to be hard to find. Some farmers bought fry through a middleman, primarily from Phangnga. In some areas, such as Laem Sai, villagers fish for grouper fry.
- Disease is a major problem for farmers raising grouper in Phuket. Availability of fry, price instability and theft were also said to be problems.
- A Taiwanese firm has a commercial farm at Ao Por, Phuket . Fry are bought from all over the south and raised in stone ponds and cages for export. A visit to the farm revealed that the fish were in poor condition, and stocked at high densities. The fish were predominantly *E. bleekeri.*

Table 2-12 Summary of key characteristics of grouper culture identified during the situation, listed by province

	Trang	Satun	Phangnga	Krabi	Songkhla	Phuket
Principal type of culture system	Floating cage	Floating cage Pond	Floating cage Some ponds	Floating cage Some ponds	Fixed net cage	Floating cages
Extent of grouper culture	Minor	Major	Major	Minor	Negligible	Negligible
Aquatic animal/species of grouper raised	Red spot grouper Few Orange spot grouper	Red spot grouper Mudcrab Seabass	Red spot grouper Seabass Red snapper Oyster	Red spot grouper Black spot grouper Red snapper Seabass	Red spot grouper Black spot grouper Seabass	Red spot grouper Red snapper Green mussel
Source of fry	Local sources	Some local Most from Trang Also Pattanee and Satun	Mostly local Suppl. Trang, Krabi, Satun and Ranong	Mostly from farmers own catch	Few local Rest from Satun, Trang, Pattanee	Mostly from Phangnga and Ranong
Cost of fry fish (size 4-5 inch TL)	20 THB	20 THB	20 THB	20 THB	20 THB	20TH B
Cost of bought trash fish (THB/ kg)	12 THB	3-4 THB	7-9 THB	5-6 THB to 10-15THB	5 THB	3-6 THB
Problems and constraints for grouper culture	Disease	Disease and poor water quality in Pakbara	Disease in summer season	Disease	Parasitic disease, fish mortality during rainy season	Disease Lack of fry Price instability
Status of the grouper fry stock	Decreased but sufficient	Decreased and hard to find.	Decreased but sufficient	Decreased but sufficient	Decreasing but sufficient	Decreased but sufficient
Importance of the grouper fry fishery	+++	++	++	+	+	+
Institutional involvement in grouper culture	++	+++	+	++	+*	+*

* DoF involvement in grouper culture has been minor, but greater efforts are being made to promote more suitable species more suited to the local environment, such as seabass in Songkhla and Red Snapper in Phuket.

2.7 Factors contributing to provincial variation

As Table 2-4 shows, the level of grouper culture was particularly high in Satun and Phangnga, whilst almost negligible in Songkhla and Phuket. The research sought to find evidence to explain this variation and found that variation in the level of grouper uptake in the provinces studies can be attributed to environmental and socio-economic factors.

2.7.1 Environmental factors

Water salinity

The low level of grouper uptake in Songkhla and Phuket provinces can be explained primarily by the low level of salinity in the coastal waters of both provinces, due to a relatively high level of freshwater run-off. The water chemistry of these provinces is therefore more suited to the culture of other fish species: red snapper in Phuket, and seabass in Songkhla.

Culture location

Mangrove canals provide an optimal culture location for grouper, where waters are brackish but also sheltered. Phangnga has the largest area of mangroves of the provinces visited, as shown in Figure 2-1, in terms of area and as a proportion of total land area. Satun, however, has less total mangrove area than both Krabi and Trang, although a high percentage of Satun's total land area is mangrove. It is possible that the extensive mangrove areas of Phangnga province provide a greater number of suitable culture locations than Krabi and Trang provinces and have therefore allowed grouper culture to develop to a greater extent that the other two provinces. This factor does not appear to explain the high level of fish culture in Satun.

Seed availability

The availability of wild caught seed is a significant factor in the uptake of grouper culture, as farmers with limited access to financial capital can catch fry from the wild to stock their cages or ponds. As grouper seed are primarily caught in mangrove channels it is possible that households are more likely to take up grouper culture in areas of extensive mangroves where grouper seed are available for capture. However, this would not explain the level of grouper culture in Trang, where seed fish appear to be sufficiently abundant to support trade in grouper seed, but grouper culture remains relatively low. Other factors, such as social or economic factors, may therefore account for

the lack of interest in grouper culture in Trang province. It is possible that seed resources are not necessarily more abundant in Trang province than in other provinces, but that there is a surplus due to the low level of grouper culture uptake. One respondent in Satun suggested that shrimp culture is preferred in Trang provinces, allowing fishers to sell grouper seed for sale in other provinces. Table 2-3 shows that shrimp culture is relatively more important in Trang province than in the other provinces on the Andaman coast included in the survey.

2.7.2 Socio-economic Factors

Proximity to market

The high level of grouper culture in Phangnga may be partially explained by its relatively close proximity to Bangkok. Most traders reported that the fish they purchased, both grouper fry and grow-out grouper, were transported to Bangkok for export. Traders in Phangnga would therefore face reduced transport costs to Bangkok, and possibly also lower fish mortality during transportation compared to traders further south.

This proximity to the market in Bangkok does not however, provide an explanation for the higher level of grouper culture in Satun province. However, it is possible that Malaysia provides a good market for grouper, particularly due to the close proximity of the tourist resorts of the Tarutao Archipelago and Lankawi island, which both provide an opportunity to sell grouper to tourist restaurants. Respondents did, however, refer more frequently to Malaysia as a market for seabass. Grouper from Satun may also be exported via Had Yai International Airport, as an alternative to transporting fish 900 km to Bangkok.

Institutional assistance from the Department of Fisheries

Although the Department of Fisheries has representatives in every province and every district of Thailand, variation in the effectiveness and priorities of each office is likely. It was found that the high cost of investment prevents many poorer households from taking up grouper culture. However, with the assistance of the Department of Fisheries, grouper culture had developed in a number of villages visited during the study. Although farmers were initially provided with seabass fry, the principle obstacle to grouper culture was the cost of cage or pond contruction. As farmers reported that they could stock wild caught grouper fry instead of seabass, and generate a greater

income as a result, many changed from seabass culture to grouper culture. As Table 2-7 shows, the DoF appeared to have been particularly active in initiating projects in Satun and Phangnga provinces. It is possible that this assistance may have contributed to the variation in uptake that exists between Satun and Phangnga and Krabi and Trang.

Alternative occupations

The level of grouper culture uptake observed in each province represents the outcome of decisions made by households to take up, reject or discontinue grouper culture. Decisions are made by households based on the assets they have available to them and the range of options from which they can select their livelihood activities. Thus, where grouper culture represents one of the best options for generating a benefit, in the absence of lower risk alternatives for example, and the household has sufficient assets to invest or where assets can be most profitably allocated, a household may decide to take up grouper culture. The likelihood of uptake is perhaps increased when assistance is provided by an institution such as the DoF. However, where a wide range of more stable and lucrative livelihood options are available households will perhaps be less willing to invest time and assets in grouper culture and prefer instead to take up another occupation. For example, in Trang province, rubber plantations, fish processing and shrimp culture provide a major source of employment and could thus explain to some extent the relatively low level of uptake of grouper culture.

2.8 Actors and beneficiaries of the grouper culture system

The appraisal showed that the majority of grouper farmers are also fishers, who derive a secondary income, or a means of saving money, from grouper culture. The high cost of investment that is required to begin grouper culture constrains the uptake of grouper culture by poorer households, unless institutional support is provided. Grouper culture is therefore often perceived as an activity for the mid-level income groups who are still engaged in fishing or have occupations associated with fishing such as fish trading or fish processing.

The livelihood profile of a household therefore appears to influence a household's decision to take-up aquaculture. This may go as far as to include the specificity of the gear used by fishers in the

household. As wild caught fish for seed and feed inputs appear to play an important role in the uptake of grouper culture, a household which lacks financial capital for investment and which uses a gear which does not target grouper for seed and/or trash fish for feed (shrimp gill nets in Thung Sa Pho, Satun, for example) will be less likely to take up grouper culture than a household who is able to catch grouper fry easily with their fishing gears. The way in which household decision making is carried out with regard to the uptake of available livelihood options is therefore a relevant issue for further study.

The owner/operator of the grouper farm is the principal beneficiary of grouper culture. In small scale systems, the owner or household therefore benefits directly from the culture system. In commercial systems, the owner is the principal beneficiary, whilst the caretaker receives payment for his work. A number of people benefit indirectly from grouper culture; these include fry fishers, fish traders and providers of materials for system construction.

The role of the Department of Fisheries in the initiation and expansion of grouper culture in the region has been significant. It appears that grouper culture has shown the most growth in those areas where the DoF has intervened and introduced seabass culture, which has subsequently developed into grouper culture. This has transformed grouper culture from an activity dominated by wealthier, middle to upper class members of coastal communities to an activity from which poorer households are able to benefit directly. In some villages, Ba Kan Khoei, Satun, for example, fish culture was initiated by the DoF as part of a program to reduce destructive fishing practices by offering alternative livelihood options. In Ba Kan Khoei, villagers were offered funds to change fishing gears or to raise fish. In some locations, however, grouper culture has developed spontaneously from a simple system for holding fish prior to sale, to a small farm system in which fishers add value to small fish by giving them trash fish for a short time before sale.

However, a number of respondents remarked that the assistance provided by the DoF was insufficient. They felt that, as grouper farmers, they lacked the knowledge they needed to successfully raise grouper and that the training provided by the DoF was impractical for their needs. Disease in grouper was an important problem for many respondents, a problem of which the DoF is aware. Respondents indicated that the DoF came to their village to take water and fish samples during periods when disease was prevalent, but could not provide any advice for treatment,

or disease prevention. The DoF had also on occasion provided farmers with small grouper fry (1-2 inches) but farmers did not have sufficient knowledge to raise grouper of this size and subsequently all of the fish died. Follow up support and support to grouper farmers who have not received help in the form of materials and fry may therefore be a significant determinant in the success of grouper culture.

DoF policy requires that villagers form groups in which to raise grouper. However, as demonstrated by Ban Tung Lin, Satun, social factors may be responsible for the demise of grouper culture in some villages where communities lack sufficient cohesion and trust to work together and manage the cages and funds generated from production successfully.

Other factors which may influence the success of grouper culture post-DoF intervention also include local availability of grouper seed and the cost of inputs, and suitability of the culture environment.

The DoF is also actively conducting research to facilitate the production of grouper fry (*E.coioides, E.malabaricus, E. lanceolatus*) in hatcheries (NICA, Krabi). A key issue for the present study is the potential impact of such a development on both fry fisher livelihoods and the development of grouper culture. The majority of grouper farmers interviewed during the appraisal derived inputs of both seed and feed from their own fish catch, supplemented with inputs from other fishers, and other provinces. Some farmers bought fry fish specifically from a small number of fishers, who regularly supplied them with fry. These respondents acknowledged the dependency of the fishers upon the sale of their fry catch to grouper farmers. However, it also appeared that very few fishers depended exclusively on fry fishing for a living, as most fishers use a variety of fishing gears to target different species.

2.9 Key issues

The preliminary overview identified a number of key issues which are not described in the literature, and which relate directly to the ability of grouper culture to provide a 'sustainable' 'livelihood' for coastal communities. They may be described as follows:

- Grouper culture is practiced primarily by fishing households or households associated with fishing activities
- The management of the grouper culture cycle is adapted according to the ability of the farmer to cope with risk and to invest financial capital
- Uptake of grouper culture is associated with wealth status
- Institutional intervention has played an important role in the uptake of grouper culture and has permitted poorer households to benefit directly from grouper culture
- In the absence of an understanding on the part of external organisations seeking to introduce grouper culture to a community of social, environmental or economic factors which may undermine the venture, and without follow-up support given by the organisation, the initiation of grouper culture by supporting institutions is not sufficient to ensure continued success of grouper culture
- Grouper culture is constrained by lack of seed fish and fish mortality
- Self-pollution by densely crowded grouper cages may be responsible for declines of grouper culture in some areas

2.10 Research outcomes

2.10.1 Definition of the grouper culture system

Boundary

The international trade in live reef fish fuels the demand for grouper culture, and ultimately dictates the level of uptake and development of grouper culture. Thus, the boundary of the grouper culture system is placed at the level of the international market for live reef fish. At present, consumption of grouper is dominated by people in urban centres in Asia, primarily the countries of China, Taiwan, Singapore and Japan. Furthermore, countries within the region, including the Philippines, Indonesia, Malaysia and Singapore, compete with Thailand for a share in the trade in LRF. These countries are therefore also included within the boundaries of the Thai grouper culture system.

Hierarchy

The hierarchical components of the Thai grouper culture system can be described as laid out in Table 2-13. The system has been grouped according to processes occurring within the system.

Table 2-13 Hierarchies within the Thai grouper culture system

Level of hierarchy*	Market	Institutions	Environmental	Social	Production system
Geo	International trade in grouper and live reef fish				
Macro	National level trade policy, tariffs and export market	National level aquaculture, fisheries and development policy			
Median	Regional trade in grouper by fish traders	Provincial level governance and policy implementation	Wild grouper population		
Small	Local level trade networks	District level governance and intervention at community level	Coastal cell and watershed within which grouper culture takes place	Inter- and Intra-provincial social networks between communities and households	
Micro		Community institutions	Culture site (multiple farms)	Community	
Nanno			Farm environment	Household	Farm
				Individual	Farm unit

*adapted from Muir (1996)

Interlinkages and processes

In keeping with systems thinking, which emphasises 'groups of interacting, interdependent parts linked by exchanges of energy, matter and information' (Costanza et al. 1993) the framework recognises the inter-linkages between the five components of which it is comprised. It was found that issues relating to the sustainability of grouper culture could be divided amongst five groups of processes, acting at various levels of the system hierarchy, as described below. A process is defined as 'an action which produces a change or development' (New Collins Concise English Dictionary 1986).

Table 2-14 Grouper system in Thailand – Processes

Process	Motivating/constraining factors		Outcomes	Impacts	With implications for:
Institutions	Promotion of fish culture: - DoF - Dept. Community Development - fish traders	Household Decisions Making	Uptake of grouper culture	-increased supply of grouper on the market - financial benefit or loss - increased waste production and demand for inputs	Market value Household well-being and vulnerability. Possible community impacts Demand for environmental goods and services
Markets	Market signals: - awareness of market value				
Social	Communication facilitated by social networks, diffusion of fish culture technology		Discontinuance of grouper culture	- reduced supply of grouper on market - reduced waste output and demand for inputs	Market value Environment
	Availability and access to assets and livelihood options		Rejection of grouper culture	- possible continuation of destructive fishing practices (or other environmentally damaging activities), if benefits greater than fish culture - otherwise benign	Environment
	Opportunity cost of available livelihood options		Rejection of grouper culture, uptake of an alternative activity	-possible uptake of environmentally damaging activity, or uptake of alternative activity e.g. less damaging fishing gear	Environment
Environmental	Local availability of natural resources and proximity to suitable culture environments				

Processes: Social

The situation appraisal found that household livelihoods, production system economics and market factors all fell within the 'socio-economics' subsystem. The separation of these factors in a new framework recognises the significance that the livelihood profile of a household may have on a households decision or ability to take up grouper culture. Household decision making has a direct impact on the level of uptake and subsequent development of grouper culture. It is assumed that a number of factors contribute to the range of livelihood activities adopted by a household. This may include, for example, the range of livelihood options open to the household, determined by access to and ownership of capital assets (primarily financial and natural capital) and the role of institutions. In the event of a household taking up grouper culture, their household and livelihood profile will influence the type of aquaculture system adopted, in terms of selection of species for culture, type of farm system, source of inputs, level of investment and culture cycle. The inter-linkages between household livelihoods and adoption of grouper culture were therefore considered to be key issues for consideration in the next stages of the research.

Processes: Environment and ecology

The environment is a cornerstone of grouper production systems and is strongly linked to Market and Livelihoods subsystems.

Decision making at the household level determines the type of gear adopted by fishers and their target species. The household then contributes to the overall level of exploitation of the fishery and ultimately the status of the fishery resource. Fishers may choose to target grouper fry either to stock their farm or to sell to middlemen or other farmers. If this decision contributes to increased pressure on juvenile, and ultimately adult, grouper stocks, the status of the fishery will influence the ability of farmers to continue if seed inputs are unavailable whilst also threatening the economic viability of the production system if fry fish increase in price.

The decision of the household to raise grouper also has an impact on the coastal environment as the household contributes to the pressure exerted overall by grouper culture in the coastal zone. The environment provides important ecosystem services, in terms of the assimilation of wastes produced by aquaculture. The level of grouper culture in the region places demands on these services and when it exceeds the environments capacity to provide those services problems arise.

Thus, the environmental impact of grouper culture is directly related to decisions made at the level of the household.

As described above, in Section 1.7.2, grouper culture puts pressure on the fishery resource for both seed and feed inputs. The extent of the demand of current grouper culture activities on the fishery resource for the provision of trash fish is currently unknown.

Processes: Markets

The demand for grouper, and the associated development of grouper culture in Thailand, is driven by the international trade in live reef fish.

The market subsystem therefore represents factors in the grouper system which exists at levels in the hierarchy which are most distant from the household and includes the international demand for grouper and the associated fluctuations in market value. It also includes the cost of seed and feed on the local markets which, together with the market value of grouper, determine the economic viability of grouper culture.

The value of grouper seed is influenced by the availability of juvenile fish. Increased pressure on the fry fishery resource is therefore likely to increase the market value of grouper fry. The value of grouper fry would also be influenced by the development of hatchery produced fry fish. Increased supply relative to demand would probably reduce the value of grouper fry on the market, and ultimately may reduce the cost effectiveness of fishing for wild fry.

The fluctuating market value of grouper shows how the value of grouper is strongly affected by consumer demand in the principal markets in South East Asia. However, as a luxury product, it is possible that increased supply to the market, which may result from hatchery production, could undermine the market and decrease the value of grouper on the international market, and subsequently threaten the ability of farmers to derive benefits from grouper culture.

Processes: Institutions

The institutions subsystems represents institutions, defined as the 'rules, norms and shared strategies that structure human action', and thus include entities such as families, churches, local governments, government agencies and most organisations, since they are defined by rules, norms and shared strategies (Crawford and Ostrom 1995; Imperial 1999). The Institutions subsystem refers to the institutions (rules or norms) and organisations that exist above the level of the community in the system hierarchy. Institutions which exist at the community and household level are incorporated within the Livelihoods component of the subsystem. The preliminary overview identified the Department of Fisheries as an important organisation in the grouper system, primarily due to its role as an initiator of grouper culture. The Department of Fisheries is also important as the principal body developing and implementing fisheries and aquaculture policy in Thailand. The DoF is also working to develop hatchery reared fry, and thus may have significant impacts on the wider grouper system.

The institutions and organisations included within the subsystem may also include financial organisations, such as banks, which may facilitate access of households to financial capital.

The Institutions subsystems is therefore linked to the Livelihoods subsystem as a key factor influencing household decision making and uptake of grouper culture through the active promotion of fish culture and provision of grouper fry. It also shares an indirect link to the Production System Subsystem as a factor influencing grouper uptake, and a direct link as a potential provider of knowledge and advice to farmers in the form of training and advice about fish disease. It is linked to the Market subsystem as a potential factor influencing the value of grouper seed and supply of cultured grouper to the market. Through these series of links, institutions also influence the environmental context. These links have both negative and positive consequences. On the one hand, the promotion of grouper culture increases pressure on the culture environment and fishery resource, whilst on the other, the production of grouper fry in hatcheries and the provision of grouper culture as an alternative to destructive fishing practices has the potential to reduce pressure on wild fish stocks.

Processes: Production System

The Production System subsystem encompasses all aspects of the grouper culture production system, including the extent of grouper culture development, the productivity and economic viability of individual systems.

As grouper culture is largely a small-scale activity at present, the development of grouper culture is determined by the level of uptake by households and thus by the factors which influence household decision making. The extent to which grouper culture develops has consequences for the culture environment, demands on the fishery resource, and market factors as dictated by the rules of supply and demand.

The production system itself can be described in terms of the culture units, inputs and outputs and the culture cycle, as determined by choices made by the farming household. These choices will also govern the economics of the production system.

2.11 Conceptual framework

During the course of the preliminary overview, the completeness of the research framework was questioned, as many of the issues identified during the study could not easily be categorised within the social, economic and environmental components which the framework comprises. The social and economic components were particularly problematic as they did not permit the differentiation between issues which influenced household economics and social processes and those which affected the economic viability of the production system. Furthermore, market factors did not sit comfortably within this category and called for a separate category which recognises the significance of market trends and aspects of supply and demand to the overall sustainability of the system and particularly the continued economic viability of the production system.

It was found that the key issues pertaining to the grouper system may be described in terms of five strongly interlinked subsystems, whose relevance is clearly illustrated by the description of the Thai grouper system and its processes and interlinkages, as defined in section 2.10.1. The subsystems identified include:

- Livelihoods

- Environment and ecology
- Markets
- Institutions
- Production systems

This group of subsystems serves both to incorporate and enhance the existing research framework. In particular it presents an alternative to the rather broad and inefficient subsystem described by the social and economic contexts. In the framework outlined above, the social dimension of the socio-economic context is more appropriately described by the Livelihoods subsystem. The inclusion of the term 'livelihoods' as opposed to the broader concept of a social context specifically recognises the significance of livelihood attributes in the process of decision making at the level of the community and ultimately the household, referring to the interpretation of a livelihood as defined by the Sustainable Livelihoods approach described in Section 1.4. It was found that economic aspects of the grouper culture system, as part of a sustainable livelihood system, were related to:

a. Household economics, where they relate to household decision making and livelihood options,
b. economics of the fish production system and the economic viability of fish culture, and,
c. the market for grouper, and the impacts of the market value of grouper on the uptake of grouper culture and issues of supply and demand.

The economic context can therefore be more appropriately divided between the Livelihood, Production System and Market subsystems of the framework.

As Figure 2-7 shows, the five subsystems of the framework incorporate the issues and inter-linkages described above.

2.12 Research development

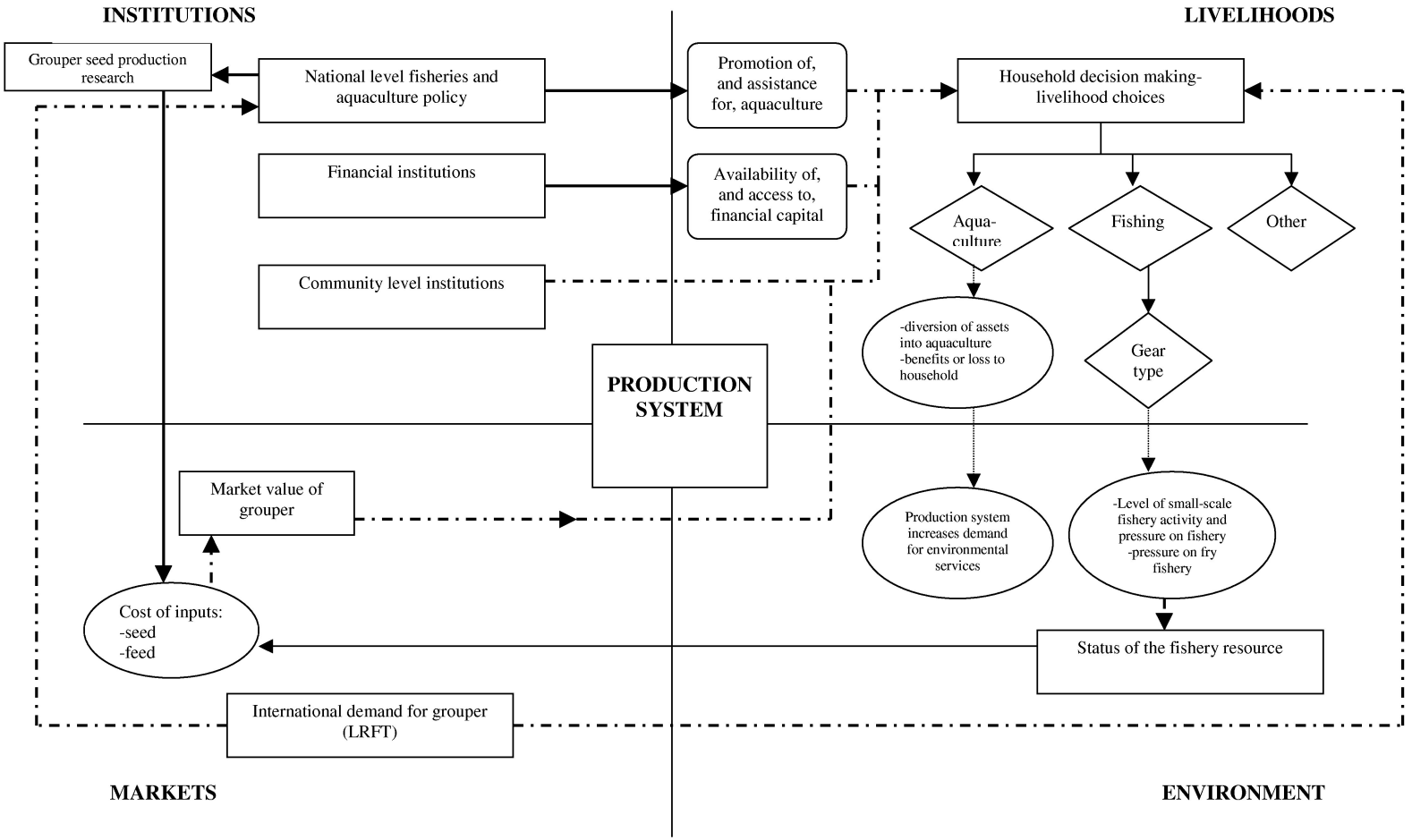
As shown in the description above, household decision making plays a pivotal role in the grouper culture system. In terms of a sustainability assessment, it would appear that changes within the wider grouper system, at any level within the system hierarchy, will ultimately be felt at the level of the community, where system perturbations are incorporated into decisions made at the household

level. The decision was therefore made to focus attention at the level of the community and the household units within selected communities.

The community was selected as the unit of interest because the findings of the preliminary overview demonstrated that, although some aspects of grouper culture can be said to be characteristic of a particular province such as lack of seed in Satun or the use of net pens in Songkhla, grouper culture took place in a wide variety of community contexts. Causes of uptake and discontinuance of grouper culture were linked with numerous community and household traits, including wealth status and institutional support, and the availability and cost of inputs. Where grouper culture is practiced, production systems vary in terms of culture systems, management of the culture cycle and levels of uptake in the community. It is therefore accurate to say that a representative community in which grouper is raised does not exist. This diversity negates the possibility of conducting a useful, cross-regional survey to explore key issues which may influence grouper culture sustainability. The costs and time requirements for such a survey are also prohibitive. As communities demonstrate such diversity, a case study methodology was selected as the most appropriate way in which to achieve an understanding of the role that grouper culture may have in the livelihoods of coastal communities. Adopting a case study approach provides an opportunity to investigate the role of grouper culture within a variety of different illustrative, rather than representative, contexts.

The selection of case study sites for further analysis forms the subject of the next part of this chapter.

Figure 2-7 Grouper culture system – Interlinkages



Part Two – Selection of case study locations in Trang and Satun provinces

Case study analysis would seek to explore and build upon the key issues and findings identified during the situation appraisal by working at the community and household level, aiming to resolve the research question with reference to each of the case study sites and the characteristics and contexts they illustrate. Case study sites would be selected on the basis of their ability to illustrate key issues in the grouper system and used to illustrate the way in which key issues affect the system at the community level, and to draw upon similarities and differences between case study sites.

The aim of this part of the study was therefore to gather data relating to key factors influencing grouper culture systems, identify the level of variation which exists between communities, and to select three communities in Trang and Satun which would illustrate the different contexts in which grouper culture takes place.

2.13 The study area

2.13.1 Rationale for selection of Trang and Satun provinces

During the provincial survey it was apparent that the provinces covered in the appraisal fell into a number of relatively discrete systems, based on feed and fish networks (see Appendix 1). The more northerly provinces of Phangnga, Phuket and Ranong show a high degree of interdependence, whilst not entirely excluding the more southerly provinces from the system. Similarly, Satun and Trang represent a second system, and the east coast provinces of Songkhla, and Pattanee a third. Whilst not exclusive, these trade network systems provide a useful way of dividing the region into groups which contain areas of high and low fry supply, and thus provide interesting cases for study with regard to fry fishing activity and the impact of fry availability on production.

As the production of grouper is concentrated in Satun and Phangnga provinces it was decided to include communities from at least one of these provinces in case study selection.

Trang and Satun provinces were therefore selected for further study as preliminary investigations had revealed that Trang was a major producer of fry and as links had previously been established with villagers and institutions in Trang which could facilitate field work. Connections between the two provinces suggested that analysis of this system would be logistically possible and cover the key

issues of the study. This region was also interesting, according to findings of the preliminary overview, for the following reasons:

⇒ Fry are caught in Trang and transported to Satun for on-growing.

⇒ Grouper fry, imported from Trang province, are nursed in ponds in Satun

⇒ Grouper are sold to Malaysia from Satun

⇒ Fry are readily available in Trang, but scarce in Satun

⇒ Fishers use different fishing methods, gears and target different fish species, with implications for resource availability

⇒ Cost of inputs and value of grouper differs between the two provinces

⇒ Production of grouper in cages is relatively low in Trang, in contrast to Satun

2.13.2 Selection criteria for case study sites

Selection criteria for case study sites were based on the findings of the preliminary overview. Case studies were to be selected on the basis of the following characteristics:

1. **Status of grouper culture** – case study sites would illustrate the possible factors which influence households to take up, reject or discontinue grouper culture. The level of participation in grouper culture, trends in production i.e. is production decreasing for any reason, the origins of grouper culture in the village and factors which led villagers to take up fish culture are therefore part of the reference criteria for case study selection.
2. **Type of culture system** – the preliminary overview showed that some farmers raise grouper in ponds, with implications for level of investment, risk and management practice. Pond culture also crosses the boundary between land and aquatic based livelihoods and therefore brings up important issues of access and participation for land-poor households. The inclusion of both pond and cage culture systems was therefore necessary in the case study sites.
3. **Livelihood activities and village well-being status** – the majority of small-scale grouper farmers are also involved in the small-scale fishery, according to the findings of the preliminary overview. It is also common for households to include a number of different activities in their livelihood portfolios. The livelihood choices and capabilities of households may influence the

households' decision to take up grouper culture and were therefore an important issue for further investigation.

4. **Availability of natural resources for fish culture inputs, sources and costs of purchased inputs** – the situation appraisal found that the uptake of grouper culture appeared to be associated with locally available stocks of wild grouper fry. The ability of grouper farmers to supply seed inputs from their own catch has important implications for the economic viability of grouper culture, as wild caught inputs require lower capital investments than purchased inputs. The local cost of seed and feed inputs also affects the profitability of grouper culture.
5. **Fishery activities and status of the grouper fry fishery** – the quantity of trash fish that fisher/farmers are able to supply from their own catch is determined to a large extent by the type of gear that they use. Fry fishing has been identified as an important activity in fishing communities and one which may be threatened by the development of hatchery produced fry. Exploring the possible impacts of this development on fry fishers was an important aspect of the case study analysis.
6. **Problems and constraints affecting grouper culture** – fish disease was the most commonly reported problem amongst grouper farmers, which some farmers associated with poor water quality. The case study analysis may provide an opportunity to explore this link further. Other problems varied between villages, particularly problems with theft and social relationships in the community.

2.13.3 Proposal of potential case study sites

A number of villages were visited during the preliminary overview that could serve as interesting case study sites. They are listed with their characteristics in Table 2-15. This study investigates the characteristics of grouper culture and fisheries in a randomly selected sample of villages in Trang and Satun province, to determine how the villages selected for case study compare with others in the area.

2.14 Methods

2.14.1 Brief method

Information was obtained for the study using primary data collection methods, and collation of secondary data from the Department of Fishers and Department for Community Development in Trang and Satun provinces. A survey methodology was adopted for this stage of the research programme to permit the collection of primary data from a representative sample of communities in the two provinces. A semi-structured interview based on a topic checklist was developed, and translated into Thai language.

The topic checklist was used to gather data regarding the extent and nature of grouper culture and juvenile fishery activities in 27 villages in Trang and Satun provinces. Two interviews were carried out in each village. Villages were selected using a random sampling method and drawn from a total sample population of 40 villages, which included all villages in Trang and Satun where grouper culture was currently taking place or where grouper culture had taken place in the past.

2.14.2 Data collection

Data collection was carried out in February 2001 with the assistance of two Thai field staff, one male and one female. Interviews were conducted with at least two respondents in each village, to permit cross-checking of responses and validation. Information from respondents was supplemented with additional notes made from direct observation, which provided an additional method of response validation.

In total, 48 interviews were conducted. In two villages, only one interview was possible.

Table 2-15 Characteristics of grouper culture and fishery activities in villages provisionally selected for case study analysis

Criteria	Koh Khiam, Trang	Pakbara, Satun	Ma Haang, Satun	Thung Sa Pho, Satun	Ba Kan Khoei, Satun
No. of households	394	1500	200	72	87
Ave. income per household (THB)*	14,300	27,310	14,703	9,772	15,800
% households income >20,000 THB/yr*	-	55.5	28.6	5.3	33.7
Years of experience	25 years	-	20 years	5 years	30 years
% households raising grouper	Unknown	11.5%	10%	21%	69%
Type of culture system	Floating cages	Floating cages	Floating cages	Ponds and cages	Floating cages
Fishing activity – gear types and target species (with emphasis on fishery for grouper fry)	Fishers use a variety of gears – gillnets, traps. Fry fishery was major activity, fall in price of *E.bleekeri* in past two years, and fall in number of *E.coioides* means fishers need seek alternative livelihoods.	Pakbara a major fish landing site in Satun, also has large fish market. Variety of gears used, commercial and small scale.	Fixed nets important. Can fish for 10-15 days per month earning 400-1000 THB per day (May-Dec). Rest of year use fyke net to catch large commercial species. Grouper caught with both types of gear, usually dead.	14 fishermen use fixed nets, but 20 fishers per net required per net for fishing. Nets 10m high and 1km long. Also use traps and gillnets to catch fingerlings.	Fishers use traps, hook and line, bag nets and gill nets. Fry fishery reported to be limited by lack of appropriate gear.
Fry resources – source, availability and cost	Fishers catch their own fry. Farmers buy within the village.	Fry from Trang, Satun and Pattanee. Fingerlings no longer available in village.	Caught fingerlings themselves when culture began. But now few fry.Fixed nets do not catch grouper fry. Buy from Pallian in Trang. Not enough local fry.	Fry resources reported to be limiting. 4-5 inch fry brought from Trang. Artificial reef close to village	
Feed resources – source, availability and cost	Feed found in the village. 10-12 THB per kg.	Find in the klong.	Fixed nets provide feed.	Fixed nets provide feed. Previously discarded trash fish are now used for feed. Cost 3-4 THB/kg. Concern expressed for small size of trash fish catch.	
Problems and constraints	Debts, disease, limited fry, cost of feed, price instability	Water pollution biggest problem	Theft of fish.	Lack of knowledge. Ponds destroyed by storms in the previous year.	

***Source: Department of Community Development, Trang and Satun**

2.14.3 Selection of the survey sample

Identification of the sample frame

The target population was defined as all the villages in Trang and Satun where grouper culture was currently taking place, or where grouper culture had taken place in the past.

The sample frame was created using lists obtained from provincial offices of the Department of Fisheries in the provincial capitals of Trang and Satun. An accurate number of villages where grouper culture had now ceased was not available, as DoF records were provided from 1996 onwards. The lists suggested a total sample population of 42 villages, 9 in Trang and 33 in Satun.

Choosing the sample

As villages were generally widely dispersed within the two provinces, and the length of the interviews estimated at approximately 30 minutes each, it was considered feasible to visit 3 villages per day. As field research was restricted to approximately 10 days, 27 villages were randomly selected, representing 64% of the total sample population.

Villages were randomly selected from the 7 coastal districts of Trang and Satun. The locations of the villages visited during the study are illustrated in Figure 2-8 and Figure 2-2.

2.14.4 Structure of the topic checklist

Villages were to be selected for case study analysis based upon the criteria for case study selection, outlined in Section 2.13.2. The semi-structured survey sought to gather specific data at the community level on the following topics, using both closed and open-ended questions:

1. livelihood options and resources
2. the nature and extent of grouper culture
3. location of the culture units and quality of the culture site
4. problems and factors constraining grouper culture
5. importance of grouper culture to the community
6. sources and costs of inputs for grouper culture
7. value of market size grouper
8. institutional involvement

9. importance and nature of fry fishing activities

10. fishing gears and target species

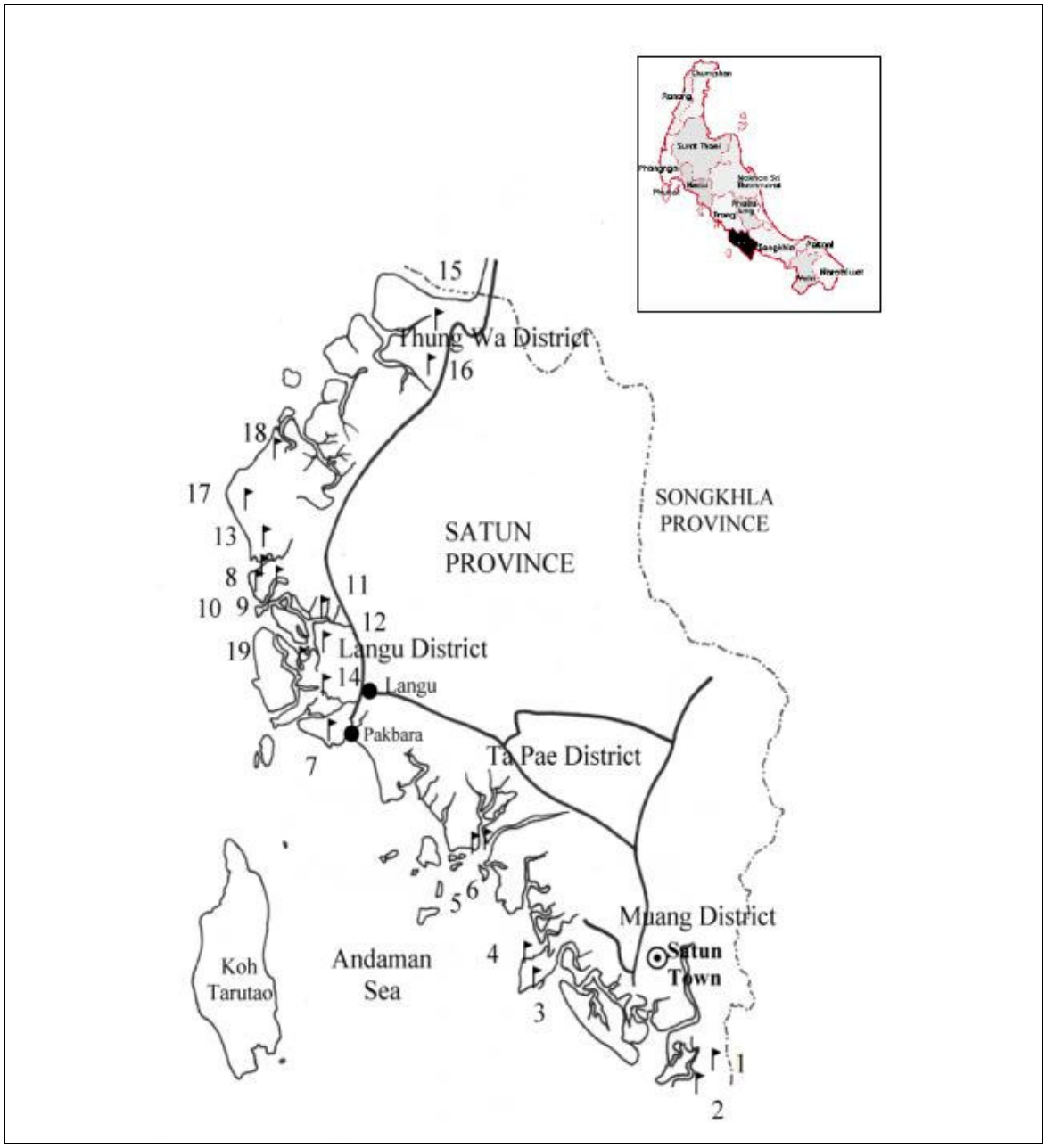
The survey was written in English and translated into Thai (See Appendix 2).

2.14.5 Recording and analysis

Interviews were conducted and recorded in Thai. Responses were noted directly onto the survey questionnaires. The responses were later translated into English and recorded on copies of the survey questionnaires.

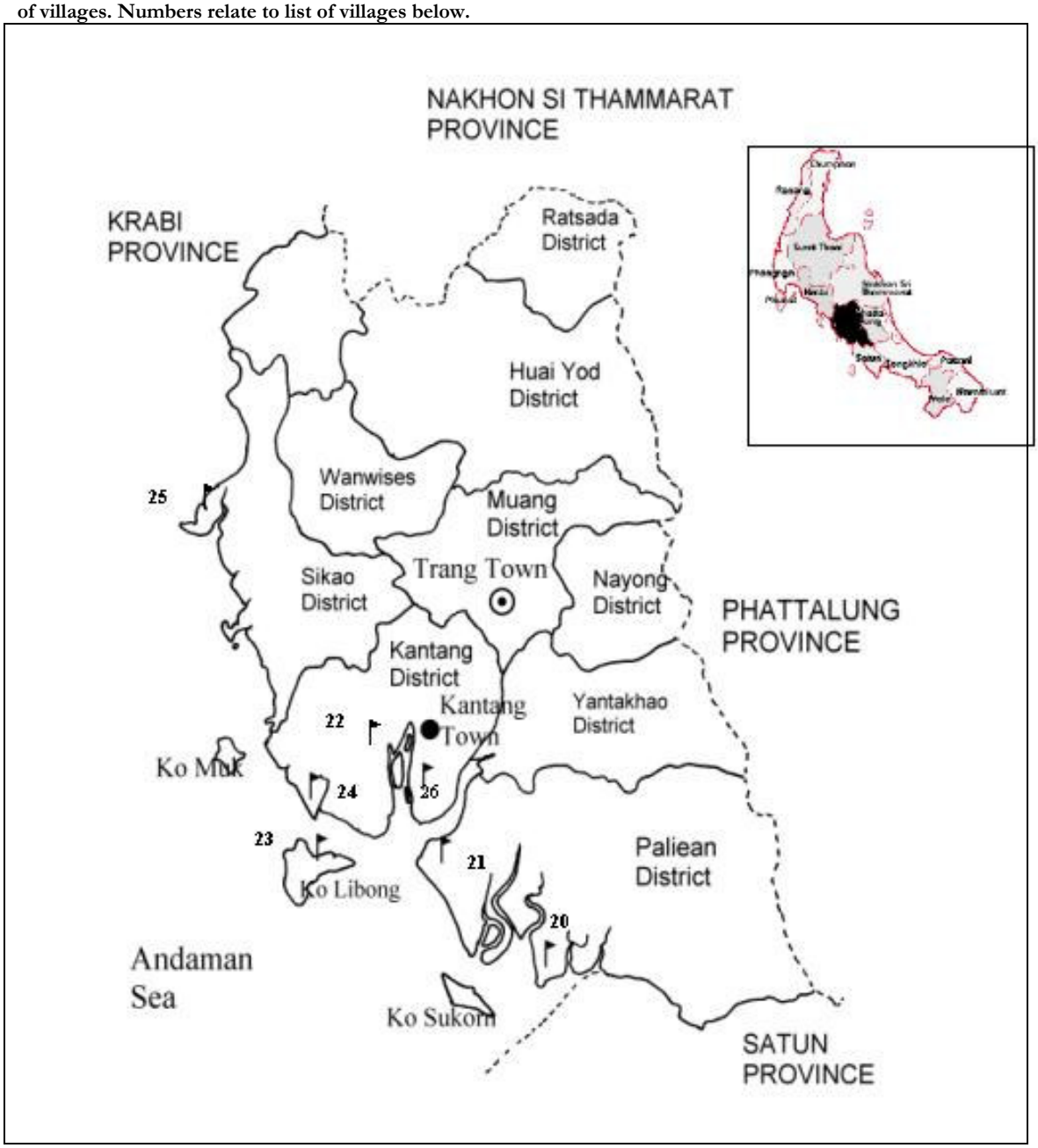
Responses were categorised and entered into Excel spreadsheets for analysis. Descriptive statistics were obtained from the data.

Figure 2-8 Map showing locations of villages visited during the survey, Satun Province



ID	Village	Sub-district, District	ID	Village	Sub-district, Distruct
1	Tan Yong Ca Boy	Phu-u, Muang	11	Tha Lae La	Kam Paeng, La Ngu
2	Phu-u	Phu-u, Muang	12	Tha Cha Muang	La Ngu, La Ngu
3	Ba Kan Khoei	Tan Yong Pho, Muang	13	Kon Karn	Kon Karn, Thung Wa
4	Haad Sao Yao	Tan Yong Pho, Muang	14	Ta Pah Yom	Pak Naam, La Ngu
5	Sa Korn	Sa Korn, Ta Pae	15	Ta Rua	Thung Wa, Thung Wa
6	Klong Lee Dee	Sa Korn, Ta Pae	16	Ta Aoi	Thung Wa, Thung Wa
7	Pakbara	Pak Naam, La Ngu	17	Thung Sa Pho	Thung Bu Lang, Thung Wa
8	Tan Yong La Nai	Laem Son, La Ngu	18	Ma Haang	Thung Bu Lang, Thung Wa
9	Bu Boy	Laem Son, La Ngu	19	Ta Lo Sai	Pak Naam, La Ngu
10	Su Knai Mu So	Laem Son, La Ngu			

Figure 2-9 Map showing locations of vllages visited during the survey, Trang Province. Flags indicate location of villages. Numbers relate to list of villages below.



	Village	Sub-district	District
20	Yong Satar	Ta-Kaam	Palian
21	Ban Pak Pron	Haad Saam Raan	Haad Saam Raan
22	Tae Hram	Kantang-Tai	Kantang
23	Ban Prao	Ko Libong	Kantang
24	Ban Chao Mai	Ko Libong	Kantang
25	Ban Laem Ma Kaam	Khao Mai Keaw	Sikao

2.15 Findings of the survey

The findings of the survey largely supported the results obtained during the preliminary overview. The results are summarised below and tabulated where possible to avoid repetition.

2.15.1 Grouper culture in context

Range of livelihood activities

As in the preliminary overview, households in communities in Trang and Satun were found to be engaged in a wide variety of activities, summarised in Table 2-16.

Table 2-16 Range of livelihood activities undertaken by households in the communities visited

• Fishing • Factory work • Labour • Shop trading • Fish culture • Fish processing: drying shrimp, making shrimp paste, salting fish, shelling crabs • Raise livestock: cows, goats • Work in rubber plantation	• Harvest neepa palm • Produce cigarettes from neepa palm • Grow fruit crops: coconut, banana, mango • Restaurant • Shrimp culture • Produce rice • Make charcoal • Tourism

Importance of grouper culture to household livelihoods

As the average level of uptake of grouper culture in the villages visited was 12.5% of households in the community (See Section 2.15.3), it is not surprising to discover that grouper culture is not considered to be the most important activity in many of the communities, as Figure 2-10 and Figure 2-11 show. Only 2% (N=1) of respondents considered grouper culture to be the most important activity in their village. 85% of respondents ranked fishing as the most important activity in their village .Fish culture was ranked as the second most important activity in the community by 36% of respondents.

2.15.2 Culture Systems

The floating cage is the principal type of culture system used for grouper culture in Satun and Trang provinces, however, pond culture represents an important divergence from this norm. Farmers nurse grouper fry in ponds in 5 villages in Satun province. However, with the exception of

farmers in Thung Sa Pho, Satun, most communities have relatively few ponds which were operated by one or two households.

Figure 2-10 Activities ranked by respondents as the most important to their village (N=47)

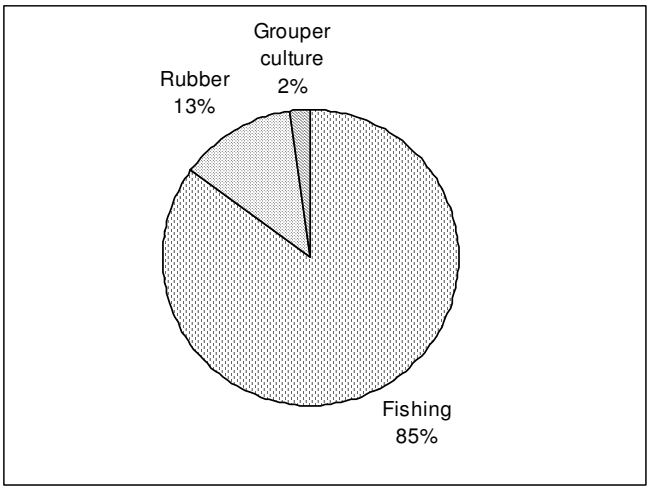
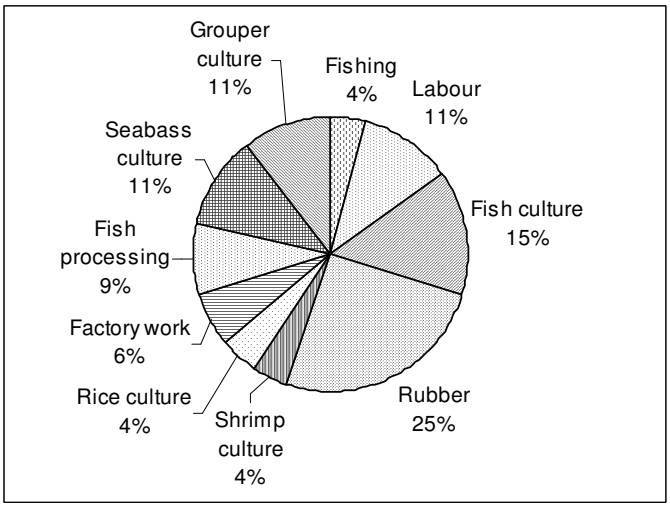


Figure 2-11 Activities ranked by respondents as the second most important to their village (N=47)



Stocking and harvesting

As observed in the preliminary overview, cage farmers preferred to stock fish within the size range 4 to 9 inches (Table 2-17). Pond farmers selected slightly small fish, in the range 2 to 5 inches. 71% of pond farmers reported that the most common size stocked was of length 2 to 3 inches.

Table 2-17 No. of respondents stocking various sizes of grouper seed

Size of fish	No. of respondents	
	Cage farms	Pond farms
1-2 inch	2	
2-3 inch	1	5
4-5 inch	12	2
6-7 inch	14	
8-9 inch	12	
≤ 10 inch	1	
All sizes	7	

Grouper were generally harvested at a size of 1.2kg, although fish were also harvested at smaller sizes of 7 to 9 inches or as kilo fish (200g) in some villages.

Culture Location

64% of cage culture activities took place in the '*klong*'. Cages were situated in open, coastal waters in 6 of the villages visited (24%). It was noted that in these villages, water quality was generally better than the klong environment. Respondents in villages raising grouper in open waters, where tidal flushing removes waste from the culture site, all reported that water quality where their farms were situated was good. Only 3 of 16 villages raising fish in the klong reported water of good quality.

The location of the cage culture system has implications for the well-being of the fish stock. A fast flowing current ensures that metabolic waste products and excess feed is carried away from the culture site and reduces the likelihood of cage fouling. Some respondents reported that close proximity of the culture site to towns, factories and shrimp farms had led to pollution incidents and episodes of fish disease and mortality. 4 respondents attributed pollution problems to factory wastes. Another 4 respondents reported that pollution came from shrimp ponds.

2.15.3 Access and participation

Level of uptake of grouper culture

The level of variation of number of grouper farms in each of the communities visited in Trang and Satun was as high as that found during the preliminary overview. The number of households who owned grouper farms ranged from 0.7% to 69%, with an average of 12.5% of households in each of the communities raising grouper. However, in 52% of the villages visited, less than 10% of households raised grouper.

Factors motivating uptake of grouper culture

In the preliminary overview, a number of organisiations and innovators in the community were found to have influenced the decision of households to take up grouper culture. The results from the survey in Trang and Satun enabled relative importance of these factors to the development of grouper culture to be quantified. The decision of households to take up grouper culture was motivated by factors which can be categorised as:

1. Endogenous development – where the idea to raise grouper arose as a result of a member of a village household being aware of the potential benefits of fish culture
2. External Promotion – fish culture was recommended to an individual or to the community by an individual or organisation external to the community

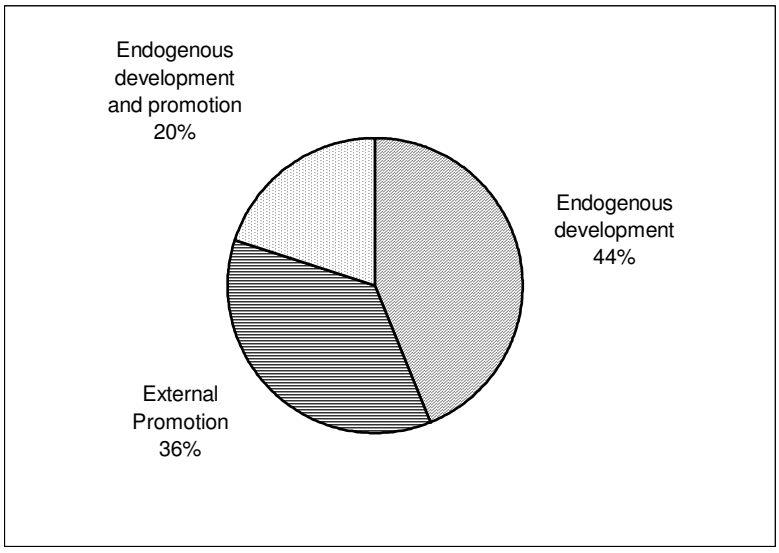
The types of factors leading to innovation, and fish culture promoters are shown in Table 2-18

Table 2-18 Grouper culture innovation and promotion

Factors leading to endogenous development	External Promoters
1. Incomes from fishing declining, households began to culture fish as an alternative income 2. Individuals saw fish culture being practiced in other places, either personally or through television, and began to raise fish also 3. Fishers added value to their fish catch by fattening fish in cages before selling them	1. Department of Fisheries 2. Advice from middlemen 3. Advice from a friend 4. Advice from an NGO

According to the survey, endogenous development was the most important mechanism in the development of grouper culture. Endogenous development accounted for the development of grouper culture in 11 of the villages visited (44%). Promotion of fish culture had led to the development of grouper culture in 9 villages (36%). The Department of Fisheries was the promoting institution in 7 of these villages. A combination of farmer innovation and promotion by external institutions had contributed to the development of grouper culture in 5 of the villages (20%).

Figure 2-12 Contribution of innovating and promoting influences in the development of grouper culture in surveyed village, shown as a percentage of villages and dominating influence



DoF projects have been established in 71% (N=7) of villages where grouper culture was reported to be increasing, suggesting that the activities of the DoF have been a significant contributor to the development of grouper culture in the two provinces. Declines in two of the villages where projects had been initiated were attributed to a lack of seed fish.

Factors constraining uptake of grouper culture

Findings of the preliminary overview showed that one of the most significant factors constraining the uptake of grouper culture by many people in the region was the high cost of investment required for start-up of grouper culture. This was confirmed by findings of the 2 province survey, where most respondents felt that poor people could not participate in grouper culture because of the high initial investment required. It was found that lack of capital for investment in grouper culture constrained the uptake of grouper culture in 81% of villages.

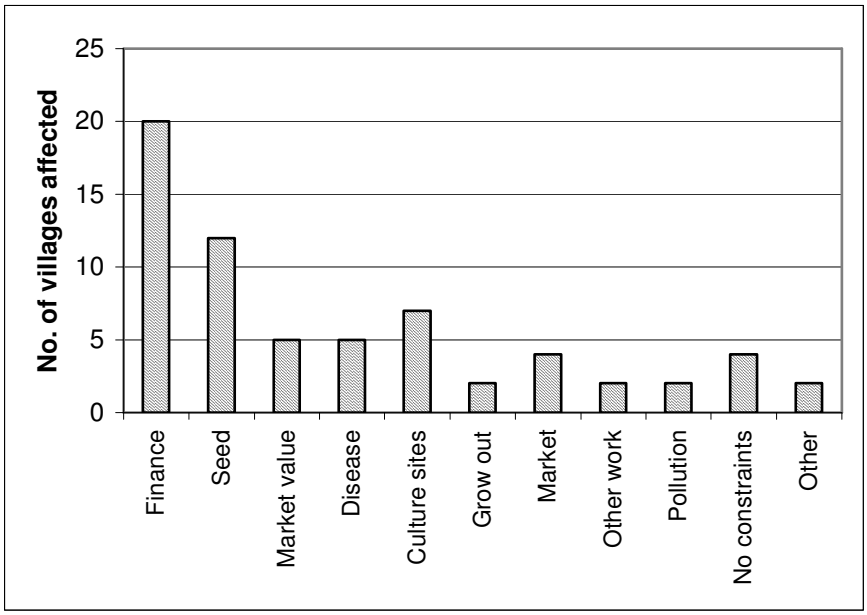
However, 33% disagreed and felt that poor people could participate if they had access to materials for cage construction, seed and feed, or assistance from institutions such as the DoF, Department for Community Development, cooperatives or bank loans. In Ba Kan Khoei, Muang district, Satun, for example, villagers had formed a cooperative following assistance from the DoF.

A number of respondents suggested that poor people could participate in grouper culture by working as labour for farm owners, and thus indirectly derive a benefit from grouper production. In Phu-u for example, working as labour on grouper farms was sufficient to provide a daily income. In a number of villages the number of grouper farms had been much higher in the past, but production had now decreased for a number of reasons including lack of seed, as discussed below. However site availability and proximity of the culture site to the village were also important contributing factors to villagers' ability to participate. A shortage of seed fish limited development of grouper culture in 12 villages (48%).

Factors contributing to the decline of grouper culture

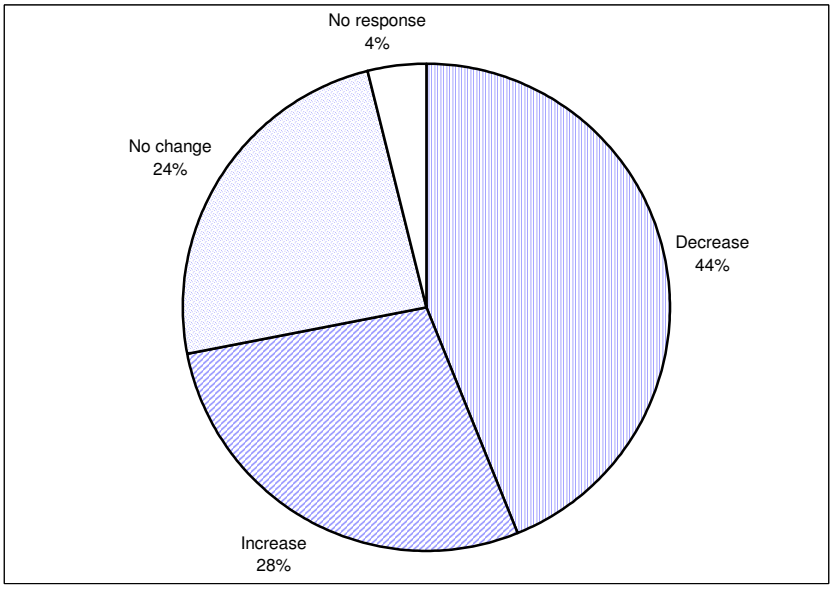
Grouper culture was apparently decreasing in a number of villages. 44% of respondents reported that grouper culture was decreasing in their village, while 28% reported an increase. Villages where less than 5% of households culture grouper appeared to be experiencing the highest levels of decline in grouper culture.

Figure 2-13 Factors constraining uptake of grouper culture in surveyed villages



Although fish disease and mortality was found during the preliminary overview to be the most common problem affecting grouper culture, this high incidence of disease did not necessarily lead to discontinuance of grouper production. Lack of seed fish was cited as the most important factor contributing to the decline of grouper culture in 63% of villages surveyed in Trang and Satun where grouper culture was reported to be in decline. Fish mortality and disease were reported to have contributed to the decline in production in 20% of the villages where grouper culture was decreasing.

Figure 2-14 Trend in number of grouper farms in villages surveyed, shown as a percentage of villages (N=25)



Pollution also appears to be a considerable problem for grouper farmers, as respondents reported a threat of pollution in 14 of 25 villages. In 10 cases, pollution problems were attributed to the release of effluent from shrimp ponds. Industrial factories and commercial fisheries were also contributors to the pollution loading of the water bodies in which farms were situated. Respondents and villagers commented on the ineffectiveness of institutions to regulate pollutants from shrimp farms and factories, and the lack of accountability and compensation when fishers and farmers suffered as a result. However, water quality in 40% of villages could be described as Ok to good. 64% of villages had no or few problems with water quality. Poor water quality was reported in 16% (N=4) of villages.

Seed resources

The preliminary overview had found that most farmers in Satun were unable to catch their own fry and were primarily dependent upon fish brought from other provinces by fish traders. However, the findings of the Trang and Satun survey did not support these findings. The survey, carried out six months after the preliminary overview, in February 2001, found that fry caught by grouper farmers was the most common source of grouper seed, as reported by 63% of respondents. However, many farmers also supplemented their own catch with fry fish from other sources including fish from the catch of other fishers in the village and from other villages, and from local fishing ports. Only three respondents reported that grouper fry are bought from middlemen.

This suggests that the number of fry available had increased in Satun during the latter half of 2000 and first months of 2001 to sufficient levels for farmers to once again catch their own fry fish. 48% of respondents did indicate that, in addition to the provision of seed for grouper culture from their own fish catch, grouper farmers also supplemented their seed requirements from other sources. Seed from other fishers in the same village was the most common supplementary source of seed fish.

Similarly to the findings of the prelimary overview, stocks of grouper fry were thought to be in decline and subsequently hard to find throughout Trang and Satun provinces, according to 57% and 43% of respondents, respectively. Some respondents attributed the decrease in fry fish to a reduction in brood fish in the wild, fishing pressure, habitat damage and pollution. 5 respondents believed there had been an increase in grouper fry. However, it should be noted that 2000 was a

year of particularly low fry availability. Stocks in 2001 were reported to be abundant when compared with the previous year, which may account for the responses that report an increase in grouper fry.

Figure 2-15 Sources of grouper fry (N=44)

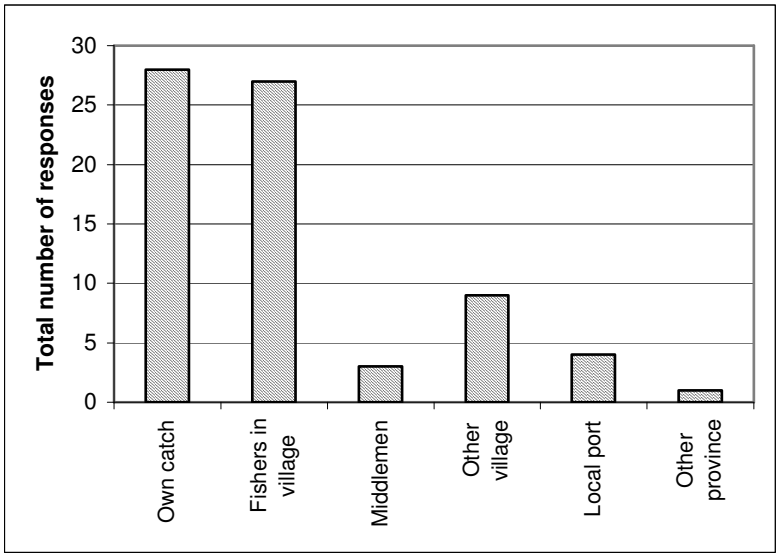
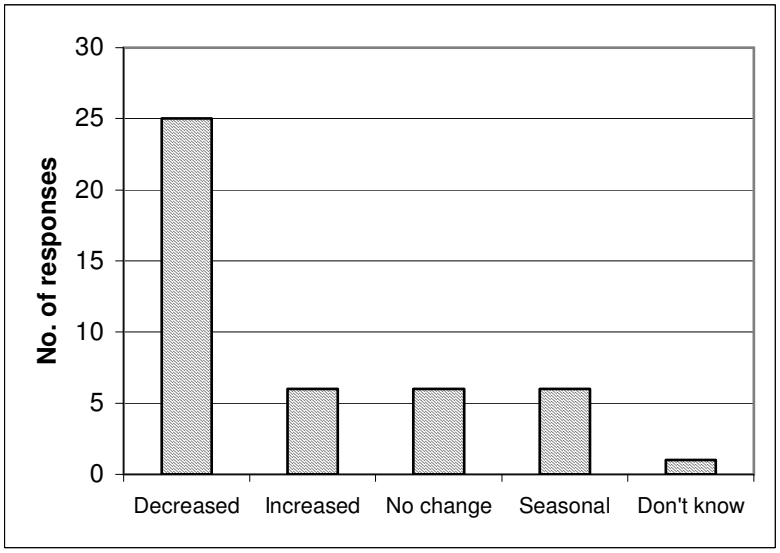


Figure 2-16 Perception of the state of the grouper fry stock, as reported by respondents (N=45)



Feed Resources

17 respondents (39%) reported that fish from a grouper farmers' own catch was the principal source of feed for grouper. An additional 10 respondents also caught fish for feed, but as a secondary source. The catch of other fishers from the farmers own village provided the second most important source of feed, used by 61% of respondents. Local fishing ports were also an important source of feed for 50% of respondents. Most respondents reported a number of

different sources of fish for feed, with 68% of respondents reporting at least one source of feed that was outside the village.

Trash fish ranged in price from 5 THB to 12 THB per kg. Respondents paid 7 THB per kg average for trash fish.

2.15.4 Market for grouper

Access to the market

Grouper farmers sell fish through a middleman rather than selling direct to the market or exporter themselves, according to 96% of respondents. Only one respondent, in Ba Kan Khoei, stated that farmers sell fish directly to the market in Malaysia. This result suggests a high dependence upon a middleman for sale of grouper fish, when compared with the market for seabass, which farmers are able to sell locally and directly to the consumer. This aspect of the grouper system appears particular to the culture of high value fish for export.

Table 2-19 Buyers and markets where farmers are able to sell grouper

Market or buyer	No. of responses
Middleman (location not recorded)	9
Middleman from outside the village	28
(from Pakbara)	(7)
(from Bangkok)	(2)
Middleman from the farmers' village	8
Export directly to Malaysia	1
Sell locally to a commercial farmer	1
Secondary middleman*	1

* respondent is a middleman

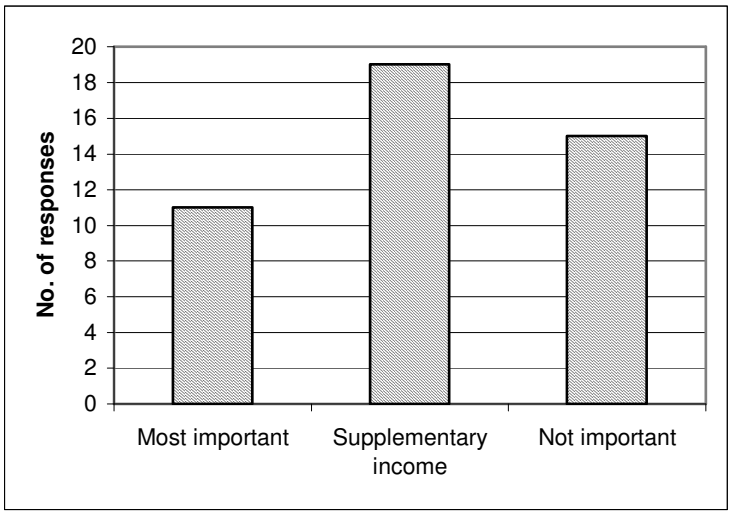
However, the findings suggest that grouper farmers have a good degree of choice in terms of market outlets for their fish.

2.15.5 Importance of fry fishing activities

In Chapter One it was suggested that proposals to develop hatchery produced fry could undermine the livelihoods of fishers who depend upon the grouper fry fishery for a living. The importance of fry fishing as a livelihood option could not be quantified during the preliminary overview, however, the survey in Trang and Satun showed that, whilst villagers in every village fished for fry fish, they did so primarily to provide a supplementary income. 24% of respondents said that fry fishing was the most important source of income for some fishers in the community, whilst 33% of

respondents did not think fry fishing was an important source of income for most fishers (Figure 2-18).

Figure 2-17 Importance of income from grouper fry fishing to fishers in surveyed communities



These results could suggest that most fishers who fish for grouper fry do so in addition to other activities and are not dependent upon it for their living. The results are inconclusive at this stage.

2.15.6 Selection of case study sites

The findings presented above illustrate the level of diversity which should be captured by the case study sites, including the variation in number of grouper farms in a community, culture systems, culture locations and quality of culture site, sources and costs of feed and seed inputs, factors motivating uptake of grouper culture and the problems and constraints affecting grouper culture. It was found that the villages provisionally selected for case study research represent this diversity of contexts and therefore provide suitable locations to study the influence of each of these characteristics on the success of grouper culture.

The results obtained for each of the provisionally selected case studies are presented in Table 2-20. Four of these communities were selected for case study analysis. Pakbara was excluded from the analysis as it was considered to be too large to permit a thorough study within the time constraints of the project.

Table 2-20 Findings of the Trang/Satun survey, showing how criteria for case study selection are represented by the provisionally selected villages

Criteria	Range	Koh Khiam	Ba Kan Khoei	Pakbara	Ma Haang	Thung Sa Pho
1. Status of grouper culture						
Uptake Level	0.7-69%	20%	69%	19%	28%	26%
Production Trend		Decrease	Increase	Increase	No Change	Decrease
Motivation		Innovation and Promotion	Promotion	Promotion	Innovation	Innovation
2. Culture system		Cages	Cages	Cages	Cages	Ponds
Location		Klong	Coastal/brackish	Klong	Klong	Coastal/Brackish
Water Quality Score		Pollution Reported	10	0	8	10
3. Livelihoods and well-being						
The range of livelihood activities did not differ greatly between villages. Fishing was considered to be the most important activity in every village, in terms of income and time spent doing the activity.						
Rank of importance of fish culture			3 or 4	3	2 or 3	2
Ave. income per person per year (THB)		10-15,000	15-20,000	>20,000	10-15,000	<10,000
DoCD Category		Poor			Poor	Poor
4. Availability of inputs for grouper culture						
Availabiloty of grouper fry			Hard to find	Can catch	Can ctach/variable	Plentiful
Status of fry stock			Decreased	Seasonal	No Change	Increased
Cost of Seed (4-5 inch)	1-20 THB	20 THB	8-10 THB		18THB	20 THB
Cost of feed (THB/kg)	Ave. 7.6 THB per kg	12	2-8	4-8	4-10	1-10
5. Fishery activities						
No. of people in village fishing for fry			Most	Most	Most	Few (1 person)
Livelihood contribution of fry fishing			Not imp./Suppl	Suppl.	Suppl.	Not important
Motivation for fry fishing			To stock	To sell	Stock and sell	Stock and sell
Fishing gears			Fish trap Gill net Hook & Line	Fish trap Gill net Hook & Line	Fish trap Large fixed gear Crab gill net Fish gill net Shrimp push net	Fish trap Hook and Line Large fixed gear Fish gill net
6. Grouper culture-						
Problems		Fish disease Price instability Water quality	Fish disease Seed shortage	Fish disease Hot water Theft Water quality	Fish disease Water pollution Theft	Fish mortality
Constraints		Lack of investment	Lack of loans Fish disease Low price of grouper	Lack of finance	Fish disease Lack of finance Lack of culture location	Lack of fry (although contradicts comments above)

Chapter 3
Case study of three fishing communities in southern Thailand – Introduction and Methodology

3.1 Introduction

Research carried out during the preliminary phase of the study led to the decision to conduct subsequent research at the community level. It was found that the community context in which grouper culture took place may play an important role in the success of individual farmers, indicating that developing an understanding of grouper culture must take place at the level of the community aswell as at the level of the individual farm. However, although villages in which grouper culture took place, or had taken place in the past, shared some characteristics, they more often showed that grouper culture took place in a variety of community contexts. This precluded the possibility of studying grouper culture using a structured survey, as appropriate questions and response categories could not be realistically defined for every community or farmer. The complexity of the situations in which grouper flourished or failed therefore required in-depth investigation to identify key factors affecting grouper culture and the role it played in fisher livelihoods, with reference to a small number of communities selected for study. The study would therefore seek to provide illustrative, rather than representative, case studies through which the research question could be answered.

The methodological approach adopted for case study analysis was based upon the collection of qualitative data, and subsequently quantitative date, guided by the research framework outlined in Chapter 2, Section 2.11, comprising the five subsystems of Livelihoods, Institutions, Environment, Markets and Production Systems. The findings presented below incorporate each component of the research framework. However, the complexity of the inter-linkages and relationships between each component is highlighted by the way in which the findings are presented; aspects of the various components can be found in each section.

The study began with the aim of gathering information with which to the address the research question:

'to what extent can small-scale grouper culture provide a sustainable livelihood option for households in coastal communities?'

The research process began by focusing on the livelihoods component of the framework, which was considered to play a pivotal role in the evaluation of system sustainability. Grouper culture represents one activity within the livelihood portfolios of households and communities. As such, the uptake of grouper culture is dependent upon decisions made at the household level in accordance with the livelihood strategy adopted by the household decision makers. The decision to raise grouper or not raise grouper contributes directly to the development of grouper culture and the extent of uptake at the national and regional level, which ultimately dictates the scale of resource demand and supply to the grouper market.

Decisions made at the household level also reflect changes and signals from the wider system. Household decision makers consider the uptake of livelihood activities based upon their resource base and motivational factors, e.g. institutions, potential risk factors, need and likelihood of success. The decisions made to take up a new activity, to restart or discontinue an activity that has been done before by members of the household therefore reflects the signals received from the wider system beyond the household unit and may provide an indicator of overall system stability and well-being.

Core themes within the definition of a sustainable livelihood include: coping, recovery, stress, shock, futurity and maintenance. Fisher households experience shocks and stress primarily as a result of fluctuations in the fishery resource. Flexibility within fisheries and diversification of livelihoods has been shown to be important coping strategies for fishers (Allison and Ellis 2001). Fish culture represents one activity by which fishers can diversify their livelihood strategies. A high market value and ease of capture of wild seed have made grouper an attractive candidate for culture, an activity which is promoted by the government of Thailand. Yet the livelihood implications of grouper culture have not been investigated.

Furthermore, although not explicitly described within the SL definition, social equity and an absence of socially negative impacts are also necessary for a livelihood to be 'socially acceptable' and thus 'socially sustainable'. Clearly, an activity which undermines the ability of others to maintain their own livelihood or resource base is not desirable.

The objectives of the study were therefore:

1. To understand and describe livelihood strategies in the selected fishing communities
2. To identify factors influencing the composition of household livelihood portfolios, with particular reference to grouper culture
3. To investigate the role of grouper culture as a component of fisher livelihoods
4. To understand the factors affecting the long-term viability of grouper culture and its potential impact on household vulnerability

3.2 Study Area and Research Method

The communities selected for case study analysis following the preliminary overview and survey of villages in Trang and Satun provinces, illustrate the range of contexts within which grouper culture takes place. The communities differ in terms of level of uptake of fish culture, culture systems, and problems and constraints associated with fish culture. They also present contrasting social and institutional contexts.

3.2.1 Case study sites

Ba Kan Khoei village in Satun was selected for study in order to investigate the high level of uptake of grouper culture in the village and the success of community institutions which have facilitated the development of fish culture. Ba Kan Khoei is a small village of 84 households, situated on the coastal fringe of Satun province, approximately 15 km from Satun town. The village was founded approximately 60 years ago. In 1975, the village first became known as Ba Kan Khoei, a name derived from the Malay language and refers to the activity of making shrimp paste, 'khoei' which had provided the main economic activity for the community in the past. The village, roughly separated into three areas of settlement, referred to as Ba Kan Khoei, Ban Klang and Ban Kreung, stretches along the coast, close to the margin of the sea, along a recently constructed concrete road. In some parts the older dirt track remains. An area of mangroves, protected for

Key events in the history of Ba Kan Khoei:

1975	Village is founded, with 50 households. A school is opened but is then closed three years later when a new school is built in Tan Yong Pho sub-district.
1990	A sea defence is constructed. A concrete wall is built along the length of the village.
1991	A well is dug and the village has electricity connected.
1994	Concrete road is built through the village.
1995	Piped water is installed in the village, to be used during the summer season. Drinking water is still limited during the summer. The district council gives assistance by providing water butts for rainwater collection. Occasionally the District council also transports water to the village.
1996	Fish culture group established in the village
1998	Regional school opens
1999	The current OBT, or representative of the Tambon Administration who acts as a key informant during the study, is selected by the villagers. The village also wins an award for cage production of grouper.

conservation and regeneration, provide a border to the north of the village (See Figure 3-1). Access to the village at the time of the study was along a dirt road, but a new asphalt road was under construction. The journey from Satun on the dirt road took approximately 30 minutes, but this will be greatly reduced upon completion of the new road.

Thung Sa Pho village was selected primarily to provide an illustration of grouper culture in ponds, as pond culture is particularly concentrated in this village. Grouper culture in cages has achieved less success in the village, in contrast to the apparent successes enjoyed by villagers in Ba Kan Khoei village. Situated in Amphur Thung Wa, in the north of Satun province, the village of 72 households covers an area of land bounded to the west by the sea and to the south by a mangrove canal (See Figure 3-1). An asphalt road provides the east and west boundaries of a roughly rectangular area of land, within which lie rice fields, grazing land and shrimp farms, providing a sharp contrast to the land poor communities of Ba Kan Khoei and Koh Khiam. Households are widely dispersed over this area, and divided into two groups of settlement. One group lies along the coastal margin to the west of the village, another along the *klong* to the south. Access to the village from a main road connecting the area with Langu town is good, along recently constructed asphalt roads. The village has been categorised as 'poor' by the Department of Community Development (DoCD), as 93% of households have an income of less than 15 000 THB per person per year. The majority of households have electricity but obtaining freshwater is a problem.

The area of land on which Thung Sa Pho is situated was once covered with mangrove, which was cleared by settlers from Pattalung who established the village and used the area to plant rice.

Primary and secondary mangroves still remain along the coast of the village, although the government permitted the villagers to clear half of the mangrove area to provide land for mudcrab culture. Land erosion along the western coastal border of the village is severe, and in urgent need of defence. More than a metre of land was lost to erosion during the course of the case study period between April and October. Respondents reported that 50 years ago the land stretched 11km further west, but the land has been lost to erosion. The village school was lost as land receded.

Important events in the recent history of the village include the introduction of grouper culture in ponds in 1996, and a flood in 1999. An important development for the village was the establishment of the Tambon Administration in 2000.

Koh Khiam village was selected as the most important area for grouper culture and grouper seed fisheries in Trang province, providing a contrast with the high levels of culture seen in Satun, and representing the source of seed fish that farmers reported purchasing in Satun. The village also has a longer history of fish culture than the other case study sites, with the cage farmers suffering mixed fortunes as production in the village has risen and declined a number of times during the last decade. The village is the largest of the three case study sites, with 394 households, and is situated approximately 10 km from Kantang, an important commercial fishing port and market town, and approximately 30km from Trang town. The village is situated at the mouth of the Trang river, occupying an area of land that was connected by a small bridge to the rest of the peninsular in 1974 (See Figure 3-2). The area was settled at the turn of the last century, when the villagers Malay ancestors established the village.

Key events in the history of Koh Khiam:

1974	First road is constructed to the village. The passenger boat is sold and a car is bought instead to serve as a bus to transport villagers to the town.
1982	People start to use motorised boats and swimming crab nets. Grouper culture begins, initiated by the DoF.
1984	The village has electricity
1990	Public Health Centre is built in the village
1995	Asphalt road is built to the village. An important event for the village providing easy access to Kantang and Trang towns.
1999	Village school begins to teach to secondary school level, allowing children to stay at home for longer, do not need to leave home for further education.

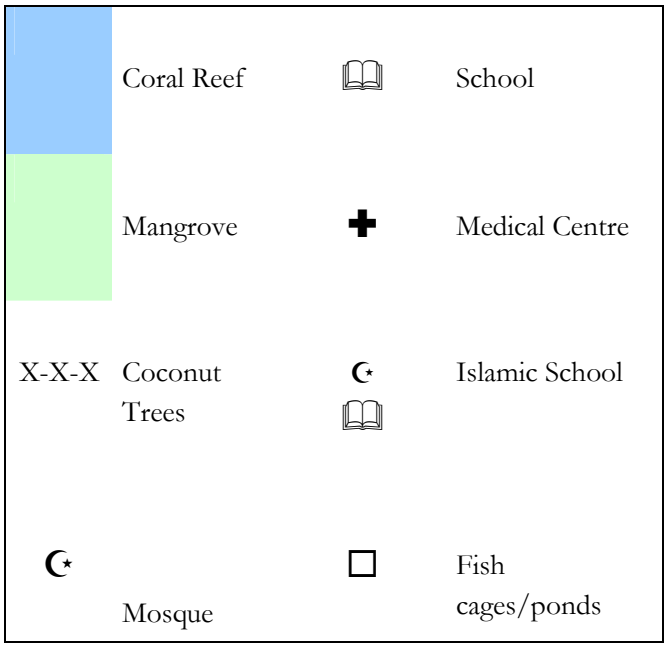
Table 3-1 Summary characteristics of the case study sites

	Ba Kan Khoei	Thung Sa Pho	Koh Khiam
Province	Satun	Satun	Trang
District	Muang	Thung Wa	Kantang
Sub-district	Tan Yong Pho	Tung Bu Lang	Kantang Tai
No. of households	84	72	394
Ave. annual income per household[a]	15 800	9772	14 300
% households in village earning less than 20 000 THB per person per year[b]	76	95	-
Distance from nearest town	15 km	11 km	10 km

[a] Source: Department of Community Development , Satun and Trang

b Defined as 'poor' by the Department of Community Development.

Map Legend for Figures 3-1 to -Figure 3-2



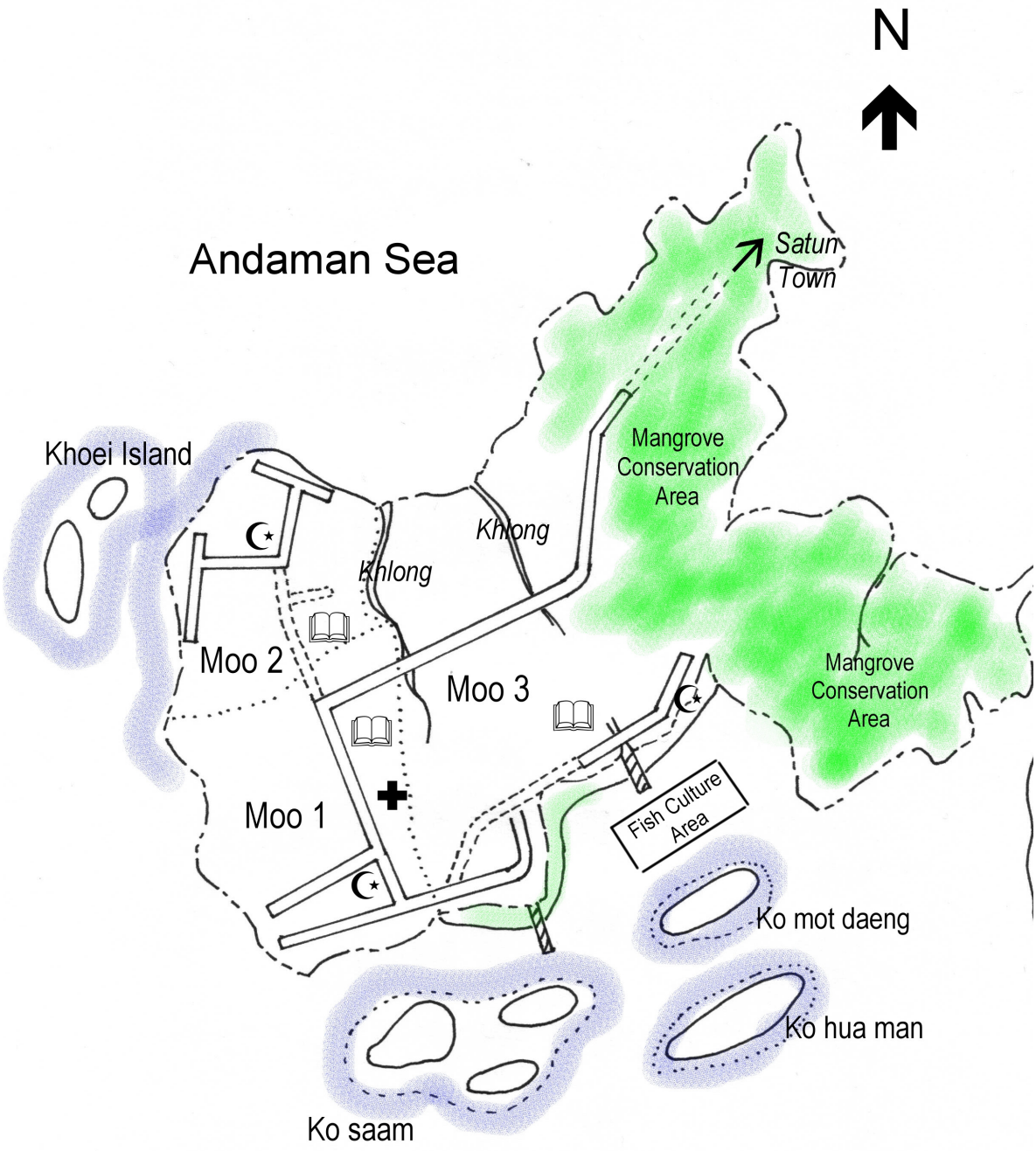


Figure 3-1 Ba Kan Khoei village

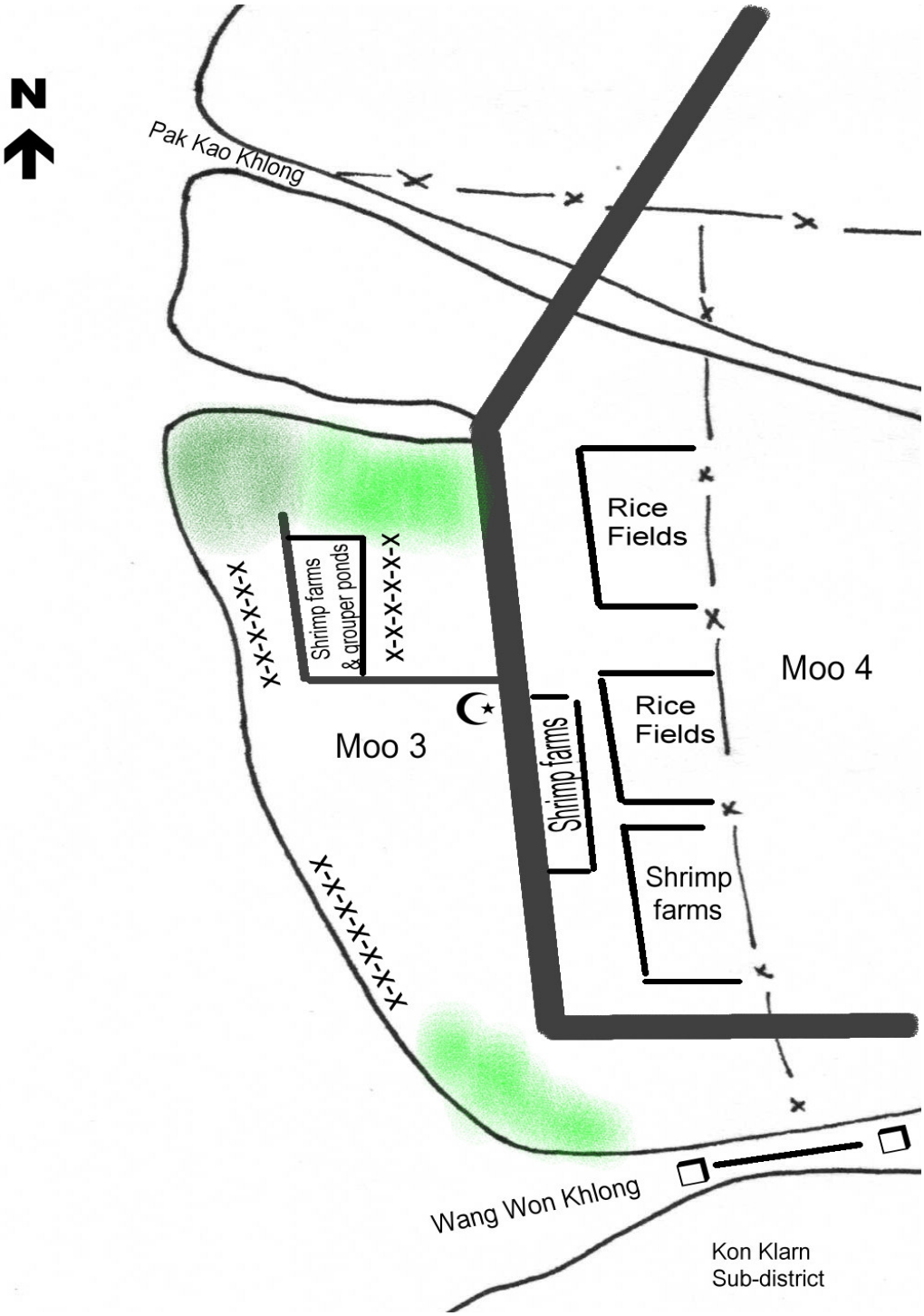


Figure 3-1 Map of Thung Sa Pho village

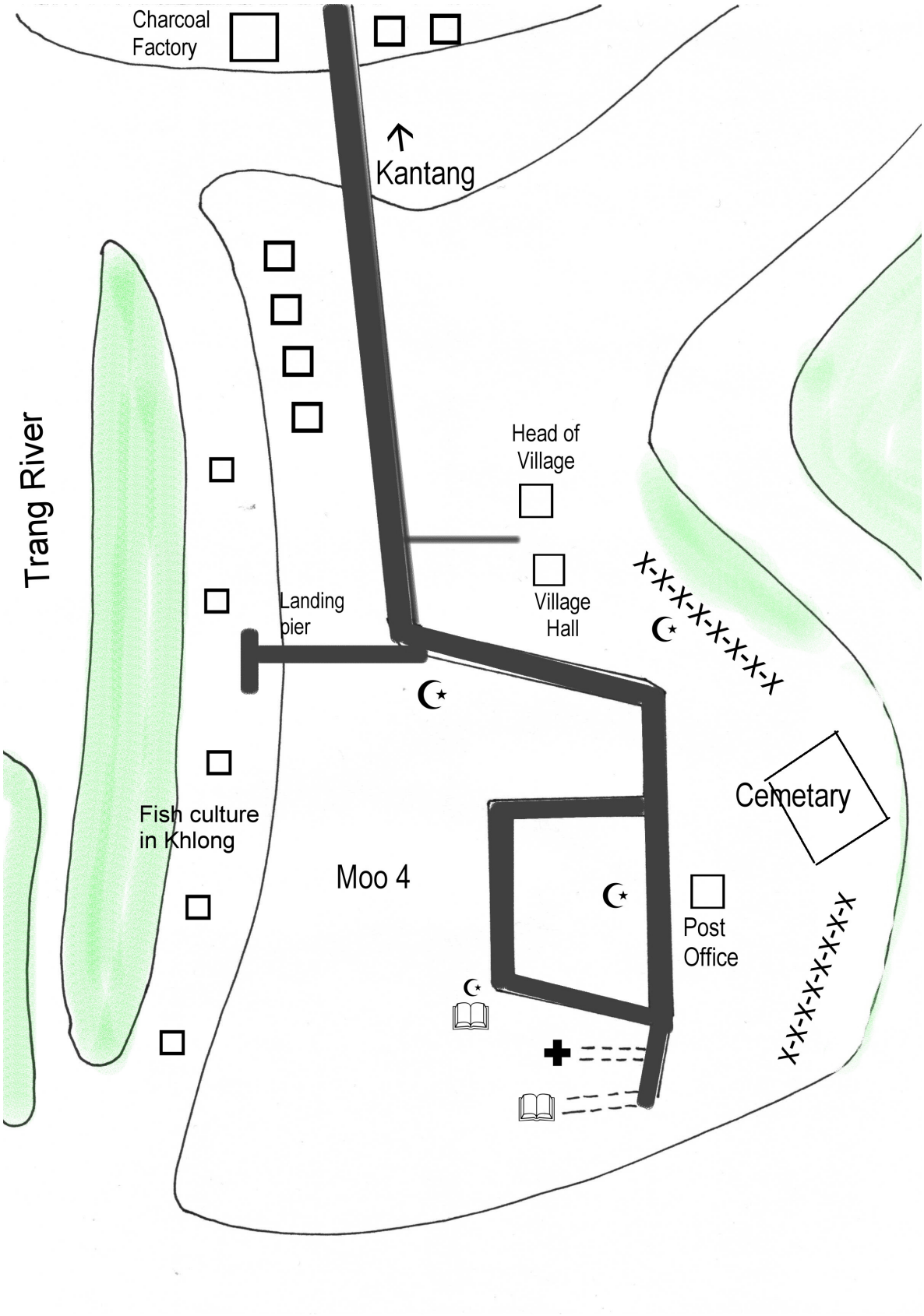


Figure 3-2 Map of Koh Khiam village

3.3 Methodology

3.3.1 General method

The research framework and the SL Framework provided guidance for the collection of information to meet the objectives outlined in Section 3.1. For the Livelihoods component of the study, emphasis was placed on the components of the SL framework relating to livelihood strategies, assets, and vulnerability. Data was collected using techniques drawn from PRA methodologies, as listed in Table 3-2, and a detailed quantitative survey.

3.3.2 Time frame and limitations

Information was gathered during three phases of field work. The first phase was carried out in July 2000 and comprised a preliminary case study in Koh Khiam village. This was followed with field research in Ba Kan Khoei and Thung Sa Pho villages between March and July 2001. The final phase, the completion of the quantitative survey, took place in October 2001.

Research carried out in the three case study communities during the 15 month period sought to gather information relating to the livelihood, market, environment, institutions and production system components of the grouper system analysis framework. The findings relating to these topics will be described in later chapters, although the methodology presented here is applicable to all aspects of the field study.

Information gathered during the preliminary case study investigation in Koh Khiam was incorporated into the broader case study analysis conducted between March and June 2001. It is acknowledged that there was a significant lapse of time between the first and second case studies. Return visits were made to Koh Khiam village during the qualitative phase of data collection and later during the quantitative survey at which time interviews were conducted with key informants to determine the nature of development and change which had occurred in the village during the 12 months which had passed. It had been intended that a full and complete case study would be carried out in Koh Khiam during 2001, following the same format as the case studies in Thung Sa Pho and Ba Kan Khoei villages. However, as the time available for field research became increasingly constrained this was not possible, and comparisons had to be drawn between the villages based on information collected in Koh Khiam during the previous year.

Case study analysis in 2001 began in Ba Kan Khoei village towards the end of March. Research in Thung Sa Pho village was carried out between April and June. However, it soon became apparent that work could not continue in Ma Haang village as the villagers were very suspicious of the research team and were no longer willing to participate in the study.

3.3.3 The research team

In 2000, the research was conducted together with a male translator from Trang province. During the 2001 phase of research, the research team included a female field assistant and interpreter from RIT, Trang and a driver. The driver played an important role in the process of data collection as his familiarity with the southern dialect and ability to communicate with respondents put them at ease and greatly assisted the research process.

3.3.4 Qualitative data collection

Each of the case studies began with a period of qualitative data collection, followed in the final stage of the research by a period of quantitative data collection, the design of which was based upon information gathered during the qualitative phase of the study. The process of qualitative data collection is described below.

Table 3-2 Qualitative data collection methodologies used for community appraisal.

Key informant interviews
Timelines
Seasonal/lunar calendars
Wealth ranking
Matrix/preference ranking
Resource mapping
Community mapping
Household mapping
Semi-structured topic focused interviews

Community register and livelihood activities

Upon arrival in a community on the first day of appraisal, an interview was sought with a key informant, specifically the head of the village or the head of the Tambon Administrative Council, to gain permission to carry out the study in the village and to gather important base line information. These community leaders were often in possession of, or had access to, an electoral register listing all of the households in the community, including the names, sex and date of birth of all household

members over the age of 18. The register provided a useful focus for discussion and a source of information for other activities, such as wealth ranking.

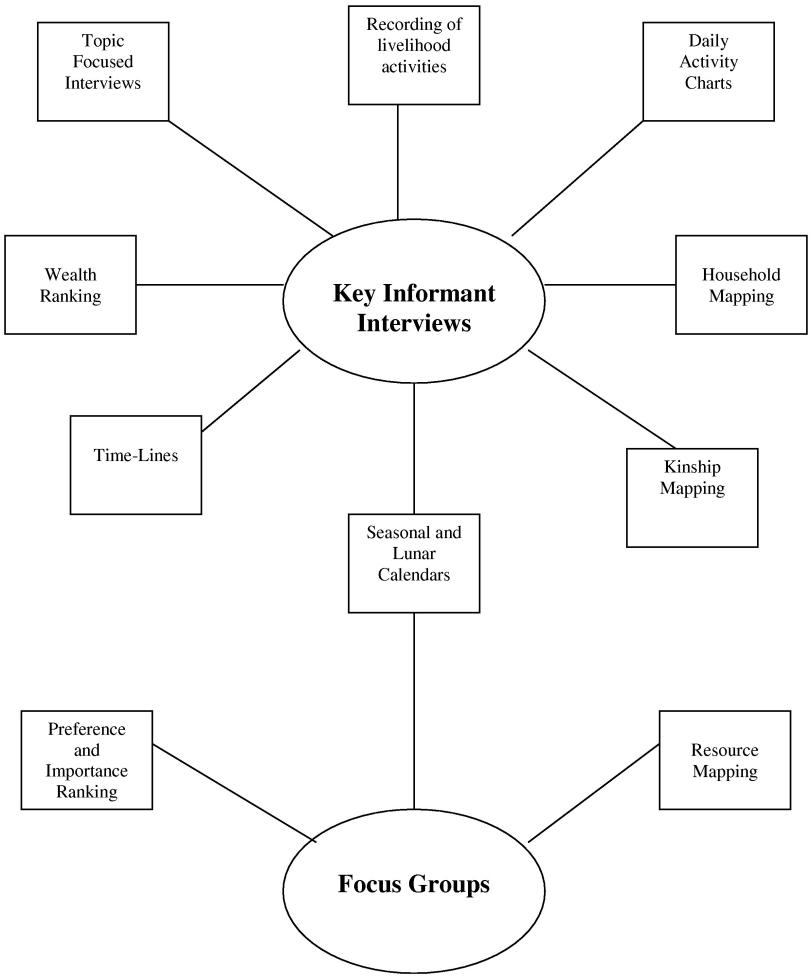
The key informant was asked to list the principal household activities in which each household was engaged, using the household register. The information was recorded alongside the relevant name in the register.

Historical time-line and key events

The discussions focused on the community register were followed by the construction of a time-line of key events in the community, paying particular attention to the development of fish culture. This activity also provided an opportunity to discuss other aspects of village life, including community development and the role of external institutions.

Key informants were also able to provide maps of the village and local area.

Figure 3-3 Activities completed with key informants and focus group participants



Creation of a simple household reference system

Using information obtained from the community register and discussions with a key informant about household livelihoods, a set of reference cards was produced which provided a useful tool for wealth ranking exercises, identification of respondents for topic focused interviews and random selection of respondents. The name of the head of each household was written on one side of the card, together with the house number. The principal livelihood activities and information relating to fish culture status was also recorded on each card. Key informants could also be recognised from the cards, as leaders of the community such as assistants of the head of the village, committee members of community institutions and middleman were also noted on the cards.

3.3.5 Wealth ranking

An understanding of the association between wealth and well-being, and livelihoods was an important aspect of the field study. It was therefore necessary to group households according to wealth status – as defined by respondents – in order to ascertain to what extent household livelihoods were associated, and influenced by, wealth status and access to capital assets.

The ranking method used in the study is described by Gregory and Kamp (1999). It was used to identify five 'wealth' or 'well-being' categories in each community and to divide the household amongst these groups accordingly. The five wealth categories were created each time by respondents, as initially it was suggested that three groups be identified (Wealthy, middle income, poor). Respondents created additional groups to accommodate households who did not fit into the three broad categories proposed. Key informants were asked to begin by defining the way in which they categorised wealth or well-being, before dividing the pack of household cards amongst the wealth groups they had described. The wealth ranking exercise was carried out three times in each of the villages to generate a wealth score. This provided a rough sample frame from which respondents could be selected to represent each of the wealth groups in the village.

Wealth indicators were developed from this information, and from information gathered during the quantitative survey. The methodology for the development of wealth indicators is given in Appendix 3).

3.3.6 Semi-structured interviews

Semi-structured interviews were the principal method of inquiry during the qualitative phase of data collection. They were conducted with respondents from a cross-section of the community and wealth groups. Respondents included members of the community who:

1. represented different livelihood activities i.e. shop traders, rubber tappers, rice farmers, fishers
2. currently raised grouper
3. discontinued grouper culture
4. rejected grouper culture
5. raised seabass or other aquatic animals
6. fished for grouper seed, or had done so in the past
7. represented government or community institutions

In contrast to the interviews carried out during the Preliminary Overview, described in Chapter Two, interviews conducted during the case study analysis followed detailed topic check lists. Interviews were also conducted with two middlemen and a grouper seed fisher from outside the case study villages, from the villages of Chebilang and Ban Chelung. These interviews were conducted during a day when interviews were not possible in Ba Kan Khoei due to wedding celebrations. They provided an opportunity to learn more about the trade in grouper seed and the experience of a seed fisher outside of the study communities.

A topic checklist was prepared for interviews with representatives of each of the categories listed above to ensure some degree of comparability.

3.3.7 Seasonal/lunar calendars

Semi-structured interviews were also used as an opportunity to construct seasonal and lunar calendars, and daily activity charts with respondents. For the seasonal calendar, a time line of annual events was created for various activities, or aspects of a single activity, for example rice planting and harvesting. Fishing communities are also strongly influenced by the phases of the moon which govern tides and the ability of fishers to catch fish successfully. Lunar calendars showing the change in activities during the lunar cycle were created. Daily activity charts showed how different households divided their day, and allocated labour.

3.3.8 Focus groups

Some attempts were made to convene focus groups. Community leaders often preferred to select participants for the focus group meetings which resulted on one occasion in a strong bias towards the friends of the community leader who were relatively wealthier than other members of the community. However, when people invited to attend were not available the meetings became impromptu. The format of the focus group comprised a general discussion of key issues identified by villagers, followed by other participatory exercises such as mapping, construction of calendars or matrices.

3.3.9 Matrices/importance ranking

A number of matrices were constructed during focus groups in each of the case study communities. The matrices varied in emphasis, for example in Koh Khiam focus group participants ranked the different fishing gears used by fishers in order of importance to the community. In Ba Kan Khoei, participants ranked in order of importance the activities they had listed according to criteria they had defined amongst themselves as they constructed the matrix.

The ranking exercise was introduced by asking participants to list on a large sheet of paper the different activities that people in the village did to generate a benefit. They were then asked to give reasons why these activities were important, thus creating a table or matrix. Using nuts as counters, villagers were then asked to indicate, on a scale of 0 to 5 (0 indicating no importance, 5 indicating that the activity is very important) which activities were most important in relation to the defined criteria. When an activity was particularly important, the participants placed 7 nuts in the appropriate position in the matrix.

These activities showed the range of activities that villagers did to get a benefit, and the reasons why these activities were important. Of equal importance, was the opportunity the ranking exercise created for discussion about the issues the participants raised.

3.3.10 Mapping

Focus group meetings also provided an opportunity to create maps of the communities and the local area, including land use and the proximity and nature of the fishery resources exploited by fishers in the community. Maps of the position of each household in the community were also

created to facilitate data collection in the quantitative stage of the research and to assess relationships between household location and livelihood strategy.

3.3.11 Data recording

Information gathered during the field research was recorded in notebooks in both Thai and English. Interviews were also recorded on cassette tape, with the permission of the respondent. All interviews were then transcribed in full, in Thai, before being translated into English and entered into Word.

3.3.12 Return visits and follow-up data collection

Subsequent to the completion of the period of intensive field research, return visits were made to each of the communities to discuss any new developments and change in the villages. These visits were informal and of short duration. The aim was not only to cross-check previously collected data but also to ensure that the villagers who assisted us were aware that our interest in the community and the people with whom we had spoken continued beyond the main period of field research.

3.3.13 Data analysis

Each interview or activity was first recorded in a notebook in the field and later recorded in Word, with details of the date and location of the interview and the name of the respondent. The data was analysed in Excel. The interview material was initially divided, sentence by sentence, into 4 code groups - fish culture, fishing, livelihoods and other issues – containing a further 32 codes. The data was then coded further to extract a greater level of detail, into 189 codes. The information contained within each code was then summarised and aggregated under headings relevant to each component of the subsystem.

3.4 Quantitative data collection

The qualitative phase of data collection provided an opportunity to explore the livelihoods of fishers and the role of aquaculture within the livelihood strategies pursued by individuals and households, as related through the thoughts and perspectives of respondents through the use of semi-structured interviews and PRA methods. The information gathered using qualitative methods

provided a basis for theory building and the identification of significant issues based on the responses of individuals.

In contrast, the quantitative phase of data collection permitted the identification and statistical analysis of patterns and associations, and the collection of numerical data from a representative sample of each community. The purpose of the survey was also to assess to what extent the thoughts and opinions expressed by individuals and focus group participants represented the opinions of the whole community. The quantitative phase of data collection comprised a structured survey. The questionnaire for the survey was generated from the information gathered during the qualitative phase of research. The findings of the qualitative research were used to guide the development of the questionnaire and the inclusion of appropriate response categories.

3.4.1 Questionnaire content

The questionnaire[14] comprised five sections:

1. Household identification and attributes
2. Household economics and livelihood activities
3. Fish culture
4. Fishing activity
5. Social capital analysis

The first phases of the questionnaire identified the household, its location, and the name and address of the respondent. It also included a number of potential wealth indicators i.e.house type and possession of household appliances, ownership of a vehicle and telephones. Household composition and education levels and a checklist of household activities were also included.

The qualitative data collection phase precluded the collection of complex numerical data that could be analysed and compared between households. A key component of the questionnaire therefore was a detailed economic analysis of each household, and an appreciation of the livelihood activities in which the household was engaged, which would permit a more complete understanding of the role of grouper culture as part of a broader livelihood portfolio. Categories for analysis, such as types of land use and sources of income, were informed by the qualitative data.

[14] The questionnaire can be found in Appendix 5

An important consideration in gaining an understanding of sustainable aquaculture and the role it can play in the livelihoods of coastal communities is the extent to which farmers continue to raise fish or discontinue fish culture when problems arise. The third section of the questionnaire identified not only households who were raising grouper at the time of the survey, but also the history of culture activities for each household. This section sought to gather data regarding the reasons why farmers stopped raising fish, why they recently started to raise fish for the first time, or restarted fish culture after a period of discontinuance. Questions were also included in the survey for households that had never raised fish, to identify constraints to uptake of fish culture and the reasons why some households do not want to raise fish.

Findings from the qualitative research showed that it is often difficult to separate grouper culture from other types of fish culture, as the culture of more than one species of fish or aquatic animal is common and aquaculture activities are highly dynamic. An attempt was therefore made to understand why some households may raise one or more types of fish, or reject the culture of grouper in favour of another fish species.

The third section also comprised questions regarding the type of fish raised, culture systems, sources of inputs, stocking, harvesting, and problems with fish culture and finance.

The qualitative research showed a strong positive relationship between fish culture and fishing activities. The inclusion of a section relating to fishing activities recognises the links between fishing and fish culture practices. It also addresses the possibility that aquaculture is an alternative to fish capture. This section sought to provide data which would allow the extent to which large grouper are still targeted to be quantified. The final questions in this section related to the importance of grouper seed capture and grouper aquaculture to the household.

The final section of the questionnaire concentrated on the level of social capital in each community, as the qualitative research identified social capital as a potentially significant factor influencing the success or failure of grouper culture in a community. This section of the questionnaire was based on the work of the World Bank's Social Capital Initiative, in particular the Social Capital Assessment Tool (SCAT) created by Krishna and Sharder (1999). The SCAT is designed to provide a uniform methodology for the empirical measurement of social capital. Questions for the present

study were drawn from Section Two of the SCAT, the household survey, which contains questions for the analysis of cognitive social capital i.e. values, norms, behaviour and attitudes, and structural social capital i.e. institutions and organisations, decision making and collective action. The SCAT was used in the present study in order to draw upon the experience of workers in the field of social capital by using a tool based on a wide range of studies, in this case 26 studies in 15 countries. The SCAT would also be evaluated in terms of its usefulness in the context of coastal communities in Thailand. Questions were selected from the SCAT household survey and modified to create questions that were relevant in content and included response categories to suit the community context of the study. Questions were selected from each section of the SCAT household survey. Some questions were, by necessity, excluded to limit the length of the questionnaire whilst maintaining the integrity of the SCAT survey.

3.4.2 Preparation of the questionnaire document

The questionnaire was prepared in English and translated into the Thai language. Each question was then checked to ensure that the wording was correctly translated and that the meaning had not been distorted in the translation process. Questions were read from the Thai questionnaire and translated back to English to ensure that meaning of each question was identical in both languages.

Each question was prepared in such a way as to reduce the need for translation following data collection. Most questions were coded for ease of interpretation and analysis. As an English speaker with limited Thai language skills would enter data into an analysis package and analyse the results, it was essential that the questions on the English and Thai versions of the questionnaire be identical. The questionnaire was compared question by question in English and Thai until no mistakes were apparent.

3.4.3 Pilot testing

A pilot test was necessary to ensure that the questionnaire could be conducted smoothly, that questions were easily understood and response categories appropriate. The questionnaire was pilot tested first in Koh Khiam village where interviews with only 2 respondents immediately showed that the questionnaire was too long. A second draft was prepared and tested in Ba Kan Khoei village. Eight respondents were interviewed, six by teams of students who would participate in the

collection of survey data. Any problems experienced by the teams were reported and the questionnaire adapted accordingly. Respondents who were questioned at this stage were excluded from the survey sample frame. The interviews were also timed and found to last approximately 30 minutes.

3.4.4 Training the data collection team

Data collection was conducted with the assistance of a team of 12 students in their third or fourth year of study from Rajamangala Institute of Science and Fisheries Technology in Trang province.

In order to familiarise the students with the questionnaire process, and to provide an opportunity for practical experience with the questionnaire, the students were taken to Ba Kan Keuy and Tung Sa Po villages prior to formal training for data collection. They were able to identify problem questions, and appreciate the difficulties inherent in questionnaire data collection.

Each question was reviewed and explained to the data collection team at a meeting that took place prior to the field visits.

3.4.5 Identifying the sample population

The time frame for the survey was short, to enable the students to work during the term break, and to remain within the budget for the project. Based on these limiting factors, ten days were available for data collection. It was estimated that a team of two people could complete approximately five questionnaires, of approximately 30 minutes in length, in one day. The total target population of the three villages was 482 households (Table 3-3).

The aim of the survey was to interview 50% of the total population. As two of the villages have less than 80 households, a sample size of less than 50% would be too small to enable firm conclusions to be drawn. (Nichols 1991).

Table 3-3 Sample frame and sample size determined for the structured survey

Village	Target population (Total no. of households)	Sample population (50% of households)
Thung Sa Pho	80	40
Ba Kan Keuy	70	35
Koh Khiam	332	166
Total sample size		**241**

The sample population in each village was randomly selected using the household cards created for the community appraisal. The cards were shuffled and the number of households selected for the sample population of each of the villages was drawn from the pile.

3.4.6 Data collection

The households selected for inclusion in the survey were marked on the household maps, which had been created during the qualitative research phase. The maps showed that the sample populations were evenly distributed in the villages. The village area was divided into six sections, with the target households distributed equally within the divisions. One area was then allocated to each of the six teams. Restricting each team to a small area of the village enabled them to reach the required number of households quickly and easily.

The students were divided into six teams, with two people in each team. The teams were given a list of the households they should aim to visit, which had been selected from the household cards. In addition, the households in their allocated area that had not been selected for the survey were also listed. The teams were instructed to begin by visiting the households from the sample list. However, if they were unable to interview representatives of any of these households, they were instructed to go to the next household on the list of those that had not been selected for the survey. It was emphasised that they should work systematically through this list, and not choose households because of their location or personal preferences.

3.4.7 Data entry and analysis

The questionnaire responses were entered into an SPSS worksheet for analysis. The data was initially analysed using simple descriptive statistics and frequency distributions, followed by tests for relationships, associations and differences using the Chi-squared test.

3.4.8 Accuracy of data entry

In order to ensure the data from the survey questionnaires had been entered correctly and accurately, a random sample of 10% of the questionnaires (i.e. 24) was selected. Survey responses were cross-checked against the responses entered into the data base. Data entry was found to be very accurate. Four questionnaire entries in the database of the 24 checked contained minor errors, in only one question in each case. Checking each questionnaire for data entry accuracy was

therefore deemed unnecessary and data analysis could proceed with high-levels of confidence in the entered data.

3.5 Economic Analysis

3.5.1 Summary of method

Data for the calculation of a detailed economic analysis was gathered throughout the provincial and community level appraisals during semi-structured interviews with grouper farmers. This information was combined with detailed records kept by farmers in the case study communities. Data collection was guided by methods described by Shang (1981) and FAO (1992) and sought to meet requirements for the calculation of fixed and variable costs. Capital costs were recorded for each component of fixed costs, including the age and lifespan for the calculation of depreciation. Data was analysed to assess the economic viability of fish production through the calculation of:

1. a detailed breakdown of production costs and benefits
2. comparative analysis of different production systems
3. sensitivity analyses to determine the effect of increases in variable costs and the economic cost of fish mortality on the economic viability of grouper culture
4. economic indicators

Table 3-4 Fixed and variable costs of cage and pond culture of fish

Cage culture		Pond culture	
Fixed costs:	*Variable costs:*	*Fixed costs:*	*Variable costs:*
Bamboo poles or iron bars	Seed Fish	Cost of land	Seed fish
Nets	Trash fish feed	Hire of excavator	Trash fish feed
Ropes	Medicines	PVC pipes	Medicines
Foam blocks	Maintenance	Mesh	Maintenance
Storage hut	Interest on loan	Aerator and engine	Interest on loan
		Storage hut	
		Cost of pond preparation	

Farmers were often not able to recall the details of the costs of their investments at the time of the interview and data collected during the situation appraisal was often incomplete for individual farmers. The community case study analysis provided an opportunity to collect data from farmers over the length of a culture cycle, and provided a detailed record of daily stocking, harvesting and feeding activities in addition to data for capital costs.

Economic data relating to fishing practices were also gathered in order to estimate the real cost of wild caught seed fish. Costs of capital assets such as boats, engines, and fishing gears and variable costs including fuel and bait costs were recorded from interviews with fishers.

3.5.2 Farmer records of fish production

Two farmers in each of the case study villages were provided with notebooks during May 2000. Farmers were selected on the basis of our previous experience during interviews which showed them to be enthusiastic to participate in the research and possibly reliable record keepers. They were asked to keep records of their stocking, harvesting and feeding of grouper over an initial three-month period. The farmers included pond farmers in Thung Sa Pho, and cage farmers in Ba Kan Khoei and Koh Khiam.

The notebooks were divided into 2 sections to record feeding activities, and stocking and harvesting activities. Separate records were kept for each culture unit. Farmers were asked to provide the following information regarding their fish culture practice:

Feeding records	Stocking and harvesting records
Date	Date
Size of fish in culture unit	Type of fish stocked
No. of fish in culture unit	No. of fish stocked
Quantity of feed given	Average size of fish stocked
Cost of feed per kg	Cost of fish
Source of feed	No. of fish harvested
Species composition of feed	Average size of fish harvested
	Payment received for fish harvested
	Mortalities
	Additional notes (including water quality, weather, medicine administered, health of fish etc.)

Information about each of the record keepers was noted including the date the farmer began to raise fish, size and number of culture units, type of fish raised and no. of fish currently stocked, and the farmer's usual source of feed and seed. The farmers were visited twice during the period of data collection to discuss any problem they were having and to encourage them to continue to keep records.

Due to time constraints, the notebooks were collected in October 2000, after a period of approximately 5 months. Three of the six farmers who had been asked to participate in record

keeping had kept detailed records. They included a cage farmer in Ba Kan Khoei and two pond farmers in Thung Sa Pho.

The record books were photocopied and the originals left with the farmers. One farmer in Thung Sa Pho intended to continue record keeping for his own benefit. The information was entered into an Excel spreadsheet for analysis.

3.5.3 Data analysis

The information gathered from cage farmers during the situation appraisal was aggregated to produce average values of production costs, which varied between farmers. These values provided the assumptions upon which the cage culture analysis was based, as listed in Table 3-4. The information was tabulated and a cost breakdown of cage culture under different culture systems was produced. Pond culture was analysed similarly using the records kept by pond farmers.

3.5.4 Estimating feed and seed inputs

In the absence of daily records detailing inputs of feed to cage culture systems, a standard was required to enable the calculation of approximate feed inputs to permit comparison of production costs between systems. The quantity of feed inputs required was calculated using data recorded by pond farmers and recommendations provided by SEAFDEC (2000) as a guideline. The feed inputs recorded for pond culture increased on average by a factor of 1.35 per month, which was found to be close to the SEAFDEC (2000) recommendation of 10% body weight per feed. The total quantity of feed required during the culture period was based on 12 feeds per month for 100 fish. The feed requirement for a system was calculated according to the size of fish stocked, the length of the grow- out period in months and the number of fish stocked. Fish mortality was not included in the calculation as the time at which mortality occurred could not be defined, and could occur at the end of the culture cycle. Inclusion of mortality would have complicated the calculation which was intended to be illustrative and comparable between culture practices.

The costs of inputs of seed and feed were derived from data collected from middlemen and farmers during the community appraisal. As stocking and harvesting practices of farmers varied widely, a standard of 250 fish per cage was used for the analysis.

3.5.5 Fishery analysis

The gross income generated by fishing activities was based on highly variable estimates of average fish catches for important target species, and the average days fishers could fish for this species based on seasonal and lunar factors. Given the high level of variability in catches and incomes reported by fishers, in the absence of detailed daily catch records, the results generated from this analysis are therefore an illustration of possible outcomes from these fishing activities and provide a rough estimation of the cost of seed fish to fisher/farmers.

3.5.6 Sensitivity analysis

Sensitivity analyses were based on the assumptions outlined in Table 3-4. Using an Excel spreadsheet, variables were manipulated to produce estimates of net profit under various scenarios.

3.5.7 Economic indicators

Indicators of economic performance were produced to compare systems, using the definitions given in Table 3-5.

Table 3-5 Definitions of economic indicators

Indicator	Calculation
Break even cost	Total operating cost / total production
Ratio of net income to operating costs	Net profit/ total operating cost
Return to capital	Gross revenue – total operating cost + depreciation
Rate of return on capital investment	Return to capital investment / total fixed costs
Profit Margin	Net profit / gross profit

3.6 Market trends

Fluctuations and trends in markets for grouper and the costs of inputs for fish culture were gathered from a number of sources:

1. average wholesale prices of live marine products in Hong Kong were obtained from INFOFISH for the period 1995 to 1999. This information was supplemented by publications by Sudari (1996, 1999, 2000)
2. recollections of farmers and middlemen during semi-structured interviews
3. data extrapolated from records of seed fish purchases kept by a middleman in Koh Khiam village for the period 1995-2001

Data was recorded in Excel spreadsheets and illustrated graphically.

3.7 Environmental context

3.7.1 Analysis of trends in the capture of juvenile grouper in Koh Khiam village

Although record keeping was uncommon amongst fish traders, a middleman in Koh Khiam kept detailed daily records of his seed fish purchases. The records referred primarily to purchases of red spot grouper (*E. coioides*) and orange spot grouper (*E. bleekeri*), which were categorised according to size. Red spot grouper were recorded in size categories of kilo fish, 8 inch, 6 inch, 4 inch and 3 inch fish. Orange spot grouper were recorded in two size categories, greater than 4 inches and smaller than 4 inches. Records were kept daily for the period 1995 to 2001 and recorded the catch of each fisher and the payment the fisher had received. Records were absent for the year 2000, as stocks of seed were too low to make seed fishing economically viable.

The data was entered into Excel and aggregated to produce weekly, monthly and annual data. As the data was not normally distributed, the Kruskal-Wallis test was applied to compare medians between more than two data sets. The Mann-Whitney U test was applied to compare two samples.

Chapter 4
Case Study of three fishing communities in southern Thailand

4.1 Understanding livelihood strategies in the case study communities

4.1.1 Introduction

Households select the activities which comprise their overall livelihood portfolio from a range of livelihood options. Grouper culture represents just one activity which households may take up as part of their livelihood strategy. An understanding of the role of grouper culture within household livelihoods therefore first requires an understanding of the broader livelihood context in which grouper culture is found. This part of the chapter contributes to the development of an understanding of livelihoods in the case study communities by describing the range of activities available to households in the three communities and the level of uptake of each of these activities. The contribution of different livelihood activities is discussed in terms of income generation in section 4.1.4. The analysis then goes on to show the way in which different activities contribute in different ways to household livelihood strategies, before concluding with a discussion of the significance of grouper culture to households.

4.1.2 Livelihood Options

Households in the case study communities were found to draw their livelihoods from a variety of possible options, as summarised in Table 4-1.

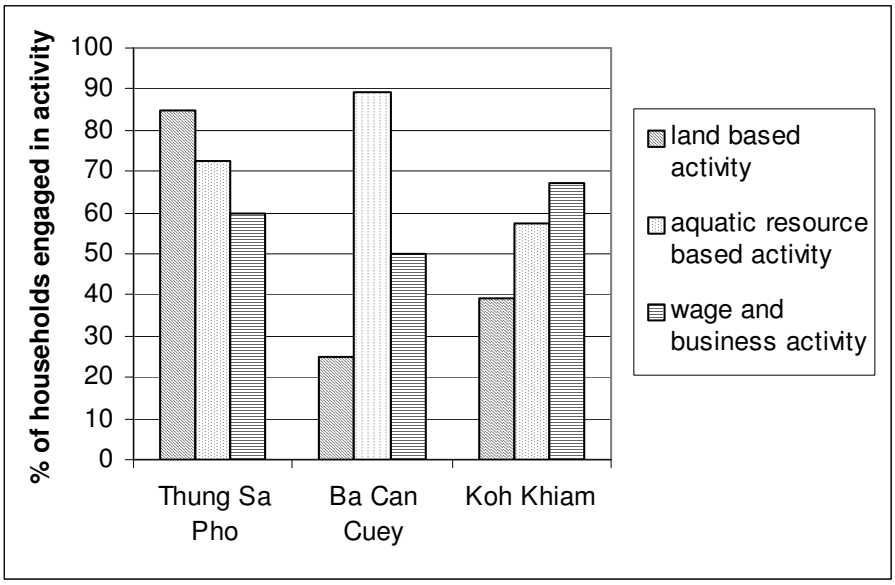
Table 4-1 Range of livelihood activities identified in case study villages

Land based	Wage and business	Aquatic resource based
Rubber plantation	Labour	Small scale fishing
Grow coconuts	Retail trade	Fish processing
Grow bananas	Factory work	Fish culture in cages
Shrimp culture	Food shop	
Rice cultivation	Tourist services	
Nipa palm harvesting	Government work	
Grow fruit and vegetables		
Rent land or ponds		
Agriculture		
Livestock		
Fish culture in ponds		

Activities could be categorised into three groups: those that are based on the utilisation of land resources; those that are reliant upon the use of aquatic resources, and activities which provide a wage or are business related.

It was found that, although activities utilising land based resources were the most numerous of all the activities available to HHs, they were undertaken by less than 50% of HHs in Ba Kan Khoei and Koh Khiam (18% and 39% respectively). In contrast, 85% of HHs in Thung Sa Pho derived a benefit from land based activities. In general, more land based activities were available to HHs in Thung Sa Pho. Land based activities accounted for 62.5% of livelihood options available to HHs in Thung Sa Pho, compared to 50% in both Ba Kan Khoei and Koh Khiam.

Figure 4-1 Importance of different livelihood activity categories in the case study villages



This difference can be attributed to the relative lack of land resources available to HHs in Ba Kan Khoei and Koh Khiam compared with Thung Sa Pho. In Thung Sa Pho, HHs owned or rented on average 7.3 rai (1.17 ha) per HH, compared with 2.6 rai in Ba Kan Khoei and 5 rai in Koh Khiam. Both of the latter communities are located in areas where land resources are limited and primarily available outside the village. Ba Kan Khoei, bounded on each side by the sea, protected mangroves and the village of Had Sai Kaew, is particularly scarce in land resources.

The location of each village and availability of land resources has therefore shaped the livelihoods of HHs in the village. HHs in each village have developed livelihood strategies which exploit the resources available to them. As a result, the livelihoods of HHs in Thung Sa Pho are predominantly

based on the use of land resources, in Ba Kan Khoei aquatic resource use is important, and in Koh Khiam opportunities for wage and business related livelihoods have been taken up by many HHs.

Land based livelihoods

Livelihood portfolios in Thung Sa Pho are characterised by a high level of involvement in land based activities and the widest range of livelihood options found at any of the three case study sites. Land based activities contribute to the livelihoods of 85 % of surveyed households (Table 4-2). Rearing of livestock (cows and buffalos) and the subsistence cultivation of rice represent the most widely adopted land based activities, and were carried out by 63% and 50% of households respectively (Table 4-2). Significantly more households in Thung Sa Pho owned or rented land resources than in the other villages (chi-square= 14.343, $p<0.01$). This results in lower costs related to food purchase for households in Thung Sa Pho compared to other villages as many households are able to grow rice for subsistence. Households in Thung Sa Pho who do not have rice fields, and therefore have to purchase rice, are regarded as poor. Aquaculture in the village is also predominantly land based. At the time of the study, 28% of households raised grouper in ponds, and 22.5% of households were engaged in shrimp culture. Two households raised both fish and shrimp. Only 2 households raised a small number of fish in cages at the time of the study.

Land resources in Ba Kan Khoei are scarce and are utilised by only a minority of households (18% of surveyed households). A small number of households have rubber plantations (4 households), rice fields (3 households) or produce a small crop of coconuts, bananas or fruit and vegetables.

Land resources are also limited in Koh Khiam, contributing to the income of 39% of households. A common activity, employing at least 16% of households, is the production of cigarette rollers from nipa palm leaves, which are often seen drying along the asphalt road that leads into the village. Rubber plantations provide employment for 11% of households, and the production of a small number of coconuts and bananas for household consumption 11% and 9% respectively, although the latter two activities are likely to be underestimated as households do not consider them to be livelihood activities. Shrimp culture also provides a lucrative occupation for 8% of households, who have converted areas of the village that were once rice fields into pond. Only one household in the village still owns a rice field.

Table 4-2 Level of household involvement in a range of livelihood activities in case study communities

Activity	% of households in community engaged in activity		
	Thung Sa Pho	Ba Kan Khoei	Koh Khiam
Land based activities:			
Rubber plantation	12.5	11	11
Grow coconuts	40	5	9
Grow bananas	10	3	10
Shrimp culture	22.5	0	8
Rice cultivation	42.5	8	0.06
Nipa palm harvesting	2.5	0	16
Grow fruit and vegetables	2.5	6	0
Rent land or ponds	12.5	0	2
Agriculture	9	0	0
Livestock	62.5	3	2
Total number of land based activities in which more than 5% community engaged	8	3	5
Aquatic resource based activities:			
Small scale fishing	57.5	80.5	48
Fish processing	0	8	4
Fish culture in ponds	12.5	0	0
Fish culture in cages	2.5	47	21
	Thung Sa Pho	Ba Kan Khoei	Koh Khiam
Make fishing gear			
Commercial fishery	0	0	0.06
Total number of aquatic resource based activities in which more than 5% community engaged	2	3	2
Wage and business activities:			
Labour	32.5	25	28
Retail trade	20	19	34
Factory employment	2.5	0	15
Government employment	7.5	5	2
Total number of wage and business activities in which more than 5% community engaged	3	2	3
TOTAL NUMBER OF ACTIVITIES IN WHICH MORE THAN 5% OF COMMUNITY ENGAGED	13	8	10
TOTAL NUMBER OF ACTIVITIES IN WHICH MORE THAN 20% OF COMMUNITY ENGAGED	6	3	4

Wage and business related activities

Wage earning and business opportunities in Thung Sa Pho exist mainly in the form of wage labour in construction, fishing and agriculture and retail trading. Although 60% of households were employed in some form of wage earning or business activity, opportunities for this type of income

earning were limited as the village is at least 11 km from the nearest town of Langu, Satun or Pakbara where such opportunities exist.

Ba Kan Khoei is, at 15 km, relatively close to the main provincial town of Satun. At the time of the study, a new asphalt road was being constructed to the village. Two households in the village had a transport business, and owned a vehicle which transported villagers to and from Satun town. Yet wage earning and business activities in the village do not appear to be well developed. Labour and petty trading account for the majority of wage and business related activities, in which 45% of households are engaged. Wage labour contributes on average 38.25% to household cash incomes (N=4), and petty trading 50% (N=5).

Remittances as a source of household income were relatively more important in Ba Kan Khoei than in the other case study villages, although there was no significant difference between villages. The close proximity of Ba Kan Khoei to Malaysia may provide an opportunity for members of the village to find employment over the border. Remittances from family members working away from home accounted for an average of 15% of household income (N=7).

Koh Khiam is the largest of the three villages studied and can be characterised primarily by its close proximity to Kantang town and the opportunities that its size and location provide for wage and business activities. As Figure 4-1 shows, wage and business activities are relatively more important to households in Koh Khiam than aquatic or land based activities, although the difference is not significant. Yet it is interesting to note that few respondents reported that members of their household were employed in Kantang town, despite the opportunities the town offers for employment. Kantang is the largest fishing port in Trang province, providing employment in the form of commercial fishery operations, fish processing and factory employment. A small number of respondents indicated that family members were employed in factory work (14%) although this figure is possibly an underestimate, as vans were seen bringing factory workers home to the village on a number of occasions during the field study. The head of the village reported that labour in factories was one of the most important activities in the village, suggesting that this activity may have been recorded as 'labour' rather than 'factory work' during the sample survey. Members of 28% of households were reported to be involved in activities described as 'labour'.

Within the village, a number of households owned small shops that sold groceries. Others owned small restaurants serving cooked food such as fried rice and noodle soups. The village also has at least 4 fish traders, trading in grouper seed, shrimp, and other economic fish landed by the small scale fishers of the community[15]. Retail trading may also include the sale of food items such as fried chicken, or sweet snacks ('*khanom*'). It is likely that due to the relatively large size of the village a number of occupations, in which small numbers of households are involved, were not captured during data collection and not recorded during the sample survey. For example, one household rents out speakers and music equipment for parties, an unusual occupation which was encountered by chance. Another household grinds coffee. In contrast to the smaller villages studied, the relatively large population of Koh Khiam provides opportunities for the development of small businesses who provide a service to the community. Trading involves 35% of households in the village.

Aquatic resource based activities

Small-scale fishing is the most important aquatic resource based activity in each of the communities, in terms of the number of households involved. Small-scale fishers, as observed in the case-study communities, use predominantly passive gears, deployed from boats in the range of 7 to 10m in length powered by engines of 11 to 13 horse power. The boats used by fishers in the study villages were typical of the boats used by fishers along the length of the Andaman coast. The majority are out-board powered boats of less than 10 GT (Gross Tonnage). In Koh Khiam, boats were approximately 7 m in length with 11 to 13 horsepower engines. Data regarding fishing vessels was not collected in the other villages. Fishers reported that a new boat and engine would cost approximately 50,000 THB (roughly US$1150). This represents more than half of the reported annual household income from fishing in Koh Khiam.

These small boats carry 2 to 3 people. Fishers often work in pairs, and married couples are common fishing partners. Wives accompany their husbands on fishing trips until they have children, at which point they usually stay at home and take care of the home and family.

[15] These traders are reliant upon the aquatic resource base for their income, however, as they are not separately identified within the quantitative survey, they are included within the wage and business activtity group for the purposes of analysis.

The gears used include various types of gill net, traps, hook and line gears and occasionally push nets and encircling nets. Respondents described 20 different types of gear used by fishers (Table 4-3). The most commonly used are the shrimp gill net, trammel net, fish trap and mackerel gill net.

Table 4-3 Range of fishing gears used by fishers in the communities studies

English name	Thai common name
Passive gears	
Fish trap	*Sai bplaa*
Crab trap	*Sai bpoo*
Squid trap	*Sai meuk*
Hook and line	*Bedt*
Long line	*Bedt rua*
Bag net	*Pong pang*
Fish corral/palisade trap	*Bpo*
Trammel net	*Auan loi, Auan lom*
Mackerel net	*Auan bplaa too*
Sand fish net	*Auan bplaa sai*
Snapper net	*Auan bplaa kapong*
Mullet net	*Auan bplaa ca bok*
Shrimp net	*Auan gung*
Crab net	*Auan bpoo*
Active gears	
Scoop net	*Sa win*
Cast net	*Dtor dtair*
Trawl	*Auan laak*
Push net	*Auan roon*

Despite the availability of numerous alternative livelihood options, small scale fishing is a relatively important activity in Thung Sa Pho, as 57.5% of surveyed households are involved in the small scale fishery. Shrimp nets and trammel nets are the most widely employed gears (both used by 48% of fishers). Mullet and mackerel are also an important part of the fish catch. Hook and line and fish traps are used by 30% of fishers. The crab catch is also important to fishers in Thung Sa Pho.

Small scale fishing was one of few aquatic resource based activities in which households in Thung Sa Pho were engaged. However, there was evidence that some households make use of other available aquatic resources, one household collects bivalves on the seashore which are sold in the village, for example. At the time of the case study analysis, activities based on aquatic resource use were relatively less common (72.5% of households) than land based (85%) and wage and business activities (60%) (Figure 4-1). However, this had not always been the case. Thung Sa Pho has shown a significant degree of development during the period 2000-2001, during which time the community has, to some extent, moved away from a reliance on aquatic resources and the small-scale fishery. During a visit to the village in May 2000, interview respondents reported that the

capture fishery was the main source of income for the village. At this time, 88% of households (60 households) were involved in the small-scale fishery, suggesting that, between May 2000 and April 2001, the number of households involved in the small scale fishery had declined by 31%. In May 2000, 50 households raised mudcrab or grouper in ponds and the village was categorised as poor, according to criteria defined by the Department of Community Development[16]. The head of the village reported at that time that the main work of the village, before villagers began to raise mudcrab in ponds, was fishing with trammel nets. They began to raise mudcrab when fishing became less profitable due to declining stocks and increasing fuel costs.

A visit to the village in January 2001, as part of the survey of villages in Trang and Satun presented in Chapter Two, showed that villagers no longer raised mudcrab, as grouper culture had become more important, although in general fewer households were involved in aquaculture. Shrimp culture increased rapidly during the latter half of 2001, as many households converted rice fields to shrimp ponds.

The village of Ba Kan Khoei takes its name from the small *Acetes* shrimp that are used in the production of shrimp paste, an occupation that once supported the economy of the village. In 2001, however, only a small number of households were able to produce shrimp paste as the ban on the use of push nets, implemented in 1997, reduced the availability to villagers of the *Acetes* shrimp that were the principal target of this gear. However, in contrast to both Thung Sa Pho and Koh Khiam, livelihoods in Ba Kan Khoei are still predominantly based on aquatic resources (chi square = 52.333, $p<0.0001$), represented primarily by small scale fishing activities in which 81% of households are involved. Shrimp nets and trammel nets are the most important gears used in the village, employed by 79% and 76% of fishers respectively, suggesting that shrimp provide the basis for the village economy. Hook and line, long line and fixed gears are more commonly used by fishers in Ba Kan Khoei than in other villages. Species such as mullet and mackerel are relatively less important to Ba Kan Khoei than to fishers in the other villages. Fish traps are used by 41% of fishers and are used by relatively more fishers in Ba Kan Khoei than in the other two villages, although this difference is not statistically significant.

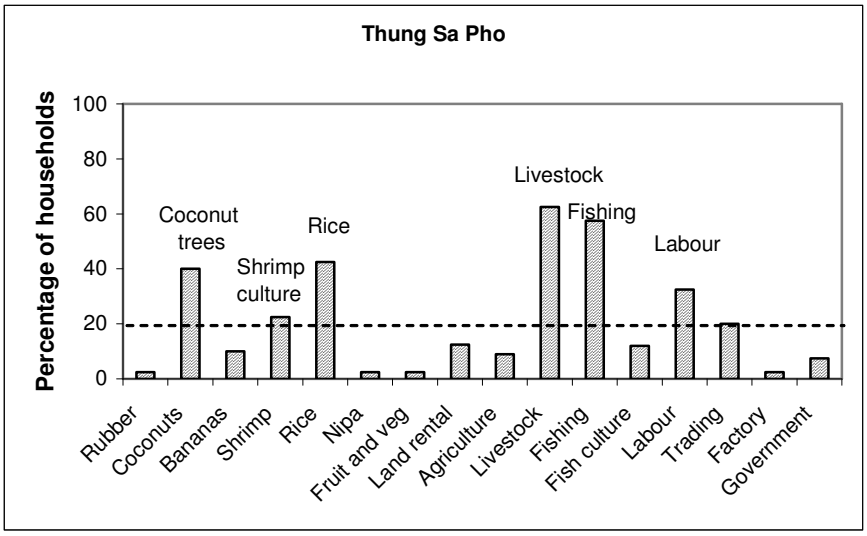
[16] Villages are categorised as 'poor' when the average income per person per year is less than 15,000 Baht

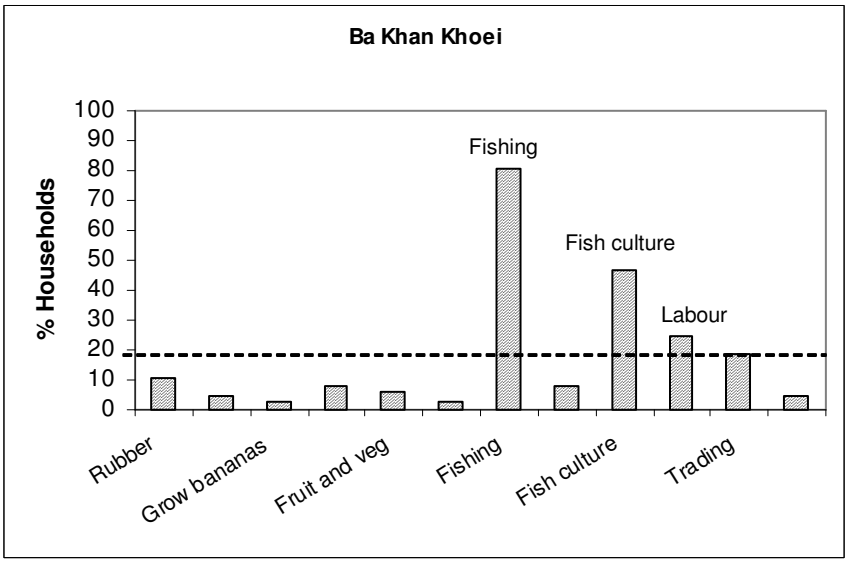
Fish processing activities, such as shrimp paste production, provide employment for 8% of households. Fish culture is the most common activity in the village after fishing, as 67% of households own fish cages.

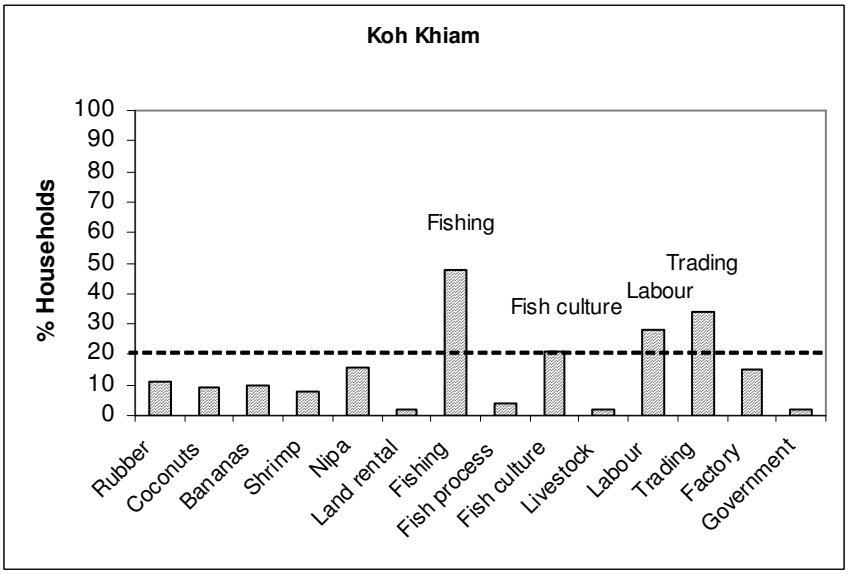
Along with trading and employment in nearby factories, fishing is one of the most important activities in Koh Khiam. Yet although the village is often described as a 'fishing' village, less than 50% of households are involved in small scale fishing (Figure 4-2). The principal target species are shrimp, grouper seed and mullet and mackerel. Some fishers also fish on the coral reefs using a hook and line gear. The shrimp net is the most widely employed gear, used by 46% of fishers. Fish traps and trammel nets are used by 35% and 34% of fishers respectively. Fishers in Koh Khiam use, on average, fewer gear types than in the other villages. Although fishers use up to 8 gear types, most use 2 different types of gear. In contrast to the other villages, a small number of people in Koh Khiam own mackerel boats which employ a crew of 7 to 8 people. Until recently, grouper seed fishing had provided an important source of income for fishers in the village. Fishers targeted the orange spot grouper, *E. bleekeri*, for sale and export to Hong Kong. However, when disease undermined production and on-growing of *E. bleekeri* the market for seed from Thailand was reduced and fishing for seed no longer profitable. Key informants reported that this had a major effect on the economy of the village. The species is not favoured locally for culture due to its slow growth rate. During June 2001, a key informant reported that the number of seed fishers was once again increasing as the value of seed fish increases.

Fish culture in cages provides an occupation for 22% of households, although the level of participation in fish culture is highly dynamic and subject to wide and rapid changes. At the time of the quantitative survey in October 2001 fish culture was reported to be increasing as grouper were fetching a higher price on the market and fish mortality was lower than previous years.

Figure 4-2 Household activities in case study communities, and level of household uptake, shown as the percentage of households which include the activity in their livelihood portfolio







4.1.3 Diversity of livelihood options

Although a number of livelihood options were available to HHs in each community, the majority drew their livelihood activities from a relatively small pool of options.

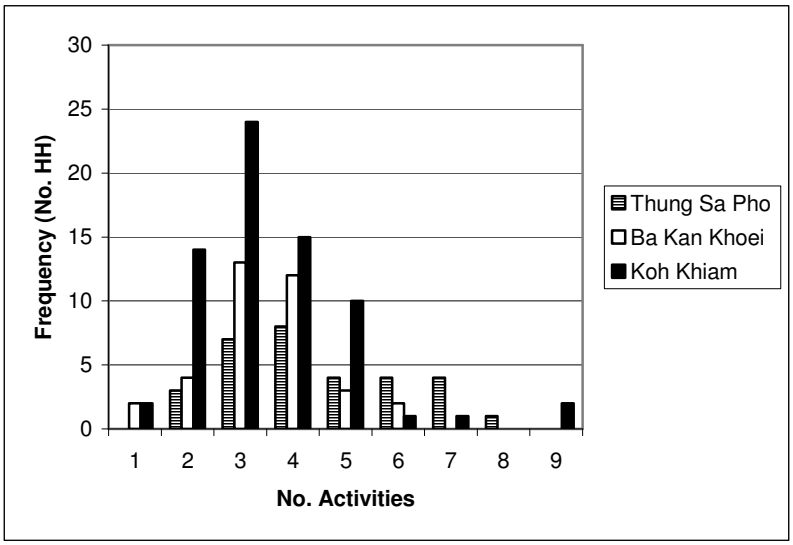
In Ba Kan Khoei, the majority of households are engaged in only 2 activities, fishing and aquaculture, of a total of 11 different activities identified in the village. Small scale fishing, fish culture, casual labour and petty trading are the only activities in which more than 20% of households in the community are engaged. This is reflected in the average number of activities each households includes within their livelihood portfolio. Households are involved in, on average, 2.4 activities per household.

In Thung Sa Pho, where 16 different livelihood activities were identified, only 6 activities were included in the livelihood portfolios of almost 80% of the households, as shown in Table 4-2. However, households in Thung Sa Pho are engaged in significantly more activities than in the other villages ($p<0.0001$). Households employ, on average, 3.9 different livelihood activities to generate a benefit.

Findings were similar in Koh Khiam, where the majority of households were engaged in 4 of a possible 16 activities. Small-scale fishing, fish culture, and casual labour generated a benefit for the majority of households in the community, who were engaged, on average, in 2.2 activities per household.

Figure 4-3 shows the frequency distribution for the number of activities taken up by each household

Figure 4-3 No. of activities taken up by households in each of the communities



In each village, it was found that livelihoods of fisher households were more diversified than non-fishing households.

Table 4-4 Average no. livelihood activities per household amongst fishing and non-fishing households

	Non-fishers		Fishers	
	N	Ave. no activities	N	Ave. no activities
Thung Sa Pho	18	3.3	20	4.5
Ba Kan Khoei	7	1.7	29	2.6
Koh Khiam	84	2.1	80	2.5

Livelihood diversity was also assessed with relation to household wealth and assets ownership. The results are presented in section 4.3, in which factors influencing the uptake of livelihood options is discussed.

4.1.4 Income from livelihood activities

Analysis of HH incomes showed that annual incomes of HHs in the case study villages were comparable to those for the southern region of Thailand. According to the results obtained from the quantitative survey, HHs in Ba Kan Khoei and Koh Khiam generate a higher average annual income than the regional average. However, the high average income calculated for Ba Kan Khoei can be attributed to the high income reported by three non-fishing HHs in the village, whose principal occupation was trading. These HHs generated an average income of 563, 750 THB per HH per year ($12, 612). In contrast, fishing HHs generated an average income of 148, 845 THB per HH per year ($3,329), although this is still above the average for the region and for the whole kingdom.

Table 4-5 Comparison of average annual incomes in the southern region and the case study communities for fishing and non-fishing households

	Southern Region*	Thung Sa Pho	Ba Khan Khoei	Koh Khiam
Average annual income per HH per year (US$)	3062	3077	4658	3472
Ave. annual income per HH per year (Fishing) (US$)		3482	3375	2860
Ave. annual income per HH per year (Non-fishing) (US$)		2634	12,783	4391

Source: National Office of Statistics, Bangkok.

In Thung Sa Pho, fishing HHs were found to generate a higher average income per year than non-fishing HHs. In Koh Khiam, the converse was found with fishing HHs earning on average almost 70,000 THB per year less than non-fishing HHs and less than both the regional average income and that of the Kingdom. However, fishers in Koh Khiam reported the highest daily income from fishing and the greatest number of fishing days per year. The low average income for fishing HHs can be attributed to the fact that fishing provides the only source of income for 21 HHs surveyed, representing 26% of all fishing HHs included in the study. Fishing also accounts for relatively more of the total income of fishing HHs than other villages, where a second or third activity may contribute as much to the HH income as fishing.

Analysis of the relative contributions made by different activities to the total reported annual income of surveyed HHs [17] showed that the activities in which the majority of HHs were engaged were not necessarily the most lucrative available to them (Table 4-6). For example, in Thung Sa Pho, 62.5% of HHs raise livestock (See Table 4-2), although the cash income from livestock represented only 7% of total reported incomes. The keeping of livestock therefore can be said to meet other needs of the HH besides the generation of a cash income, which will be discussed later in this chapter. Similarly, many HHs in Thung Sa Pho have fruit crops, and cultivate rice, activities which also generate little or no cash income, but require substantial inputs of labour.

The results show that income generation in Thung Sa Pho is spread across a number of activities, although fishing, shrimp culture and retail trade account for the largest proportion of income generation. Fishing, although carried out by 57.5% of HHs, accounts for 27.3% of reported income, roughly comparable to the contribution that fishing makes in each of the case study villages (Table 4-6). In contrast, 3 activities in Ba Kan Khoei (fishing, fish culture and petty trading), and 2 in Koh Khiam (fishing and petty trading) accounted for the majority of the total reported income of the community.

[17] The sum of the total income reported by each HH, based on calculations from information provided by respondents during the quantitative survey. Only questionnaires which were considered to contain complete information regarding HH incomes were used for the analysis. As a result, 57.5% of questionnaire responses from Thung Sa Pho were used for income analysis (N=23), 60% in Ba Kan Khoei (N=21) and 53.6% from Koh Khiam (N=88).

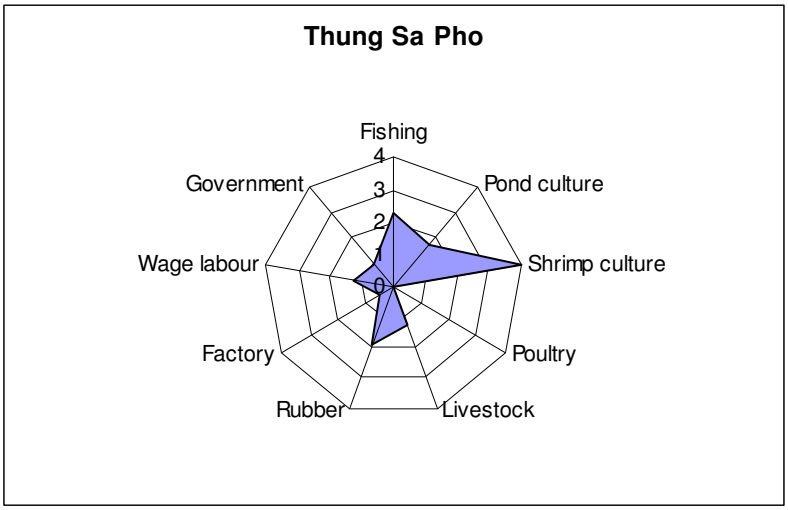
Figure 4-4 illustrates the Income:Household ratios given in Table 4-6. The figures show that petty trading was by far the most lucrative activity in both Thung Sa Pho and Ba Kan Khoei. In Thung Sa Pho, retail trade, fish culture and shrimp culture were shown to generate the greatest average benefit for HHs involved in them. Twenty-three HHS (57.5%) included at least one of these activities in their portfolio. Table 4-6 gives an indication of the relative income generated by different activities, by showing how the proportion of income generated by the activity corresponds to the proportion of HHs in the community that are involved in the activity.

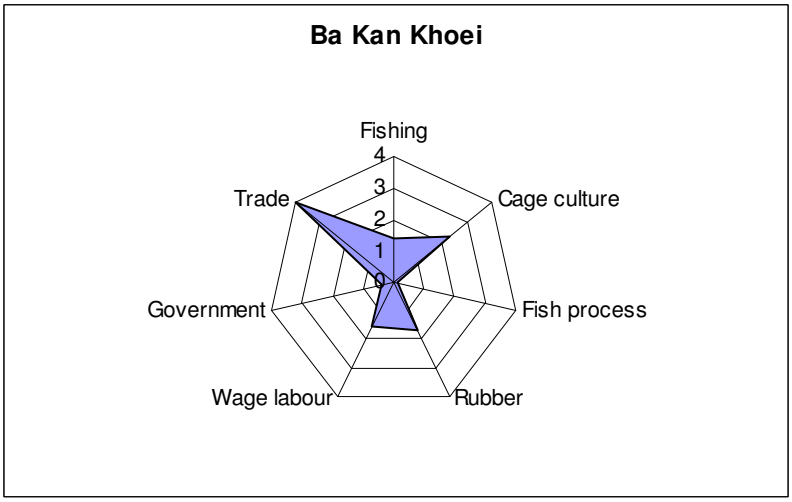
Fish culture made the largest contribution to the income of the community in Ba Kan Khoei, where 71% of HHs included in the analysis who were involved in fish culture generated 35.2% of total community income. In comparison, fishing generated 26.9% of total community income although 80.5% of HHs were involved. Fish culture was the single most important contributor to the economy of the village. Retail trading, as in Thung Sa Pho, was the most lucrative occupation, with 24% of HHs generating 20.2% of total reported income through trading activities.

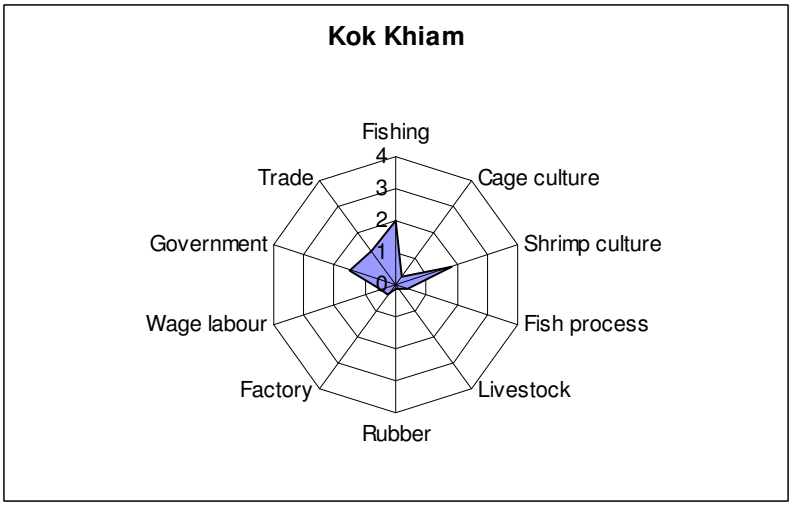
Table 4-6 Contribution of activities to the total reported income generated by communities (N is the number of households involved in the activity).

ACTIVITY	Thung Sa Pho	Ba Kan Khoei	Koh Khiam	Thung Sa Pho			Ba Kan Khoei			Koh Khiam		
	% contribution made by activity to total community income			N	Ave. income	Income to HH ratio	N	Ave. income	Income to HH ratio	N	Ave. income	Income to HH ratio
Fishing	27,3	26,9	26	12	69,075	2,3	19	67,441	1,4	53	68,200	2
Pond Culture	8,7	0	0	5	53,000	1,74	0	0	0	0	0	0
Cage Culture	0	35,2	6,6	0	0	0	15	88,500	2,3	23	45,681	0,3
Shrimp	16,3	0	3,6	4	124,000	4	0	0	0	2	250,000	1,8
Fish Process	0	0,4	1,7	0	0	0	1	18,000	0,13	4	57,000	0,4
Poultry	0,1	0	0,1	6	687	0	0	0	0	12	7,273	0
Livestock	7,2	0	0,6	6	36,333	1,2	0	0	0	4	21,550	0,15
Rubber	3,8	5	0,1	2	57,500	1,9	3	12,444	1,7	1	7,500	0,1
Fruit	1,9	0	0	4	14,500	0,5	0	0	0	4	2,387	0
Nipa	0	0	0,6	0	0	0	0	0	0	5	16,100	0,12
Factory	0	0	6	0	0	0	0	0	0	16	51,346	0,4
Wage	8,7	6,2	10	7	37,658	1,2	4	15,688	1,5	21	65,942	0,5
Retail	14,8	20,2	37	4	112,350	3,7	5	50,652	4	29	172,833	1,3
Government	3,8	1,2	3	4	28,850	1	3	17,400	0,4	2	206,400	1,5

Figure 4-4 Income:Household ratios showing individual activities contribute to total community income. In Thung Sa Pho, shrimp culture generates the highest income per household. In Ba Kan Khoei, trading is a relatively lucrative activity.







In Koh Khiam, fishing contributes less to the total community income than in other villages. However, fishing generated a relatively larger benefit per HH than in the other villages. The

reported benefits from fish culture are lower in Koh Khiam than in the other villages. Fish culture contributes only 6.6% to total community income although 21% respondents reported that they raise fish. This may indicate that farmers in Koh Khiam experience more problems with fish culture than farmers in other villages, and are thus able to harvest fewer fish. However, the figure could also suggest that some farmers have recently started or restarted fish culture and have not yet been able to harvest fish and therefore generate a benefit. It was found that the relative income from fish culture per HH in Ba Kan Khoei is almost double that of the other two villages.

The results indicate that retail trade can generate the greatest financial return for HHs involved. However, it should be noted that there was a great deal of variation in the activities categorised as trading differed, and included the trading of food items such as fried chicken or '*Khanom*', and more lucrative activities requiring a greater financial investment, such as fish trading. The structure of the quantitative survey did not permit any distinction to be made between different types of trading activities.

Fish culture was found to have the potential to generate a good benefit if successful, as in Ba Kan Khoei where the income from fish culture accounted for the largest proportion of the reported income in the community. Although the return per HH was lower than activities such as trading, shrimp culture or fish processing, it was shown that fish culture could provide a good financial return to HHs. However, the income generated by fish farmers in both Thung Sa Pho and Koh Khiam did not differ greatly from the income generated from wage labour. The willingness of fish farmers to continue to raise fish despite the problems they experience suggests that fish culture plays an important role in HH livelihood portfolios that cannot be explained only in terms of the direct financial benefits associated with an activity. The role and significance of fish culture and other activities are discussed below.

4.1.5 Role of livelihood activities in household portfolios

It has been shown that some activities can generate a greater financial benefit than others. However, it was found that those activities which generated the greatest benefit were undertaken by only a small number of households. Household wealth and associated asset ownership was found to provide a partial explanation for this observation and a contributing factor in the determination

of household livelihood. Activities within a livelihood portfolio therefore contribute in different ways to the needs of a household by providing, for example, a source of daily income, or the means to save money with which to pay for education or to build up assets. The findings presented here serve to show the role and significance of various different activities, as reported by respondents during the qualitative phase of data collection.

Importance ranking exercises allowed villagers to describe the importance of various livelihood activities to their overall livelihood strategies. The criteria they chose to define the importance of activities included:

- The importance of the activity as a source of income
- The activity as a source of sufficient income to allow households to save money
- The level of risk, financial or to life, associated with the activity
- The level of investment the activity requires
- The importance of the activity in relation to other livelihood activities
- Lifespan of physical capital
- The length of time villagers must wait to see a return on their investment

The matrices generated during the focus groups in Ba Kan Khoei and Thung Sa Pho are shown in tables Table 4-7 andTable 4-8. They show clear similarities in the selection of importance criteria, which was identified independently by focus group participants. The results are summarised in Table 4-9. Focus groups in Koh Khiam had a different topic focus and cannot, therefore, be compared with the other villages.

Table 4-7 Significance of livelihood activities, according to criteria defined by pond farmers in Thung Sa Pho

Livelihood activity	Criteria						
	Generates an income	Generates enough income for saving	Risk involved (5 indicates high risk activity)	Investment required	Length of time needed to generate a benefit	Level of income	Related to another activity
Fishing:							
- Trammel net	3		4	2	3	2	5
- crab net	3	2	4	3	1	3	
- mackerel net	4	4	4	3	1	5	5
- sand fish net	4	2	4	3	1	3	
- mullet gill net	4	1	1	1	1	2	
- Hook and line	4		1	1	1	5	
- large fixed gear	5	5	1	3	5	5	5
- grouper trap	4	2	1	1	3	2	5
- mudcrab trap	3	2	1	2	2	2	
Raise grouper in ponds	4	3	1	2	4	4	
Raise shrimp in ponds	5		5	5	3	5	
Livestock:							
Buffalo	5	5	2	4	4	5	
Goat	5	3	2	2	5	5	
Duck	3	1	1	2	2	3	
Rice production	4	1	1	4	5	4	
Shop trading	5	3	4	4	1	3	
Coconut plantation	2	1		1	5	5	
Labour	5	4	1	2	3	5	
Government /public service	5	5	1	1	4		

Table 4-8 Relative importance of livelihood activities, according to criteria selected by villagers in Ba Kan Khoei village

Activity	Generates an income	Lifespan of physical capital	Generates enough income for saving	Investment required	Activity is related to another activity	Risk involved (5 indicates high risk activity)
Fishing:						
- crab net	2	2	1	2		1
- grouper trap	2	4	2	2		1
- hook and line	3	5	3	3		2
- shrimp push net	5	5	5	2		2
- trammel net	2	2	3	5	5	5
Fish culture, grouper and seabass	5	5	5	5	5	4
Produce and sell shrimp paste	5		5	2		
Rubber plantation	5	5	3	2		
Goats and poultry						
Shop trading	5		5	3	5	
Transport service	5	3	3	7	5	3
Labour in Malaysia	5		7	1	5	3

Table 4-9 Activities described by respondents as most important (ranked 5) according to defined criteria

Importance criteria	Ba Kan Khoei	Thung Sa Pho
Important for income generation	Shrimp push net Fish culture Rubber plantation Trading Transport service Labour in Malaysia	Large fixed gear Shrimp culture Buffalo Goat Trading Labour Government/public service
Important for saving money	Hook and line Shrimp push net Fish culture Rubber plantation	Large fixed gear Buffalo Government/public service
Risky activities	Trammel net	Shrimp culture
Require a high investment	Trammel net Fish culture Transport service (very large investment required)	Shrimp culture
Activity is related to another HH livelihood activity	Trammel net fishing associated with fish culture	Trammel net Mackerel net Large fixed gear Grouper trap (all related to provision of inputs for grouper culture)
Physical capital (Lifespan of capital relatively long)	Hook and line Shrimp push net Fish culture Rubber plantation	
Level of income is relatively high		Mackerel net Hook and line Shrimp culture Buffalo Goat Coconut Labour
A relatively long time is needed to generate a benefit		Large fixed gear Goat Rice production Coconut plantation

4.1.6 Contribution of fishing and fish culture to household livelihood strategies

Fish culture scored highly with relation to all criteria in Ba Kan Khoei, where it represents one of only two options in the matrix in which poorer households participate[18], and which provides a sufficient income for saving. The alternative option, the shrimp push net, is essentially an illegal gear, which the DoF hoped to eradicate with the introduction of fish culture. At the time of the research, only 3 households reported that they continued to fish with the shrimp push net[19]. The push net provides the shrimp required for the production of shrimp paste, although respondents did not point out the association between the two activities during the ranking exercise. Respondents reported that the production of shrimp paste is the most important activity for households in the Ba Kan Khoei area of the village, although only three households reported that fish processing contributed to their household livelihood. These were not the same households who fished with a shrimp push net.

Fish culture and fishing using a trammel net were identified as being closely related activities (Table 4-9). Trammel net fishing is defined as a high risk, high investment activity but does not appear to be a particularly lucrative activity, and therefore does not seem to justify both the risk and investment involved. Its importance, and the justification for taking on the risks and investment involved to fish with a trammel net, may be due to the importance of the activity as a means for providing trash fish for fish culture. According to survey data, 61% of fish farmers also fish with the trammel net.

It is interesting to note that the majority of fishing activities, on which much of Ba Kan Khoei depends, scored relatively low in terms of income generation but also in terms of risk and investment. In contrast, fishers in Thung Sa Pho targeted more economically valuable fish species including mackerel, sand fish and mullet, and received greater associated benefits in terms of

[18] See section 4.3.3 for a more detailed analysis of the association between household wealth and livelihood uptake.

[19] Although the actual number may be higher. It is possible that respondents did not want to report use of the shrimp push net, as it is officially an illegal gear

income and ability to save money. Fishing was also considered to be a high risk activity for fishers in Thung Sa Pho.

Focus group participants in Thung Sa Pho mainly raised grouper in ponds. Fish culture did not appear to carry the same significance in Thung Sa Pho in terms of income generation, saving money or profit as it does in the other two villages. In contrast to fish farmers in Ba Kan Khoei, investment and risk associated with fish culture in Thung Sa Pho was considered to be relatively low. Although scoring quite highly in terms of income and profit, fishing, livestock rearing (including goats), labour and rice cultivation provided comparative benefits and were possible options for uptake by most households in the village. Fishing activities appeared to provide relatively high returns to fishers and were not primarily supporting activities for fish culture as seen in Ba Kan Khoei. Results shown in Table 4-6 confirm that fishers in Thung Sa Pho generate a relatively higher financial benefit from fishing than fishers in the other villages.

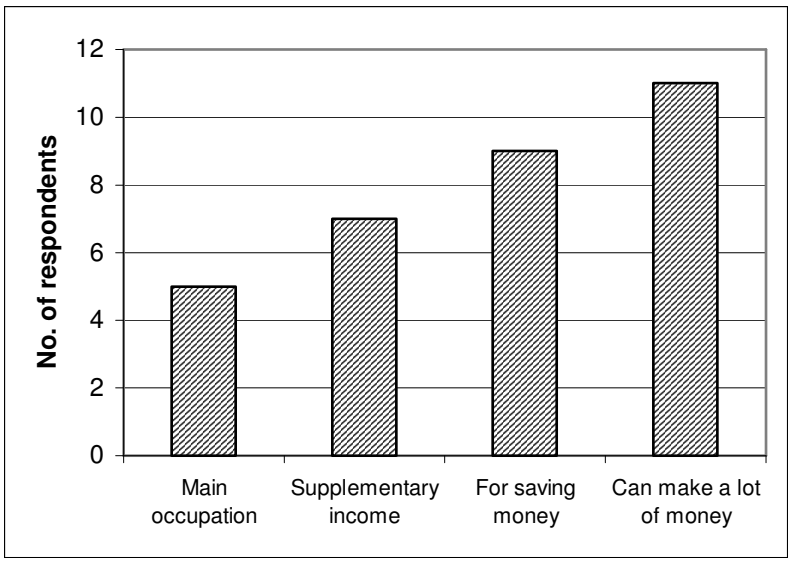
Grouper culture is generally not considered to be a main occupation in any of the villages (Figure 4-5), as it primarily provides households with a means of saving money. It is therefore an important means by which poorer households can build assets and, as shown in section 4.3.3 it is one of the only activities which allow households to save money that is not significantly restricted to wealthier households. Other activities, such as fishing, trading and labour are generally considered to be more important occupations in terms of time invested and as providers of income to meet daily expenses. This supports data presented in Table 4-6, which identified fishing, trading and labour as the biggest contributors to household cash income.

However, in Koh Khiam, grouper culture was '*the main economics of family and the majority of the community.*' At the time when grouper culture was at its peak in Koh Khiam, prior to the collapse of fish culture due to fish disease and bank debts '*every family in Ban Koh Khiam raise groupers as their main income, when the price of grouper went down, everything was planned to do according to the income from grouper production, like repay debts, to buy boat, to buy new engine, or plans like these we had to give up for we relied on major income for grouper raising, so this was huge economic impact of the village of Koh Khiam.*' The fact that fish farmers are now actually generating a relatively small financial benefit from fish culture compared to the past and their expectations, as shown in Table 4-6, suggests that the problems experienced by

fish farmers in the village may have had a considerable impact on HH incomes and the village economy.

In contrast, in Ba Kan Khoei, one respondent commented that '*fish culture has increased the wealth of the village*', another that 'the *life of the farmer is improved because of fish culture*.'

Figure 4-5 Significance of grouper culture to household livelihood strategies (N=33) , aggregated for all three communities



One respondent in Thung Sa Pho reported that they had lost money as a result of raising grouper. Five respondents reported that they were able to generate a good benefit from raising grouper. However, most respondents (N=15) reported that although they often received only a small benefit, and occasionally no benefit from grouper culture they did not necessarily lose money. This opinion stems largely from the attitude of fisher/farmers who do not consider that they have lost financially if their fish die, if seed and feed fish have mostly come from the farmers usual fishing activities and have therefore not required any direct financial input. The indirect costs of fishing are not generally taken into consideration.

4.1.7 Fishing livelihoods

In each of the villages, fishing played an important role in the village economy, contributing at least a quarter of the total village income. Respondents in Koh Khiam reported an average daily income of between 150 and 200 THB per day (US$3-4.5) from mullet and shrimp fishing, after expenses. Fishers in Thung Sa Pho reported that the income from hook and line fishing can be highly variable, from 100 THB to 3000 THB in a day (US$2.2-67). According to respondents, fishers

could earn an estimated annual average income of between 35 000 THB per year in Ba Kan Khoei (US$ 783) and 68 000THB per year in Koh Khiam (US$1521). The income from the larger fishing boats operating out of Koh Khiam, which target mackerel, may reach 15,000-70,000 THB per month to split between a crew of 8 people. The income from fishing is therefore highly variable, and is dependent upon the type of gear used by fishers, the fertility of local fishery resources, seasonality, tidal cycles and the experience of the fisher. At times, fishers may be barely able to meet the daily expenses of the household, at other time a successful trip can yield good profits.

'Hard to find an income, even going out to sea. Sometimes people get less than 200 THB, doesn't even pay for fuel.' (Fisher, Koh Khiam)

As part of a livelihood portfolio, fishing provides a daily income to enable households to purchase their daily food and household needs. For many households, it may be the only source of cash income. However, fishers experience a number of problems as they pursue their livelihood.

Information gathered during the qualitative phase of the research reported that they experience problems with:

- High cost of fuel and lower profits. Increasing costs of fuel are reducing the daily profits of fishers, forcing them to fish closer to home and making it harder for fishers to meet the daily needs of their household on days when the fish catch is poor.
- Although fishing provides a daily income, it also incurs daily costs for nets, repairs and fuel. Fishers become indebted as a result, as they must invest daily in their boats and gears.

'Low profit because they must pay for fuel when they go fishing and sometimes mainly in the storm season can't go fishing. No money to pay.' (Fisher Thung Sa Pho)

'She thinks fish culture is a good thing, because she can save money, and this way can keep a lot of money at one time. Fishing income makes daily income, but have to pay every day. For example, pay to buy nets, fuel, repair nets.' (Fisher, Ba Kan Khoei)

- Lack of investment to purchase gears appropriate to the season. Fishers become indebted to banks or private lenders and struggle to keep up with increasing interest rates.

'Investment to operate is a problem. Brother fishermen who make living out of fishery always lack of capital investment, sometimes when the season of fishes comes, but we don't have the fishing gear which is specified for harvesting the species. So sometime we have to borrow money from private person, then it becomes a chain or cycle, we have to struggle a lot in order to repay the loan with a high interest rate.' (Fishers at a focus group in Koh Khiam)

'Head of Village says that life of a farmer better than life of fisher because investment for fish culture less than fishing they must pay fuel at least 10 litres per day. They must have money for fishing gear, or for boat, or for engine. Fishers have debts. Fishers can't pay back money to creditor (middleman). Problem gets bigger, as debts get higher.' (Head of Village, Thung Sa Pho)

Fishing is hard work and often there are not fish to catch,

'He started to raise fish because he thought fishing work very hard to work. Sometimes they go fishing 5 to 6 days but no fish.' (Fisher/Farmer, Ba Kan Khoei)

The future of fishing is insecure and unstable as there are too many people fishing in the sea with modified gears to make their fishing more effective, and illegal destructive gears,

'Future of fishing – instabilities or insecurity of the fishing occupation, from the condition of people using the sea, too many capacity of people using the sea. Even small scale have tendency to use traditional gears, but still modify gears to be more effective.' (Fisher, Koh Khiam)

Many fishers do not know how to do any other activity, and are concerned that they cannot make a living if they cannot fish (Fishers, Koh Khiam),

'If he can't make a living from grouper, doesn't know what alternative would be. Can only look for things in the sea as nowhere else to go. Cannot go to mainland as has no education. That's why he sends his children to school, although a very big burden for him. Cannot expect an income from the sea, so many factors affect work in the sea. Generally people in Koh Khiam have low education so have to work in the sea.' (Fisher, Koh Khiam)

The fishery resource has declined dramatically in recent years, according to respondents from Koh Khiam and Thung Sa Pho. Eight interviewees in Koh Khiam commented on the declining fishery

resources. The decline is attributed to an increase in fishers, the use of more powerful and destructive gears, and poor water quality. In recent years, there has been a considerable amount of conflicts in the region between small scale fishers and commercial fishers using destructive gears such as push nets.

In both villages, fishers had looked to other activities, primarily aquaculture, to provide an alternative occupation in the face of declining fish stocks.

'Have to raise grouper, which they hated in the past. A substitute as fishes in the wild are very rare. Still want to keep some in the sea. If don't raise fish also, they will be gone.' (Fisher, Koh Khiam)

'Before they raised mudcrab the main work of villagers was fisheries, the main auan loi gung. This is why they get idea to start to raise mudcrab because difficult to find animal in sea.' (Fisher/farmer, Thung Sa Pho)

'There has been a big change to the fishery – less catch. Less aquatic animals. Size is the same for mackerel, but number is a lot less. Previously when they could catch 100 fish, now catch 20. Thirty years ago. Income from fishing at that time a lot better. But even in past, if stormy and windy, sometimes catch too many to bring back. Doesn't happen anymore.' (Fisher, Koh Khiam).

'Has noticed a big decrease in fish. Now the number of fishermen more than the fish in the sea. Environment is bad, water from shrimp farm.' (Fisher, Koh Khiam)

4.2 Grouper culture and fishery activities in the case study communities

4.2.1 Introduction

In Section 3.1, in which the research objectives of the case study analysis are described, it was shown that an understanding of the grouper culture system, management of the culture cycle and resource demands were necessary in order to assess the compatibility of grouper culture with household livelihood strategies and available assets. This section presents the findings of the research related primarily to grouper culture and fishery activities in the case study communities, building on the more technical information relating to grouper culture systems presented in Chapter 2. The emphasis here is on the significance of particular characteristics of grouper culture to fisher livelihoods. It begins by describing the nature of aquaculture in each of the case study communities, before going on to discuss specific aspects of the aquaculture systems, primarily of grouper culture systems, the adoption of different management approaches by risk-averse and risk-neutral farmers and the significance of wild feed and seed resources to grouper culture uptake.

4.2.2 Aquaculture activities in the case study communities

Thung Sa Pho

Aquaculture in Thung Sa Pho began in 1985, when villagers first began to raise mudcrab in ponds following the advice of a middleman. At this time, an area of mangroves along the coastal margin of the village was modified to form a holding area for mudcrab. Mangrove trees remained within the holding area and nets prevented the mudcrab from escaping. It was not until 1998 that ponds were constructed using funds obtained from the Southern Border Province Support Centre, primarily for the culture of mudcrab. Villagers received 5000 THB per person to raise mudcrab, and a total of 30 people participated in the scheme. However, farmers found that grouper could grow well in the ponds, self-recruiting with other species including tiger prawn, white shrimp, tilapia and mullet. Grouper were subsequently raised in 30 ponds, in a polyculture system with mudcrab and soft shelled crab. However, in January 2001, only 15 households continued to raise grouper in 30 ponds. Four months later, only 15 ponds were still producing grouper as farmers had made a rapid shift to shrimp culture. This change was reported to be prompted by a lack of sufficient grouper fry to stock ponds. Fry brought from other provinces did not survive and people

turned to shrimp as they began to lose money on grouper culture. The Head of the village did however predict a return to grouper culture as the value of the fish increases, in line with a demand that cannot be met by supply.

Cage culture trends in Thung Sa Pho are not so clearly defined. Some villagers began to raise fish in cages c.1990 , but numbers of farms increased when the DoF provided assistance in 1999. However, cage culture has not been successful in Thung Sa Pho. Most farmers lost their stock because of disease. The small sized fry (1-2 inches) the DoF provided suffered heavy mortalities. A lack of confidence and interest has led most households to abandon fish culture. Only a few fishers continue to stock a small number of fish in their cages.

At the time of the study, 30% of households reported that fish culture contributed to their livelihood portfolios, 28% of households reported that they raised grouper in ponds. Only 2 households were apparently still raising fish in cages. However, quantifying the exact number of people engaged in fish culture was problematic, as responses varied during both the qualitative and quantitative phase. The sample survey found that at least three households had restarted fish culture during the last year, and two households had restarted grouper culture. A total of 64% of households in Thung Sa Pho had raised fish at some time in the past, indicating a discontinuance rate of 68%.

Grouper of size 4 to 5 inches are stocked by pond farmers in Thung Sa Pho, who obtained the majority of fish for stocking from middlemen or other fishermen in the village. One farmer reported that they obtain seed fish from their own catch. The local villages of Korn Klarn and Ma Haang also provided a minor source of seed fish[20]. All respondents reported that they harvest their entire fish stock at one time, a feature of pond culture that contrasts with the regular harvests carried out by cage farmers in Ba Kan Khoei and Koh Khiam. Fish are generally harvested at size 8-9 inches (100g) to 200g.

[20] NB The information gathered during the sample survey refers primarily to pond culture of grouper, which represents 71% of fish culture activities in the village.

Qualitative research suggested that farmers in Thung Sa Pho purchase their fish feed from other fishers in the village, rather than their own catch, as successful farmers who raise fish as their main occupation, have stopped fishing and rely on the remaining fishers in the village to provide their trash fish requirements. This was supported by analysis of the survey data which showed that 58% of farmers purchase feed from middlemen, other fishers in the village or other villages. However, in contradiction to the findings of the qualitative research, the quantitative survey indicated that 42% of farmers also use their own catch for fish feed. Futhermore, the analysis showed that significantly more farmers in Thung Sa Pho obtain fish feed from their own catch than in the other villages (chi square 13.071, df 2, p 0.001).

Analysis of the responses given by villagers who had discontinued fish culture showed that discontinuers were more likely to have harvested fish regularly than continuers and generally harvested larger fish of 200g-1.2kg. Feed obtained from the farmers own catch, or from other fishers or middlemen, were equally important for discontinuers. However, these results can be explained by the fact that the majority of discontinuers were cage farmers, and thus harvesting larger fish than pond farmers.

Table 4-10 Continuance and discontinuance of fish culture in the case study communities

	Thung Sa Pho		Ba Kan Khoei		Koh Khiam	
	No. of Respondents	% of responses	No. of Respondents	% of responses	No. of Respondents	% of responses
New Starter	4	10	6	16	12	7.3
Continuer	4	10	16	44	16	9.7
Restarter	1	2.5	1	2.7	8	4.8
Discontinuer	17	42.5	11	30.5	73	44.2
Rejector	14	35	2	5.5	56	34
Total	40		36		165	

Ba Kan Khoei

Fish culture began as early as the latter half of the 1960's in Ba Kan Khoei, although the majority of respondents reported that fish culture was firmly established in the villages during the 1980's. Discussion with the assistant head of the village found that a group began to raise fish in 1976, but only lasted 2 to 3 years, apparently as farmers lost interest in fish culture. The origins of this fish culture group were not given. In 1996, a second group was initiated by the assistant head of the village, who created a group of 100 households who wanted to raise fish. He approached the

Department of Fisheries for assistance, who provided sufficient funds for twenty farms[21]. Since the establishment of the fish culture group, fish culture has continued to increase in the village, with a relatively low incidence of discontinuance (33%). The number of new starters, restarters and continuers was significantly higher in Ba Kan Khoei than in the other case study villages (chi square 28.809, df 4, p 0.000). Rejection of fish culture was also therefore lower than in other villages.

Most fish farmers in Ba Kan Khoei raised both seabass and grouper at the same time (62%), whilst a small number raised only seabass (33%) and only one household raised only grouper. One respondent in Ba Kan Khoei commented that '*poor people raise seabass only, not many people though*.'

Seed fish from the farmers own catch provides the most important source of seed input for grouper farmers in Ba Kan Khoei, supporting the comments of two interview respondents who commented that '*Almost all people in the village raise grouper by catching seed themselves*', although the contribution of own caught seed to total seed inputs does not differ significantly from other villages. Local villages, other fishers and the town of Langu also provide a source of seed fish. Feed inputs are derived primarily from the farmers own catch (28% of farmers) and the middleman in the village (28%).

Koh Khiam

Aquaculture in Koh Khiam has had a turbulent history over the last three decades. Since the first innovators began to raise fish in the second half of the 1960's, aquaculture went through a period of development as the number of farms increased after 1983, when extension officers from the Department of Fisheries promoted fish culture to the village. A key informant reported that people had tried to culture grouper prior to 1983, but only on an experimental basis. However, fish culture operations were badly affected by an outbreak of fish disease in 1991, attributed to pollution from Kantang town and a local fishmeal factory. Many farmers subsequently discontinued fish culture. Three years later, in 1994, people once again began to raise fish. As the value of grouper was good at this time, 89 households obtained a loan from the Bank of Agriculture and Agricultural

21 Further details of the involvement of the Department of Fisheries and the fish culture scheme are provided in section 4.3.5.

Cooperatives (BAAC), however, conditions of the loan[22] caused many to fall into debt and grouper culture once again declined. A key informant reported that, in 2001, 50% of the group was still operating their cages. At this time, approximately 70 households were raising fish in Koh Khiam, those households who raised fish independently of the loan group, or who participated in the DoF initiated project. It was reported that the good price of grouper and relatively low fish mortality was encouraging more people to once again take up grouper culture.

Table 4-11 Timeline of events in history of grouper culture in Koh Khiam

Year	
1960's	Innovators begin to raise fish
1983	Fish culture increases as a result of DoF promotion
1991	Severe outbreak of disease attributed to pollution from Kantang town and local fishmeal factory causes dramatic decrease in fish culture activities
1994	Villagers begin to raise fish once more and number of farms begins to increase. The value of grouper is good and 89 households take out a loan from the BAAC bank to raise grouper
1995	Many farmers become indebted and numbers of farms decreases
2001	Number of farms begins to increase as value of grouper good and fish mortality is low

Aquaculture in Koh Khiam is also dynamic in terms of species cultured. Seabass and grouper are the most popular species raised, but the relative proportions of each species raised by a farmer changes according to prevailing market conditions for the species and availability of seed fish. Farmers who began to raise fish with the support of the DoF initially raised seabass, with seed provided by the DoF, but added their own catch of grouper seed to their cages. During a preliminary visit to Koh Khiam in 1999, it was found that approximately 100 households were raising grouper in cages. The number of cages was reported to be increasing, but with a small number of fish stocked per cage, and farmers were beginning to raise soft shelled crab. Upon returning to the village in July 2000, it was found that the culture of soft-shelled crab was already declining as farmers were losing crabs to cannibalism during the moulting stage. Grouper culture had also decreased and fewer cages were visisble in the *klong*. In November 2000, a lack of grouper fry had led many to abandon grouper culture in favour of seabass. Subsequently, as fry availability increased during 2001, grouper culture in Koh Khiam also increased. Farmers once again began to stock grouper, and additional farms were installed. Records collated by the Head of the village show

[22] Details of the loan obtained by households in Koh Khiam are given in Section 4.3.6

that in April 2001 42 farms were in operation in Koh Khiam, representing 161 cages and 19,360 grouper. Only 11 farms stocked seabass.

Grouper farmers in Koh Khiam obtain grouper seed fish from their own catch (25% of farmers) and middlemen inside and outside the village (34%). Fishermen in the village also contribute to seed inputs (11%), with the local fishing port and other villages being minor sources. Farmers stock slightly larger seed in Koh Khiam than in the other villages, with most farmers stocking fish of 6 to 9 inches (81%). Three farmers harvest their stock all at one time, but the majority harvest fish regularly as they reach market size. Most farmers harvest fish at 1.2kg (61%), although a number of farmers also harvest 'kilo' fish (36%).

The fishers own catch contributed significantly less to the feed requirements of grouper farmers than in the other villages (chi square 15.959, df 2, p 0.000)[23]. Only two farmers (6%) provided their own trash fish. The village middleman and the local small scale fishing port provided the most important sources of trash fish for feed (41% and 25% respectively).

Farmers who have since discontinued fish culture had at one time provided a market for fishers in the village to sell both seed and trash fish, as 28 farmers had purchased their seed and feed inputs from fishers in the village. 30% of discontinuing farmers had provided seed fish for grouper culture from their own catch. The majority of farmers had raised only grouper (65%). They tended to stock larger fish, with 71% of farmers stocking fish of size 6 to 9 inches, and harvested mainly fish of size 1.2kg (80%). Although most harvested fish at regular intervals, 26% harvested their entire stock at one time. Discontinuers were more likely to have used their own trash fish than continuers, but again village middlemen and fishers in the village were the most important sources of trash fish feed (32% and 28% respectively).

[23] 3 cells (50%) have expected counts less than 5.

Table 4-12 Comparison of fish culture characteristics in the case study communities

	Thung Sa Pho	Ba Kan Khoei	Koh Khiam
Year in which aquaculture began	1985	Late 1960's, most in 1996	Late 1960's, later in 1983
Motivation for uptake	Advice from middleman to raise mudcrab	Original motivation for uptake unknown. In 1996, villagers requested assistance from DoF	Originally began through farmer innovation, later with the assistance from the DoF
No. fish farmers at time of study (% respondents)	9 (22.5%)	23 (64%)	36 (22%)
% respondents discontinuing fish culture	77.5%	33%	78%
Species cultured	*Epinephalus coioides* *Lates calcarifer* *Scylla serrata* Shrimp	*Epinephalus coioides* *Lates calcarifer*	*Epinephalus coioides* *Lates calcarifer* *Scylla serrata* Shrimp
Main source of seed fish	Fish trader, fishers in village	Own fish catch	Fish traders from outside the village, own fish catch
Main source of feed fish	Fishers in village, fish trader, own fish catch	Own catch, fish traders	Local fish trader, village fishing port

4.2.3 Aquaculture production and culture systems

As the above account shows, aquaculture activities in the case study communities, whilst showing some degree of variation, also share many characteristics, such as sources of seed and feed and species cultured. The culture systems and approaches to management of the culture cycle can also be compared between the communities, and can be categorised in a number of ways:

1. by type of system i.e. ponds or cages
2. by species raised i.e. seabass, grouper, red snapper, mudcrab, shrimp
3. scale of production i.e. number of culture units, proportion of purchased or wild caught inputs
4. management of the culture cycle i.e. short grow-out period, low risk or longer grow-out period, higher risk

In general, culture activities did not differ greatly between villages, although pond culture is significantly more important in Thung Sa Pho than in any other village.

The culture systems

Two types of culture system are used to raise grouper in the case study communities:

1. Earthen ponds
2. Floating cages

85.5% of respondents raising grouper at the time of the survey had cage culture systems. Ponds accounted for 11.5% of culture systems, and were entirely located in Thung Sa Pho. Cage culture systems were the most common type of system in Koh Khiam and Ba Kan Khoei villages (Appendix 6)

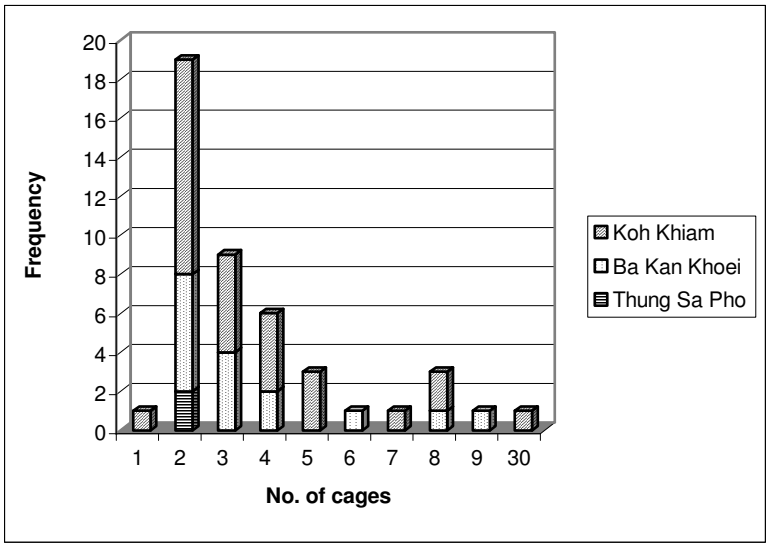
The materials used and the structure of cages and ponds have been described in Chapter 2

Table 4-13 Comparison of characteristics of cage culture and pond culture of grouper (Source: qualitative and quantitative data)

	Cage culture	Pond culture
Stocking size	Most sizes from 2 inches to 9 inches are stocked. The preferred size is 8-9 inches, to reduce the length of the grow-out period.	Smaller size seed are stocked in ponds than in cages. Seed of size 4-5 inches (TL) are preferred.
Number of fish stocked	Approximately 200 per cage	500-1000 seed in a 1 rai pond
Harvest size	'Kilo' size fish (approx. 200g) or 1.2kg	8-9 inches (TL) (150-200g)
Grow out period	Highly variable according to stocking size and harvest size. Grow-out from 6-7 inches to a market size of 1.2kg takes 1 year. Fish were reported to grow approximately 100g per month.	Fish reach a harvest size of 8-9 inches in 3 months, from a stocking size of 4-5 inches
Frequency of harvest	Fish are harvested regularly, usually at monthly intervals, when they reach the farmers preferred harvest size	The whole pond is harvested at one time.

Cage farms ranged in size from 1 to 30 cages. The mean size of fish farms in all three villages was 4 cage units, or 1 pond unit. Fish farmers in Koh Khiam generally had more cages than farmers in Thung Sa Pho or Ba Kan Khoei (Not significant, p=0.431). The higher number of cages per farm in Koh Khiam may be explained by the longer history of fish culture in Koh Khiam compared to the other villages, which has allowed time for farmers to develop their cages.

Figure 4-6 Size of fish farms in the study communities.



The size of cage farm is of particular significance for farmers who wish to rotate their stock, which is possible when farmers have 4 or more cages. Respondents defined stock rotation as an indicator of successful fish culture. When farmers have a sufficient number of cages, fish are graded, enabling fish to be more efficiently harvested when market size is reached. When the cage is completely harvested, new fish can be stocked in the empty cage. This system allows the farmer to maintain fish of different sizes, permitting regular harvesting as each cage reaches market size. Grading reduces losses to cannibalism. Farmers are unable to stock new seed fish in a cage containing fish close to market size. The ability to rotate the stock is therefore the key to a regular income from fish culture, and requires a minimum of 4 cages. According to the quantitative data, 37% of respondents who raised fish in cages had 4 or more cages, and were therefore able to rotate their stock. The majority of these farmers (76%) lived in Koh Khiam. A farm of 2 cages was the most common farm size class (Figure 4-6).

Location of the culture units

Cages are most frequently located in mangrove channels or close to the coast where tidal range is small and the water current is not strong enough to damage the cage. Farmers often need to use a small boat to reach their cages. Lack of culture sites close to households is a limiting factor for cage culture development. Cage farms are often placed as close as possible to the home of the farmer for ease of management and to guard against theft.

In Thung Sa Pho and Koh Khiam, cages are situated in mangrove channels that run alongside the village, and close to the farmers home. The village of Ba Kan Khoei is situated on the coast, and cages are moored close to the shore (see Figures 3-1 to Figure 3-2)

Ponds must be situated in an area where water can be easily exchanged. Areas without easy access to a *klong* or a source of brackish water are not suitable for pond culture. In Thung Sa Pho, villagers relied on natural tidal water exchange, with water draining at low tide and being replenished at high tide with a system of pipes and valves. Fish cannot be raised in ponds in areas of nipa palm, as the roots of the palm ferment and degrade water quality, causing fish mortality.

Culture species – the significance of raising both seabass and grouper

As shown in Table 4-12, and as mentioned earlier in the study, farmers do not only raise grouper. Many farmers raise both grouper and seabass according to the prevailing market conditions and the availability of seed inputs.

As the Department of Fisheries promoted fish culture in coastal communities by providing materials and seabass seed for new farmers, the uptake of seabass culture has been influenced particularly by institutional factors. Seabass also have a short grow-out period when compared to grouper, and seed are easily available from government or private hatcheries. However, respondents reported that seabass require more feed than grouper. Seabass must be fed every day, in order to prevent a loss of condition. Grouper can be fed every two or three days without any detriment to fish health or growth. Seabass also lose value if they exceed the preferred market size.

'Stopped raising seabass. Have to give a lot of feed, and feed every day. For grouper (small seed) feed once a day, or every other day. Small seabass seed must be fed 3 times a day or they get problem with their stomach, too flat or backbone becomes curved, deformed, stunted growth.' (Farmer, Koh Khiam)

'He doesn't raise seabass because they must be fed every day with a lot of trash fish. If seabass don't have enough food, they become thin and cannot grow. Grouper can go without food for 1 week.' (Farmer, Ba Kan Khoei)

Culture characteristics of seabass

Although the value of seabass is lower than grouper, seabass culture supplements the income that farmers obtain from grouper culture and provides a means of balancing the risks that grouper culture involves. Seabass culture enables farmers to minimise risks in two ways:

1. grouper are more vulnerable to fluctuations in salinity, and to disease than seabass. If the grouper stock suffers heavy mortalities, the farmer may still be able to generate an income from the sale of seabass, which are less likely to be affected.

'Why raise seabass? Grouper have higher survival in the dry season. Seabass provide a supplementary income for the future. Seabass can cope better with changes in weather.' (Farmer, Koh Khiam)

'She thinks raising seabass is better than raising grouper because higher survival is possible' (Farmer, Thung Sa Pho)

2. Seabass can also be sold on the local, domestic market, allowing farmers to sell fish locally to a relatively stable market at times when grouper may be hard to sell.

'Seabass can sell in Thailand so easy to find market and can sell dead fish. Easy to find seed.' (Farmer, Ba Kan Khoei)

'There is always a good market for seabass. If bring to market early in the morning can sell for 110 THB per kg.' (Farmer, Koh Khiam)

However, occasionally the supply of seabass exceeds demand and the value of stocked fish falls,

'This year a lot of pla Kapong (seabass) and farmers tries to get rid of seabass and try to sell, although low price, 50 or 60 or 70 THB per kg, farmer will sell. Farmers try to turn to raise grouper. ' (Seed fisher, Ban Chelung)

'During this time (time of interview) middleman tries to make price[of seabass] lower. A lot of seabass and difficult for farmers to sell seabass. They think now because Malaysia raise seabass and make lower price. But this problem not all the time.' (Focus group participants, Ba Kan Khoei)

Seabass may also provide food for consumption by the household. Due to their high value, and a cultural dislike of the grouper fish, grouper are generally not consumed by the household.

'Raises grouper, but if sees seabass or red snapper, also raises those, usually for own consumption.' (Farmer, Koh Khiam)

Although farmers reported that they would prefer to raise grouper than seabass, as they are able to generate a greater benefit with grouper culture, they were constrained by a lack of grouper seed.

'Grouper better than seabass because high price. Seabass 100 THB per kg, grouper 300 THB per kg.' (Farmer, Ba Kan Khoei)

'The reason farmers raise seabass more than grouper is because it is difficult to find grouper seed.' (Focus group, Ba Kan Khoei)

'Another big problem is that it is difficult to find grouper seed. They do not have this problem with seabass.'(Focus group, Ba Kan Khoei)

A summary of the characteristics of seabass culture is provided in Table 4-14.

Table 4-14 Characteristics of seabass culture

Stocking size	4-5 inches (TL)
Harvest size	500-800g
Length of grow out period	6-8 months
Source of seed fis	Department of Fisheries, wild catch or private hatcheries
Average cost of seed fish	9 THB for 4-5 inch seed (2-3 THB per fish from DoF)
Frequency of feeding	Every day. Three times per day when small.
Market	Domestic, can be sold dead. Sometimes consumed by household.
Value (2001)	High value: 115 THB per kg Low value: 80 THB per kg

Table 4-15 Comparison of grouper and seabass culture

	Seabass	Grouper
Market size	500-800g	1.2kg
Grow out period	6-8 months	1 year
Seed availability	Stable. Hatchery supply available	Unstable. Only available from wild stocks.
Health and survival	Can cope better with changes in weather	Higher survival in the dry season
Ease of culture		Require less feeding and care than seabass
Feeding	Feeding required daily. 3 times per day when seed are small.	Feeding every other day. Missed feeds not problematic.
Value	Lower value than grouper. 80-115 THB per kg. If size exceeds 1kg value is reduced.	Sometimes unstable. 300-400 THB per kg. Value increases during Chinese New Year. Value is not reduced if size exceeds 1.2kg
Market	Local. Can be sold dead. Cannot be exported. Supply often exceeds demand.	Tourist restaurants and export. Usually sold live. Limited local market. Not consumed by producers or villagers.
Profit	Profit from seabass lower than from grouper.	Higher income from grouper than seabass.

The culture cycle

Availability of capital for investment and ability to cope with risk influence the management practice and culture cycle adopted by grouper farmers. The farming practices of farmers raising grouper in floating cages in the case study communities can be divided into 2 broad categories:

1. Short grow-out period, emphasising risk reduction
2. Long grow-out period, to obtain the maximum price for market size fish of 1.2kg

The management systems that these two categories represent are illustrated below. Farmers A and B can be said to be typical of the grouper farmers encountered during the study.

Farmer A: Short grow-out, risk reduction

Farmer A has a small number of cages, usually no more than 2 for grouper culture, although they may have a further 2 cages for seabass culture, and catches his own seed for stocking. Seed are stocked regularly throughout the month, when it is possible to fish for seed during the dead tide. The farmer keeps only a small number of fish, keeping the larger size of 8-9 inch fish and selling the smaller ones. The fish are raised for 3-5 months and sold every 2-3 months as kilo fish for on-growing by other farmers. This ensures that risk of disease is kept to a minimum whilst giving the farmer a regular turnover. Less feed inputs are also required for the small size fish making this a process of value adding to the fishers' usual fishing activities.

Farmer B: Long grow out to market size 1.2kg

Farmer 2 may catch his own seed or purchase seed for stocking. Seed are stocked perhaps once per month, or occasionally farmers will stock all the seed they require over a short period of time (10-30 days), this is particularly common amongst pond farmers in Thung Sa Pho. Twenty to fifty fish may be stocked each time. The number of fish stocked is determined by the farmers' ability to invest and the availability of seed fish. Fish of size 8-9 inches are preferred, to reduce the length of the grow-out period, but farmers may also select sizes 4-5 inch and 6-7 inch fish, representing a lower investment in the cost of seed fish but ultimately a greater investment in feed and a longer period before the investment is recouped.

Fish reach a market size of 1.2kg from a size of 50-100g within 12-13 months. Farmers harvest some fish every month, or every 2-3 months. The number of fish harvested can range from less than 10, to 150, or the entire cage. However, amongst cage farmers it is unusual for the whole stock to be harvested at one time. This cyclical process of harvesting ensures that farmers can receive a benefit at regular intervals as the fish in each cage reach market size. It is also determined by the size of fish stocked, as farmers are not always able to select the size of fish for stocking. The fish reach market size at different times and must be regularly graded according to size to reduce cannibalism.

'Start with 8-9 inches, raise 6 months sell per kilo fish, cannot raise to 1.2kg as takes too long to grow. Less risk if shorter period of time to raise.' Grouper farmer, Koh Khiam

Farmers with a large number of cages are unusual in the communities studied and more common in more commercial culture areas such as Pakbara Klong. Two respondents in Koh Khiam had 20 and 30

cages holding 5000 to 10000 fish respectively. Seed for farms of this size are purchased entirely from middlemen or fishers and stocked at a size of 300-500g. Farmers with such large farms are able to harvest approximately 200 fish of size 1.2kg per month.

The decision to sell fish at kilo fish size is sometimes taken according to the prevailing market value. If the farmer can get a good price for his fish before they reach 1.2kg, he may prefer not to gamble and will sell the fish.

Table 4-16 Comparison of low risk and higher risk culture cycles

	Farmer A – minimising risk	Farmer B – higher risk
Stocking size of seed	8-9 inches	8-9 inches, although 2-7 inches will also be stocked
Source of seed	Own catch, supplemented with purchased seed	More seed are purchased than caught
Regularity of stocking	Regular inputs from own catch	Once per month, some farmers may stock all their fish at one time
No. of fish stocked	200 total	200 per cage
No. of cages	2	More than 4
Grow-out period	3-5 months	12-13 months
Size at harvest	Kilo fish (3-4 fish per kg)	1.2kg
Frequency of harvest	Every 2-3 months	1-3 months
No. of fish harvested	Approx. 10	10-150

Labour

Most cage farmers do not employ labourers to assist with fish culture. The majority use family labour, calling upon relatives to assist with harvesting. Relatives are not paid for their assistance. Pond farmers also receive assistance from relatives. Fish are harvested from ponds using fish traps, which are baited and set in the ponds. When the traps fail to catch any more fish, and the pond is drained and the remaining fish caught by hand. However, one respondent in Thung Sa Pho reported that he did hire labour to assist with harvesting. The labourers were not paid but were given the by-catch from the pond, which included tilapia, mullet, shrimp and seabass.

Husbands and wives often work together on the fish cages. Couples also go fishing together, although it is often the woman's job to chop the feed and the man's job to give the feed to the fish. However, there appeared to be no strict division of labour according to gender.

One respondent in Koh Khiam hires labour once per month to clean nets, sort fish sizes and harvest. One person is paid 100 THB for 2-3 hours work. Another respondent commented that he mostly

raises big fish so that he doesn't have to chop the fish feed, or hire someone to chop feed. To hire labour to chop feed would cost 0.15 THB per kilo.

Trash fish feed for grouper and seabass

Grouper are fed with trash fish every 2 to 3 days, seabass every day. A small number of farmers reported feeding fish every day. Fish are fed whole to larger fish, or fish of more than 200g, and chopped for smaller fish. Farmers may spend up to 2 to 3 hours per day chopping fish to feed to grouper, for a farm of 2 cages. The fish are fed between high and low tide, when the tidal current is at its lowest velocity.

Respondents reported a preference for the composition of trash fish feed:

1. The yellow-striped trevally (*Selaroides leptolepis*) – 'Pla see gun khang luang' – is preferred by farmers as the flesh is stronger than other fish, and remains whole without crumbling.
2. In Ba Kan Khoei, the short-bodied mackerel (*Restrelliger brackysoma*), or Pla dtoo, is the most common component of trash fish.
3. In Thung Sa Pho, Pla Meow is an important component of the trash fish catch, along with Pla lang keow (Indian mackerel, *Restrelliger kanagurta*). The latter is considered to be the best type of fish for fish feed. One respondent also caught Pla dtiene (mudskippers) to feed to fish.

Table 4-17 Species composition of trash fish fed to grouper

Village	Composition of trash fish
Koh Khiam (Pla ped)	Short bodied mackerel (*R. brackysoma*)
	Yellow-striped trevally (*S.leptolepis*)
Ba Kan Khoei (Pla gai)	Short bodied mackerel (*R. brackysoma*)
	Yellow striped trevally (*S.leptolepis*)
	Indian mackerel (*R. kanagurta*)
Thung Sa Pho	Indian mackerel (*R. kanagurta*)

Discussions with middlemen indicated that better quality fish, such as *S.leptolepis*, are more expensive than lower quality fish. Better quality fish, such as *S.leptolepis*, are selected for feeding to larger fish. However, flesh quality is less important to farmers raising small fish, who must chop the fish prior to feeding. This may reduce the costs associated with pond culture in Thung Sa Pho, where farmers raise only smaller size seed fish.

In Koh Khiam, trash fish is called '*pla ped*', meaning 'duck fish' or fish not suitable for human consumption which is fed to animals. In Ba Kan Khoei the same type of fish is called 'chicken fish'. The middleman in Ba Kan Khoei reports that the size of fish that makes up Bplaa gai is in the range

of 2-4 inches. Fish for human consumption are generally bigger than 4 inches, suggesting that the fish used for grouper culture would not be used for human consumption. However, during one visit to a fishing port in November 2000, a basket of fish put aside for grouper farmers contained good quality fish, larger than 4 inches in size.

Respondents reported difficulties in finding trash fish during the neap tide, when fishing is not possible.

Table 4-18 Sources of trash fish for feed

Koh Khiam	Ba Kan Khoei	Thung Sa Pho
Kantang commercial fishing port	Own catch	From fishers with large fixed gears
Bycatch from shrimp gill net	Middlemen	From fishers who use gill nets
Frozen feed from Kantang	Haad Sai Yao village	From own catch using trammel net
Local landing pier	Fishermen in village	Langu market
Own catch	From owners of large fixed gears	Village port market
From fishermen	Tammulang port, during the dead tide	Korn Klarn village
From a middleman		Owners of fixed gears in Ma Haang village
Sources in the village		

Qualitative research suggested that most respondents in Ba Kan Khoei catch their own trash fish, but supplement this with feed purchased from the commercial port or the middleman. More farmers in Thung Sa Pho buy their feed from fishers than in other villages, as successful farmers, who raise fish as their main occupation, have stopped fishing and rely on the remaining fishers in the village to provide their trash fish needs. However, statistical analysis of the survey data showed that significantly more farmers in Thung Sa Pho use their own catch for fish feed than other villages (P=0.000).

Seed Inputs

Source of seed inputs

Grouper farmers obtained seed fish from 5 different sources:

1. Other fishermen in the village
2. Their own fish catch
3. Middleman
4. The Department of Fisheries
5. Other villages (Ma Haang, Korn Klarn).

Seed fish caught by grouper farmers themselves was the most important source of seed fish amongst the case study villages. 50% of farmers reported that they obtain seed fish from their own catch. Middlemen provided 42% of respondents with seed fish. Only 14% of farmers reported that they bought seed fish from other fishermen in the village. Other sources were of minor importance, providing seed fish for less than 10 farmers. The Department of Fisheries gave grouper seed to farmers on some occasions, but farmers complained that the fish were too small for them to raise and most did not survive.

4.3 Access and participation

4.3.1 Introduction

Although households may seek to diversify their livelihood portfolios, entry constraints often exist which prevent some households from participating in certain activities. Constraints may include, for example, lack of assets or social factors leading to exclusion. Section 4.2 has shown that the nature of the grouper culture system and its reliance upon wild stocks of seed and feed resources has allowed the take up of grouper culture using wild-caught inputs. This section further explores the relationship between asset ownership and livelihood uptake in order to permit a comparison between grouper culture and other livelihood options available to households in the case study communities. The analysis leads to the identification of factors which influence household decision making, and primarily the decision by a household to take up or reject grouper culture.

This section of the study therefore addresses the issue of equitability in household livelihoods which may arise from differentials in asset ownership and examines the potential of grouper culture to provide a sustainable livelihood option to which households from all wealth groups have access. The first section addresses wealth status and the relationship between assets and livelihood uptake. Section 4.3.4 describes factors which constrain the uptake of grouper culture. This is followed by Section 4.3.5, which shows how the intervention of institutions such as the Department of Fisheries has allowed households to overcome these constraints. However, in the absence of institutional support, many households are unable to take up grouper culture, or other additional livelihood activities, due to a lack of finance. The final section therefore looks at credit options and their significance in the development of fish culture in the case study communities.

4.3.2 Assets and activities

Definition of wealth in the case study communities

One of the first appraisal techniques to be conducted in each community in the early stages of data collection was a wealth ranking exercise. This allowed information to be gathered to generate an understanding of how members of the community defined wealth, and to ensure that subsequent research included representatives of each wealth group. When asked to describe how household 'wealth' could be defined, the responses from key informants in each of the three villages were similar (Table 4-19). A key criterion used by key informants participating in a wealth ranking exercise to define wealth were the types of income generating activity in which a household was engaged, as this determined the ability of the household to save money, or build up assets. The portfolio of livelihood activities in which a household was engaged was also used to define the level of household wealth, as wealth defining activities typically required financial investment, the use of land resources, and perhaps also a high level of education or social status.

Table 4-19 Key criteria for the assignment of wealth groups, as identified by key informants during the wealth ranking exercise (not given in order of importance)

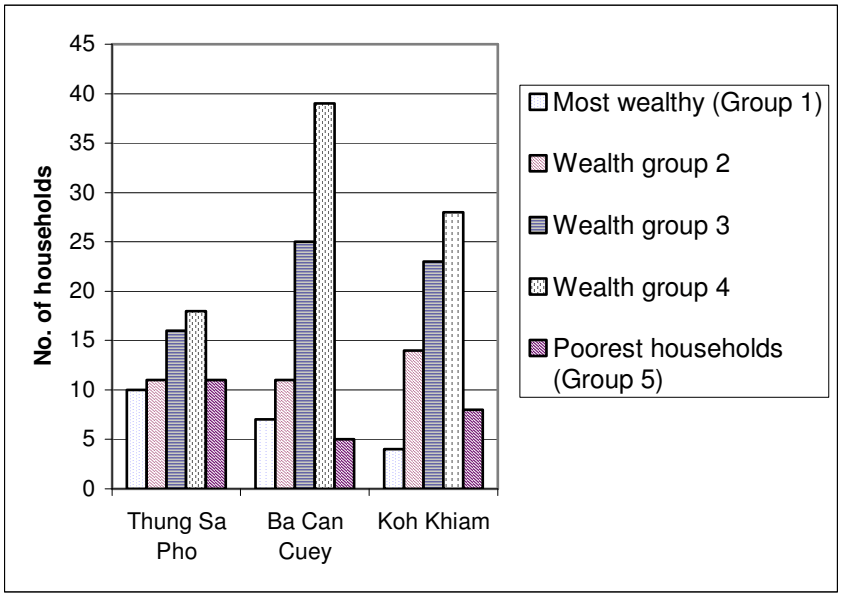
Thung Sa Pho	Ba Kan Khoei	Koh Khiam
Land ownership	Type of income generating activities	Type of fishing gear used
Dependence upon fisheries work	Average income per day	Ownership of a boat and gear
Ability to save money	Ability to save money	Ability to save money

Perceptions of wealth in Thung Sa Pho were based on land ownership, dependence upon fisheries work and an ability to save money. People who work at sea, who are unable to save money and thus live hand to mouth, and who did not have land to cultivate rice are categorised as the poorest group in the village. All other wealth groups possessed some land, at least for the subsistence cultivation of rice.

The respondents in Ba Kan Khoei based their assessment on income generating activities, average income per day, ownership of assets and ability to save money. A household categorised as wealthy may earn an average of 1000 THB per person per day and is thus able to save money. Members of these households are generally traders, fish traders for example, and may own a car and some land. A middle income household may earn 500 THB per day from activities including trading shrimp paste and raising fish, in addition to fishing. The poorest group is categorised by having little or no work, and possibly not enough money for daily expenditure. The lower middle income group is likely to depend upon fishing for a daily income and may not have any ability to save.

Wealth groups in Koh Khiam were assigned by the head of the village, and later triangulated by two further key informants, who categorised the group primarily on the type of fishing gear used by a household. Fishers in the wealthiest group in Koh Khiam use large gears, requiring a large boat and crew, for mackerel fishing for example. The middle and upper-middle wealth groups, whilst having less money to save, also have complete fishing gears and boats, although these may be smaller than those of the wealthiest households, and do not permit the fishers to travel so far to fish. Households were assigned to the poorest wealth group if they did not possess their own fishing gear or boat. Members of this group may work as labourers on the shrimp farms and fishing boats owned by households of the wealthy income groups.

Figure 4-7 Distribution of households amongst five wealth categories. Category 1 indicates the wealthiest households in the community, category 5 the poorest.



As illustrated in Figure 4-7, Category 4 (middle to poor) represents the largest group in each community.

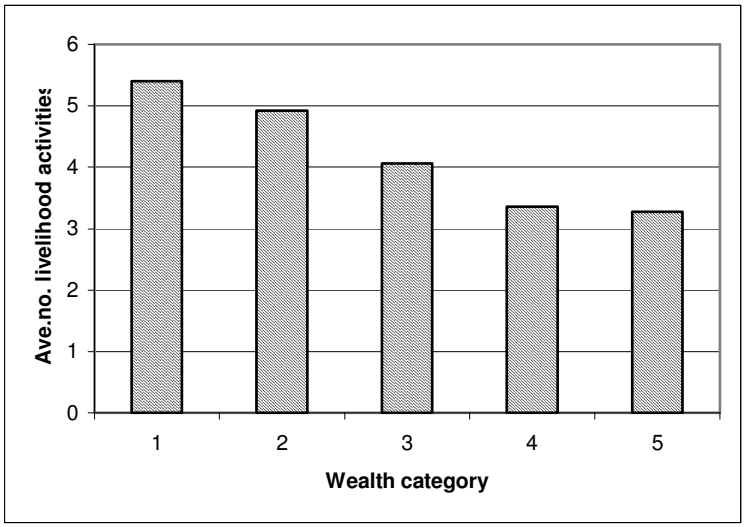
4.3.3 Livelihood portfolios and wealth status

Households have livelihood strategies that incorporate activities relevant to their capabilities, assets and desired livelihood outcomes. As suggested by the wealth ranking exercise, differences in household livelihood portfolios are associated with household wealth status.

Results obtained from the quantitative phase of data collection indicate that, in the communities studied, poorer households diversify their incomes less than wealthier households. Statistical analysis revealed a highly significant association between wealth group and number of livelihood activities

employed by households (p= 0.000). Wealthier households (Groups 1 and 2) are engaged in significantly more livelihood activities (Mean = 5) than poorer households (Groups 4 and 5) (Mean = 3) (Figure 4-8) .

Figure 4-8 Average number of livelihood activities per household by wealth group (P < 0.000)



Activities that required substantial inputs of financial capital and/or land resources i.e. rubber plantations, shrimp culture and shop trading, were significantly associated with wealthier households. Government work was also strongly associated with wealthy households and may be associated with social status and education. Small scale fishing was significantly associated with poor households (Figure 4-9). Middle-income households were the most likely to have rice fields (Table 4-20). In contrast to the findings presented in Chapter 2, where it was observed that grouper culture was an activity undertaken primarily by wealthier members of the community, the adoption of fish culture, or grouper culture specifically, was not confined to any well-being category, and was equally incorporated into the livelihood portfolios of wealthy, middle income and poor households (Figure 4-10).As suggested in Chapter 2, and as shown in the following section, the equality of uptake and participation in grouper culture can be attributed to the intervention of institutions external to the community, such as the DoF.

Figure 4-9 Relationship between wealth status and small scale fishing. Shown as percentage of HH in each group which included small scale fishing in the livelihood portfolio. The association between wealth group and fishing is significant (P=0.000)

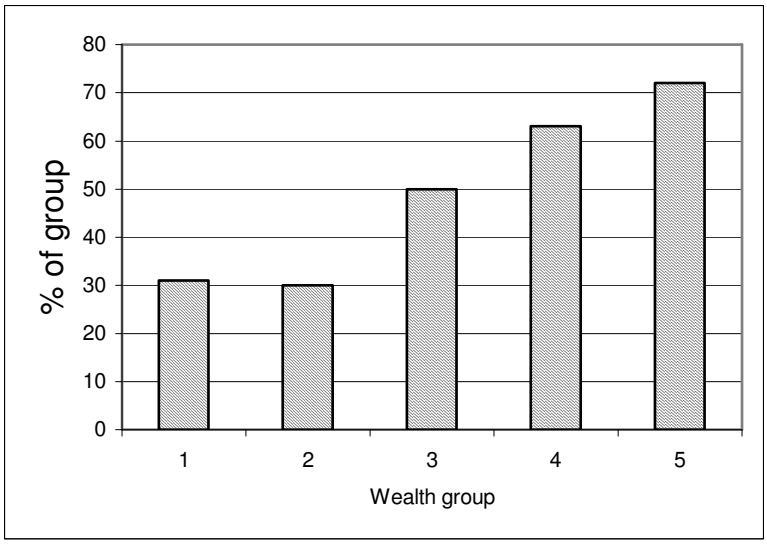
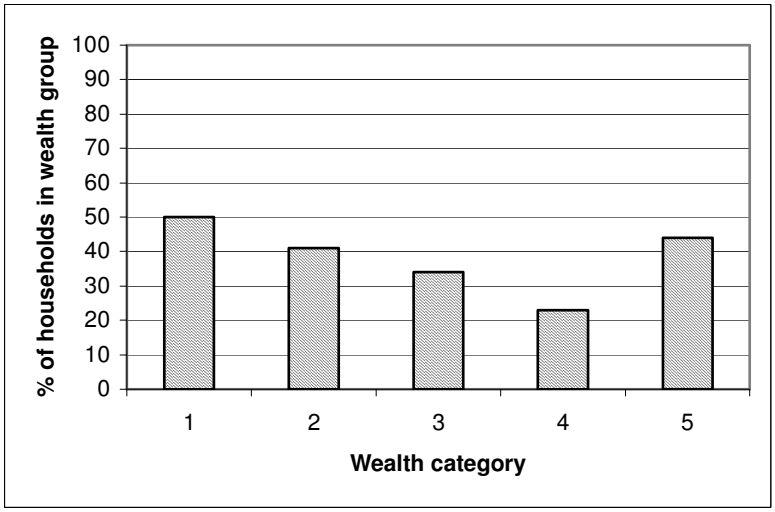


Figure 4-10 Percentage of households in each wealth group whose livelihood portfolios include fish culture (No significant association P=0.065)



Ownership of a rubber plantation was found to be associated with wealthier HHs, although the financial benefits generated by the activity do not contribute a particularly large share to community income or individual HH incomes. The benefit of the activity may therefore lie in other attributes of importance to HHs, including the ability to generate a stable income.

Table 4-20 Associations between livelihood activities and household wealth status. +/- indicates a positive or negative statistically significant association, o indicates there was no statistically significant association.

	Wealthy households (Groups 1-2)	Middle income households (Group 3)	Poor households (Groups 4 –5)	Chi square	Df	P
Rubber plantation	+		-	85.541	2	0.000
Shrimp culture	+		-	25.197	2	0.000
Rice cultivation	+	++	-	12.082	2	0.002
Small scale fishing	-		+	16.203	2	0.000
Labour	o	o	o	2.816	2	0.245
Retail trade	+		-	16.434	2	0.000
Factory work	o	o	o			
Fish processing	o	o	o			
Government	+		-	18.260	2	0.000
Fish culture	o	o	o			0.065
Grouper culture	o	o	o			0.220

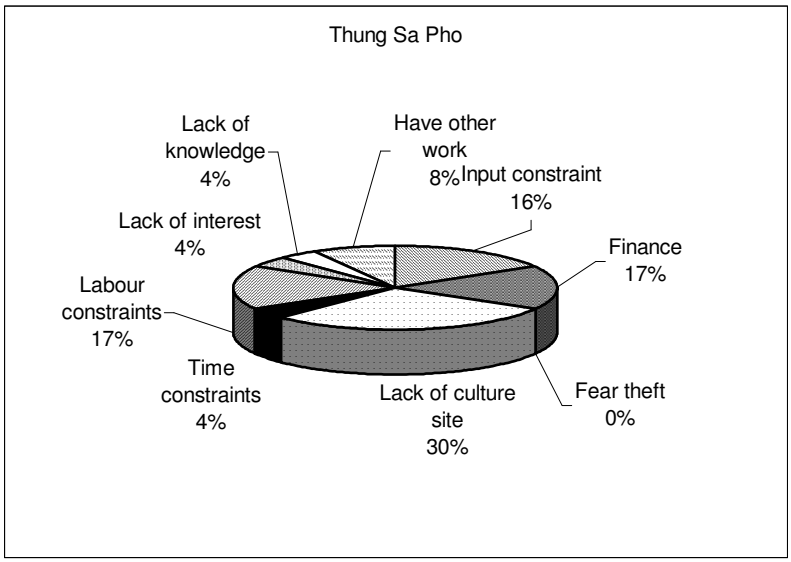
4.3.4 Factors constraining the uptake of grouper culture

Although 78% of respondents who had never raised fish indicated that they would like to, they reported that they were primarily constrained from taking up fish culture by a lack of financial capital for investment, which accounted for 37.6% of responses. This supports the findings presented in Chapter 2, which indicated that lack of finance was the principal constraint to the uptake of fish culture in the region. Other respondents reported that there were no available culture sites for them to raise fish, or that they did not have sufficient labour available to take care of the fish. 100% of respondents who indicated that they did not want to raise fish reported that they had other work.

Lack of finance was the most significant factor preventing households in Koh Khiam from taking up fish culture, with 66% of respondents reported that financial constraints led to their decision not to raise fish. During the survey of villages in Trang and Satun (presented in Chapter Two), respondents in Thung Sa Pho reported that the only factor constraining uptake of grouper culture was a a lack of seed fish. However, responses obtained from a broader, representative cross-section of the community during the case study analysis, indicated that uptake of grouper culture by households in Thung Sa Pho was also constrained by lack of finance, the high cost and low availability of seed and feed inputs and lack of labour. However, a lack of a culture site was the most important factor which prevented people from taking up fish culture in Thung Sa Pho, accounting for 50% of responses of fish culture rejectors. (Figure 4-11) As the level of fish culture in the *klong* at the time of the study was low, with

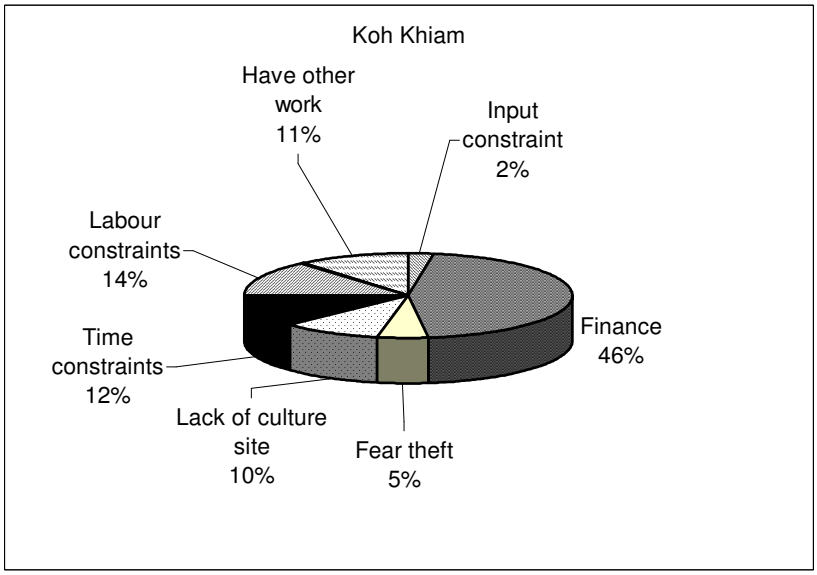
space available for the introduction of additonal cages, it is likely that respondents were referring to a lack of land in a suitable location for the uptake of pond culture.

Figure 4-11 Constraints to uptake of fish culture in Thung Sa Pho (N=23)



Respondents who raised fish, but who had rejected grouper culture, were asked to give the reasons why they did not raise grouper. Once again, financial constraints accounted for the majority of responses (31.8 %), followed by the cost and availability of inputs (27%).

Figure 4-12 Constraints to uptake of fish culture in Koh Khiam. As only two households in Ba Kan Khoei had never raised fish, they were not included in the analysis.



4.3.5 Institutional intervention and impact on uptake of fish culture

The Department of Fisheries and the Department of Community Development were the most commonly referred to external organisations in the case study communities. Evidence of DoF

activities to implement the SSFD programme was apparent in each of the villages, where projects to implement cage culture were found, as were the credit schemes and the construction of artificial reefs.

Implementation of fish culture projects in Satun province

The Brackishwater Aquaculture Station in Langu, Satun played a key role in fish culture interventions implemented by the DoF in the case study villages. In contrast to many of the DoF stations visited during the course of the study, the officers in Langu were enthusiastic and knowledgeable about their work and provided valuable information about their role in the development of cage culture in the Province.

Projects are implemented under the banner 'Economic Brackish Water Fish Culture' which provides a package for poor villages to adopt fish culture or other aquaculture activities. One fisheries officer described how the project works, summarised as follows,

Each village selected for participation in the project is given a set of materials, sufficient for 20-30 families to construct cages. They are given 'almost everything' they need to begin fish culture – nets, floats, seed or fingerling of seabass. The raw materials are provided but the villager has to construct the cage for themselves. Officers are sent to the village in order to train new farmers in cage construction, nursing of seed, fish grading and recognising signs of disease, to increase chances of fish survival.

The DoF provides seabass seed, but on the Andaman Coast, farmers prefer to raise grouper, because they can generate a higher income, although the DoF have no grouper seed. This does not present a problem for the project. New farmers are provided with funds to buy the fish and are able to purchase seabass or grouper, according to their preference.

The DoF provides only materials and not money, they are not providing a loan. After harvesting, the farmer must return some of the profit to a central fund in the village, administered by a member of the community acting as the group secretary, which enables more people in the community to raise fish, as the fund can only provide sufficient resources for a limited number of households. New farmers are required to return 50% of the value of the materials and seed with which they were provided . As it is difficult for farmers to return this amount of money in one year, they spread repayments over two years.

However, the Officer who provided this information commented that the repayments *'are not so serious. After harvest sometimes have problem that production is lower than expected. Suppose he has to return 25% about 5000 THB, but if they can't sell, not enough money to return then perhaps say that 3000 THB or 2000 THB is ok.'*

The funds created by the fish culture group also have to be made available to the rest of the village. The DoF reported that 10% of the funds from the net cage culture group is donated to the development of the community. The project can only support 2 villages per year in Satun.

Projects are tailored to the preferences of the villagers and available resources. Meetings are held with villagers, who are asked what type of aquaculture they would like to do. They are not restricted to finfish culture. Villagers may also take up green mussel or black cockle culture.

The village selected for inclusion in the project must have the following criteria:

- The village has to be 'poor' when compared to other villages
- Village should have access to brackish water, the project should not be land intensive

Community experiences of DoF assisted fish culture projects

Ba Kan Khoei

A project to raise fish in cages in Ba Kan Khoei was initiated by members of the community, who saw fish culture as a potentially beneficial livelihood option. They approached the DoF with their request to raise fish,

'The group began because villagers would like to raise fish. They created the group and sent documents about project to raise fish to the DoF.' (Grouper farmer, Ba Khan Khoei)

Initially, 100 households wanted to participate. However, under the terms of the project, a village receives materials for the construction and seed fish to stock 20 farms, each of two cages each. Villagers in Ba Kan Khoei shared the materials amongst 40 households, who each received 1 cage each, although two households worked together on one farm comprising two cages. The group received materials and seed, but not money. Respondents attribute their ability to initiate fish culture to the support of DoF, without which they think they would not have been able to raise fish ,

'Started to raise fish because DoF provided support' (Grouper farmer)

'They think if DoF didn't help them they would not have money to raise fish.' (Focus group participant)

'If DoF does not provide support villagers cannot raise grouper and seabass…Can raise seabass because the DoF support' (Grouper farmer)

Some villagers reported that they had had previous experience of fish culture, as one group had begun in 1976 but had discontinued activities. Respondents did not indicate why they stopped fish culture. One respondent commented that 'the reason people in the village don't want to raise grouper is because high price for grouper seed and DoF not support them to raise grouper.' As the same materials are provided whether the beneficiaries of the project choose to raise seabass or grouper culture, the respondent refers to the fact that seabass seed are provided when the project first begins, but farmers must later provide their own grouper seed if they prefer to raise grouper.

Thung Sa Pho

The DoF provided funding for cage culture in Thung Sa Pho in 1999. Interviews with five respondents who had taken part in the fish culture project established that the DoF had initially provided the group with cage materials (iron bars, foam floats and nets), and 500 grouper seed of 2 to 3 inches. One respondent reported that they received money to buy seed fish, which she purchased from the Head of the Village. Another reports how when they received seed fish for a second time, they received 1500 seabass seed and 100 grouper seed. However, participants in the cage culture project experienced problems which they attribute to the small size of seed provided by the DoF. One respondent reported that he could only harvest 200 seabass from the 1500 seed provided as 'he thought maybe because the seed was bad, very small'. Another commented that the seed fish were diseased and showed a slow growth rate. A third was able to harvest only 50 fish of the 500 grouper seed that were stocked. At the time of the study, only two households were raising fish in cages, 78% of grouper culture discontinuers in the village were cage farmers. The head of the village attributed the failure to lack of interest on the part of the households involved. As one respondent commented, they could find grouper seed if they wanted to – lack of interest was also a factor in the failure of cage culture. It is interesting to note that 29% of discontinuers reported that they stopped raising fish because they had other work to do, this is equal to the number who reported that they stopped fish culture because of fish disease and mortality, supporting the idea that fish culture is less successful when the opportunity cost of the activity is high.

Koh Khiam

The DoF launched a fish culture scheme in Koh Khiam in 1983, prior to the establishment of grouper culture with funding from the Bank of Agriculture and Agricultural Cooperatives (BAAC). A prominent member of the community, who had previously held the position of the Head of the

Village, had contacted the DoF as he thought that Koh Khiam was a suitable place for raising fish and he was aware of a fish culture promotion centre in Satun. He contacted the DoF to request training for a group of 15 villagers. The DoF provided materials for cage construction (iron bars, foam, net) and seabass seed, and assistance from a technician to demonstrate how they should construct the cages and raise fish. They did not receive any money and were not required to pay anything back. They had only to provide feed for fish culture. The new farmers were given seed fish three times. On the first occasion, the DoF provided cage materials for one cage and 1000 seed. After their first harvest, farmers sold their fish, and built another cage, with the assistance of a DoF supervisor. Following the second harvest they were able to expand their farms to four cages and received their last batch of seed fish from the DoF. Most farmers subsequently began to raise grouper instead of seabass. Ten farms which had been established with the assistance of the DoF were still in operation in 2001. The DoF scheme is considered to have been a success, and encouraged others in the village to begin fish culture. However, here wealthier households appeared to be the principal beneficiaries of the project, as respondents who had belonged to this group were relatively wealthy with large houses and businesses.

4.3.6 Access to Credit

Rural credit in Thailand

Rural households in Thailand have access to finance from three principal sources:

- Formal sector – bureaucratic organisations including commercial and agricultural banks
- Informal sector – credit available from friends, relatives, moneylenders, traders, landlords and other farmers (Onchan 1992).
- Group lending schemes, or 'village banks'

Access to credit from the formal sector is, for many farmers with little or no collateral, limited to the (BAAC). The BAAC was established in 1966 as a result of the introduction of a new policy by the Thai government which aimed to increase farmers' access to financial capital and reduce their dependence upon informal sources of finance, traditionally considered to be exploitative and prone to ensnaring farmers in a cycle of debt created by interest rates as high as 250%. Informal sources of finance do, however, remain important to rural households.

Thai villages usually have a number of informal commercial lenders (moneylenders and traders) and numerous non-commercial lenders (friends and relatives) (Poapongsakorn and Netayarak 1989). The lenders generally provide loans of small sums for short duration at interest rates which tend to be higher than those of formal lending institutions (Onchan 1992). According to Siamwalla et al. (1990) almost 75% of households active in the credit market 15 years after the BAAC was established continue to obtain finance from informal sources. The continued popularity of these informal lenders as a source of finance, despite the availability of loans at lower interest from formal sources, is due to a number of factors, summarised by Onchan (1992):

- Borrowing from an informal lender saves time, when finance is needed quickly
- No collateral is needed to obtain the loan
- The borrower is unable to obtain a loan from formal sources as a previous loan has not been repaid
- The borrower does not know how to borrow from formal sources
- Finance is required for consumption – for which a loan is not possible from formal sources

Informal lenders are often associated with usury. Interest rates charged by both commercial and non-commercial lenders are generally higher than formal sources, which are regulated by usury laws. Data presented by Onchan (1992) for the period 1986/87 indicates that the interest rates on loans provided by the BAAC bank were 12.5%, and had remained relatively stable for two decades at rates of 12 to 14%. Relatives and lenders charged 26% and 56% interest respectively. However, borrowers appear to have generally positive attitudes to informal lending (Onchan 1989) as the type of credit available meets the needs of the farmer in terms of collateral requirement, forms of contracts, duration of loan and repayment schedule (Onchan 1992). Another advantage of informal lending agreements is the possibility of obtaining credit in kind. For example, in agricultural areas, fertiliser is often obtained on credit from suppliers. Usufruct loans may also be an important source of finance for households migrating out of the village or working overseas.

An important issue constraining access to finance for many rural households is lack of collateral, an important form of loan security in the absence of client information. However, informal lenders work through a system of contractual obligation and social sanction that reduces the requirement for collateral (Siamwalla et al. 1990). The higher costs incurred by formal lending institutions for the

evaluation of client creditworthiness makes it financially unviable to offer the small loans that farmers require to support their mostly small scale enterprises (Coleman 1999). To overcome this problem and meet the needs of farmers, agricultural banks such as the BAAC have sought low-cost solutions for ensuring repayment of loans through the introduction of collateral substitutes such as group guarantees. The application of the concept of joint liability, or peer-monitoring, is apparently responsible for the high repayment rates associated with this form of loan security. As a basic requirement for lending, farmers must form a group of 5 to 30 people who know and trust one another (Tohtong 1988), social capital thus may come to play an important role in the acquisition of credit particularly as delinquent borrowers cannot receive a new loan until the old loan is paid. If the groups debt cannot be repaid, the whole group becomes ineligible for future loans (Siamwalla et al. 1990), the pressure for every member of the group to repay their debt is therefore high. However, as will be shown below, the impact of bank policy to provide loans to groups of farmers may not always be successful.

Group lending schemes may offer an alternative to both informal and formal sources of finance, and are a preferred method of providing development aid to rural communities in Low Income Countries (LIC's) by many NGO's, including for example CARE and Save the Children (Coleman 1999). Similar to the concept of joint liability, villagers form peer groups but individuals receive the loan. The group members co-guarantee each other's loans. All group members are denied future credit if they do not meet their collective responsibility to pay back the loan (Coleman 1999). In Thailand, the first loan amount is 1500 THB per member, with members entitled to borrow this amount plus the value of their accumulated savings in the village bank for subsequent loans (Coleman 1999[24]). Repayment rates are usually high, and attributed to the peer monitoring aspect of group lending activities.

Sources of credit – experiences in the case study communities

The findings of the research suggest that access to credit is an important factor in the ability of poor households to take up an activity which enables them to accumulate further assets. Households in Ba Kan Khoei appeared to have experienced a beneficial effect resulting from the credit system established as part of the fish culture project in the village. Fish culture has facilitated access to formal

[24] Coleman (1999) describes the group lending system developed by the Foundation for International Community Assistance, rather than the Grameen Bank Design, the success of which has fuelled interest in village banking.

credit that was later used to support other livelihoods. Villagers in the case study communities did, however, report that they had also obtained credit from formal credit institutions, with most reporting a negative outcome from their lending.

These credit institutions were most often discussed in Koh Khiam, where villagers had taken loans from the Bank of Agriculture and Agricultural Cooperatives (BAAC) to fund grouper culture. One respondent related the events as follows:

'The loan from the bank was 50 000 THB per person. The money was received in kind, as the bank deducted the cost of the materials. The bank had negotiated contracts with a trader in the town, where they had to get the materials. The bank gave the documents to the shop, as they had already contacted the trader. They get the nets, foam and rope from the trader to build cages, but used their own labour for building the cages. They received cash from the bank to buy wood. The bank estimated the price of wood and gave us about 5000 THB each. To build a house (guarding and storage hut) and we were given 15, 000 THB

The people had to organise themselves into groups, 10 people per group. It was difficult to work in a group. It is better to work alone. We could not trust amongst friends in the same group. We took it in turns to watch over the fish, but when some people watch the fish disappear. This created feelings of suspicion. Each person had 2 cages. They had to buy seed with cash from the bank.

He (the respondent) hasn't paid back the loan from the bank. Among ten members, they harvested fish 5 times, and gave 80 000 THB to the bank, but they don't know where the money has gone. Part of the conditions of the bank loan were that we had to give 75% of the money from the sale of our fish to the bank, and keep 25% to share amongst the group. If we sold 40 000 THB, we had to give 30,000 THB to bank and share 10 000 THB. If we release bigger seed into our cages,it takes 8 months for them to grow, and we receive only 1000 THB in a year. We could not survive raising grouper like this. We needed to feed the fish 50-80kg (of feed) per day. We received 20 000-30 000 THB per harvest. There are no receipts or documents. The interest on the loan is 14%.

Our group send 80 000 THB to the bank. Each group has 2 authorised persons to send to the bank. They made a mistake as they didn't look at receipts. No one kept the receipts or a record of the amount paid back to repay the loan. This was their own carelessness. Both sides can be responsible, not only bank.

Middleman who comes to buy has contract with the bank also. At the time they agree a price of 150 THB per fish of 1.2kg. The price outside the contract is 300 THB per fish, but they are not allowed to sell at that price.'

The account related here is supported by reports given by respondents at a focus group who recounted how a trader from Hong Kong worked in collaboration with the bank, '*they had agreement with the bank offices. Example like when the price went down to 100 baht, they made contract with the villagers at 120 baht but when the fish grow the price went up to 250-300 baht. It was the matter of business people make us failed in the past. Then the group was sued by the bank and the group broke down.*' They also report that 83 households in the community each have debts of 50,400 THB.

Respondents also relate a problem with the timing of the loan, although whether this relates to the account given above or a later loan is unclear,

'The principle was, we raised the fish to sell as a single fish (1.2kg). But the repayment deadline for the loan came before the fish had grown to a marketable size of 1.2kg, so they forced us to sell kilo fishes, which brought them very low price.'

Villagers had previous experience of this practice,

'just like they encourage us to grow water melons, they wanted their money back before the water melon was ripe so they forced the villagers to sell young watermelons for a low price. A ripe water melon can sell at 5-20 baht per fruit, but they force the villagers to sell at 20 water melons for 1 baht.'

'At that time, if only they let us keep on raising grouper for a few more months more, we probably would have been able to sell the fish for 200 baht per fish, but we were forced to sell at 5 fishes per 100 baht. So the bank made us fail….System of the bank – usually when they borrow from bank, in a year have to repay once a year a big amount of money, cannot pay by weeks or months. Have to pay 15 000 THB in one instalment. If cannot given a good price, have to borrow from a private money lender, interest 60% per year, or 5 % per month. This happens everywhere in Trang.'

One key informant had attempted to obtain another loan in order to invest and raise enough money to pay back the loan. However, when he mortgaged his land title with the bank, the debt was subtracted and he was left with 10 000 THB.

They hoped that the government would launch their policy to abolish non-profitable loans, although they believed this would never happen. The following year, 2001, Prime Minister Taksin Shinawatra delivered a speech to the national assembly in which the he declared that the relief of the burden of debt ad the establishment of a people's bank were urgent policies for the government, through the granting of a period of grace for both interest and payments for 3 years for individual small farmers.

According to data obtained from the quantitative survey, 33% of respondents who raised fish or who had raised fish in the past had obtained finance from formal lending sources or group-lending organisations within the village specifically to fund fish culture activities. As questions regarding finance were framed only in the context of fish culture and were asked only of respondents who raised fish or who had raised fish in the past the results cannot unfortunately provide representative information regarding the borrowing activities of the whole communities. Borrowing from informal sources is also underrepresented in the findings, as this option was not included within the finance questions of the survey. Observations made about the borrowing activities of fish farmers and fish culture discontinuers and summarised in Table 4-21.

Table 4-21 shows that loans obtained from the BAAC were generally almost three times as high as loans provided by community groups, from community credit schemes established as a result of the fish culture projects. Uptake of loans from the BAAC was also low in Thung Sa Pho village and non-existent in Ba Kan Khoei, where the fund created by the fish culture group, essentially a village bank, provided the only apparent source of finance for fish culture continuers and discontinuers. It is, however, possible that loans obtained for activities besides fish culture were sought from other sources and were not recorded during the survey.

Table 4-21 Prevalence, sources and amounts of loans obtained by fish culture continuers and discontinuers in the case study village

	Thung Sa Pho	Ba Kan Khoei	Koh Khiam
Total No. respondents	40	36	165
No. fish culture continuers and discontinuers	28	34	109
No. HH who obtained a loan	11 (27.5%)	14 (39%)	32 (19%)
SOURCE OF LOAN			
BAAC	2	0	25
Community Credit group	7	14	1
DoF	0	0	2
Other	2	0	2
Ave. amount of loan	12,045	7145	27,987
BAAC	30,000		21,987
Community Credit group	8055	7154	5000
DoF			10,000 and 45 000

The number of fish culture continuers and discontinuers in Koh Khiam who had obtained a loan was lower than expected, based on information obtained during the qualitative phase of research,

accounting for only 19% of respondents from this group. 78% of respondents who had obtained a loan had borrowed from the BAAC.

As shown above in section 4.3.4, access to finance was the most important factor constraining uptake of grouper culture in Koh Khiam. Based on the information obtained from the survey, it appears that villagers in Koh Khiam had few sources of finance, and are limited primarily to the BAAC. Yet, as will be shown in the following chapter, two community groups exist within the village which provide an opportunity for villagers to obtain small loans, although fisher farmers and discontinuers do not appear to have made use of these loans. It is probable that the size of loans available is not sufficient to fund the uptake of grouper culture. However, respondents in Thung Sa Pho and Ba Kan Khoei were able to fund fish culture through the provision of credit from community credit groups. Financial constraints were less important to households in Thung Sa Pho, and apparently insignificant in Ba Kan Khoei, where only 2 respondents had not been able to take up fish culture. Further investigation would be required to identify whether the lack of uptake of loans from the BAAC was due to the availability of other, preferable sources of finance, or due to the problems faced by potential borrowers to meet the requirements of the loan.

As a result of the problems reported by grouper farmers relating to their experiences with loans from the BAAC, it was hypothesised that the level of discontinuance of grouper culture in Koh Khiam may have been associated with this source of finance. However, analysis showed that the two factors were not significantly associated ($p=0.144$).

In the case study communities, it was found that credit options are limited with community group lending providing an important source of small loans for households. In Thung Sa Pho and Ba Kan Khoei, uptake of loans from the BAAC, the only source of formal lending accessible to households with little or no collateral, was negligible. Experiences in Koh Khiam suggest that the terms of the loans provided by the BAAC were not appropriate to the needs of grouper farmers, with loan conditions unsuited to the fish culture activities for which loans were obtained. The BAAC bank imposes a strict deadline on the repayment of loans. However, villagers in Koh Khiam reported that the loan repayment date was not appropriate for the time scale of fish harvesting which led them to sell their fish below optimum market size, therefore receiving a smaller benefit which prevented them from repaying their debts. This case highlights the need for lending institutions to be aware of, and

accommodate, the special characteristics of fishing communities. As Tietze and Villareal (2003) note, the seasonal nature of fishing and fish culture activities must be taken into account and appropriate repayment schemes developed to ensure that earnings of fisher households are not endangered.

Enforcement of repayment by peer monitoring also failed leaving members of the borrowing group in debt and unable to obtain further loans, supporting the observation by Tietze and Villareal (2003) that peer group monitoring and group guarantee schemes require strong social and organisational environments to succeed. . Thus, while it may be said that the expansion of institutional credit, as given by the BAAC, is a positive development which has eased access to credit and freedom from usury of the small farmer (Hirsch 1989), evidence from the present study suggests that the BAAC does not meet the needs of households in coastal communities, as the loan system failed in Koh Khiam and was not taken up in Thung Sa Pho or Ba Khan Khoei. Further investigation would be needed to confirm this hypothesis.

Group lending organisations or 'microcredit' schemes could, however, perform an important function in these communities. However, as the name 'microcredit' implies, the sums of money available are small and may not be sufficient to meet the needs of the whole community, a problem which may have deterred villagers from utilising available funds in Koh Khiam. Respondents in Ba Kan Khoei commented that the money available to the community through the fund was too small, echoing complaints heard by Coleman (1999) during a study to assess the impact of group lending schemes in North eastern Thailand, where a borrowers reported was that the size of the village bank loan was too small. In Colemans' study, village bank loans had a negligible impact on village welfare. In Ba Kan Khoei the impact of the group lending programme was not quantified, but the success of the scheme was judged on the basis of the expansion of culture activities from 40 households to 60, and individual reports from villagers that the fund had contributed to the development of the community, by providing access to funds for activities such as the improvement of homes, the purchase of assets including refrigerators and televisions, and provided a scholarship fund to send village children to school. However, the success of such a scheme lies also with the participants. As Bastelaer (1999) discusses, social capital may play an important role in the success of rural credit schemes.

4.4 Vulnerability and Fisher Livelihoods

4.4.1 Introduction

Vulnerability is a key theme in livelihoods analysis, describing the degree to which shocks, trends and seasonality affect the ability of households to maintain their livelihood and generate a consistent benefit (Table 4-22). Grouper culture, reliant on inputs of wild seed and dependent upon a remote, urban elite market to sustain the value of the cultured product could, for example, increase the vulnerability of households by exposing them to risks and shocks.

This section begins by looking at the factors which may lead to household vulnerability in the case study communities, particularly seasonality, before looking specifically at the factors which may reduce the ability of households to derive a benefit from grouper culture. Problems which reduce productivity of the production system are first addressed, followed by an economic analysis to determine the economic viability of grouper culture in the face of these problems. Finally, the significance of the export market and its impact on grouper value, and hence household vulnerability, to fluctuations in market value is analysed and discussed.

Table 4-22 Examples of factors which may affect household vulnerability (Source: DFID SL Guidelines)

Trends	Shocks	Seasonality
Population trends	Human health shocks	Of prices
Resource trends	Natural shocks	Of production
National/international economic trends	Economic shocks	Of health
Trends in governance	Conflict	Of employment opportunities
Technological trends	Crop/livestock health shocks	
Principal sources of vulnerability for fishers in case study villages:		
Decline in fishery resources	Floods	Livelihood activities, particularly fishing activities
	Conflict with commercial fishers	

4.4.2 Seasonality

Livelihood and fishing activities

The most apparent of the factors contributing to the vulnerability of fishing households were the seasonal patterns which govern fishing activities. In the context of the present study, the influence of seasonality on household livelihoods can also be extended to the daily and monthly cycles to which fishers are subject. An appreciation of these patterns is necessary to understand the decisions made by

households and the way in which a household shapes their livelihood portfolios. It is also necessary to understand the livelihood role that fishing plays, and the factors which govern decisions to remain within the fishery, including problems and aspirations.

The daily and seasonal activity of the fishers in the study communities was very apparent during the period of field research. Fishers were often at sea as long as the weather was suitable for fishing. During the first part of the year, fishers were often not available for interview until the late afternoon, when they had returned from their morning fishing trip, after which they would eat and rest.

Fishing activities are also strongly influenced by the seasons and the lunar cycle. The lunar month can be divided into two 'waters', which can be further divided into 'big' (spring) and 'dead' (neap) waters. Fishing for shrimp is done during the 'big tide' whilst grouper seed are caught during the 'dead tide' (See Figure 4-13). However, fishers did not generally fish every day, particularly as they are often prevented from fishing by bad weather. According to responses given during the quantitative data collection phase, fishers reported an average of 14 days fishing per month in Ba Kan Khoei, 16 days per month in Thung Sa Pho and 20 days per months in Koh Khiam. This information is comparable with that recorded by Librero et al (1985), who found that fishing units in the Philippines averaged approximately 211 fishing trips per year. They report that fishers went on expeditions four or five times a week, and spent the remaining two to three days resting or taking part in non-fishing activities. Similarly, fishers in Malaysia were reported to fish on average 11 to 25 days per month (Fredericks et al 1985), whilst fishers in Thailand were found to fish between 22 and 26 days per month (Panayotou 1985). Seilert and Sangchan (2001) present gear specific data from fishers in the Phangnga bay area of Thailand, and record that fishers using the Trammel net fished on average 17 to 18 days per month in one village, and 10 to 12 days in another. The mackerel gill net, used for only 6 months of the year, was used on average 6 to 12 days per month (Seilert and Sangchan 2001). These results compare well with the patterns of fishing described by respondents in the case study villages.

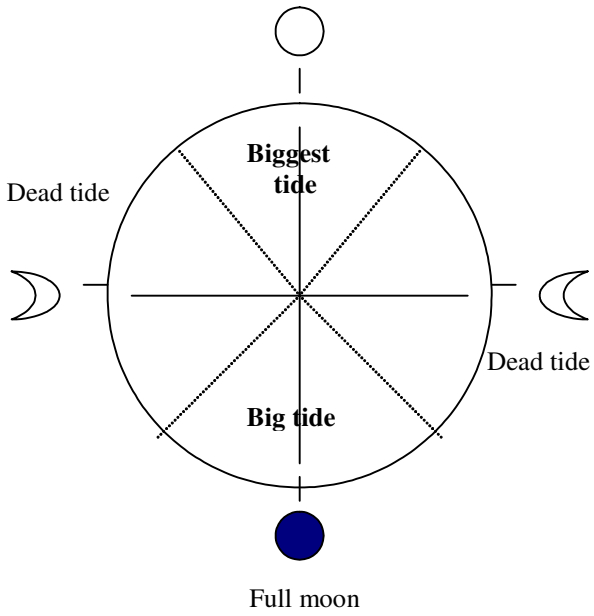
Information obtained from records collected from a middleman in Koh Khiam illustrates the monthly pattern of grouper seed capture, as shown in Figure 4-14. Fishers fished for grouper on an average of 17 days per month. However, no comparable records were available to show the monthly trend of other fishing activities.

Table 4-23 No. of days per month on which fishers caught grouper juveniles, 1995-2001 (Source: Middleman records, Koh Khiam)

Month	1995	1997	1998	1999	2001
January	11	0	19	18	
February	22	8	26	20	
March	26	27	26	28	
April	29	18	19	24	
May	25	27	13	20	
June	29	26	15	12	12
July	23	24	23	12	13
August	25	16	24	8	9
September	21	22	3		12
October	13	19	1	13	2
November		19		2	
December		14		16	
Total	224	220	169	173	48

The influence of the tides particularly affects small-scale fishers, whose boats and gears are more vulnerable to strong currents. The lunar calendar has a number of implications for coastal fisher livelihoods:

Figure 4-13 Phases of the moon and the tidal cycle

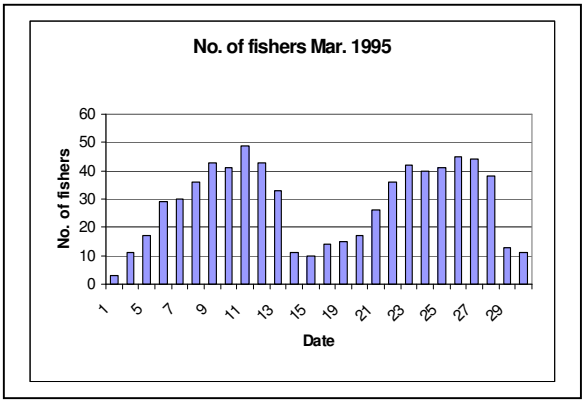


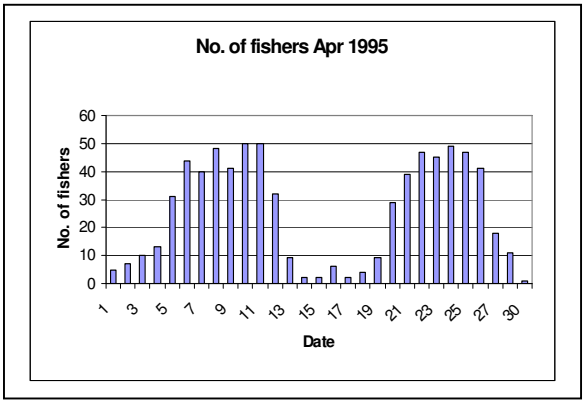
Fishers must adapt to the prevailing conditions, and therefore show a degree of flexibility in their approach to livelihood activities

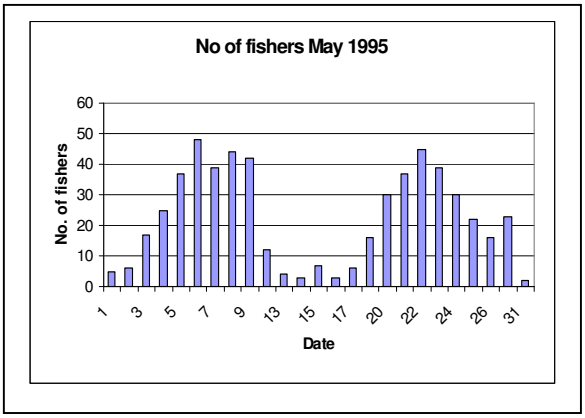
1. Fishers who are unable to fish during part of the month, perhaps due to lack of financial capital to invest in fishing gears, potentially cannot earn an income for half of the month.
2. Fishers may therefore seek to add an additional activity to their livelihood portfolio by making use of the time available to them when they return from fishing, or during the part of the month when they cannot fish. The monthly cycle may therefore lead fishers into livelihood diversification.

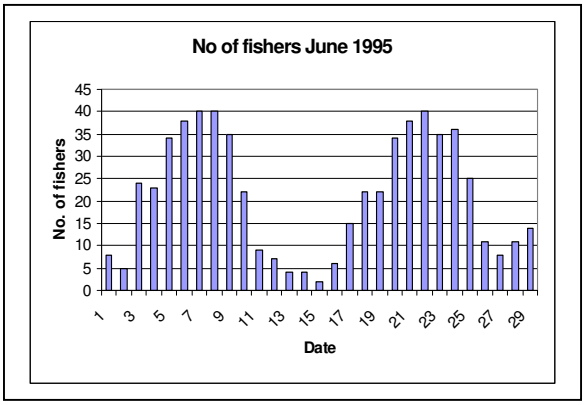
Most fishers adopt a fishing strategy which reduces their vulnerability to seasonality in their fishing activities and the fish catch. Gears are selected that permit them to fish throughout the year, following peaks in abundance and proximity of the fish prey and the prevailing weather conditions. The seasonal calendars shown in Figure 4-15 and Figure 4-16 show the seasonality of fishing activities and the different gears used by fishers during the year. It appears that the fishing seasons experienced in Koh Khiam, Trang province differ slightly from those of fishers in Satun. In Koh Khiam, the mackerel season runs alongside the shrimp season (trammel net), yet in the Satun villages, mackerel is caught during the early months of the year. Seasonal differences also exist for the capture of crab. However, all three villages experience peaks in the abundance of grouper available for capture at comparable times, during the 4th and 5th months of the year.

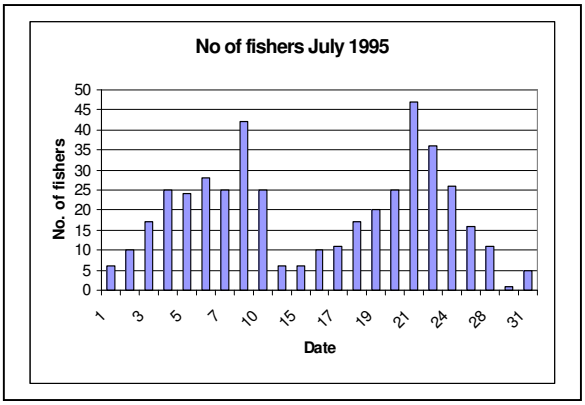
Figure 4-14 Monthly trend in fisher numbers, Koh Khiam 1995

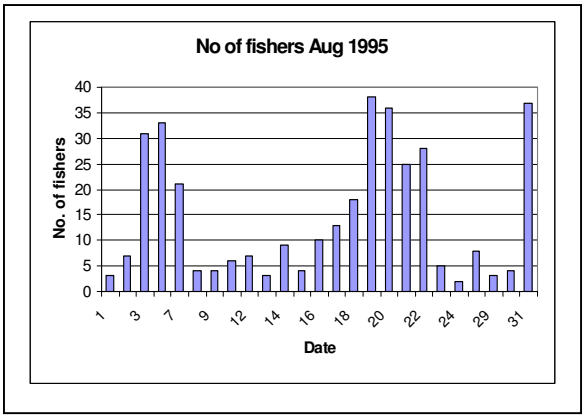


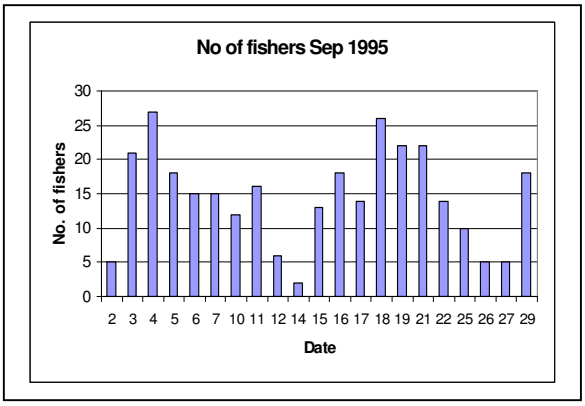












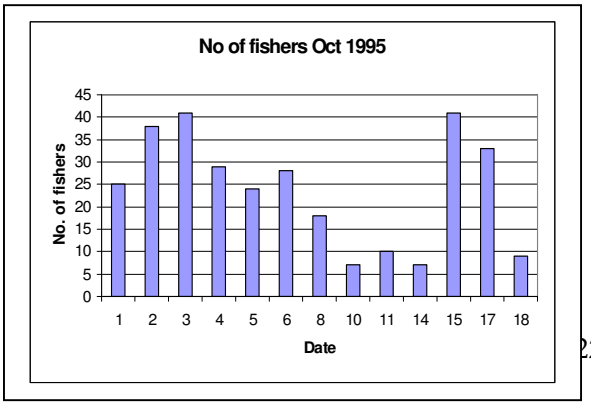


Figure 4-15 Seasonality of fishing activities in Koh Khiam village, Trang

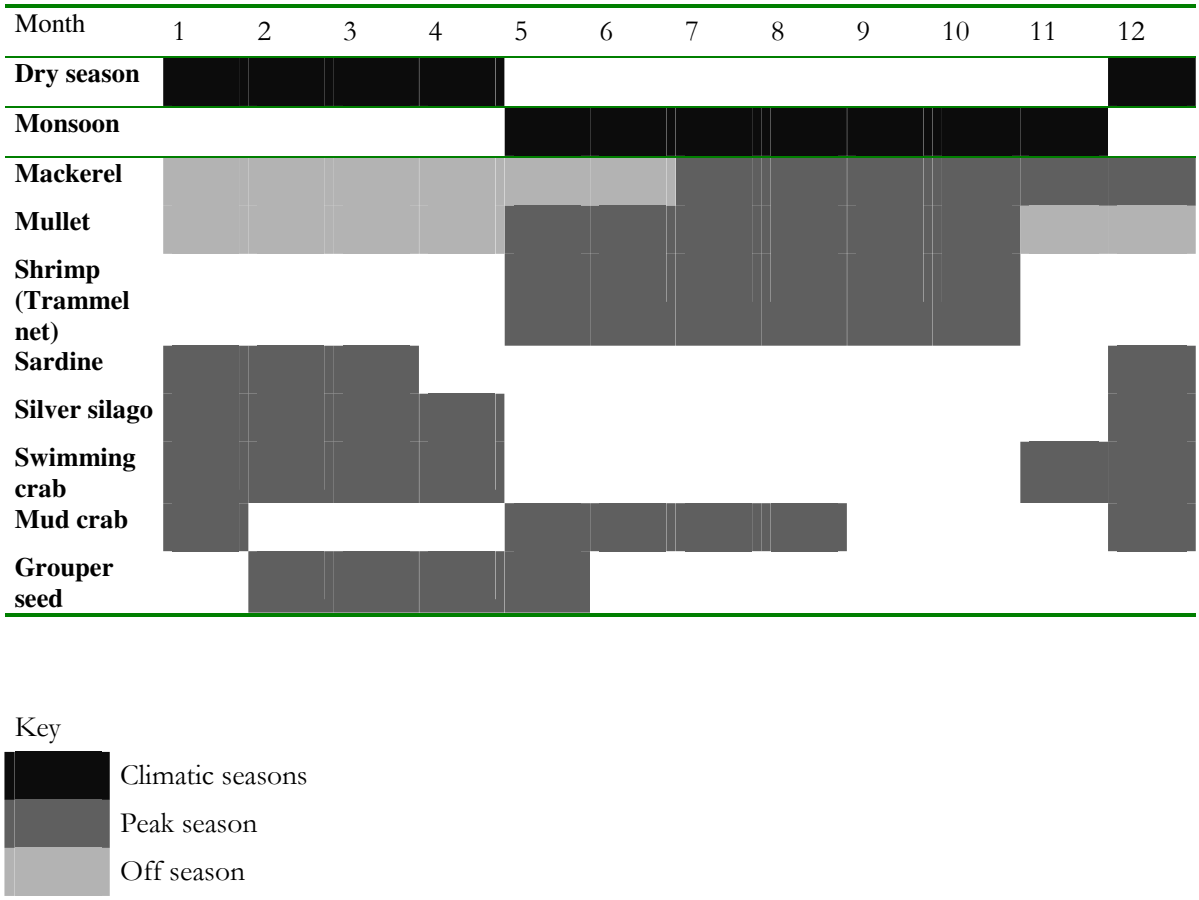
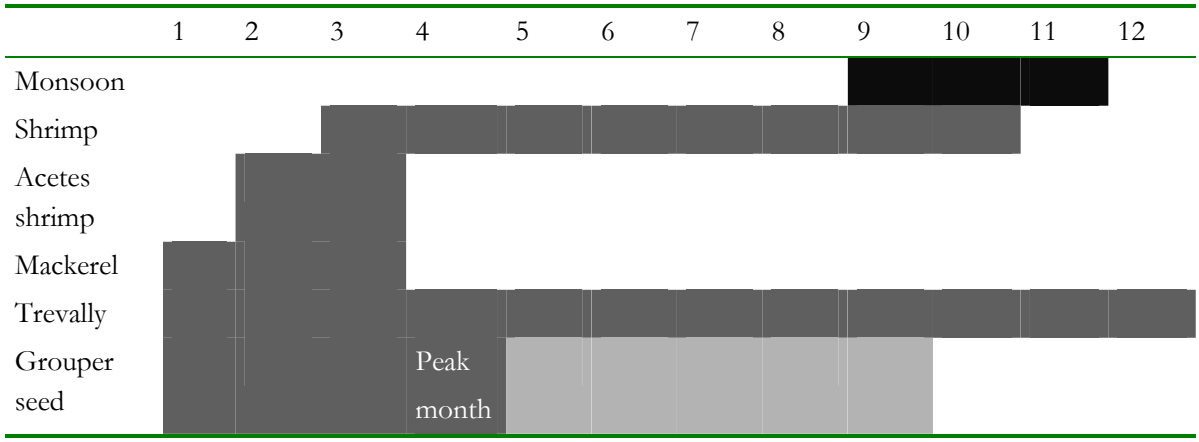


Figure 4-16 Seasonality of fishing activities in Ba Kan Khoei village, Satun



4.4.3 Sources of vulnerability associated with grouper culture

Grouper culture, as an economic activity as opposed to a subsistence activity, may only contribute to household livelihoods when production remains economically viable and sufficient fish can be harvested to exceed production costs. However, although farmers reported that they could make a good income from grouper culture, many were often only able to break even. Grouper farmers

experienced a number of problems with fish culture that undermined the contribution that fish culture could make to their livelihoods.

'They decide to raise fish because inheritance from father. Her father gets idea from DoF. They advise her father to raise seabass. She changed to raise grouper because high price, about 500 THB per fish in the past. In the past time when they harvest fish can get more than 100,000 THB per harvest.' (Farmer, Ba Kan Khoei)

'He raised grouper but stopped 3 years ago, after raising for 5-6 years. He now raises shrimp instead. Many fish died, spinning disease. He only got back the investment, and very small profit.' (Farmer, Koh Khiam)

The principal factors which reduced the ability of aquafarmers to generate a benefit from grouper culture were:

1. Fish disease and mortality
2. Poor water quality
3. Insufficient and unstable supply of grouper seed

4.4.4 Fish Disease

The most common problem encountered, and reported by 49% of survey respondents, was fish disease. A further 16% of respondents reported that fish mortality due to an unknown cause was also a problem. Respondents described disease as 'the biggest risk', or the 'main' or 'major' problem. The survey found that fish disease was the most important problem experienced by fish farmers in the three villages, reported by 49% of respondents (excluding fish culture rejectors). Fish mortality, which farmers could not attribute to disease, was also reported by 16% of respondents. As Figure 4-17 shows, farmers reported a number of problems but many were of minor importance in comparison to problems they experienced with fish disease.

Respondents in Koh Khiam and Thung Sa Pho referred particularly to a 'spinning' or 'whirling' disease. Farmers in Ba Kan Khoei did not describe the fish disease they had experienced in these terms. The range of symptoms described by farmers is listed in Table 4-24.

Figure 4-17 Problems reported by fish farmers, past and present, as percentage of total counts (respondents could give up to three responses)

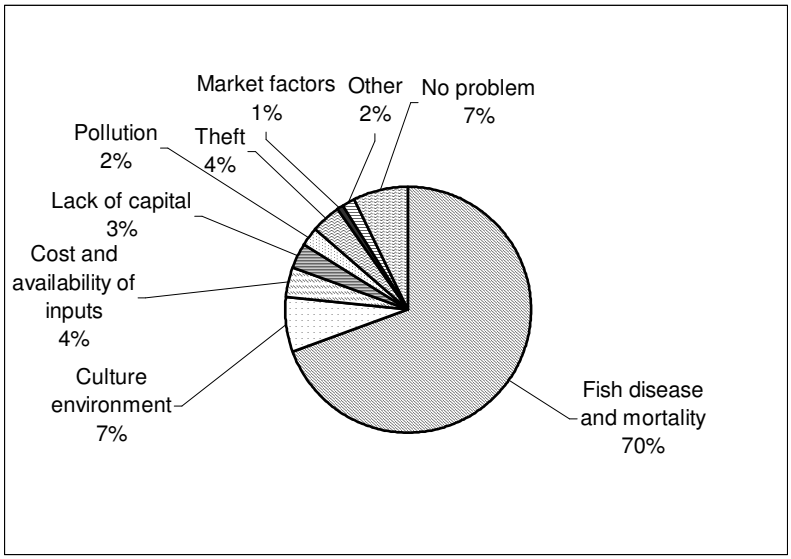


Table 4-24 Symptoms of grouper disease, as described by respondents

Village of respondent who described symptoms	Symptom of disease	No. of observations
Koh Khiam	Spinning disease and lesions	8
Koh Khiam	'wounded spot'	1
Koh Khiam	'boiled by hot water'	1
Thung Sa Pho and Ma Haang	Whirling disease, red mouth, red eye	6
	Damage skin and damaged tail, fish bent in middle	
	Eyes pop out	
Ma Haang	White spots on whole body of dead fish	1

Four respondents indicated that fish disease problems were declining in Koh Khiam. One respondent reported that there had been fish disease problems three years previously, but in 2000, the problem had gone. Others reported that spinning disease happens 'continuously, but now less' and 'not every year'.

The time of year when disease was most prevalent differed amongst respondents and villages. Respondents in all three villages commented that fish die most often in the summer season, particularly during the hottest month, April. Mortality was also associated with reduced salinity during the rainy season and times of flooding. Respondents described how the fish look '*like they have been boiled in hot water*' (cage farmer, Koh Khiam) and that damage and spots occur on the body and tail when the water is hot.

Farmers treat their fish with some forms of chemical treatments when they show signs of disease. Participants in a focus group in Ba Kan Khoei referred to the drug 'detta', which is mixed with food

and fed to the fish to heal damaged skin. During the disease period, farmers in Ba Kan Khoei will also use oxytetracycline hydrochloride once per week. One spoon is used per kg of trash fish. The treatment cost 1200 THB for a 1 lb container and was recommended by the DoF at the brackishwater station in Pakbara. The farmers believe this treatment is very effective. Farmers attempted to prevent disease by covering the cage with leaves to reduce the exposure of the fish to the sunlight and providing shelters for the fish, such as car tyres.

4.4.5 Water Quality

During the qualitative phase of research, seven interview respondents attributed fish disease to poor water quality. Five of these respondents came from Koh Khiam, two from Ba Kan Khoei. One farmer in Ba Kan Khoei did not know the cause of fish disease but had been told that disease could be caused by waste water. This view was supported by participants at a focus group in Ba Kan Khoei, who did not think their fish died of an infection, but from waste water from shrimp farms in Tan Yong Pho sub-district. They could not see any damaged skin on the fish, as they would if the fish had a disease or parasite,

'They think shrimp farmers use chemicals to kill fish in ponds. When they drain waste water from shrimp ponds maybe chemical is released also, killing fish in cages and coastal zone. Fish die every 4 months, at the same time as harvesting of shrimp. If high tide no problem because water runs another way, but low tide have problem. In the past there was no shrimp farm they think they can raise fish better than the shrimp farm. When have shrimp farm the fish have more disease.' (Fous group, Ba Kan Khoei)

In Koh Khiam, poor water quality was considered by three respondents to be a contributing factor to the failure of fish culture at the time of the 'bank group', when the number of farms in Koh Khiam was at its peak. Respondents attributed problems of water quality to pollution from shrimp farms, industry in Kantang and overcrowding of cages in the *klong*.

'Used to be cloudy by the cages, as so many people operate a farm. At that time about 50% of fish die.' (Cage farmer, Koh Khiam).

'There were many cages at the time when disease happened.' (Cage farmer, Koh Khiam)

One respondent moved his fish in an attempt to escape the water quality problem, but found that his fish continued to die,

'He thought maybe because he raised fish in that klong a long time and feed settle in the klong made pollution. But when they move to raise fish to another place, they still die. He moved to raise fish in Ko Libong but his fish die again.' (Cage farmer, Koh Khiam)

Analysis showed that Koh Khiam experienced relatively greater problems with the culture environment than the other villages. Poor culture environment was positively associated with Koh Khiam village and negatively associated with Thung Sa Pho ($P<0.05$).

Problems experienced by grouper farmers, including other relatively minor problems reported by farmers,are summarized in Table 4-26.

Analysis showed that there were significant associations between problems of fish disease and mortality and case study villages, and also between reports of problems with the culture environment and case study villages (Table 4-25). It was found that reports of disease problems were lower than would be expected in Thung Sa Pho if community and fish diease variables were independent. Analysis also showed that reports of problems with the culture environment, including hot water, problems with salinity level, and high water velocity were found to be higher than expected in Koh Khiam, and lower than expected in Thung Sa Pho. The low incidence of problems with culture environment in Thung Sa Pho may be explained by the difference in culture system. Most grouper farmers in Thung Sa Pho raise grouper in ponds, and therefore have relatively more control over the culture environment than cage farmers in the other two villages. No significant associations were found between case study community and other problems reported by grouper farmers.

Table 4-25 Results of Chi-square analysis to test for association between case study communities and problems experienced by grouper farmers

Problem	Chi-Square	P	Level of significance
Fish disease and mortality	9.070	0.011	P<0.05
Culture environment	7.988	0.018	P<0.05
Cost and availability of inputs	5.703	0.058	Not significant
Financial constraints	1.137	0.566	Not significant
Pollution	0.389	0.823	Not significant
Theft	3.424	0.180	Not significant
Market value instability	1.141	0.565	Not significant

Table 4-26 Problems experienced by grouper farmers in the case study communities

Fish disease	The most common problem reported by respondents, accounting for 70% of survey responses
Water Quality	Respondents attributed poor water quality to shrimp farms, industrial activities and overcrowding of cages.
Cost and quality of seed and inputs	6 respondents in Koh Khiam, and 1 respondent in Ba Kan Khoei, commented that trash fish was expensive for them to buy. Respondents from Thung Sa Pho did not experience problems to obtain trash fish for fish culture. Four respondents, from Koh Khiam and Ba Kan Khoei, commented on the high price of grouper seed. In Koh Khiam the high price was not only associated with the seed shortage experienced in 2001, as one respondent stopped raising grouper in 1998 due to the high price of seed fish. Some respondents experienced problems of seed quality from DoF and trade sources, '*DoF gave him grouper seed and seabass seed but seed fish have disease and slow growth rate. Grouper seed get disease and damaged skin and whirling disease*.' (Grouper farmer, Thung Sa Pho) '*But when no seed make farmer try to buy grouper seed from Pattani or another place to stock but not successful. Fish were damaged and not too strong from transport. From transport, and from different areas so low survival*.' (Grouper farmer, Thung Sa Pho)
Lack of financial capital for investment in fish culture	Lack of investment was particularly a problem for grouper culture due to the relatively high cost of seed fish
Market factors	Problems created by market factors included instability of the market for grouper, and low value of grouper
Lack of institutional support or knowledge about fish culture	Respondents reported that they could not raise grouper as the Department of Fisheries does not 'support' grouper culture, meaning they did not provide grouper seed fish but rather provided materials for cage construction, seed fish and knowledge for seabass culture.
Availability of labour to raise fish	Respondents indicated that raising fish could be inconvenient for them when they had other work to do. They were also unable to guard the cages from theft
Availability of feed and seed inputs	Farmers reported shortages of seed and feed fish. Six respondents in Koh Khiam, and 1 respondent in Ba Kan Khoei, commented that trash fish was expensive for them to buy. Respondents from Thung Sa Pho did not experience problems to obtain trash fish for fish culture.
Damage to cages	Cage damage was primarily an issue for cage farmers in Ba Kan Khoei, where 4 respondents and participants in a focus group referred to the problem. Focus group participants reported that the '*two biggest problems for fish culture [in Ba Kan Khoei] are cage damage and disease*.'
Theft of grouper from cages and ponds	Theft was described as a '*major problem'* in Koh Khiam. In Thung Sa Pho, respondents were wary of theft. One respondent did not want to culture fish as she did not want to guard her cages against theft (Fish culture rejector, Thung Sa Pho). Another respondent commented that grouper culture in cages was vulnerable to theft, but they had no problem with theft in Thung Sa Pho (Fish farmer, Thung Sa Pho). Focus group participants in Ba Kan Khoei reported that there is no theft in the village as members of the village act as security guards. Three people guard the cages each night (Focus group, Ba Kan Khoei).

4.4.6 Availability of grouper seed

Two particularly clear views were apparent regarding the availability of grouper juveniles from the wild for culture:

1. Grouper juveniles were particularly scarce during 2000, but were relatively abundant in 2001
2. Overall, juveniles were hard to find during the period 2000-2001

Respondents also reported that the availability of grouper seed showed seasonal trends:

1. Most grouper juveniles are available between January and April, reaching a peak in April
2. It is difficult to find grouper juveniles during the winter months (October to December)
3. Juveniles are particularly hard to find in December
4. Some respondents did, however, report that they could find grouper juveniles all year round.

Farmers who bought seed fish and farmers who caught seed fish appeared to have different perceptions of the availability of grouper seed. Farmers who bought seed were more likely to believe that the seed supply was constant, as middlemen were able to purchase seed outside the locality and thus stabilised the supply when local stocks were low. Farmers who caught their own seed were more aware of, and more vulnerable to, local fluctuations in seed abundance. As Section 4.5.1 will show, insufficient and unstable supply of grouper seed was one of the most important factors found to contribute to grouper culture discontinuance. The status of the grouper seed fishery is discussed further in Section 4.6.

4.4.7 Hatchery seed production as a potential solution to problems of grouper seed supply

The production of hatchery produced seed is generally regarded as the most obvious solution to the problem of insufficient and unstable supplies of grouper seed. However, in addition to overcoming the current technical problems currently faced by researchers in attempts to produce a consistent supply of good quality seed, consideration must also be given to the likelihood of uptake of hatchery produced grouper. This issue and the possibility that the development of hatchery seed production may undermine the livelihoods of grouper seed fishers were explored during the course of the research.

The willingness of grouper farmers to purchase grouper seed from a hatchery was dependent upon the price and quality of the fish. Farmers were not optimistic about the possibility of the Department of Fisheries successfully producing sufficient good quality seed. However, a number of respondents thought that the production of hatchery reared grouper seed would be a positive development for grouper farmers (5 of 11 respondents). Farmers were keen to be able to stock fish of the same size at one time.

4.4.8 The fishery for grouper seed

Grouper seed were targeted by fishers from every wealth group, from both fish farming and non-fish farming households. Grouper seed fishing was for many households an opportunistic activity, taken up

when seed fish were available and could fetch a good price, and discontinued when the activity no longer generated a benefit. The possibility for fishers to make an additional income from the capture of grouper seed during the neap tide, when other fishing activities are disrupted, attracts both fishers and non-fishers to take up the activity.

'Many people still fish for seed, but less than previously. About 20% of previous number.' (Focus Group, Koh Khiam)

'This year have a lot of seed fish. Fishermen who did not fish for seed in the past, have invested money to buy boats so they can fish for seed.' (Middleman, Ban Chebilang)

'Almost all coastal villages that are close to the Andaman Sea catch grouper seed.' (Seed fisher, Ban Chelung)

Grouper farmers were more reliant on the fishery than non-fishers, as the ability to catch wild seed reduced the need for financial capital inputs for grouper culture.

Few fishers relied entirely on the grouper fishery to provide their main income due to the opportunistic nature of the activity. However, as reported in Koh Khiam, a small number of fishers did derive their main income from grouper fishing

'About 10 people have main income from grouper seed fishing. The rest fish for grouper occasionally.' (Focus group, Koh Khiam)

These findings suggest that the fishery for grouper seed, whilst providing a good source of income for many fishers, is largely an opportunistic activity on which few fishers are totally dependent. The development of hatchery produced seed may therefore have little impact on fisher livelihoods overall. However, the impact on those fishers who are reliant upon the grouper fishery for their livelihood should be further investigated. Given that these fishers are reliant upon a highly seasonal fishery, restricted to certain periods of the lunar calendar, for which a simple, inexpensive gear is used, it is likely that these fishers belong to the most vulnerable group within the fishing community.

4.4.9 Economics of fish culture – viability and impact on vulnerability

Introduction

Information provided by respondents during the course of the qualitative phase of data collection indicated that grouper culture has the potential to contribute to livelihood strategies primarily by providing a form of saving. However, fish mortality, fluctuating market prices and increasing costs of inputs affect the ability of farmers to generate a benefit from fish culture. The benefits generated by fish culture were also influenced by the size of the fish culture system and the ability of the farmer to rotate stock, the level of risk the farmer was willing to absorb and the level of wild caught inputs the farmer used. The economic analysis explores the potential effect of these variables on the economic viability of fish culture in the communities studied.

Production costs of a small scale cage farm

Production systems were highly variable in terms of number of fish stocked, frequency of harvest and harvest size of fish, and sources of feed and seed, making the calculation of a representative production system problematic. The analyses presented below are based on aggregated information provided by 18 cage farmers, which has provided a set of basic assumptions, as presented in Table 4-27.

The resulting estimated fixed costs, as shown in, compare well with figures given by Chaiyakam (1999), who calculates a total investment of 13,390-17,920 THB for the construction of 4 cage units. With regard to grouper culture, assuming a survival rate of 50 to 60%, as applied in Chaiyakam's calculation (1999), the resulting net profit from the first harvest of fish is also comparable. Chaiyakam (1999) calculates a net profit of 31-33,000 THB, based on the harvesting of 50-60% of the fish stock, from an initial stock of 450 fish. In the calculation presented below, a similar mortality rate would result in a net profit of 42,081-57,081 THB, based on an initial stock of 500 fish.

Table 4-27 Basic assumptions upon which the analysis of grouper culture economic viability is based. The information was obtained from interviews conducted with grouper farmers during the qualitative phase of data collection

Factor	Basic assumptions and estimates
Materials for construction:	
Bamboo	Range of responses 8-14 pieces per cage, 100-150 THB per piece. DoF (1999) gives a value of 50-60 THB per piece, a lot lower the price indicated by farmers interviewed. Accepted average: 120 THB per piece, 8 pieces per cage (2 pieces per side). Lifespan = 3 years.
Iron bars	Only used by respondents if supplied by the DoF. Lifespan = indefinite. Cleaned and painted every 2 years.
Nets	Range of responses 100-200 THB per kg, 1500-2000 THB per cage. Accepted average 7kg per cage, 150 THB per kg. Lifespan = 3 years
Foam	225-322 THB per piece. Accepted average 300 THB per piece. 12 pieces per 2 cages. Lifespan = 1 year
Ropes	5-7 kg per cage. 80-150 THB per kg Lifespan = 3 years.
Seed fish:	Estimated stocking rate 250 fish per cage.
Feed:	Feed costs vary according to location. Average costs: Koh Khiam 12 THB/kg Ba Kan Khoei 7 THB/kg Thung Sa Pho 5 THB/kg Average cost for general analysis 5 THB per kg. Feeding 5% body weight trash fish.

Comparative analysis of grouper and seabass culture

Comparing the costs and benefits of producing grouper or seabass revealed that, for the same investment, grouper culture can provide considerably greater benefits than seabass culture (Table 4-28).

Table 4-28 Comparison of grouper and seabass culture systems

	Seabass Culture	Grouper Culture
Gross Profit	28 000	120 000
Fixed Cost	5407	5407
Variable Cost	16 431	27 512
Annual Cost	21 838	32 919
Net Profit	6162	87 081
Ratio net income to operating costs	28%	264%
Break even cost value per fish	78 THB per kg	82 THB per fish
Rate of return on capital investment	128%	1025 %
Profit margin	22 %	72 %

Comparative analysis of low risk and high risk systems

Section 4.2.3 describes how farmers adapted their culture systems in order to manage the risks of fish disease and market fluctuations that may reduce the profitability of their culture system. Some farmers adopt a low risk system with a minimal investment of financial capital (Farmer B), others are able to invest in a larger culture system and a longer grow-out period, which carries a greater risk but, as Table 4-29 shows, considerable benefits if fish mortality is low.

Table 4-29 Economic comparison of low-risk and higher-risk grouper cage culture systems

	System A: Short grow out	System B: Long grow out
Gross Profit	48 000	360 000
Fixed Cost	5407	12 020
Variable Cost	34 125	82 537
Annual Cost	39 532	94 557
Net Profit	8468	265 443
Ratio net income to operating costs	21 %	281
Break even cost value per fish	165 THB per fish	79 THB per fish
Rate of return on capital investment	154 %	1214 %
Profit margin	18 %	74 %

Inputs of grouper seed and feed from the farmers own catch are an important contributor to variable costs of the culture system, which are often considered to be 'free' inputs by farmers,

'He has problem about cage damage but didn't lose money because he finds trash fish and grouper seed by himself.' (Farmer, Ma Haang)

'He thought waste water from shrimp ponds affects his fish. But he thought he finds fish by himself and not a big problem as he did not spend money for fish.'(Farmer, Thung Sa Pho)

In order to incorporate the actual cost of seed fish and feed into economic calculations, an analysis was completed to determine the indirect costs of seed fishing.

Table 4-31 shows that the cost of seed fish to fisher/farmers ranges from 13 THB to 17 THB per fish, assuming an average catch of 15 fish per day, and disregarding the size of the fish. These figures compare favourably to the price farmers pay for seed fish, which ranges from 20 THB for a fish of 4 to 5 inches (TL) to 70 THB for a fish of 8 to 9 inches (TL). In the event that fishers catch predominantly small size fish (4 to 5 inches) they are still able to benefit economically from their own fish catch. However, fuel represents between 20 and 40% of the total variable costs. Increases in fuel costs have been reported by fishers to reduce the economic efficiency of fishing for grouper seed. The

figures presented also assume an average catch of 15 seed per day. If seed fish stocks are in decline, as fishers report, the economic benefits of seed fishing will also be reduced.

Table 4-31 shows three common fishing strategies adopted by fisher/farmers in the three villages studied. The results show that fishing *only* for mullet and shrimp may not be a viable strategy, as the costs of fishing using only these gears exceeds the benefit. Similarly, fishing only for juvenile grouper gives only a small return on the fishers' investment. Combining both strategies allows fishers to maximise their investment by increasing their income during periods of the neap tide, by fishing for shrimp and grouper.

As described in Section 4.4.2, fishers adopt a fishing strategy which employs more than one gear, adapting their fishing strategy according to the season and phase of the moon.

Table 4-31 attempts to calculate the relative benefits of a number of common fishing strategies, and thus to calculate the true cost of seed fish to fisher/farmers, based on the basic assumptions presented in Table 4-30.

Table 4-30 Basic assumptions included in economic analysis of seed fishing

Item	Assumptions
Fixed costs:	
Boat	Size of boat for seed fishing 5-10 m
Engine	11 horse power
Gear	Traps : average number used by fisher = 35 Shrimp nets : lifespan 2 months. Cost given per year.
Variable costs:	
Fuel	Based on average value of 4 litres per day given by fishers, at an average cost in 2000 of 16 THB per litre
Labour costs	Given as food costs of 20 THB per person per day. Assuming a crew of 2 people. Unpaid members of family.
Bait	Based on values given by fishers. On average, 1kg used per 5 traps at a cost of 4 THB per kg.
Potential gross revenue from seed fishing only:	
Value of seed	Based on value of seed at 3 THB per inch (as sale price to farmers from middleman 5 THB per inch).
No. of fishing days	Seed fishing during the dead tide, estimated at 8 days 'per water', or 16 days per lunar month. Assumption uses calendar month. Excluding storm season, fishers fish approx. 10 months per year. Approx. fishing days per year = 160 days.
Opportunity cost of family labour	Alternative to fishing occupation most likely to be labour. Average income from labour per day = 200 THB. For women, alternative employment would be factory work. Average income per day = 150 THB. Assumed opportunity cost of family labour for 2 people is 350 THB per day.

Table 4-31 Economic assessment of three common fishing strategies, based on interview data.

	Fishing strategy					
	Fish trap only		Mullet + shrimp		Fish trap + gill nets (mullet and shrimp)	
Average no. fishing days per year	80		174		174	
Quantity fuel/day	4 litres		6.5 litres		6.5 litres	
Cost fuel per litre	16 THB		16 THB		16 THB	
ESTIMATED GROSS INCOME[a]	19800		41 700		61 500	
TOTAL FIXED COSTS	52 450	6450	58 290	12 290	22 840	7640
Total variable costs (Including opportunity cost)	40 680		94 264		86 956	
		Excluding opportunity cost		Excluding. opportunity cost		Excluding opportunity cost
Total annual costs (THB)	47 130	19 130	106 554	45 654	94 596	33 696
Cost per day (THB)	589	239	612	262	543	193
	Fish trap only		Mullet + shrimp		Fish trap + gill nets (mullet and shrimp)	
Estimated cost of grouper seed (THB per fish)	39	16	41	17	36	13
Opportunity cost of grouper seed	55.5 THB	32.5 THB	57.5 THB	33.5 THB	52.5 THB	29.5 THB
NET PROFIT	-27 330	670	-64 854	- 3954	-30 096	27 804

[a] Based on average catch and value of catch per day.

[b] Data from interview with grouper farmer, Koh Khiam

Table 4-32 Average catch and value of fish catch, based on interview data.

	Ave. catch per day	Value of catch	Total per day
Grouper seed	15 fish	16.5 THB per fish	247.5 THB
Mullet	10+ kg	18 THB per kg	150 THB average
Shrimp	5 kg	80 THB per kg	300-400 THB average

Using the data derived from Table 4-31, in which the real cost of wild caught grouper juveniles was estimated, it can be shown that farmers utilising wild caught inputs are able to generate a higher net profit than farmers using purchased inputs (Table 4-33). However, for farmers who are able to afford purchased inputs, the time that would otherwise be used to catch seed and feed fish and prepare trash fish for feeding can be employed in other activities, which may generate a greater benefit than the difference in net profit between wild caught and purchased input based systems. Thus, the opportunity cost of labour employed to catch fish for use in fish culture may be high when households are able to undertake other livelihood activities.

Table 4-33 Comparative analysis of systems using primarily purchased or wild caught inputs of seed and feed.

	Purchased Inputs	Wild caught inputs
GROSS PROFIT	120 000	120 000
TOTAL FIXED COSTS	9020	9020
TOTAL VARIABLE COSTS	40 800	22 000
TOTAL ANNUAL COSTS	46 207	27 407
TOTAL NET PROFIT	73 793	92 593
Ratio net income to operating costs	160%	338%
Break even cost	115 THB per fish	68 THB per fish
Return to capital	79 200	22 000
Rate of return on capital investment	878%	244%
Profit margin	61%	77%

Production costs of grouper culture in ponds

Two ponds farmers in Thung Sa Pho kept detailed records of the fish culture practices, providing data sets of complete culture cycles for the presentation of economic analyses of their production systems, as described below.

Farmer No. 1

Farmer No.1 has three ponds, each of 1 rai and 1m deep. He began to raise grouper in 1995, and grouper culture is now an important activity for the household. He catches seed for himself, but also buys seed from Ma Haang village, Su So village (Trang), Korn Klarn village and Pattani province. He buys trash fish feed from people who fish with '*pong paang*' (large bag net, fixed gear) in neighbouring Ma Haang village, and also catches fish for feed himself. He feeds his fish every 3 to 4 days. When grouper are harvested, they are sold in Pakbara.

Farmer No. 2

Farmer No. 2 started to raise grouper in ponds in April 2001. He has two ponds. When he began to record feed inputs he had a total of 1200 fish, purchased from neighbouring Korn Klarn village, of size 4-5 inches. He buys feed from fishers in the village, which costs between 5 and 10 THB per kg, depending on the species composition of the feed. Feed was given to the fish every two days.

Complete feed input records were kept between April and July 2001. Fish were harvested on 6th August 2001. In May, feed was purchased from Korn Klarn village and Wang Tong village, or from fishers in Tung Sa Po.

The last feed input was recorded on 14th July. Fish were harvested on 6th August. Farmer No. 1 reports that many of his fish died. Friends in the village suggested this was due to over stocking, so he harvested his fish rapidly. A total of 720 fish were harvested. Assuming a complete harvest, this represents mortalities of 40% of the stock. However, he was still able to make a good return on his investment. He sold the seed fish, of sizes 6 to 7 inch, and 8 to 9 inch, for an average of 65 THB per fish. This represents a total gross profit of 46, 800 THB.

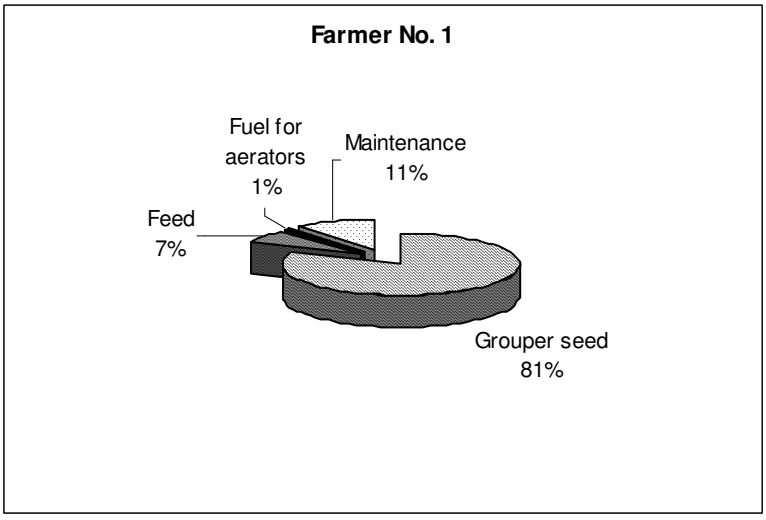
Cost breakdown

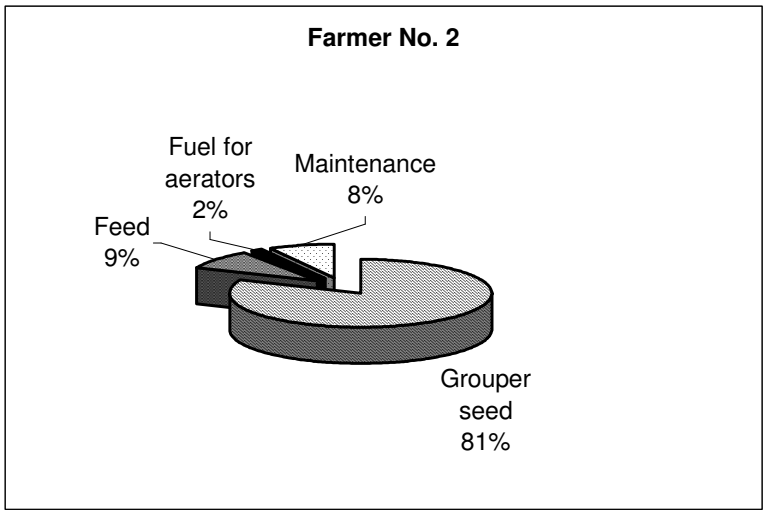
Grouper seed accounted for 81.5% of total variable costs in both culture systems.

Table 4-34 Economic analysis of two pond culture systems for the production of grouper, based on records kept by farmers

	Farmer No. 1	Farmer No.2
	3 rai, 3 ponds, 2870 fish stocked at 26 THB per fish. 100 % survival. Sold at a value of 70 THB per fish, 200-300g in size.	**1 rai , 1 pond, 1200 fish stocked, 60% survival, 720 fish sold at a value of 65 THB per fish, 250g in size.**
Gross Profit	200 900	46 800
Fixed Cost	9600	3406.67
Variable Cost	91 881	29 434
Annual Cost	101 481	32 840
Net Profit	99 419	13 960

Figure 4-18 Cost breakdown of two pond culture systems





Sensitivity analysis - grouper production

Farmers reported that fish disease and mortality were the most important problems affecting their ability to successfully raise grouper and to generate a benefit. In Koh Khiam, farmers had fallen into debt as the price of grouper on the market fell, leaving them unable to meet loan repayments. Increasing costs of inputs, particularly the high price of feed in Koh Khiam also affect the profitability of grouper culture. However, a sensitivity analysis of grouper culture found that grouper farmers should be able to break even at high levels of mortality, a substantial fall in the market price of grouper and increases in the costs of inputs.

The following conclusions can be drawn from the sensitivity analysis:

1. Grouper culture systems can sustain levels of mortality as high as 80% (Figure 4-19).
2. Profitability is not very sensitive to increases in feed cost. Farmers could break-even if feed costs reached as high as 40 THB per kg, which is highly unlikely.
3. The profitability of grouper culture is not very sensitive to increases in the price of grouper seed, as Figure 4-21 shows. As the price of seed fish doubles, the profit margin for each system is reduced by only 9%. Figure 4-19shows that farmers are still able to break even at more than 85% mortality, even when the cost of 4 to 5 inch seed fish increases to 40 THB per fish.
4. Grouper farmers could theoretically break-even if fish mortality was 20% and the value of fish at the farm-gate fell as low as 100 THB per 1.2kg fish

5. According to the analysis, economies of scale do not appear to benefit the grouper farmer. Although a farmer can increase his or her net profit by increasing fish production, the increase is proportional to the number of fish stocked/harvested by the farmer.
6. Increasing the length of the culture period, and thus increasing the value of the fish, generates an increasing benefit for farmers as the returns from the sale of farmed fish increases at a greater rate than the associated costs of keeping the fish for longer. According to the analysis, farmers can generate a considerably greater benefit if they are able to keep fish for 11-12 months, at which point the fish stocked at a size of 4 to 5 inches reach the preferred market size of 1.2kg. The financial benefits are greater if farmers sell their stock per fish rather than as 'kilo fish', the lower risk alternative.

These findings, suggesting that grouper farmers are able to break even, even under conditions of high fish mortality or a fall in the value of grouper, is supported by comments made by respondents during the qualitative phase of research,

'Price previously came down to 100 THB, if compare to how people here raise grouper, probably cannot say we really lose, only loose part of profit as cost of investment and price is still the same. So not making a profit' (Farmer, Koh Khiam)

'Risk of fish culture: cage damage, all fish can escape, disease - they cannot receive a profit. But they never made a loss, and have always made a profit with grouper culture.' (Focus group, Ba Kan Khoei)

'Price of seed is quite stable so can carry on as long as there is still some profit. Profit is more or less, but don't necessarily lose.' (Farmer, Koh Khiam)

However, farmers felt that they would not continue to raise grouper if the price fell below 150-200 THB per fish, based on their calculations of the cost of seed and feed. The high value of grouper was attributed to the export market,

'If there is no export market could no longer raise grouper. Lowest price that they could continue – 250 THB per fish. If this happened would probably have to go back to fishing.' (Farmer, Koh Khiam)

Figure 4-19 Impact of fish mortality on net profit of grouper production[25]

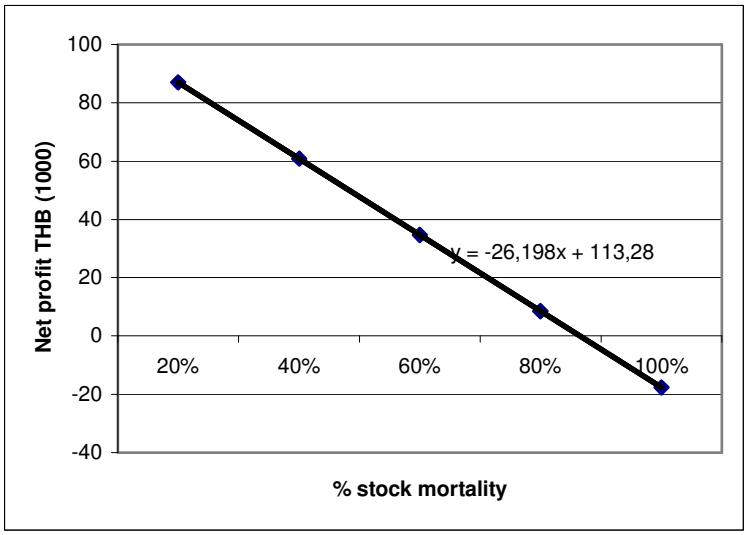
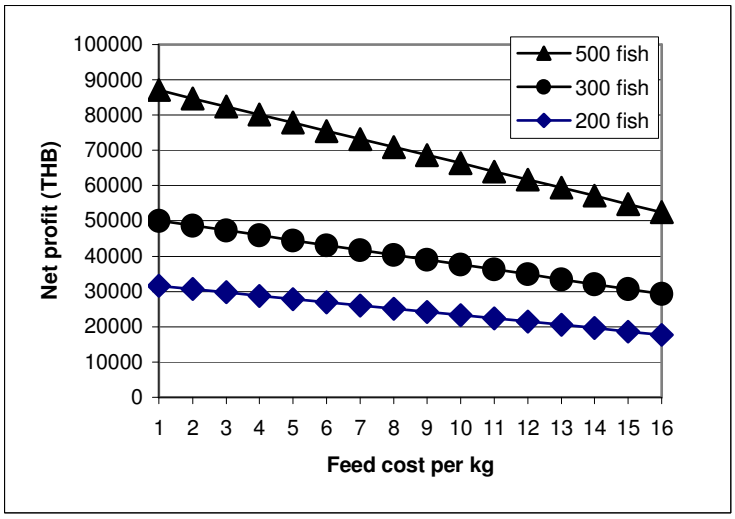


Figure 4-20 Impact of increases in feed cost on the profitability of grouper production



[25] In this analysis, a reduction in feed requirement as fish die has not been included in the calculation.

Figure 4-21 Impact of increases in the cost of seed fish

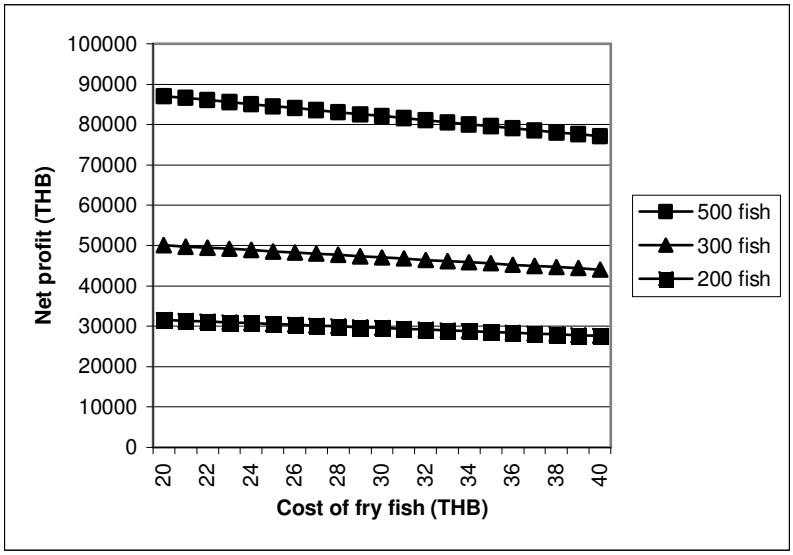
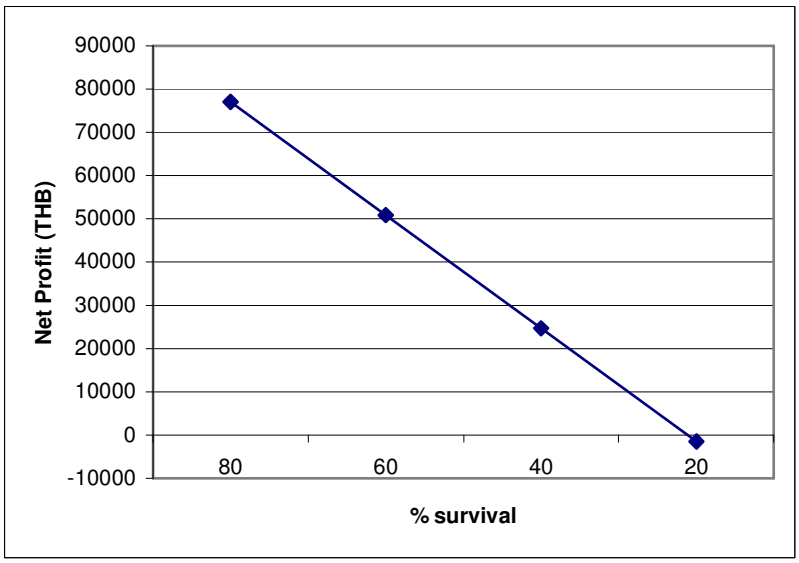


Figure 4-22 Net profit from grouper culture when 500 fish of size 4 to 5 inches are stocked at a cost of 40 THB per fish, shown at varying levels of fish mortality.



4.4.10 Market trends – impact on vulnerability

Farmers reported that instability of fish prices were a constraint to successful grouper culture, and that low prices of fish in the past had caused them to discontinue fish culture. It was also reported that the cost of grouper seed was increasing, thus making grouper culture less profitable. Information obtained from interviews with grouper farmers, middlemen, the National Statistics Office of Thailand and the International fish marketing organisation 'INFOFISH' is presented below to show the extent to which the cost of seed inputs and the value of reared grouper has changed in recent years, and to illustrate the likelihood of market factors having a significant impact on the economic viability of grouper culture.

4.4.11 Cost of inputs

Information obtained from grouper farmers regarding the price of grouper seed to purchase from direct from fishers or from middlemen during the years 1998 to 2001 does not show a consistent trend amongst seed fish of different sizes. According to interview respondents the cost of seed fish of 4 to 5 inches has remained relatively constant, whilst the cost of fish of 6 to 7 inches has increased between 1999 and 2001. The cost of 8 to 9 inch fish appears to have fallen in 2000. The cost of fish of all sizes increased between 2000 and 2001.

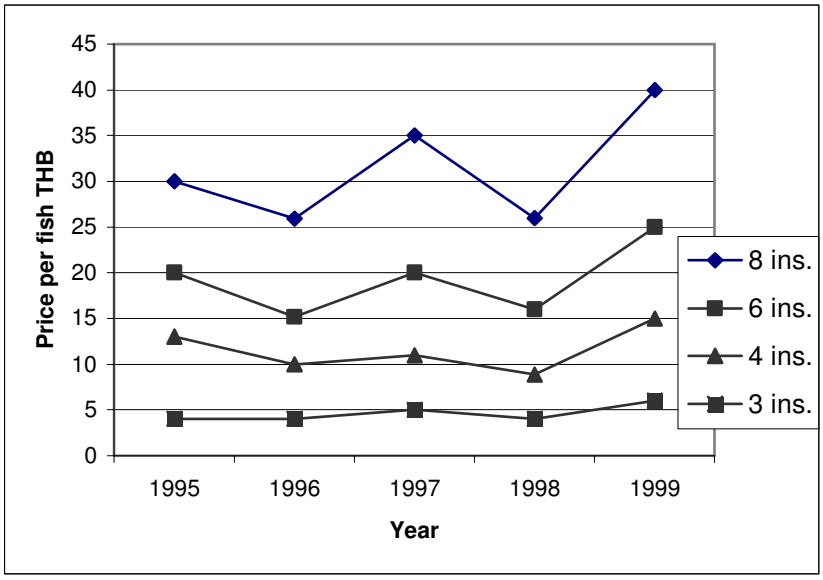
Figure 4-23 Purchase price of grouper seed bought by grouper farmers. Source: Grouper farmers, interview data. Aggregated from the data obtained from during the preliminary overview, survey in Trang and Satun and case study analysis.

Records provided by the principal trader in grouper seed in Koh Khiam provide data for the period 1995 to 1999. The records, kept daily and recording the amount of money paid to each fisher for their catch of grouper juveniles, gives an accurate indication of trends in the cost of grouper seed. Figure 4-24 shows the price the middleman paid for the fish when they were purchased from the fisher. The cost to the grouper farmer to purchase these fish would therefore have been slightly higher than the values shown. The figure shows that the price of grouper seed changes slightly from year to year. The smallest fish show the least fluctuation in price, of approximately 2 THB. Larger fish of 8 to 9 inches varied by almost 15 THB per fish, reaching a cost of 40 THB per fish in 1999. The cost of fish of all sizes was higher in 1999 than in the previous 5 years.

Value of grouper

Respondents interviewed during case study research reported that the value of farmed grouper had fluctuated dramatically at some times during the previous 10 years. Particularly consistent were reports that the value of farmed grouper (1.2kg per fish) reached a peak of approximately 450 THB per fish in 1990-1992 which was followed by a dramatic fall in price. The difference in price between 1982 and 1983 represents the increase in fish value associated with the beginning of the trade in live grouper. Grouper value also fluctuates within the year, with prices peaking during the Chinese New Year.

Figure 4-24 Trend in price of seed fish (*E.coioides*) purchased by middleman from seed fishers in Koh Khiam village, 1995-1999



According to National Statistics, the value of aquaculture produced grouper fluctuated little during the period 1991-1997 (Figure 4-26). The high value of fish reported by farmers in the early 1990's does not appear in records held at the National level, although as these figures represent the average for the whole kingdom, it is possible that the high values reported were balanced by lower values in other provinces. Figure 4-26 also shows that large difference in value between seabass and grouper, at times more than 200 THB per fish.

Statistics showing the wholesale value of grouper in Hong Kong also indicate a relatively stable market price during the first half of the 1990's. However, as was shown in Figure 1-5, Chapter 1, according to figures available for the malabar grouper (*E. malabaricus*) and Red grouper (*E. akaara*) prices began to fall at the end of the 1990's, following the financial crisis that hit Asia in 1997, and again due to the events of September 11 2001 and the SARS outbreak in 2003. However, data for *E.coioides* during this

period is not available. As a lower value fish, it is possible that the market for this species did not suffer as greatly as for the more valuable species.

Figure 4-25 Trend in value of farmed grouper (*E. coioides*). Source: interviews with grouper farmers and middlemen

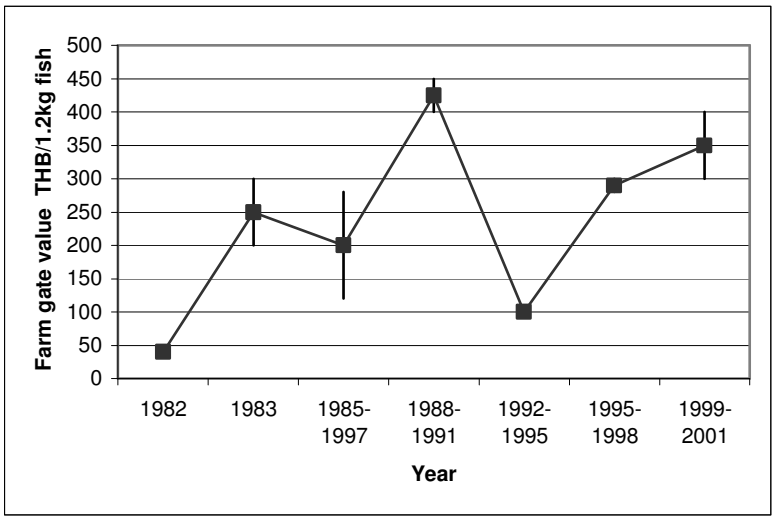


Figure 4-26 Average price of grouper and seabass, 1991-1997 (THB/kg) Source: National Office of Statistics, Thailand

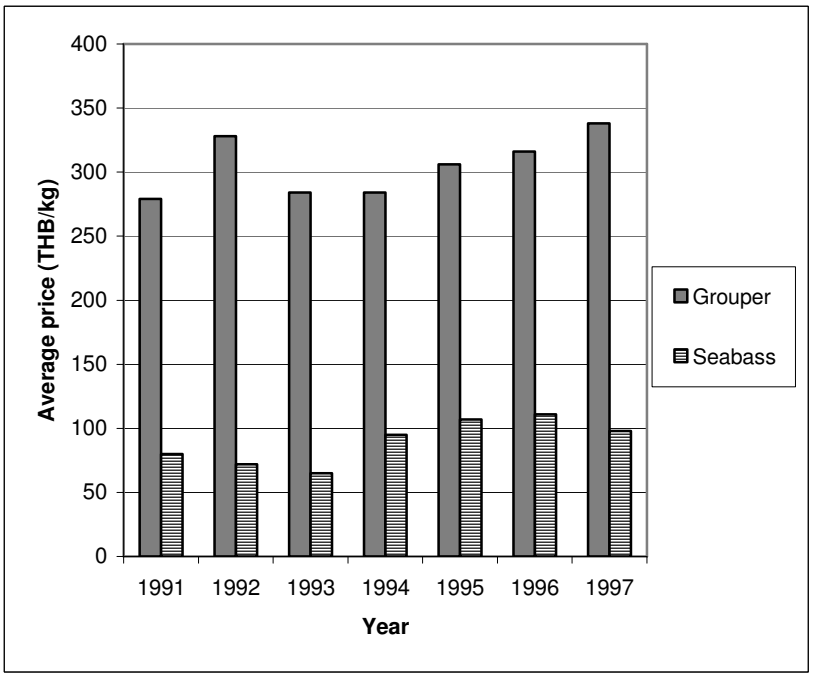
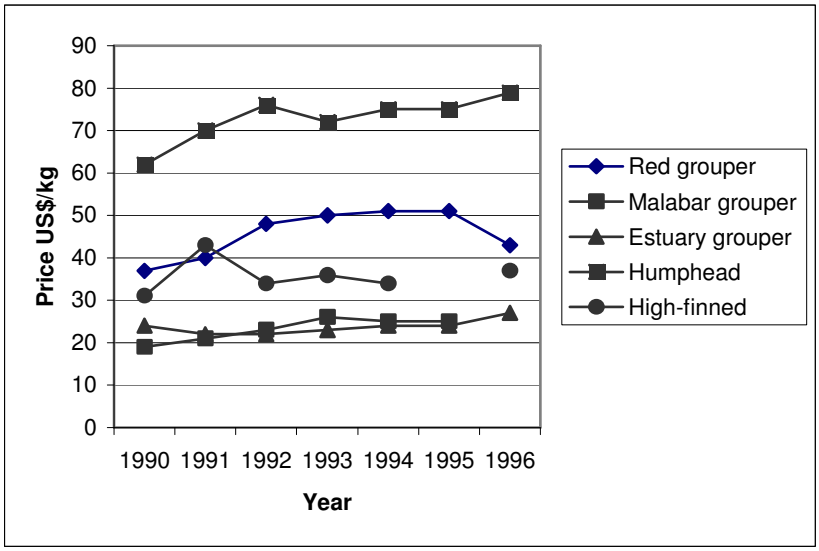


Figure 4-27 Average wholesale price in Hong Kong (US$/kg) Source: INFOFISH



4.5 Long-term viability and conditions for successful grouper culture

Section 4.4 has already shown how the benefits that households are able to derive from grouper culture may be reduced by problems that affect the productivity or profitability of grouper culture. However, as described in Chapter 3, data gathered during the qualitative data collection phase suggested that a number of more fundamental issues acting at the community level may also determine the extent to which grouper culture will be successful in the long-term. This section first presents data showing the extent to which farmers have taken up of stopped raising grouper in the case study communities. The respective roles of motivation and incentive, and finally of social capital, in the long-term success of grouper culture are then discussed. The emphasis in this section is therefore at the community level rather than at the household level, as in section 4.4.

4.5.1 Discontinuance of grouper culture

At the time of the survey, a total of 50 households in the three villages reported that they were currently raising grouper. However, 102 had begun to raise grouper, but had for various reasons discontinued (Table 4-35).

Statistical analysis to test for association between fish culture[26] and grouper culture status showed that there is a significant association between fish culture and Ba Kan Khoei (p=0.000). The results indicate that the number of households raising fish in Ba Kan Khoei is higher than would be expected if the variables were independent. Fish culture in Ba Kan Khoei accounted for 55.7% of the test statistic.

No significant association was found between level of discontinuance and case study villages, although Koh Khiam and Thung Sa Pho have higher levels of discontinuance than would be expected if the variables were independent, with Koh Khiam showing the greatest divergence from the expected value.

When the Chi Square analysis was applied to grouper culture uptake, discontinuance and rejection, no significant associations were found.

Table 4-35 Level of uptake, discontinuance and rejection of fish culture in the case study communities (Source: survey data)

	Thung Sa Pho N=40		Ba Kan Khoei N=35		Koh Khiam N=166	
Fish culture (all species)	N	%	N	%	N	%
Farmers raising fish	9	22,5	23	66	36	22
Discontinuers	17	42,5	11	31	73	44
Rejectors	14	35	2	5	56	34
Grouper culture						
Farmers raising grouper	6	15	16	46	28	17
Discontinuers	16	40	11	31	75	45
Rejectors	18	45	9	26	62	37

4.5.2 Factors contributing to discontinuance of grouper culture

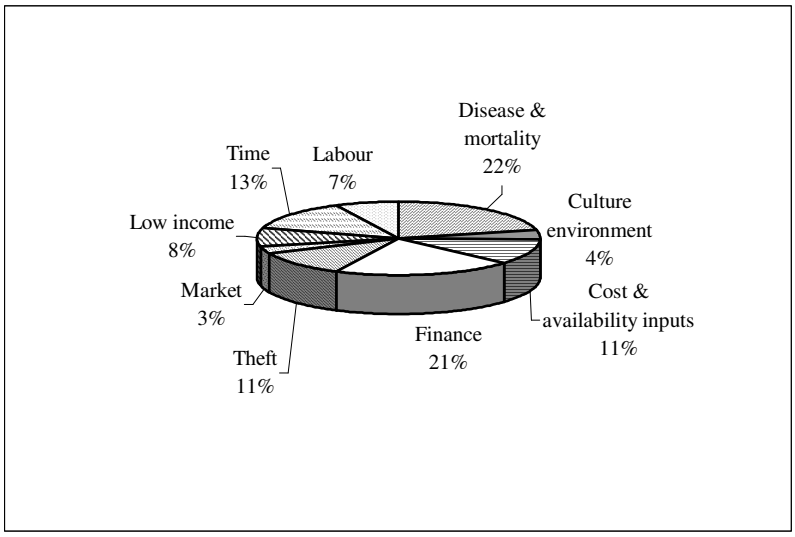
It was found that the problems grouper farmers had experienced when they were raising fish differed from those which ultimately led them to discontinue grouper culture. For example, fish disease and mortality, although still one of the major causes of discontinuance, accounted for a smaller proportion of the responses given as causes of discontinuance than was found when farmers reported grouper culture problems. It was found that fish disease and mortality accounted for 21% responses given to

[26] Here fish culture is described as the culture of all finfish species, including grouper. Grouper culture refers specifically to inclusion of grouper in culture activities, and the subsequent continuance or discontinuance of grouper production.

explain grouper culture discontinuance. This may suggest that while grouper farmers consider disease and mortality to be a problem for them, they continue to raise fish despite fish mortality. This can be explained with reference to the economic analysis presented in Section 4.4.9, which showed that farmers could sustain substantial losses of fish without making a loss.

Financial factors also made a greater contribution to the results explaining discontinuance than was found for grouper culture problems, including the lack of financial capital for investment in grouper culture, and the cost and availability if inputs. This suggests that although farmers may receive support to begin fish culture, they are unable to continue if there is a lack of seed supply from the wild, and they are unable to invest in purchased seed inputs. Lack of grouper seed accounted for 40% of responses relating to the cost and availability of inputs. Theft and labour constraints were also found to be relatively important factors in grouper culture discontinuance, as shown in Figure 4-28.

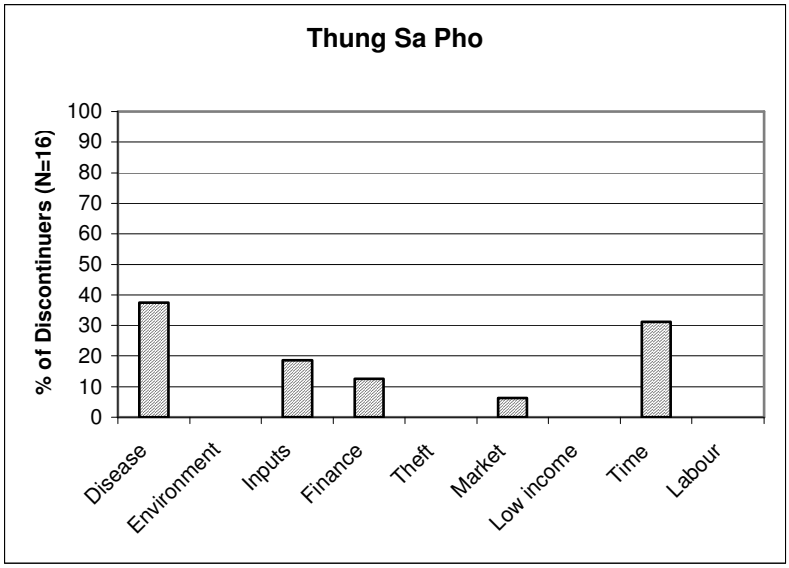
Figure 4-28 Factors contributing to the discontinuance of grouper culture in the case study communities (N=102, 142 responses)

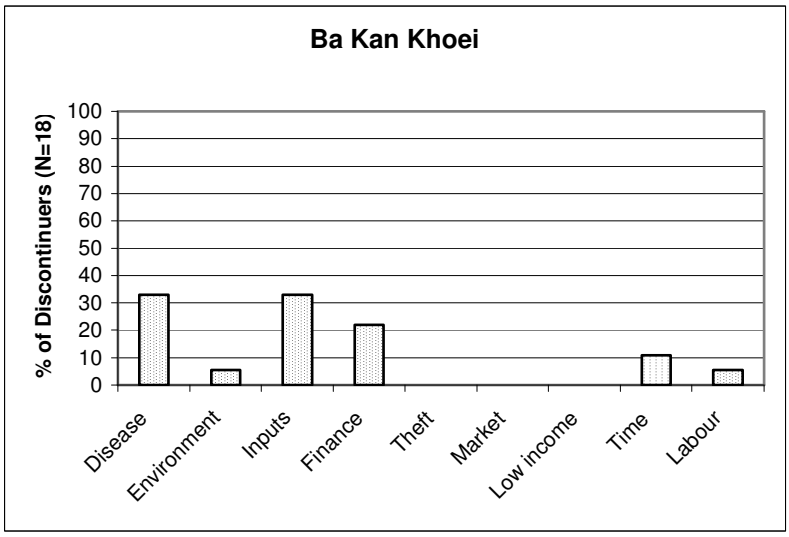


As Figure 4-28 shows, causes of discontinuance varied between communities. Analysis showed that theft, cost of inputs and income were significantly associated with individual communities (Table 4-34).

Statistical analysis of the responses obtained from discontinuers to explain the reasons for grouper culture discontinuance showed that theft was significantly associated with Koh Khiam. 22% of respondents indicated that theft of fish from their cage farms had been a factor in their decision to discontinue grouper culture. Theft was not reported as a problem or as a cause of discontinuance in either of the other two case study villages. Low income from fish culture as a cause of discontinuance was also significantly associated with grouper culture discontinuers in Koh Khiam (P=0.033).

Figure 4-29 Factors contributing to grouper culture discontinuance in each of the case study communities. Responses shown as a percentage of discontinuers who reported each problem





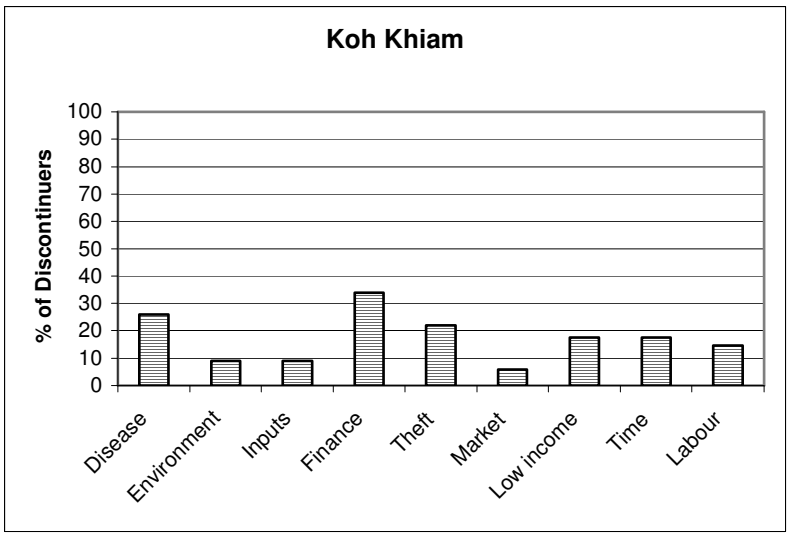


Table 4-36 Results of Chi square analysis for association between factors contributing to grouper culture discontinuance and community

Factor	Chi square value	P	Level of significance
Fish disease and mortality	0.921	0.631	NS
Culture environment (Incl. Pollution)	1.636	0.441	NS
Cost and availability of inputs	7.064	0.029	P<0.05
Financial constraints	3.308	0.191	NS
Theft	8.793	0.012	P<0.05
Low or unstable income	6.800	0.033	P<0.05
Time constraints	2.396	0.302	NS
Labour constraints	3.532	0.171	NS

The results suggest that grouper farmers in Ba Kan Khoei experience more problems with the cost and availability of inputs for grouper culture than the other two communities. A significant association was identified (p= 0.029) between the variation in the cost and availability of inputs and Ba Kan Khoei. The number of responses from discontinuers indicating that high costs of inputs and lack of seed had led them to discontinue grouper culture were higher than expected if the variables were independent. However, as shown in Table 2-20, both seed fish and feed costs were found to be lower in Ba Kan Khoei than in the other villages. That grouper farmers were unable to continue to raise fish due to the cost and availability of these inputs suggests their relatively greater dependence upon their own catch for wild inputs and lack of financial capital to sustain grouper culture.

4.5.3 Motivation and incentive

The variation in success in fish culture, where success is defined in terms of the level of uptake and continuance of fish culture, could also be explained by the necessity of households to make a success of alternative livelihoods, which in turn could be influenced by village location and access to resources. Fish culture was particularly successful in Ba Kan Khoei, where 66 % of households raised fish, the benefits of which contributed 35.2 % to the total income of the community (Section 4.1.4). Fish culture uptake in Ba Kan Khoei was also significantly higher than in the other case study villages. Fish culture in Thung Sa Pho had its successes primarily amongst pond farmers. Cage culture was less successful with 42.5% of households discontinuing. Although fish culture continued in Koh Khiam, farmers had experienced varying levels of success and significantly high levels of discontinuance. One possible explanation for these differences in levels of success could be explained by the availability of livelihood options, which in turn are influenced by the availability of resources and the location of the village.

Households in Thung Sa Pho were engaged on average in a greater number of livelihood activities than households in either Ba Kan Khoei or Koh Khiam, and were able to select their activities from a wider range of possible options, many of which were reliant upon the communities relatively abundant land resources. Fishing activities were more lucrative than in other villages and fishing households earned more on average than non-fishing households. Households were therefore able to generate a good benefit from the activities in which they were engaged, and perhaps had less incentive to succeed in fish culture than in other villages. As the materials for fish culture were provided by the DoF, with farming households having to provide no investment of their own, as the Head of the village suggested, they had nothing to lose and were largely uninterested in fish culture. In contrast, households in Ba Kan Khoei were able to choose from very few livelihood options, and were largely dependent upon aquatic resources to meet their household needs. With fishing generating relatively low incomes per households, fish culture offered an opportunity for income generation and asset building. Households therefore had a greater incentive to make a success of fish culture. As the community has experienced the benefits that their fish culture activities can generate for individual households and for the community, the motivation to continue has been strengthened.

It could also be argued that fish culture is more successful when villagers approach the DoF for assistance, as opposed to the DoF selecting beneficiaries of the extension project. In this way, the DoF acts as a facilitator, rather than as an initiator of fish culture, with possible implications for the success of the project.

4.5.4 Social capital

During the study, it was noted that members of the communities raised issues of trust and community cohesion, referred to in the development literature as 'social capital', in connection to the problems or successes that fish farmers had experienced. There was sufficient evidence generated to suggest that social factors and the ability of community members to work together can have a significant impact on the ability of fish farmers to generate a benefit from aquaculture. The issue was identified during the qualitative phase of research. The hypothesis that social capital could contribute to the success or failure of grouper culture was tested using a quantitative survey. However, as will be discussed later in Section 5.5.2 and Section 5.5.3, problems encountered during data collection in the field led to the generation of mostly inadequate data for analysis. The hypothesis could therefore not be tested. The

information presented here is therefore a summary of the evidence gathered during the qualitative phase of research, and the analysis of a small number of questions for which the quality of the data collected was sufficient for analysis, with emphasis on the issue of trust and the ability of members of the community to work together.

Attention was first drawn to the issue of social capital in Koh Khiam during key informant interviews in the village in July 2000. At this time, informants described their experiences as part of a fish culture group, established in 1988 with credit from the Bank of Agriculture and Agricultural Cooperatives (BAAC). The group failed financially and many villagers fell into debt as a result. Comments made with reference to this experience indicated a lack of trust and honesty in the village. Credit had been granted to the group on the condition that villagers form groups and work together to raise fish. This appears to have created problems amongst the villagers,

'The people have to organise themselves, 10 people per group. It was difficult to work in a group, better to work alone. Cannot trust amongst friends in the same group. Take it in turns to watch over the fish, but when some people watch the fish disappear. Creates feelings of suspicion' (Grouper farmer discontinuer, Koh Khiam)

The hypothesis that a lack of community cohesion existed in the village was supported by comments made by the head of the village and other respondents who felt there was a lack of trust and honesty in the village. The head of the village reported that '*the problem in the village is trust*.' Another respondent reported that there is '*no honesty in this (fish culture) group*'. In contrast, another respondent commented that there is now less trust in the village than previously, and that trust had been greater when people worked together,

'Respondent says everybody trusts him. In past when he raised grouper could trust the people in his group and the would help each other for every kind of work for fish culture. Now more people independent and now he says there is less trust in the village'

The hypothesis that levels of social capital may differ between villages was drawn primarily from experiences in Koh Khiam and Ba Kan Khoei villages, due to the apparently sharp contrast in the experiences of farmers working together in groups to raise fish. In contrast to the problems encountered in Koh Khiam when villagers worked together to raise fish, the fish culture group in Ba Kan Khoei has grown since its inception in 1996 from 40 to 60 households and now provides a source

of credit for any villagers who wish to receive a loan (see Section 4.3.6). Members of the group act as security guards to protect the fish cages, and as result the farmers reported that they do not experience problems with theft, which is supported by results from the sample survey. Farmers work together to raise fish, with two people sharing two cages.

'Villagers won an award for fish culture in 2000. They won because they were able to return all the money they owed, they have a strong system and villagers trust the committee'. The secretary of the fish culture group also commented that trust is important for the success of fish culture. The evidence from qualitative data collection therefore suggested that levels of trust and community cohesion were higher in Ba Kan Khoei than in Koh Khiam, the quantitative survey sought to test this hypothesis.

The survey did not support the hypothesis that levels of trust and community cohesion are greater in Ba Kan Khoei than in Koh Khiam. Although levels of trust were, according to the survey, proportionally higher in Ba Kan Khoei than in Koh Khiam (Figure 4-30), no significant difference was found between the two villages. The highest levels of trust, according to responses to Question 6.1, are to be found in Thung Sa Pho. A later question regarding trust did, however, reveal that the majority of people (89%) in Ba Kan Khoei consider that most people in their community are 'basically honest and can be trusted', significantly more than in Koh Khiam (chi square7.355, df 1, p 0.007).

Figure 4-30 Responses to question 6.1 'Do you think that in this village people generally trust one another in matters of lending and borrowing?'

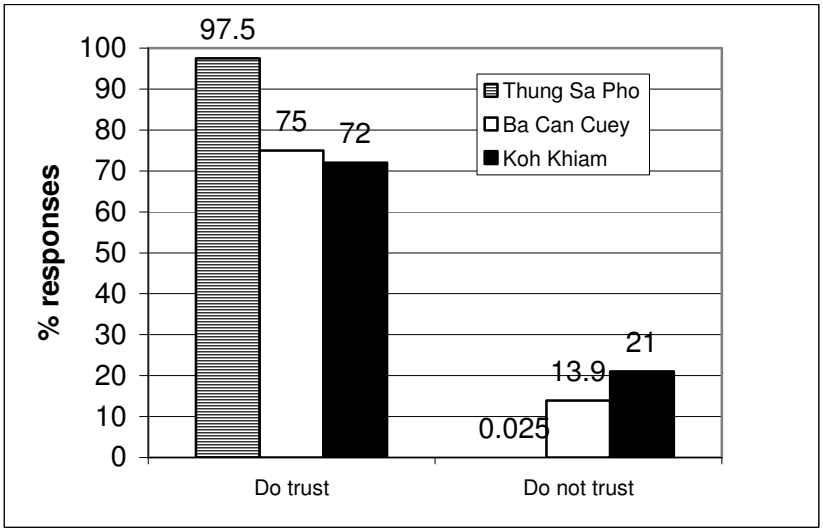
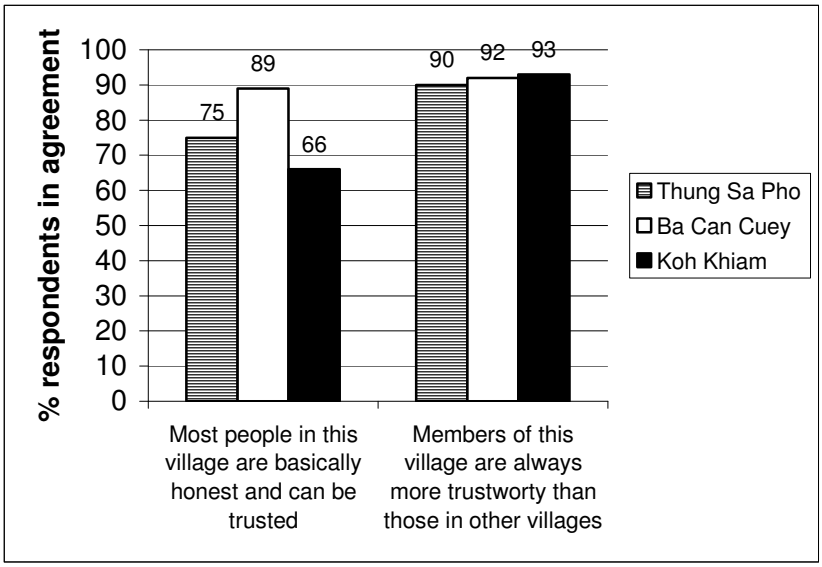


Figure 4-31 Responses to questions regarding trust in the community. Figures shown are thepercentage of respondents in agreement with the statement shown



4.6 Grouper culture and the environment

4.6.1 Introduction

As discussed in Chapter 1, grouper culture is seen as a potential solution to the problems associated with the trade in life reef fish. However, the impact of grouper culture on the environment, particularly its impact on wild grouper stocks, is a key factor in the determination of grouper culture sustainability and whilst it does, on the one hand, provide an alternative to the capture of wild adult grouper, it does have associated problems of its own. Concerns have been raised that grouper culture, dependent upon inputs of wild seed, constitutes a threat to the stock of grouper through the removal of large numbers of juvenile fish. Furthermore, the production of carnivorous fish based on a diet of trash fish produces a substantial output of waste products which may degrade the area surrounding the culture unit, and ultimately lead to self-pollution, fish disease and mortality.

This part of the study therefore aimed to determine the nature of the interactions which occur between grouper culture and the environment through discussions with farmers and fishers, collection of quantitative data using farmer record books and longitudinal studies at local fishing ports. Ecological aspects of grouper culture are, however, best studied through focused, longitudinal investigations which were beyond the scope of the present study. Constraints were imposed by logistical and time limitations and the lack of success achieved with studies based on farmer record keeping. This section

therefore represents an overview of the relevant issues pertaining to the environmental context of grouper culture, drawing on primary and secondary data where available.

4.6.2 Impact of grouper culture on wild fish stocks

Status of juvenile grouper in the wild

The majority of respondents reported that they thought the number of grouper juveniles and adult grouper in the wild was decreasing. The issue was discussed with 21 respondents, 12 of whom thought that fry stocks were decreasing. For some fishers, it is no longer worth while to fish for grouper,

'He stopped fishing for grouper as fuel and bait were expensive, the fish fetched a low price and he had to travel a long distance to fish. The number of fish has decreased. The fish are also a smaller size. Grouper are hard to find and smaller. Ten years ago could make a very good income from grouper fishing. Now some days cannot earn enough to cover fuel and daily expenses. Some days buys 100 THB of fuel, no return. To change gears as need investment to buy new gears, but had saved money. Changed about three years ago.' (Fisher, Koh Khiam).

The pattern of availability of grouper juveniles can be illustrated by the records kept by a fry trader in Koh Khiam. The records, kept between 1995 and 2001, show every purchase of grouper juveniles made by the fry trader during this period. Information recorded included:

1. Grouper species (principally *E.coioides*, and *E.bleekeri*)
2. Size of the fish
3. *E.coioides* was recorded in size groups of 'more than 200g', 8 inches, 6 inches, 4 inches and 3 inches.
4. *E. bleekeri* recorded as greater that 4 inches, or less than 4 inches in size 'cm' fish
5. The name of the fisher who had caught the fish (recorded by boat, not by number of fishers in boat). The data therefore includes the number of fishers who had fished for grouper each day and sold their catch to the fry trader[27].
6. The sum paid for the total catch

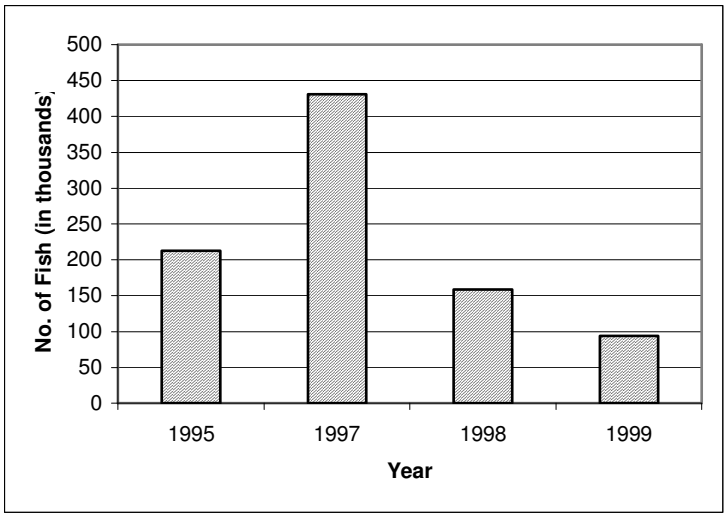
[27] Fishers generally consistently sold their fish to the same fish trader. There is therefore little possibility that the figures represent only the data from those fishers who had chosen to sell their fish to this particular fisherman on any particular day.

7. The records are kept consistently on a daily basis. Complete data sets are available for the years 1995, 1997, 1998 and 1999.

Analysis of these records shows that the total number of grouper juveniles purchased by the fry trader, and the number of fishers fishing for grouper, showed an overall decline between 1995 and 1999.

Figure 10-1 shows a peak in the purchase of grouper juveniles in 1997, although the average number of fishers recorded fell between 1995 and 1997 (Figure 2).

Figure 4-32 Total number of grouper juveniles purchased by fry trader, 1995-1999.



A separate analysis of the two principal species caught by fishers, *E. bleekeri* and *E. coioides*, shows that the peak in the number of grouper juveniles captured and sold in 1997 can be attributed to a peak in capture of *E. bleekeri* sold by fishers, which later declined. The number of *E.coioides* caught declined between 1995 and 1998, showing a slight increase in 1999. The decline in the number of *E. bleekeri* sold to the fry trader may, however, be due to the fall in value of *E.bleekeri* in 1999, which occurred when demand for the species in Hong Kong fell. At this time, fishers reduced effort in targeting this species and some may also have left the fishery, contributing to the decline in fisher numbers.

Figure 4-33 Average number of fishers selling wild caught grouper to fry trader, per day, 1995-1999

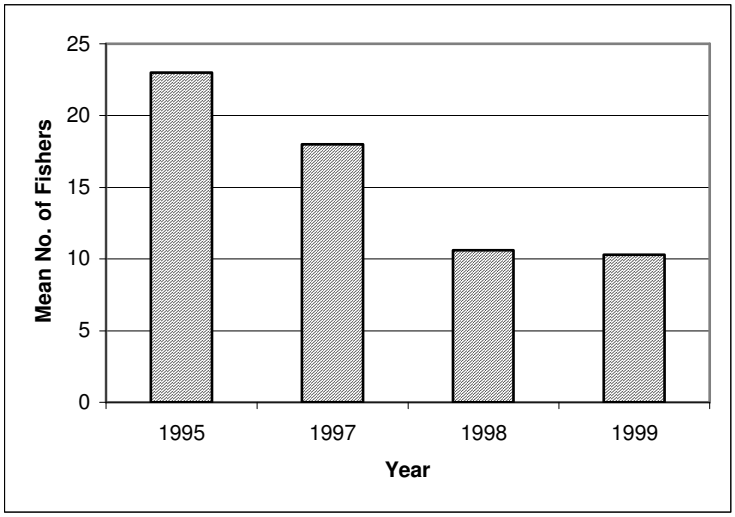


Figure 4-34 Catch Per Unit Effort[28] for two grouper species, 1995-1999

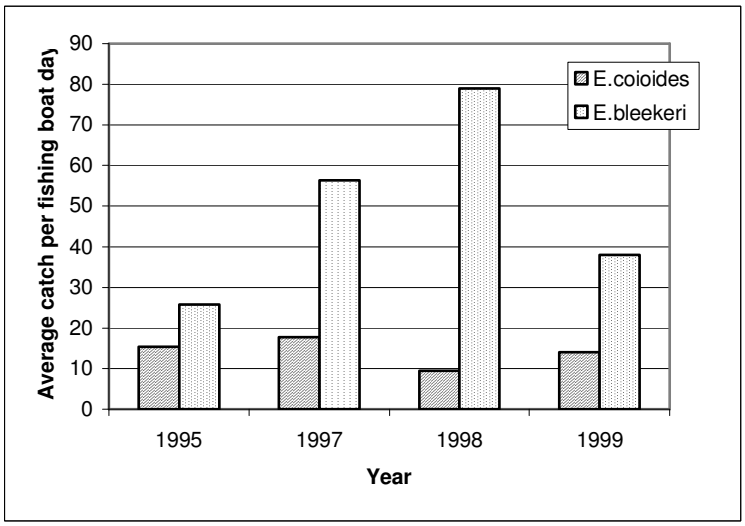
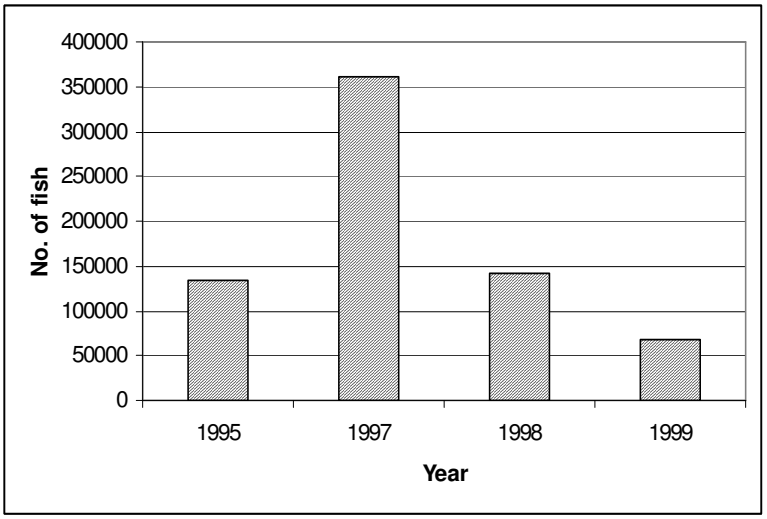
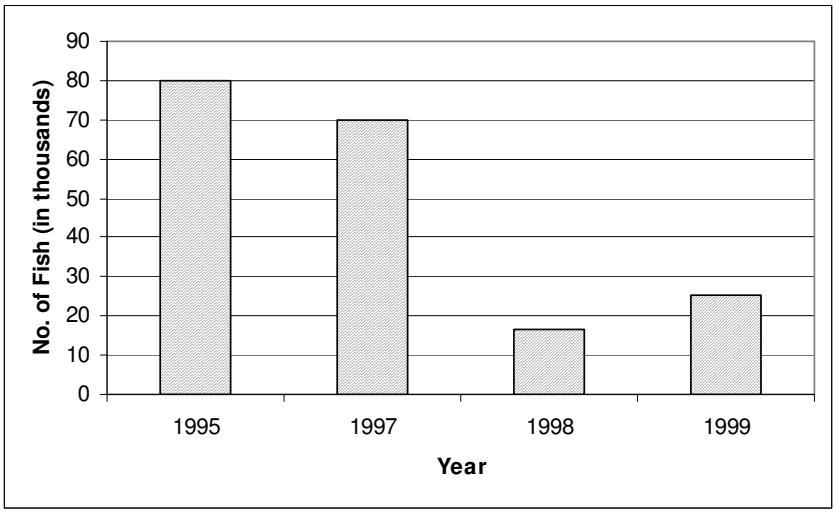


Figure 4-35 Total number of *E. bleekeri* juveniles sold to fry trader1995-1999



[28] CPUE calculated as: the average number of fry caught per fishing boat, per fishing day

Figure 4-36 Total number of *E. coioides* juveniles sold to fry trader 1995-1999



However, the market for *E.coioides* did not experience the same decline in value, yet still shows a decline in fish purchases recorded by the fry trader. Analysis of CPUE (calculated as the catch per fishing boat day) shows that overall, there was little variation in the number of fish caught per fisher per day, with numbers of fish caught remaining relatively stable between 14 and 18 juvenile fish on average, per fisher per day. This would indicate that the fall in numbers of fish sold to the middleman can be attributed rather to a fall in the number of fishers, rather than to a fall in the number of fish available.

The overall conclusion that can be drawn from the data is, however, that during 1995 and 1999 evidence based on the CPUE suggests that there was no decline of *E. coioides* in the wild. Results for *E. bleekeri* are inconclusive. The data set covers a relatively short period of time in biological terms, and could therefore not provide any firm evidence of trends in the stock of grouper juveniles. Reports from fishers that the availability of grouper has declined in the last 10 years cannot therefore not be confirmed or rejected. At present, no alternative source of information regarding the status of the grouper stock in the region exists.

4.6.3 Factors contributing to the apparent decline in grouper juveniles

The apparent decline in the availability of grouper juveniles, in addition to a more general decline in the fishery overall, was attributed by respondents to the commercial fishery and the use of destructive fishing gears. Pollution was also implicated in the degradation of the marine environment and the associated decline in fish availability,

'Reason for decline- because use of auan laak ku ('two pull net' – trawl net). People also use a drug and fry fish die.' (Respondent, Ba Kan Khoei)

'He thought if no auan lark would be more fish. Auan lark catches a lot of fish, send the fish they don't need to feed factories. There are no few auan loon. He thinks this isa good thing and can find grouper fry in klong this year and he thinks this year have a lot of grouper fry maybe from (banning of) auan loon' (Fry fisher, Chebilang)

'If fishermen don't catch fry fish and wait to catch adult grouper, is this better or not? He answer, if fishermen don't catch the fry, auan lark will catch them instead. When grouper fry are bigger they will go to deep sea. And auan loon have a bad effect for grouper fry also.' (Fish trader, Chebilang)

Fishers in Koh Khiam also reported problems of dynamite fishing and channel dredging in the area.

4.6.4 Impact of grouper culture on the local environment

As discussed in section 4.4.3, farmers experienced problems with water quality, which they attributed both to external sources such as shrimp culture and upstream industrial activities, but also to the density of fish culture units in the culture area. As analysis of the impacts of water pollution on grouper culture and of grouper culture on its wider environment were beyond the scope of the current study, this issue is addressed here through a discussion of the available literature on the interaction of tropical mariculture on the aquatic environment.

The impacts of mariculture on the environment are related to the demand imposed on natural resources for the provision of coastal land, coastal water area and water resources, biological resources for inputs of seed and feed and the provision of environmental goods and services for the provision of oxygen and the assimilation of waste products (Phillips 1998; Beveridge et al. 1997). In Asia, Chua et al. (1989) report that the impacts on the environment as a result of cage culture are not as severe as the problems experienced in temperate regions, as the level of production remains low, with relatively low stocking densities and small farms. However, the impacts of pond culture in the region are well-documented and a subject of much debate. Coastal lands and waters have been modified for the culture of shrimp and carnivorous fish, which results in pollution from the release of sulphuric acid to surrounding water bodies from the acid sulphate soils of the reclaimed pond area, the hardening of bottom soils due to long-term lime application, and release of pollutants into the surrounding aquatic environment from the use of pesticides, fertilizers and trash fish feeds (Chua et al. 1989).

Studies investigating the environmental impact of fish culture in tropical marine waters are relatively scarce in comparison to the research that has been carried out in temperate waters, and studies to investigate the impact of shrimp pond culture dominate the literature. However, the impact of fish culture in tropical waters cannot be extrapolated from temperate studies as environmental conditions and culture practices differ between the two climatic zones. As Wu et al. (1994) point out, two principal differences influence the environmental impact of fish culture in tropical waters:

1. Trash fish, rather than pelleted feed, is the most commonly used feed in tropical/sub-tropical fish farms. Food wastage, organic and nutrient loadings are therefore higher when copared to pelleted feed. Smaller particles are produced from trash fish which are dispersed over a wider area.

2. Higher water temperatures increase the rate of biological processes in the water.

Two studies have been conducted which analyse the impact of grouper culture systems on the aquatic environment.

Songsangjinda et al. (1993) found that the quality of sediments between areas of Khlong Pakbara under grouper culture production was degraded by accumulation of organic matter, with associated high levels of nitrogen and phosphorous. Grouper culture in Satun province is concentrated in Pakbara, where cages are densely packed, lining the mangrove channel. Grouper farmers had experienced low levels of disease problems since culture began, but in 1993 grouper culture in the area suffered massive mortalities with farmers losing between 70 and 90% of their stock (Songsangjinda et al. 1993). A pathogenic origin for the mortalities was not identified and the culture environment was hypothesised to be the cause of the problem. The study presented by Songsangjida et al (1993) indicates that accumulation of high levels of waste beneath the cages could have led to eutrophication and a subsequent decrease in the levels of dissolved oxygen available in the culture area. The practice of throwing dead fish into the *khlong* is also suggested to be a causative factor in the degradation of the environment and the spread of disease. Impacts are, however, localised.

Arulampalam et al. (1998) found evidence of a significant relationship between vibrio and harmful bacterial counts in waters and sediments in the vicinity of grouper and seabass cage farms in Malaysian waters. Their analysis found that nitrite levels in water were positively correlated with the abundance of

aerobic bacteria and yellow vibrios, secondary pathogens which may often cause disease when fish are under stress (Arulampalam et al. 1998). Similar results were observed in the sediments of the study areas. The study showed that nutrients in the aquatic environment can increase the bacterial density in the cage culture system, a problem exacerbated by the use of trash fish feed, which leads to high levels of waste output (Arulampalam et al. 1998).

Chapter 5
Discussion and Conclusions

5.1 Discussion of the research findings

5.1.1 Fisher livelihood strategies in southern Thailand

Livelihood strategies

Throughout the study it was observed that fishing represented only one livelihood option for households in coastal communities. Furthermore, households were not dependent upon aquatic resources. Activities could generally be categorized as land-based, wage and business related or aquatic resource based. The relative importance of each of these livelihood categories varied between communities.

Detailed analysis at the case-study level showed that the principal strategies employed by households in the case study village included diversification of livelihood activities and flexibility both within the fishery, manifested in the use of different gear types, and the flexibility to enter and leave the fishery according to the benefits generated by available livelihood options. These findings are in agreement with the conclusions put forward by Allison and Ellis (2001), who identified flexibility within fisheries, geographical mobility and livelihood diversification to be key strategies employed in the livelihoods of fishers.

Panayotou et al. (1985) also found evidence of diversification in Thai coastal communities. The study highlights the occupational structure of small-scale fishing households, which undertake a variety of supplementary occupations in addition to fishing. Farming, including coconut and rubber plantations, were found to be the most common non-fishing activities in which households were engaged. Other activities fishers included in their livelihood portfolios include small business (e.g. retail trade), wage employment (government office, construction and unskilled labour) and other farming activities such as livestock raising and fish culture.

The monthly and annual patterns of fishing activity also contribute to the participation in multiple occupations by fishers. Fishers do not go to sea everyday, as shown in this study Section 4.4.2, leaving

periods of time between fishing where fishers are able to undertake other activities. Librero et al. (1985) and Seilert and Sangchan (2001) report similar findings in the Philippines and Thailand, respectively. Fishing activities are also reduced during the storm season. These fluctuations in fishing activity can create vulnerability in fishing households when no alternative employment opportunities exist, but they also have implications for the type of alternative activities that could be undertaken alongside their fishing activities.

Panayotou et al. (1985) observed that the degree of diversification of activities shown by households was influenced by the profitability of the fishery and the availability of other, well-paying alternatives. This was also observed in the case study analysis.

According to current literature, the reasons put forward for livelihood diversification are summarised as either those arising out of necessity, or out of choice (Ellis 2000). Necessity implies an involuntary move to adopt new occupations for reasons of survival, which may be defined as 'push' factors (Barrett et al. 2001). Ellis (2000) gives examples such as the dispossession of a tenant family from its access to land, or the effects of environmental deterioration, natural disasters or conflict. 'Pull' factors represent motivation to diversify resulting from a strategic choice made by a household to accumulate assets for the improvement of general life quality. The uptake of activities may also be prompted in the absence of functioning credit markets. The adoption of new activities is therefore necessary for the further development of household livelihood portfolios. In this study, 'pull' factors dominated as the motivating factor for diversification in the case study communities. Diversification, with particular reference to the uptake of fish culture, was associated with the accumulation of assets for the improvement of living standards, and investment in education for children of the household.

The extent to which households diversified varied between villages. Livelihood diversification was found to be relatively low in Ba Kan Khoei and Koh Khiam villages, with households adopting, on average, 2.4 and 2.2 activities per households respectively. However, it is possible that the plurality of occupations recorded during the study represents the individual activities of each household member. Therefore, any household in which two or more adults are employed in different occupations would be categorised as a household which has adopted a 'diversified' portfolio. As the average number of adults per household is 3.7 and 2.9 in Ba Kan Khoei and Koh Khiam respectively it may be suggested that most households adopt fewer activities than the number of adults in the household could support, and

may possibly indicate unemployment in the villages. Data relating specifically to the level of unemployment in the villages was, however, not collected.

Livelihoods were relatively more diversified in Thung Sa Pho, with households employing, on average, 3.9 activities. The availability of land resources, averaging 7.3 rai per household, in Thung Sa Pho and the associated availability of land-based livelihood options may be the principal reason for the differences observed between the level of livelihood diversification in Thung Sa Pho and the other two villages. The relatively large number of livelihood options available in each community negates the possibility of adequately analysing all the possible combinations of activities put together by households, and how the choices made by an individual household may be related to certain attributes such as skill, education, gender or status. A number to indicate the total number of activities taken up by a household therefore fails to illustrate the complexities of household livelihood portfolios, and permit the differentiation between households who adopt five low income activities, compared with a relatively wealthy household employing one or two relatively high income options.

The benefits accruing from diversification differ according to the risk profile of the household and the uptake of low risk, low return activities on the part of risk averse households, and the ability to invest in profitable activities which require a lumpy investment on the part of wealthier households. Evidence from the literature, based primarily on research conducted in rural Africa, is contradictory and suggests on the one hand that diversification is associated with higher incomes (Reardon et al. 1992; Barrett et al 2001), on the other hand that diversified portfolios are associated with lowering risk at the cost of lower incomes (Dercon and Krishnan 1996). The benefits resulting from diversification therefore appear to be context specific, as it seems that diversification may lead to the generation of higher incomes, or may suggest that entry barriers exist which reduce the ability of the poor to diversify, whilst in other contexts diversification reduces risk and promotes income smoothing, but also results in an overall reduced benefit.

In the current study, diversification was significantly associated with household wealth. However, poorer households were also found to undertake on average 3.3 livelihoods, compared with 5.4 activities for the wealthier households. Analysis of the available livelihood options and the association between uptake and wealth status indicates that diversification in the case study communities is associated with wealth, as many of the available livelihood options are inaccessible to poorer

households lacking investment capital. Most households are therefore limited in their ability to diversify by barriers which prevent them from taking up further, more profitable activities.

5.1.2 Role of grouper culture in livelihoods of coastal households

Although households may wish to diversify their livelihood portfolios in order to reduce household vulnerability, the uptake of a new livelihood may not always be possible for some households. As Dercon (1998) notes, with respect to cattle farmers in Tanzania, the most profitable activities and assets are characterized by entry constraints. This was also found to be true in the case study communities. Livelihood choices made by households could be influenced by the existence of entry constraints determined by wealth (or access to financial capital), skill and education. Activities including the ownership of a rubber plantation, shrimp culture, retail trade and work in government were found to be statistically significantly associated with wealthy households. These activities require access to land resources (rubber plantation, shrimp culture) or the ability to purchase land. If the community is poor in land resources, then the owner must be able to reach the plot of land, and may therefore also need some form of transport. With the exception of employment in local government, the activities also require a substantial financial investment. Fish traders, for example, require a truck for transportation of the fish. If live fish are to be transported, tanks and aerators are also needed. Households who are involved or wish to be involved in these activities must therefore have access to sources of financial capital, which for many households with little or no collateral for a bank loan is impossible.

However, it was found that fish culture, together with wage labour, fish processing and factory work, were not significantly associated with any wealth group. As one of few options that allows households to save money and build assets, the ability of poorer households to take up fish culture is particularly significant. Like many profitable activities, fish culture requires a 'lumpy investment', but is a 'liquid asset', similar to other types of livestock, which permits consumption smoothing (Dercon 1998). Liquid assets allow households to have access to funds through the sale of stock during times when other income sources are limited or unavailable. More importantly, they act as a means by which households can accumulate assets to invest in other productive activities, or development of capital assets, which is seen in development policy as being a necessary step away from poverty and to

improved quality of life. Similar observations were made in Vietnam on the Lo River (AIT Outreach 2000) and in Hué (Crumlish and Sheriff, unpublished), see Section 1.5.3. In the early stages of the research, during the preliminary appraisal and survey of Trang and Satun provinces, fish culture was often associated with wealthier households, as the cost of investment in cage units was prohibitive to most poor households. However, with the intervention of the DoF, the greatest obstacle to the participation of poorer households in fish culture, the initial investment in cage materials, or 'lumpy investment', is removed and it was observed that poor households could benefit from fish culture.

Contribution of activities to livelihood strategies

The information provided by respondents, particularly during focus group sessions, provided a good indication that the activities which contribute to the livelihood portfolio are selected based on the role of the activity within the livelihood portfolio. Respondents reported that activities may contribute to the overall livelihood of a household by providing a daily income, permitting the household to save money and thus build assets. Activities may be important because of the amount of income it can generate, or due to its relationship with other activities, and the skills and assets of the household and their ability to take up the activity. Seasonality also influenced activity uptake.

Fishing households are vulnerable to the seasonal nature of fishing activities, which are particularly affected by the annual storms occurring towards the end of the year, during which time fishers may be completely unable to fish. At this time, the household has no income unless additional occupations are undertaken. However, for a number of households, fishing was the only activity they reported, leaving them vulnerable at times when fishing is impossible. The lunar cycle also exerts an influence on the livelihoods of fisher households. Unless fishers are engaged in the fishery for grouper juveniles or shrimp, fishing ceases during the neap tides and fishers either use the time to repair fishing gears and rest, or to take on a secondary activity. If fishers do not wish to discontinue fishing, additional occupations must fit within the monthly pattern of fishing activities.

Potential contribution of fish culture as an alternative livelihood option

It was found that fishing provides a source of daily income which pays for the daily needs of the household. In contrast, a number of activities, including fish culture, rubber production and the keeping of livestock, were identified as being of importance to the households ability to save money and thus to accumulate assets. The role played by fishing in household livelihoods therefore differs

from that of fish culture. This represents a key finding in the study, with implications for interventions which seek to encourage fishers to leave the fishery in order to take up aquaculture as an alternative livelihood occupation (e.g. examples in Haylor et al. 2003) Proposals to encourage fishers to leave the fishery by offering fish culture as an *alternative,* may therefore fail, as fish culture cannot meet the daily needs of the household. It is unlikely that in any of the villages studied, fish culture could provide an alternative to fishing. Fish culture meets a different need in the livelihoods of fishers, as a means of saving, whilst fishing provides the daily income that fish culture cannot provide. As a source of daily income, alternative occupations in both Ba Kan Khoei and Koh Khiam generate a smaller benefit than fishing, so fishers would have no incentive to discontinue fishing activites. In Ba Kan Khoei, fishing and fish culture are strongly related activities which contribute in different ways to household livelihoods. Furthermore, respondents in Ba Kan Khoei defined the high risk associated with trammel net fishing as a risk to life. This combination of factors provides an indicator of the importance of fish culture to Ba Kan Khoei, where the risks associated with fishing and fish culture (attributed to cage damage and fish disease) are considered together with the relatively high investment required for both trammel net fishing and fish culture. It is also likely that households take on these risks and investment in the absence of a more favourable alternative.

In Thung Sa Pho, the reported income from fishing was higher than in other villages, and fishers felt no need to replace their fishing activities with an alternative such as fish culture, as long as their fishing activities generated a good benefit. Also in Thung Sa Pho, the average income of fishing households was higher than that of non-fishing households. The reverse was found to be the case in Ba Kan Khoei and Koh Khiam. However, in Koh Khiam, fishing provided a relatively higher income compared with other alternative activities which could provide a daily income, such as wage labour or factory work. Fishers in Koh Khiam therefore also had an incentive to continue fishing, rather than taking on alternative employment. In Ba Kan Khoei, 80.5% of households were employed in the fishery, although the income to each household appears to be lower than that from wage labour. It is possible that wage based employment is limited in the village or, alternatively, fishers do not want to cease fishing. In Ba Kan Khoei, the success of fish culture provides an incentive for fishers to remain in the fishery. Fishing was reported to be an important activity in Ba Kan Khoei with respect to its relationship to fish culture. Fishing activities provided households engaged in fish culture with a source

of wild caught seed and feed inputs, which enabled poorer households who did not have the financial capital to purchase inputs to participate in grouper culture.

5.1.3 Factors affecting the long-term contribution of grouper culture to fisher livelihoods

Fish disease and mortality were the most commonly reported problems experienced by grouper farmers, yet were found to be less important as a contributing factor to grouper culture discontinuance than might be expected. Financial factors, the availability of inputs, fish theft and the availability of time and labour to maintain fish cages and take care of the fish stock were also important factors affecting the ability of farmers to continue grouper culture.

Financial constraints

A number of respondents reported that lack of access to credit made it impossible for them to invest in the purchase of grouper fry, and they could not therefore continue to raise grouper if they did not catch their own seed and feed inputs. The continuation of fish culture beyond the initial assistance of the DoF is therefore made possible for many farmers by the substitutability of natural and financial capital in the provision of inputs to grouper. Fisher/farmers from poor households with little financial capital or access to credit are able to stock their cages by fishing for grouper seed and trash fish feed. A number of respondents reported that they would be unable to continue raising fish if they could not catch wild caught seed, as the cost to purchase seed fish is too high. Thus the open-access nature of the aquatic resource allows poorer households to participate in an activity from which they may otherwise be excluded. Similarly, access to the water resource for the anchoring of cages is also an important factor in the accessibility of the activity to all households. Land based activities, including the raising of livestock, which may be considered aquaculture's terrestrial counterpart and another possible activity which would allow households to accumulate assets, are open only to households with land resources, or the ability to rent or purchase land. In contrast, there were no restrictions governing who had access to local water resources. However, similarly to the limits imposed by the availability of land resources on the uptake of land based activities, respondents did report that lack of a suitable culture site close to the household was a constraining factor in the uptake of fish culture.

However, during the year 2000 there had been a severe shortage of grouper seed from the wild, forcing many farmers to discontinue grouper culture. The substitutability of natural for financial capital is

therefore only relevant so long as natural resources can support fish culture activities. At this time farmers turned to seabass culture, as seabass seed are available from hatchery sources. However, a surplus of seabass on the market led to a fall in the value of seabass and many farmers were unable to sell their seabass stock.

Access to credit is a common problem for rural households (Coleman 1999). The Department of Fisheries has therefore been a key factor in the ability of households to take up fish culture, by removing the need to finance the initial investment in materials and seed fish. However, as discussed above, farmers may be unable to continue fish culture in the long-term without being able to further invest in seed fish. The projects established by the DoF therefore also include a component which permits the community to build up a central fund for use by the whole village using funds generated by successful fish culture. The credit programs established in each of the case study communities are examples of group-lending programs, one of the most common mechanisms by which households can access credit in rural areas of developing countries.

However, as the name 'microcredit' implies, the financial support offered by the village bank schemes established by the DoF provide small loans, intended to assist households in the development of new income generating activities such as petty trading. Respondents in Ba Kan Khoei commented that the money available to the community through the fund was too small, a comment also heard by Coleman (1999) during a study to assess the impact of group lending schemes in North eastern Thailand, where a common complaint amongst borrowers was that the size of the village bank loan was too small. Coleman (1999) suggests that the negligible impact of loans on borrower welfare may be due to the small sums of money available. The study found that there was no evidence that village bank loans are being directly invested in productive activities with a positive return (Coleman 1999). However, similar to the problem raised by the Head of the Village in Koh Khiam, villagers often did not take out loans to invest in productive activities, but rather to make home improvements or purchase new household goods. In Coleman's example, loans were used to smooth consumption.

The availability of loans from the Bank of Agriculture and Agricultural Cooperatives (BAAC) means that rural households in Thailand are less credit constrained than those in other countries (Coleman 1999). The bank offers both group loans and individual loans, which 84.5% of households have taken advantage of (Coleman 1999). However, the experiences of farmers in Koh Khiam, and the success of

the fish culture and credit scheme in Ba Kan Khoei suggests there is also a need for microfinance programs which allow households to have access to small funds, which reduces the opportunities for borrowers to get into unmanageable debt, negotiated amongst peers rather than amongst state officials, of whom many respondents were suspicious. Unfortunately, no detailed study of the precise conditions of credit access in Ba Kan Khoei was carried out, and it is therefore possible that problems and inequalities in the scheme exist that were not observed during the period of field research. The success of the scheme was judged on the basis of the expansion of culture activities from 40 households to 60, and individual reports from villagers that the fund had allowed people to improve their homes, and provided a scholarship fund to send village children to school. Furthermore, this success may not be achieved in every village where a village bank is established.The successful functioning of such credit programmes requires the investment of social capital, which may not be abundant in every village.

It is clear from the results presented above, that the removal of financial obstacles is not sufficient to ensure the success and continuity of fish culture, and particularly grouper culture. The motivation and incentive compelling households to take up and continue fish culture and the level of 'social capital' in a community were found to be possible contributors to the success of fish culture following its initiation either by innovators within the community, or by external institutions.

Motivation and incentive

The variation in success in fish culture, where success is defined in terms of the level of continuance of fish culture, could to some extent be explained by the necessity of households to make a success of alternative livelihoods, which in turn could be influenced by village location and access to resources. Fish culture was particularly successful in Ba Kan Khoei, where 66 % of households raised fish, the benefits of which contributed 35.2 % to the total income of the community. Fish culture in Thung Sa Pho had its successes primarily amongst pond farmers, cage culture was less successful with 42.5% of households discontinuing. While fish culture continued in Koh Khiam, farmers had experienced varying levels of success and high levels of discontinuance. One possible explanation for these differences in levels of success could be explained by the availability of alternative livelihood options, which in turn are influenced by the availability of resources and the location of the village. Households in Thung Sa Pho, for example, were engaged on average in a greater number of livelihood activities than households in either Ba Kan Khoei or Koh Khiam, and were able to select their activities from a

wider range of possible options, many of which were reliant upon the communities relatively abundant land resources. Fishing activities were more lucrative than in other villages and fishing households earned more on average than non-fishing households. Households were therefore able to generate a good benefit from the activities in which they were engaged, and perhaps had less incentive to succeed in fish culture than in other villages. As the materials for fish culture were provided by the DoF, with farming households having to provide no investment of their own, as the Head of the village suggested, they had nothing to lose and were largely uninterested in fish culture. In contrast, households in Ba Kan Khoei were able to choose from very few livelihood options, and were largely dependent upon aquatic resources to meet their household needs. With fishing generating relatively low incomes per households, fish culture offered an opportunity for income generation and asset building. Households therefore had a greater incentive to make a success of fish culture. As the community has experienced the benefits that their fish culture activities can generate for individual households and for the community, the motivation to continue has been strengthened.

It could also be argued that fish culture is more successful when villagers approach the DoF for assistance, as opposed to the DoF selecting beneficiaries of the extension project. In this way, the DoF acts as a facilitator, rather than as an initiator of fish culture, with possible implications for the success of the project.

Social capital

These factors may not, however, entirely explain the different levels of success seen in the three villages. Social capital and the role of institutions were also considered to be important factors contributing to the uptake and continuance of grouper culture. The ability of members of the community to trust one another was essential to enable them to work together in groups, one of the conditions of the fish culture projects implemented by the DoF, and common condition in many bank initiated microcredit programs (Tohtong 1988; Siamwalla et al. 1990). The importance of trust was particularly evident in Ba Kan Khoei where members of the fish culture group relied upon one another to guard the fish cages from theft.

The findings of this study were inconclusive with respect to the role of social capital in the success of fish culture. This is attributed to the lack of success achieved by using the SCAT tool to analyse social capital, which is discussed further in Section 5.5.3 below. However, other studies suggest that

aquaculture may actually contribute to the development of social capital (Brugere et al. 2000). Meyer et al. 2003 suggest that aquaculture development may benefit participants by increasing both household and community social capital by increasing community cohesion and increasing the propensity of the community to act jointly for the members of the community.

Institutional Support

Section 4.3.5 showed the important role that institutions, primarily the DoF, have played in the promotion and uptake of grouper culture. It was shown that the assistance provided by the DoF allowed poorer households to overcome the principal constraint to the adoption of aquaculture, investment in the culture system. However, a number of studies have also indicated that continued institutional and extension support is also a factor in the continuation of aquaculture (Meyer et al. 2003; Lovshin et al. 2000). Research for this study did not investigate the long-term involvement in the projects implemented by the DoF, although this is an issue that should be explored further in the future. The role of supporting institutions in the success of development interventions suggests that agencies which attempt to introduce or promote established aquaculture to relieve pressure on wild fish stocks must also consider the long-term needs of the project, which may require cooperation with local government agencies or NGO's to provide continued assistance to farmers. Mutual support and collaboration amongst farmers can serve to strengthen the benefits of extension support, again highlighting the significance of social capital (Meyer et al. 2003).

Significance of non-technical factors in development intervention

These findings highlight the significance of non-technical factors in the adoption/continuance of grouper culture in the communities studied. However, despite the implications of these findings for the success of development interventions, and effective targeting of appropriate communities, studies which report post-project outcomes, and the causes of their successes and failures, are lacking in the literature. In one of few studies that incorporates analysis of the socio-economic context for the adoption and continuance of aquaculture, Lovshin et al. (2000) found that abandonment of fish ponds in Guatamala could only be explained by a combination of technical, economic and social factors. Meyer et al. (2003) included mutual support and lack of consistent institutional support as factors contributing to the level of abandonment of fish ponds in Honduras.

A lack of motivation to succeed in fish culture was one of the reasons given in the current study for the discontinuance of grouper culture in Thung Sa Pho, where households had other livelihood options to select from, and fishers did not necessarily want to be tied to the responsibilities of fish culture. This finding, when taken together with the observation that groups who approached the DoF for assistance to raise fish were also the most successful in terms of longevity of culture activities, supports arguments for community-driven development.

5.1.4 Impact of grouper culture on household vulnerability

It has been shown that grouper culture is able to contribute a positive benefit to households, when the motivation to succeed and social conditions to support culture activities in the community exist. However, it has also been shown that grouper culture may be subject to risks imposed from outside of the community, due to the international nature of the market, which has experienced a number of perturbations in response to events taking place on a global scale, and risks arising from fish disease and problems of pollution and fluctuations in environmental conditions in the culture environment. These factors affect the economics of production, and may lead to increased vulnerability of households investing in grouper culture.

Fish disease and mortality was the most common problem reported and the greatest source of risk for fish farmers. However, although farmers called for assistance from the DoF to reduce their losses to fish disease, fish disease was not the main cause of discontinuance. Risk averse farmers employed a management strategy for fish culture that reduced the probability of losing the fish stock to disease, and the level of financial losses they would sustain if the fish became diseased, although the short culture cycle common amongst risk averse farmers returned lower financial benefits than the benefits of a longer culture cycle during which few fish are lost to disease.

Farmers also showed flexibility in the choice of species they chose to raise, particularly between grouper and seabass. Cultured species were selected according to prevailing fish prices, availability of seed inputs, and the level of risk the farmer could sustain. Seabass culture is relatively less risky, as the fish are less prone to disease and can better withstand changes in salinity than grouper. As seabass can also be sold on the local market, the dependence upon a middleman to access the market is reduced, and the market is relatively stable. Production of seabass seed in private and government hatcheries

also ensures a stable supply of seed fish. However, lower risk comes at a price, as the value of seabass and the financial benefits from seabass culture are lower than grouper culture. Farmers who are able to absorb the risk associated with grouper culture often choose to raise only grouper, and thus utilise their farm units to generate the greatest returns.

It should be noted that the flexibility in species cultured observed throughout the study may lead to a false interpretation of fish culture activities if a snap shot view of fish culture in any particular community is taken. Fish farmers could not be defined according to the species they raised at any one time. Fish farmers were opportunistic, adapting their culture systems according to the most beneficial options available.

Respondents reported that pond culture was relatively lower risk than cage culture, with farmers reporting a lower incidence of disease. However, pond culture is land intensive, and only households with access to land that is sufficiently close to a suitable water supply, or households with sufficient financial capital to rent land for pond culture can take up pond culture. Pond culture of grouper or other brackish species is not therefore a suitable activity for promotion, as the environmental costs in terms of the use of coastal land resources, such as mangrove forests, are relatively high and the benefits to the community would appear to favour relatively asset rich households. In Thung Sa Pho, 80% of pond owners were categorised as 'middle' to 'upper middle' in terms of household wealth status. Although this figure also indicates that 2 households from the lower-middle wealth group were able to take up grouper culture in ponds. Due to the small sample size of pond farmers, the association between wealth group and uptake of pond culture could not be tested for significance.

In addition to fish disease and mortality, factors such as motivation and incentive, and social factors were considered to contribute to the success or failure of fish culture. As these factors are not attributes of fish culture per se, but rather of the fish farmers and household decision making, they cannot be ascribed to the activity of fish culture in particular as they would apply similarly to any comparable activity.

Grouper culture, although not without risks, was found not to increase household vulnerability. In financial terms, respondents reported that they generally did not lose financially as a result of fish culture, although this belief may arise from a view held by many farmers that, as they had not

purchased inputs for seed and feed, and had received assistance with the provision of materials for farm construction, they had not invested financially and could not therefore lose anything. The indirect costs of fishing for seed and feed, or the time and labour invested in fish culture were not taken into consideration.

According to the responses obtained from fish farmers, grouper culture appeared to serve, at best, as a means by which households could save money and accumulate assets if they harvested fish, and at worst, as time wasted. Fish culture could contribute to consumption smoothing, and thus the reduction of household vulnerability, through the liquidation of assets at times when a source of daily income was not available, for example during the storm season.

This conclusion is supported by the analysis of the economics of grouper culture, which showed that grouper culture appears to have a relatively low sensitivity to increases in the cost of inputs or a fall in value of grouper at the farm gate, and is able to sustain high levels of fish mortality before fish farmers make a loss financially. It was also shown that for a comparative level of investment, the benefits of raising grouper far outweigh the benefits of seabass culture. Clearly, if grouper culture can be sustained by a stable supply of seed fish, and does not degrade the local environment to its own detriment, it has the potential to provide a good benefit for households in coastal communities in Thailand, in terms of asset accumulation. It was also shown that the benefits of fish culture compared well with other livelihood options available to households in the case study communities.

5.2 Grouper culture – the environmental context

The interaction of grouper culture with the environment is a key factor in the sustainability of grouper culture, both in terms of the classic definitions of sustainability presented in Chapter 1, and as part of a sustainable livelihood. The information presented in Section 4.6 suggests that grouper culture currently has a low impact on the environment. No conclusive evidence was found to indicate that that the fishery for grouper fry is causing a decline in wild fish stocks, or that fry fish are declining. There is clearly a need to determine the current status of the grouper fry stock and activities within the coastal zone that may contribute to its decline before options can be put forward for the provision of a sustainable supply of grouper seed, or measures to management the stock can be implemented.

The impact of grouper culture on the surrounding environment has implications both for other resources users and the long-term viability of grouper culture. Studies by Songsangjinda et al. (1993) and Arulampalam et al. (1998), discussed in Section 4.6.4, highlight the detrimental impact that cage culture can have primarily on the culture system itself and indicate a need for management measures to ensure that the development of cage culture remains within the carrying capacity of the environment, in order to minimise the degradation of the aquatic environment and reduce the potentially high levels of losses as a result of water quality associated disease. Wu et al. (1999) have developed models to simulate hydrographic and water quality conditions within a sub-tropical marine fish culture site, where trash fish feed is used. In the same way that such models have been applied in temperate systems to advise site selection, appropriate stocking densities, culture species and feed inputs, the models would be valuable tools in the planning of grouper culture development in coastal areas to mitigate environmental impacts (Wu et al. 1999). It is interesting to note that pollution loadings are reduced by the use of pelleted feed (Warren-Hansen 1982, in Wu et el. 1999) and may be influenced by the culture species. Leung (1996, in Wu et al. 1999) found that the adult mangrove snapper, *Lutjanus argentimaculatus*, excreted 50% more ammonia than the grouper *Epinephalus aerolatus*, when both species were given the same amount of feed. This would suggest that the culture of grouper would be more appropriate in areas with low tidal movement where the higher levels of ammonia excretion from other species such as the snapper may lead to more rapid degradation of the culture environment due to higher nutrient loadings and low rates of flushing.

Pollution incidents reported by respondents in Section 4.4.5 also highlight the impact of activities taking place in the coastal zone on grouper culture.

5.3 Development and the future of grouper culture as a sustainable livelihood option

5.3.1 Challenging the traditional aquaculture development paradigm

The development of broodstock and hatchery production technology of grouper seed is currently a major area of research in the Asia-Pacific region, as workers in the field attempt to close the grouper culture cycle. It is hoped that by rearing grouper in aquaculture systems, pressure on wild fish stocks will be reduced. As grouper culture is dependent upon a wild seed supply, it is considered that goals to

reduce pressure on wild stocks cannot be achieved until a supply of hatchery produced seed is available to farmers. However, this traditional approach to aquaculture development, which requires that the culture cycle is closed, may be inappropriate in the case of the grouper culture system and may ultimately lead to reduced benefits from grouper culture for coastal communities.

At present, grouper culture can generate a good benefit for many households in coastal communities of southern Thailand. It is an activity in which households from any wealth group are able to participate, with appropriate support from external agencies. The ability of fishers to provide their own seed and feed resources from wild sources enables households with limited financial capital to maintain their culture system, based on substitution of financial for natural capital. Farmers are able to manage the culture cycle according to their ability to absorb risk and to purchase or capture wild seed. Many farmers are able to generate a small but significant benefit from grouper culture by stocking a small number of seed, which are fattened for a few months before being sold. When grouper culture is successful, households are able to save money and accumulate assets. The high value of grouper, which is maintained by demand which exceeds supply, from an elite market where value is associated with rarity, allows farmers to generate a good benefit which is relatively low in risk, as production can remain economically viable even when farmers incur considerable losses.

A number of characteristics of the grouper culture system would suggest that the closing of the culture cycle could undermine fisher livelihoods:

- The high value of grouper on the market is based on rarity. If production increases and grouper are seen to be common, consumer demand for grouper will most likely decrease. As the market for species such as salmon, seabream and shrimp show, increased production is almost inevitably associated with a fall in market value.
- Grouper culture is an attractive livelihood option for households because of its high value, and the returns from culture can be high. If the value of grouper falls, grouper culture may no longer be attractive as seabass already provide an option for the culture of medium value fish. Seabass can be sold to a domestic market and households also consume some of the fish they produce. For cultural reasons, fishers in southern Thailand do not eat grouper, which they consider to be unlucky and have previously 'hated'.

- Many farmers raise grouper because they are able to catch the seed during periods of the month when other fishing activities are not possible. Non-farmers also catch grouper during this time to sell to middlemen. Fishers will probably continue to fish for grouper seed in the wild as long as they are available.
- The capture of wild seed and feed inputs reduces the requirement for inputs of financial capital to maintain the culture system. Farmers who lack capital to purchase seed will either continue to capture wild seed, or discontinue grouper culture.

5.3.2 Management in the coastal zone

If grouper culture is to remain in the hands of small scale farmers, two principal issues which may undermine the sustainability of grouper culture must be addressed:.the availability of grouper seed and the interaction between grouper culture and the local environment. The capacity of grouper culture to provide an appropriate and sustainable livelihood for coastal communities may therefore be best served by:

1. Managing the grouper stock to provide a sustainable supply of seed fish from the wild.
2. Increasing productivity by reducing losses to fish disease to increase the benefits that households are able to generate from grouper culture, and to reduce the wastage of seed.
3. Developing aquaculture within an integrated management plan for the coastal zone

Managing the current stock of wild grouper presents one possible solution to the potential problems which may arise from continued and increased exploitation of the fry resource and those associated with the development of hatchery reared fry. However, further research to understand grouper ecology and to determine the status of the grouper stock would be required to support management efforts. As discussed in Section 1.7.2, , it is known that early natural mortality rates of pelagic spawning fish such as the groupers are extremely high, but it is not known whether the bulk of mortalities occurs between egg production and settlement, or whether mortality remains high after settlement (Sadovy and Pet 1998). Research is currently underway in some areas, such as the Solomon Islands (Hair 2002), to evaluate the possibility of harvesting seed to mimic the levels of natural mortality.

Management of the fish stock in combination with measures to reduce post-capture mortality of seed fish may ensure that wild stocks are sufficient to support the small-scale culture of grouper in Thailand.

Sadovy (2000) estimates that 60 million seed fish are necessary to produce 23,000 mt of table-size live fish. Farmers reported that seed often died in the first few weeks after stocking. Fish traders reported few losses during transportation. Mortality was particularly high during the hottest months of the year, yet farmers continued to stock fish during this period. More knowledge regarding the culture cycle and seasonality of risks and problems is required in order that farmers can modify culture practice to reduce the incidence of fish disease and mortality and to increase productivity from fish seed. Sadovy (2000) also proposes a ban on the export of fry fish from Thailand. Research is currently underway to investigate problems of disease in grouper culture (Bondad-Reantaso et al. 2002).

Community management for the conservation of the fish stock would require the participation of fry fishers to develop appropriate management strategies to allow sustainable harvesting of grouper fry. However, this would require that fishers identify their role in the depletion of fish stocks as significant enough to justify their own investment in such a scheme. As shown in 4.6.3, respondents throughout the study attributed declines in wild grouper fry to the activities of commercial trawl fisheries, fishers using destructive fishing gears, urban pollution and channel dredging. Without the fishers seeing themselves as contributors to the problem of seed fish availability, it is unlikely that coastal communities would be committed to conserve the stock.

The management of activities within the coastal zone which negatively impact wild fish stocks should be incorporated into a broader coastal zone management plan for the conservation and management of all fish stocks. Mangroves and seagrass beds were reported to be important habitats for grouper at various stages of development. These habitats act as important nursery areas for many fish species and their management and conservation should feature prominently in any plan for the management of coastal resources. Respondents reported that the status of the fish stock has improved dramatically since the introduction of the ban on push-net use. Artificial reefs were also thought to prevent the encroachment of commercial fishers in the coastal zone. The significance of coastal habitats for the rapidly expanding tourism industry on the southern Andaman coast of Thailand should also not be underestimated. Trang is home to one of the largest remaining seagrass beds in Thailand, which supports a population of 40 dugong. The tourism value of this habitat and that of the coral reefs which attract thousands of divers to Thailand each year indicates that the preservation of these areas is of sufficient local and national interest to feature in national policy and development plans.

Managing activities in the coastal zone would also require that aquaculture development, including grouper culture, is managed in the coastal zone to prevent production from exceeding the carrying capacity of the environment in terms of waste assimilation. Of equal importance would be the need to protect aquaculture from other activities in the coastal zone which have the potential to undermine aquaculture productivity.

5.4 Criteria for the development of sustainable grouper culture in coastal livelihoods

Achieving sustainability in the grouper culture system will inevitably involve compromise, as alternative development models will lead to the generation of benefits from which not all stakeholders will benefit. Aquaculture development goals for the promotion of sustainable livelihoods must therefore identify the most important stakeholders according to development priorities, and seek to protect the most vulnerable groups. If stakeholders from communities with limited livelihood options are identified as vulnerable to developments which are likely to disturb the current system, alternatives should be sought to reduce the negative impacts of changes brought about by development. If the benefits of grouper culture as an alternative option for small-scale farmers are considered to be a priority over other stakeholders, for example those representing commercial interests, the system should be managed in order to ensure that the benefits of grouper culture remain in the hands of small-scale farmers.

The five-component framework developed during the study, and presented in Chapter 2, has been found to provide an appropriate tool for the investigation of the principal factors contributing to system sustainability. Issues have been identified within each of the sub-systems which threaten the long-term sustainability of grouper culture as a suitable livelihood option for coastal fishers. These issues can be used to guide the development of criteria to guide sustainability assessment in small-scale rural aquaculture. A set of possible assessment criteria are given in Table 5-1. The management of the system would require that priorities are set in order to determine in which direction grouper culture should develop.

Table 5-1 Issues influencing the long-term sustainability of grouper culture as an alternative livelihood activity in coastal communities. The criteria highlight key areas which were found to be important determinants of sustainability in the case study communities and are intended to provide a guideline for indicator development. The scale of analysis emphasises the hierarchical nature of issues affecting the grouper culture system as the community and household level.

Sub-system	Key attributes for investigation	Criteria	Scale of analysis
Institutions	Institutional actors: External agencies and influential institutions	National development goals Aquaculture development policy	National
		Role of external agencies, appropriateness and assistance and reliance of beneficiaries on external support	Provincial
		Extension activities	District
	Financial institutions - Access to credit	Availability of credit, conditions of access and penalties for failure to repay	National/Local
Livelihoods	Livelihood options	Availability and profitability of livelihood options compared to aquaculture Motivation to adopt new activity	Community/ Household
	Wealth relationships	Equitability of aquaculture amongst wealth groups Benefits to vulnerable groups Potential negative social impacts	Community/ Household
	Suitability of proposed activity	Appropriateness of fit of aquaculture to existing activities in livelihood portfolios (seasonal, monthly and annual activity trends, labour and time constraints)	Community/ Household
	Livelihood contribution	Potential role of aquaculture in household livelihoods.	
	Social capital	Community cohesion, trust and leadership. Capacity to develop strong community institutions to support aquaculture activities.	Community
Production system	Problems and constraints to production	Problems reducing the benefits derived from aquaculture. Factors constraining uptake of aquaculture	Farm
	Causes of discontinuance	Factors contributing to unsustainable culture which has led households to discontinue the activity	Household
	Economic viability	Sensitivity of economic return to increases in costs of inputs, loss of stock or fall in market value of product	Farm
	Availability and source of inputs	Potential of input sources to support aquaculture without undermining the natural resource in the foreseeable future, and without increasing in cost to levels which are no longer economically viable	Farm/National/ International
Environment	Characteristics of culture site	Area available for culture, currents and flushing properties, salinity	Culture site
	Upstream activities	Activities discharging waste into water body that may impact aquaculture	Coastal cell and watershed
	History of water quality problems	Evidence of previous damage to aquaculture systems due to water quality problems Evidence of pollution from culture units, negative impacts on culture activities and activities of other resource users	Culture site
	Demand for wild inputs	Level of exploitation of the fishery resource for aquaculture and potential impact on the resource	Farm
	Culture unit density	Potential for self-pollution if production exceeds	Culture site

Sub-system	Key attributes for investigation	Criteria	Scale of analysis
		carrying capacity of the culture location	
Markets	Market and consumer characteristics	Consumer traits and demands. Possible response to changes in value and levels of production	International
	Market trends	History of trends in market value and evidence of instability	International
	Development trend and potential market impact	Possible development scenarios and possible impact on consumer demand	International/ National

5.5 Evaluation of the research approach and methodology

5.5.1 Understanding the grouper system – lessons learned from a sequenced and phased approach

At the outset of the study, it was found that the literature available on grouper culture in Thailand and elsewhere was limited and focused primarily on the technical attributes, and development constraints, of grouper culture. As described in Chapter One, information regarding the principal actors and beneficiaries of grouper culture and its characteristics at the community and household level were lacking. The research approach was therefore developed with the aim of generating information from which hypotheses about the role and sustainability of grouper culture in fisher livelihoods could be developed and tested. The result was a sequenced approach, which sought to gather information from the general to the specific, descending the hierarchical levels of the grouper culture system from the provincial to the household level. Simultaneously, the methods adopted for data collection became increasingly more focused as the study progressed, beginning with the use of a topic check list comprising a small number of open-ended questions at the provincial level, to a detailed questionnaire survey at the household level in the final stages of the study.

The preliminary overview at the provincial level served to provide baseline information and the identification of the hierarchies, processes and interlinkages of the grouper culture system. The results obtained, based on 36 interviews, clearly revealed similarities and differences in grouper culture practices across southern Thailand. At this level it was possible to describe with certainty the type of culture systems used, species raised, stocking and harvesting practices and scale of production. It was also possible to identify factors motivating adoption of grouper culture, including the role played by external institutions such as the DoF, constraints to uptake and problems experienced by grouper

farmers. Research at the provincial level was also necessary in order to identify the market networks operating between provinces. From this perspective, it can be said that the preliminary overview served its purpose well as a first step in the research process. However, the results obtained at the provincial, community and household level show that the provincial level study would not have sufficed as a stand alone study.

It was apparent from a comparison of the information obtained regarding the status of the grouper fry stock and sources of seed fish for stocking that the availability of seed to grouper farmers in Satun had changed between the time of the provincial overview and work carried out in Trang and Satun provinces the following year. In May-July 2000, farmers in Satun reported that seed shortage was a constraint, and that culture was largely dependent upon seed fish brought in from other provinces, most notably Trang. However, in February 2001, farmers reported that seed fish from their own catch was the most common source of seed for culture, although availability of fry fish remained low. Seed fish obtained from other provinces was now the least important source of seed fish. This observation highlights an important issue raised by the phased nature of the research over a period of one year - the temporal nature of the fish culture and fisheries systems observed.

The temporal nature of fish culture and fisheries in southern Thailand was revealed as a result of making repeated visits to the same villages during 2000 and 2001. In addition to the differences reported in the sources of grouper fry, it was observed that both the level of fish culture and the species cultured could change dramatically between visits, as described in Section 4.2.2. These findings suggest that, in the context of fisheries and aquaculture, relying on a 'snap-shot' approach to data collection may lead to inaccurate conclusions.

5.5.2 Use of qualitative and quantitative research methods

The sequenced approach also highlighted the value of combining qualitative and quantitative research methodologies. The qualitative methods employed during the provincial level study were essential in the early stages of the research in order to draw out key issues in the grouper system, keeping the research process very open-ended and unconstrained by preconceptions. They were also suited to time limitations and financial constraints. However, quantifying the findings of the survey carried out in Trang and Satun, based on a qualitative topic check-list, allowed the findings to be placed in the

context of a representative sample of communities in two provinces (selected using quantitative sampling methods). This sequenced approach ensured that findings at the provincial level were both credible and representative. Furthermore, the continued exploration of many of the issues identified at the provincial level ensured that the confidence in the research findings increased with each stage of the research, as they were repeatedly subjected to cross-checking and validation.

Combining qualitative and quantitative methods during the case study analysis showed both advantages and disadvantages of the two approaches. Qualitative research allows the respondent to participate in the development of discussion, whether as a key informant influencing the direction of a semi-structured interview which is sufficiently open to allow exploration of new topics and issues raised by the respondent, or by taking control of a focus group. Mapping exercises in particular provided a catalyst for discussion as issues were brought to the mind of participants as they mapped their local area and fishing grounds. Members of the communities were also willing to participate in the qualitative activities conducted during the study, unconstrained by questions devised by the researchers, these activities tended to be initiated by the research team but were ultimately led by members of the community. Problems arose, however, when focus group participants were selected by a key informant, who often chose members of their peer group. Furthermore, the timing of fishing activities made it difficult to convene focus groups, and a number of appointments were cancelled.

The aim of the questionnaire survey carried out in the final stages of the study was to provide quantitative data to accompany a number of key issues explored during the qualitative phase of data research, particularly with respect to household incomes and the respective roles of livelihood activities, grouper culture production methods and the significance of social capital. The quantitative data would permit the significance of these issues to be analysed statistically and comparisons made between communities to test relationships between factors at the household level, such as household wealth and livelihood uptake, grouper culture discontinuance and fish production methods, and at the community level e.g. variation in social capital. However, whilst providing valuable data for the study, a number of limitations and problems inherent in conducting a questionnaire survey became apparent during the study.

Quantititave methods are often criticised for being time consuming and expensive and, whilst the use of a quantitative survey provided valuable results in this study, it was noted that the results did come at

a price in terms of both the quality of the data obtained and the nature of the relationship between researcher and respondent. In contrast to qualitative methods, a survey questionnaire is largely an extractive process from which the respondent can learn little and cannot influence the direction of the discussion. The questions in the survey, although based on initial qualitative work, impose limitations on the respondent to conform to the assumptions of the questionnaire. Ultimately, however, the quality of the data is dependent upon adequate training of the enumerators. A successful questionnaire survey requires that enumerators present the questions in a uniform way, without creating bias. The training of a team of enumerators can therefore be very time-consuming and costly. The questionnaire survey in the current study suffered as one of the key questions regarding the discontinuance of grouper culture was misunderstood by enumerators, which led to this data being excluded from the analysis and the loss of potentially valuable information.

The findings of the social capital section of the survey particularly suffered as a result of insufficient training of the research team. Problems arose due to a lack of understanding of the questions which offered multiple responses, which often generated multiple answers rather then just the one answer required. There also seemed to be a strong bias in the questionnaires submitted by some teams of enumerators which suggested that the respondents had been prompted. This indicated a possible need on the part of the enumerators to prompt respondents in order to get a response. This can be attributed to the unusual content of this part of the questionnaire. Whilst respondents were comfortable to answer questions regarding fish culture and their daily livelihoods, with which they were familiar, questions relating to trust and community harmony were more difficult to answer. Hypothetical questions were also problematic, in which respondents were asked to imagine how they may respond in certain situations. It was also observed during the qualitative phase that respondents often had difficulty in responding to questions regarding hypothetical situations.

Combining qualitative and quantitative methods does however provide an important means by which data can be cross-validated. Whilst survey methods allow observations gathered in the qualitative phase to be placed in context by quantification, observations made based on qualitative methods may also indicate inaccuracies in the survey results, Lovshin et al. (2000) noted in relation to the involvement of women in aquaculture projects in Panama, where observation suggested a higher level of involvement by women than was indicated survey data.

5.5.3 Social capital research tool

The evaluation of social capital as a significant contributing factor to the decline in grouper culture in the case study communities was carried out using the Social Capital Assessment Tool (SCAT) described in Section 3.4.1.

Questions relating to membership of community groups were not particularly useful if not considered in the context of what membership involves, the level of interaction with other members of the community, or variation in participation of group activities amongst different members of social groups within the community. Data regarding the frequency of group meetings in the three case study communities showed that meetings were held with less frequency in Ba Kan Khoei, where observation and evidence accumulated during the qualitative phase of the study had indicated that social capital and group participation was higher in this village than in the others. According to social capital theory, this finding would suggest lower levels of structural social capital in Ba Kan Khoei, although infrequent meetings may indicate there is less need for formal discussion.

Experience revealed that many of the questions were too simplistic and did not allow for the subtleties of relationships between members of a community to be understood. For example, questions designed to determine levels of conflict or trust in the group gave respondents the choice of selecting that whether they 'trust *or* do not trust' in matters of lending and borrowing, or whether the community is 'Harmonious *or* disgreeable'. Ultimately, it was found that a questionnaire approach of this kind is inappropriate for understanding the nature of social relationships within a community. Furthermore, although intended as a tool to make social capital assessment uniform, no guidelines are provided which indicate how the data should be interpreted. Application of the entire SCAT tool, which includes tools for the community level analysis, may have provided a more complete picture of social capital issues, but the size of the complete tool precluded this possibility.

Thus, while social capital, such as issues of trust and group participation and cohesion may be important contributing factors to the success of an intervention such as aquaculture promotion, the means for assessing its existence in a community is lacking. However, a quantitative tool for the analysis of social capital is inappropriate, suggesting that qualitative methods, including anthropological methods such as participant observation could provide more insights into the extent of social capital in a community.

5.5.4 Language and Translation

Language barriers and the need for translation are fundamental considerations when carrying out field research in a foreign country. In south-east Asia the problem is exacerbated by the complexity of the languages and the difficulty inherent in learning a language such as Thai to fluency. Although language studies were undertaken before work began in the field, and a level of proficiency reached where much could be understood of the general topic being discussed in a interview, asking questions and understanding the details of a discussion were not possible. Assistance from a translator was therefore essential.

Working with a translator raises two principal issues: The first and most obvious is the quality of translation itself. Problems naturally arise in the process of translation from one language to another during a discussion, in which the meaning of questions and responses can be unintentionally distorted by the interpretation of the translator. As Phillips (1960) comments 'almost any utterance in any language carries with it a set of assumptions, feelings and values that the speaker may or may not be aware of but that the field worker, as an outsider, usually is not'. This problem is exacerbated when the grammatical and syntactical structures of the two languages, as in the case of the Thai and English languages, differ (Ercikan 1998). The cultural context of the study, the relationship of the translator to the respondent and cultural norms may also lead to distortion of translation, for example to avoid loss of face or embarrassment on the part of any of the participants in the exchange, whether the foreign researcher, the translator or respondent, a factor of particular importance in Thai culture.

Conducting interviews through a translator brought with it not only linguistic problems but also led to the creation of a barrier between myself and the respondent, reducing direct communication to a minimum and making it difficult to build a relationship directly with members of the community we were working with. In such situations, the use of a translator becomes more than a way of understanding language, but also determines the quality of the relationship between researcher and participants in the study and the level of trust on which the collection of information must be built. Roney (2001) describes experiences similar to my own. She refers to the importance of a translator who was not only proficient in translating the exchanges between researcher and respondent, but also the ability of the translator to empathise with respondents, build trust an rapport and to have an understanding of the subject and needs of the study. This allowed the translator to follow a thread of

discussion based on her own observations, translating at appropiate times during the conversation. Furthermore, the status of the translator also plays a role in the translator/respondent relationship. The translator with whom I worked in southern Thailand was a teacher at a well-respected fisheries college in the area. In Thai culture, teachers have a high social status and her position was therefore very beneficial in meetings with officials, as her status went someway to counteract the fact that we were both 'young' and female. Roney (2001) experienced a comparable respect for the status of her translator in Poland. However, on occasion, we were assisted by our driver, a local man who spoke the southern Thai dialect and was able to create an easy rapport with some of the men in the community.

Despite the problems encountered, working through translation does create the advantage of allowing time for observation. During interviews it was possible to observe the body language of respondents as they discussed the issues raised which could indicate that the question made the respondent feel uncomfortable, or that they were unsure but did not want to reveal their lack of knowledge about a subject for example. It was also possible to take a note of immediate surroundings or observe activities taking place close by, which could then be brought into the discussion. These details would have been easily missed if all my attention had been focused on the questions and answers of the discussion.

5.6 Conclusions

- The study has contributed to an understanding of fisher livelihood strategies and the role of grouper culture within the livelihoods of households in coastal communities. Fisher liveihood strategies were found to be diverse, flexible and opportunistic, drawing on aquatic, land-based and business and wage related livelihood opportunities.

- It was found that grouper culture is unlikely to provide an appropriate alternative livelihood for fishers. Grouper culture was found to provide a form of savings and means of asset accumulation whereas fishing allowed households to meet their daily needs. The two activities are therefore not substitutable. Fishing may also be an important supporting activity for grouper culture, for the provision of seed and feed inputs. Furthermore, fishers may choose fishing as their preferred occupation, and as part of their cultural identity.

- Grouper culture was found to be an activity in which households from all wealth groups in the community could participate. The substitutability of natural capital i.e. wild caught inputs of seed and feed, for financial capital i.e.purchased inputs, was an important factor in the ability of poor households to continue grouper culture. Institutional support for grouper culture and the availability of credit for livelihood development were found to be important factors in the ability of poorer households to take up grouper culture and thus diversify their livelihood portfolios.

- Poorer farmers were also found to offset the risks inherent in grouper culture by adapting the culture cycle according to their capacity to cope with risk, adopting a shorter culture cycle.

- The adoption and continuance of grouper culture was found to be dependent upon non-technical as well as technical factors. Household motivation and incentive, access to financial capital and levels of social capital in the communities studied were also found to be important contributing factors to the level of grouper culture success observed in the communities. It was noted that comparable studies which address the causes of success and failure of development intervention were lacking in the literature.

- The sustainability of grouper culture was assessed in terms of its ability to contribute to a sustainable livelihood for coastal fishers in southern Thailand. It was found that grouper culture

has the potential to provide a positive benefit to households in coastal communities. Problems with fish disease and mortality, fluctuations in availability of seed fish and water quality undermine the ability of most farmers to obtain the maximum benefit from grouper culture. Under the interpretation of 'sustainable livelihoods' given in Section 0, grouper culture currently contributes in a sustainable way to the livelihoods of coastal households. At present, it appears to be an activity which is relatively resilient to shocks and stresses, including the numerous problems experienced by farmers and fluctuations in the cost of inputs and the value of farm-gate grouper. It has the potential to enhance or maintain household assets, and there is no firm evidence to suggest that grouper culture undermines the natural resources base, although there is some debate as to the impact of the removal of wild fry.

Glossary

Khlong	Canal
Rai	Thai land measurement.
	1 Rai = 1600sq. m or 0.16 ha

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