SUSTAINABLE LIVELIHOODS FROM FLUCTUATING FISHERIES

FINAL TECHNICAL REPORT

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Sustainable Livelihood Strategies from fluctuating fishery resources in Malawi and Indonesia

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The opinions presented in this report are those of the research team only, and are not necessarily shared with those who helped and advised us.

1. EXECUTIVE SUMMARY

The purpose of the project was to identify management regimes and development policies appropriate to the delivery of maximum benefits to subsistence and small-scale commercial fishers dependent on fish stocks that fluctuate extensively, so that livelihoods may be sustained and improved, and poverty in fishing communities reduced.

Research activities were in three main areas:

i. A statistical analysis of variability in time series of fish stock biomass or catches, so that fisheries could be classified on the basis of the extent and pattern of variability. The resultant fisheries 'typology' could then be used to derive principles for managing different types of fishery (e.g. steady state, cyclic, spasmodic).
ii. A theoretical study of the consequences of different management regimes on fluctuating fisheries, using bioeconomic simulation models;
iii. Analysis of informal management regimes and community and household level adaptations to fluctuating fisheries in Malawi and Indonesia. Findings were discussed in the context of current moves towards co-management of fisheries in these countries.

These research activities were supplemented by reviews of changing management and policy in the fisheries sector in the target countries, and by research to promote the uptake of livelihoods approaches in the study of small-scale fishing communities.

The fisheries typology study analysed 51 catch and biomass time series, and classified them into six categories. An attempt was then made to link these categories to fish life history characteristics. The belief that fisheries based on small pelagic stocks fluctuate more than those for large demersal stocks is not as clear-cut as has been widely assumed. It is possible to say that equilibrium or steady-state dynamics are rare, so that the use of equilibrium MSY-based indicators as target reference points or management targets is problematic in many fisheries, not just those for small pelagic species.

Preliminary bioeconomic simulation models indicated that there was little theoretical justification for more precautionary management for stocks with higher stochastic variations in biomass and recruitment per se, except via the effects such stochasticity might have on the accuracy of estimates of the resource dynamics and desirable targets. However this result is preliminary and the model relates only to fisheries displaying high resilience and strong recovery from low stocks.

Given that most fish stocks are highly variable, the remainder of the project sought to understand how fisherfolk dependent on fluctuating stocks adapted to these unpredictable events.

In Malawi, two main strategies for dealing with variable catches were encountered. Specialist fisherfolk, mainly Tonga people from Northern Malawi, remained highly mobile. Settled lakeshore villagers in southern and central Malawi tend to be part-time fishers, with farm and non-farm labour being important in sustaining households. There are high degrees of reciprocity and mutual economic advantages in the relationships between migrants and residents.

In West Java, Indonesia, the same two main strategies are evident. In North Java, specialist fisherfolk range widely along the coast, and between islands, depending on the availability of fish and strength of local markets. In South Java, fishing is much more seasonal, and many crew and boat owners have other occupations and investments, but are much less mobile.

In both countries, the research calls into question prevailing wisdom that fisheries are open-access occupations of last resort, and the refuge for the poorest of the poor'. Instead, involvement in fishing is dependent on the ability to raise capital for investment, and the availability of employment opportunities as fishing labour are obviously related to the level of such investment. Fishing still provides rural communities with viable small-scale business opportunities, rather than just the means to subsist, even in the densely populated areas of Malawi and West Java.

There are significant mismatches between adaptive strategies, such as livelihood diversification and mobility, and styles of fisheries management that promote specialisation and fixed territorial fishing rights.

Co-management arrangements built on existing arrangements, such as negotiated reciprocal access agreements, are more likely to succeed than attempts to introduce idealised village-community or territory-based management to fisheries where these arrangements diminish the flexibility of livelihoods. Paradoxically such attempts to increased local 'control' and 'ownership' of fish resources may increase vulnerability and dependence if the wrong sort of local-level management is advocated and promoted by external agents.

Research findings on fisherfolks' livelihood strategies in Malawi are already influencing fisheries management policy. A strong commitment to externally-conceived village-level management institutions is now being re-thought, partly in the light of this project's findings on mobility and migration of fisherfolk. A move towards larger management areas, defined on the basis of ecological zones and fisherfolks' main migratory patterns is now being piloted. This will now build on the existence of traditional access arrangements and beneficial economic linkages between residents and migrants that have been highlighted in this project.

In Indonesia, research findings are informing the current move towards increased power of district government to regulate port access through levies and licences granted through the state-run fish marketing system. District authorities, like in Malawi, are currently being encouraged to mobilise fisherfolk to exclude outsiders, despite the perception by many fisherfolk that outsiders bring economic benefits, rather than environmental costs.

Livelihood approaches to studying fisheries have been disseminated and promoted to target institutions – fishery departments in the target countries and fisheries departments and fisheries scientists and managers in international institutes, national development organisations

The project outputs contribute toward the FMSP goal of 'Optimum sustainable yield from capture fisheries achieved by improved resource management'. Recognising the validity of flexible and adaptive strategies, and seeking ways to promote their effectiveness, should allow yields from fluctuating fisheries to be maximised, while building resilient and adaptive management institutions to ensure sustainability. The outputs also help ensure that fisherfolks' existing livelihoods strategies are recognised

and supported, rather than undermined by poorly designed resource management strategies, thereby contributing to poverty eradication in fishing communities.

2 BACKGROUND

2.1. Small scale fisheries management – the global context

The role of small-scale fisheries in meeting food-security needs and contributing to livelihoods in developing countries is increasingly recognised. Past development and management emphasised 'scaling-up' fisheries by programmes for industrialisation and centralisation of capture, landing, processing and marketing sectors (Cycon, 1986). Institutional development focused on increasing state-based research, monitoring and enforcement capability (Mahon, 1997). Since the introduction of the FAO Code of Conduct for Responsible Fisheries (FAO, 1995) many of these processes have been reversed, and there is now more emphasis in developing country fisheries on environmental sustainability issues, maintaining fisheries-based livelihoods, food security and distribution networks, and decentralised or community-based management (Payne, 2000).

This shift in emphasis follows from a perceived crisis in world fisheries (reviewed in Allison, 2001). The current situation in world fisheries is summarised in Box 1.1

Box 1.1. The state of world fisheries (from FAO, 2000)

Total capture fisheries production in 1998 was 86 million tonnes, a noticeable decline from the maximum of about 93 million tonnes recorded in 1996 and 1997, although there was a considerable recovery to an estimated 92 million tonnes in 1999. Although in decline, marine capture fisheries continue to account for more than 90 percent of world capture fisheries production. The remainder comes from inland water fisheries, which have increased their output by almost 0.5 million tonnes per year since 1994.

World marine capture fisheries production dropped to 78 million tonnes in 1998, representing a 9 percent decline with respect to the all-time production highs of about 86 million tonnes in 1996 and 1997. The decline appears to have been caused essentially by climatic conditions. The estimated first sale value of the landings also decreased, from about US$81 billion in 1996 and 1997 to US$76 billion in 1998.

Inland aquatic resources are under pressure from loss or degradation of habitat and overfishing, but it is extremely difficult to assess the state of inland fisheries resources because reporting does not include all the sectors of the fishery and catch is seldom broken down by species.

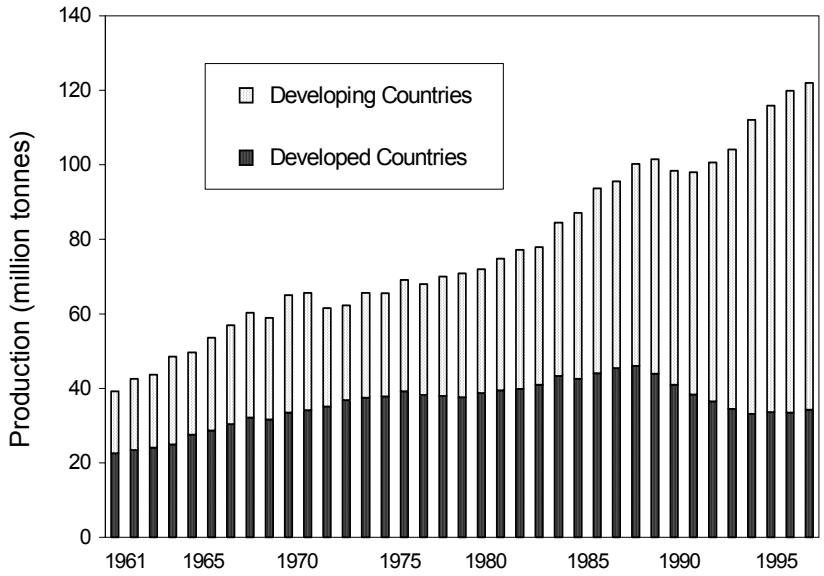
Exploitation status: Among the major marine fish stocks or groups of stocks for which information is available, an estimated 25 to 27 percent are under-exploited or moderately exploited. About 47 to 50 percent of stocks are fully exploited. Another 15 to 18 percent are overexploited and have no potential for further increase. The remaining 9 to 10 percent of stocks have been depleted or are recovering from depletion.

Employment in the primary capture fisheries and aquaculture production sectors in 1998 is estimated to have been about 36 million people, comprising about 15 million full-time, 13 million part-time and 8 million occasional workers. . Over 120 million people were involved in activities relating directly to capture, processing and sale of fish; 95% of them are in developing countries Employment in inland and marine aquaculture has been increasing, and is now estimated to account for about 25 percent of the total. Marine capture fisheries account for about 60 percent and inland capture fisheries for the remaining 15 percent.

A key feature that we wish to emphasise is that more than 58% of fisherfolk are described as being either part-time or occasional workers. The relationships between fishing and other sources of livelihoods have seldom been addressed in policy and management for the fisheries sector. Indeed much past development has sought to 'professionalise' the small-scale fisheries of both developed and developing countries by encouraging greater involvement in fishing and capitalisation of fishing enterprises (Allison & Ellis, 2001). The rationale for promoting economic specialisation in the context of small-scale fisheries has never been seriously questioned.

Further unpacking the production and employment figures reveals that, in 1990, 84% of the world's fishers were concentrated in Asia, and 6.5% were in Africa. The vast majority of these are involved in small-scale or artisanal fisheries. The contribution of small-scale fisheries and aquaculture in developing countries to global fish production continues to increase (Figure.1.1).

Figure 1.1. Global fish production (millions of metric tonnes) from developed and developing countries. (FAO, 2000). Production figures include farmed fish, non-fish marine products (e.g. molluscs and crustacea), and inland fisheries.



While aggregate employment and production figures in developing-country fisheries are at all-time highs, there is evidence that many fisheries are overexploited (see Box 1.1). There are also indications that the number of people employed in the sector has begun to level off over the last five years, despite continuing population increase (FAO, 2000).

The blame for the current overexploitation of capture fisheries is often directed at the state agencies responsible for managing fisheries and their scientific advisors (Finlayson, 1994; Masood, 1997). There is a consensus that 'modern' state-controlled

fisheries management has failed in its central objective of maintaining productive fish stocks by limiting fishing to sustainable levels (Crean & Symes, 1996).

The failure of state-managed fisheries based on fish stock assessment science (the 'stock assessment driven' or SAD approach – Mahon, 1997) is due in part to what the SAD approach has neglected – consultation with fishing communities and analysis of the social, economic and political forces that interact to affect compliance with state regulations. The problems caused by this neglect are now evident, and the science of stock assessment is now seen as just one part of fishery studies that should be driven by defined management objectives (the management objective driven or 'MOD' approach, Mahon, 1997). It is now also widely recognised that resource users – not just scientists and government management advisors - can and should decide on the objectives of management, and on how these objectives might be achieved (Dyer and McGoodwin, 1994). These, and other proposed reasons for fisheries management failure are outlined in Box 1.2.

Box 1.2: Summary of proposed reasons for the failure of fisheries management around the world. Many or all of these may apply to any individual fishery (from Allison, 2001).

I. Access and ownership regimes unsuitable or poorly defined, leading to 'Tragedy of the Commons'.

II. Lack of political will to limit fishing, due to the minor economic importance of the fisheries sector in most countries.

III. Conflict with other uses of the ocean, principally as a 'common sink' for discharge of pollutants and degradation of key coastal habitats (e.g. mangroves, coral reefs) leading to habitat degradation affecting fisheries

IV. Inadequate financing and capacity to enforce states' fishery and ocean laws, allowing circumvention of management aimed at sustaining stocks.

V. Prevalence of production-orientated 'development' paradigm, leading to neglect of sustainability issues.

VI. Subsidised over-capacity in fishing fleets; subsidies mask signals of resource scarcity.

VII. Failure to manage the consequences of rapid technological and political change.

VIII. Failure to specify long-term management objectives to allow for rational sector-wide planning and development.

IX. Lack of resource-user involvement in management and policy making.

X. Inadequate or incorrect scientific advice on sustainable harvesting levels and a management system that is over-reliant on that advice.

XI. Insufficient consideration of social, economic and political dimensions of fisheries by fisheries advisory services.

XII. Value of marine ecosystem services not taken into account in the prevalent single-species management approaches.

XIII. Mobility and transboundary nature of fish stocks – fish move through governed spaces.

XIV. Management and development plans fail to adequately account for natural (climate-induced) variability in resource productivity.

This project addresses most directly the problem that management and development plans are usually not designed to take environmental variability, both temporally and spatially, into account (Box 1.2, XII, XIV). It will be argued that this spatio-temporal variability is a dominant feature of many fisheries, and one that small-scale fisherfolk have to confront directly through adaptation to more or less unpredictable periods of localised resource scarcity. In looking at how the livelihoods of households involved in small-scale fishing cope with variability, and how groups or communities of fishers organise their responses to variability through informal management systems, the project also addresses means by which fisherfolk could become more involved in management and policy formulation (Box 1.2, IX).

Many of the other reasons for fisheries management failure can be regarded as constraints to state-led scientifically based management (Box 1.2). While much effort in fisheries development has focused on dealing with these constraints (lack of effective state enforcement capacity, inadequate scientific advice etc), this project looks at what can be done given that these constraints are likely to persist. In this way, the project has adopted one of the guiding philosophies of the livelihoods approach: a focus on opportunities and assets, rather than problems and inadequacies.

2.2. The importance of fishery fluctuations

Many fisheries resources fluctuate dramatically from year to year due to climactic variability (e.g. Glantz, 1992). There has long been widespread recognition that constant catch or constant effort approaches to management, based on the paradigm of an achievable optimum sustainable yield, are inappropriate for these fisheries (e.g. Beddington & May, 1977; Larkin, 1977). Potentially included in this category of 'fluctuating fisheries' are industrial fisheries for small pelagic fish in upwelling systems, and artisanal and subsistence fisheries for small pelagic fish in coastal marine waters and the pelagic zones of large lakes. It is not clear what form of fish stock management, if any, is appropriate for stocks where biomass and therefore catches appear to fluctuate independently of fishing effort in previous years (see Box 1.3).

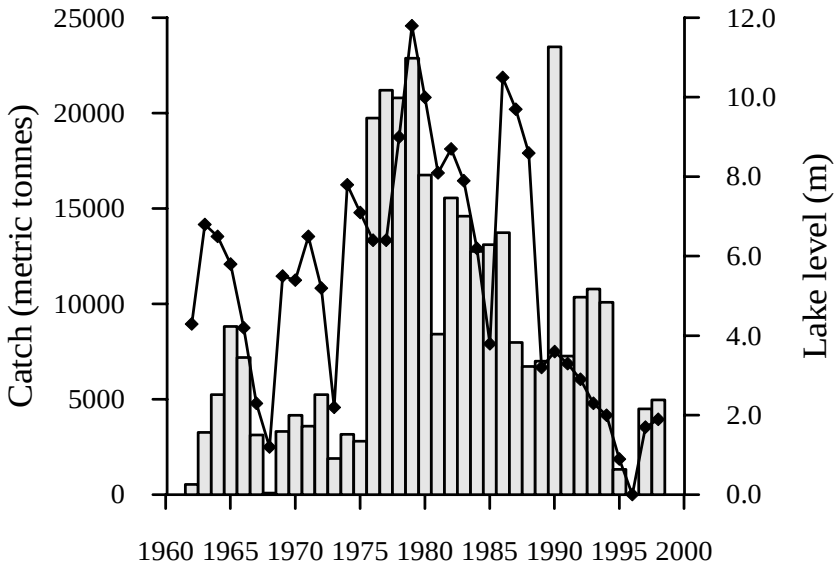
Most research on fluctuating stocks is targeted at understanding in detail the mechanisms *causing* fluctuation in stock size. This is the study of fish recruitment processes and the environmental factors driving them (e.g. Cushing, 1996). There has been much less emphasis on the study of the *responses* of fishers to stock size fluctuations (Vestegaard, 1996), or even of the different ways in which the larger industrial fisheries respond to such fluctuations.

Some of the questions on fisherfolks' responses that remain unanswered include:

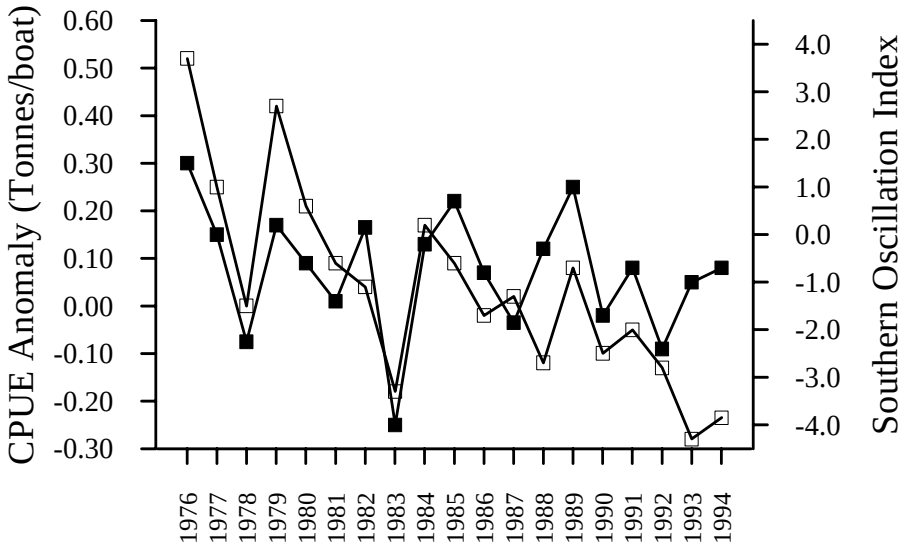
- In artisanal fisheries, do fishers migrate between fishing areas, maintain diverse livelihoods, or accept income variability and adapt their investment levels accordingly?
- Given a knowledge of coping strategies and livelihoods, how can fishery management policy best assist artisanal and subsistence fishers in maintaining their livelihoods?
- Does management, at the level intended to stabilise catches, have a role in systems where fisheries fluctuate independently of fishing effort?
- What sort of development interventions can assist in eradicating poverty among artisanal fishing communities dependent on these types of fishery?
- What sort of national investment strategy is appropriate in industrial fisheries dependent on fluctuating resources

Box 1.3. Examples of environmentally-driven stock fluctuations from the inland waters of Africa

Catch fluctuations (shaded bars) and lake level variations in the shallow Lake Chilwa, Malawi 1962-1998[a] (Sarch & Allison, 2000). Fish populations appear to be highly resilient, recovering rapidly after the lake dries out. Management for equilibrium catches is not appropriate for fisheries of this type.



In Northern Lake Tanganyika, there is a strong and significant relationship ($r = 0.62$, $p < 0.05$) between stock abundance anomalies of small pelagic clupeids (□), measured as the differences from the long-term average in Catch per unit of fishing effort by the Bujumbura-based industrial purse-seine fishery in Nov-Jan, and the Southern Oscillation Index or 'El Niño effect' (■) in the previous Feb-March (Redrawn from Plisnier, 1997).



[a] Note that the lake gauging system was changed in 1989 and the lake level measurements from this period onwards may not be directly comparable with those in previous years, and have a lower apparent amplitude of fluctuation.

Similar questions have recently been addressed in the context of designing appropriate development interventions and management regimes for semi-arid rangelands in Africa (Scoones, 1995). Here, the paradigm of an achievable stable carrying capacity of livestock (analogous to a maximum sustainable yield of fish) has been challenged (Behnke *et al.,* 1993). This challenge follows widespread recognition that development interventions based on this model, such as de-stocking, encouraging settlement of nomadic pastoralists and investment in improving forage quality, have failed. The 'new rangeland ecology' has suggested that these failures are due to the non-equilibrium nature of these rangelands (Westoby *et al.,* 1989). Production of the grass/forage resource is dependent largely on the spatial and temporal distribution of rainfall. Nomadic pastoralism and high but variable stocking rates have come to be seen as the optimum exploitation and management strategy, in terms both of spreading risk and of maximising utilisation of production without causing long-term irreversible resource degradation.

This project aims to explore the transfer, from rangelands to fisheries, of some of those lessons for management of fluctuating resources. First it must be determined if non-equilibrium models are appropriate descriptions of some fishery systems, then it must be established if there already exist in these fisheries the opportunistic exploitation strategies that follow logically from the recognition that systems are driven by abiotic variability. Finally, the development and management interventions appropriate to enabling opportunism and risk-spreading must be addressed.

These questions will be answered by a combination of empirical analysis of fisheries data series and bioeconomic simulation modelling, and the analysis of fishers' livelihoods in two fisheries known to fluctuate: the fisheries for small pelagic species off the south coast of Java, Indonesia, and in southern and central Lake Malawi (Malawi).

2.3 Fisheries Typology

Despite the fact that different fisheries are known to have very different patterns of catch series, there have been few attempts to classify fisheries according to extent and patterns of variability. Caddy & Gulland (1983) classified fisheries as steady, cyclical, irregular and occasional. This latter category denotes so called 'boom and bust' stocks that sustain important fisheries episodically before disappearing for decades, or even for centuries. For irregular and occasional stocks, it has never been satisfactorily demonstrated that overfishing is the cause of either the high variability or the collapse of stocks (e.g. see the contradictory statements on the cause of the decline in Peruvian anchoveta in the 1970s in Cushing, 1982 and the review of the debate in Hilborn & Walters, 1992).

Caddy and Gulland's (1983) typology, based on a visual inspection of four representative fish stocks, has recently been tested statistically, and enlarged to six categories (Spencer and Collie, 1997), but its implications for stock management have never been properly considered. Despite the clear indication that different fisheries have different production dynamics, all are managed, explicitly or implicitly, by application of principles derived from the same class of models, based on equilibrium assumptions. Catch fluctuations are regarded as environmentally generated 'noise' rather than an inherent property of the ecological system. This study will aim to further develop a system of classifying fisheries, by examining the dynamics of stocks for which there are long data series, and to look as some simple associations between the parameters of environment, stock and fishery to develop a set of attributes identifiable with each major category of fishery.

2.4 Bioeconomic modelling

To further explore the implications of uncertainties in stock size estimates and patterns of variability on exploitation and management strategies, the utility of bioeconomic simulation models will be considered. Many models of ecological-economic system interaction effectively skirt round uncertainty by using point estimates of parameters and state variables. Thus many models include uncertainty related to the future growth of a resource, but take current stock and harvesting levels as known (e.g. Alvarez 1998). A more realistic process requires either a Bayesian approach in which uncertainty about system parameters and state is built in (Frederick and Peterman 1995), or use of fuzzy probability theory (Faucheux et al 1997). These approaches inform a search for strategies which are relatively more robust with respect to maintaining acceptable levels of key social objectives. This reflects recent developments in ecological economics focusing on the resilience of ecological-economic systems in variable environments (Perrings 1998). It also reflects the emerging view that fisheries economics has in the past been overly concerned with optimisation of narrowly defined economic objectives, and hence has largely failed to influence management, where predicting the diverse potential impacts of different policies is seen as more important (Deacon et al 1998).

Thus there is a need to develop new models which embrace uncertainty and complexity, which take proper account of stakeholders and which seek procedural rationality within the context of widely defined social objectives (van den Bergh and van der Straaten 1997). This study will explore the use of Monte Carlo simulation techniques in moving towards discrete-time models to inform decisions relating to the attainment of broad social goals in fluctuating fisheries.

2.5 Investigating fishers' livelihoods

The future catches of fisheries that are driven by fluctuation in environmental variables will never be predictable. At present, it is possible to predict catches one or more years in advance from surveys of young fish before they enter the fishery. This is only possible for major stocks where expensive stock surveys are feasible. These techniques will never provide regular input into the management of smaller stocks in developing countries, due to their prohibitive cost and high technical inputs. Rather than strive for the impossible goal of prediction, it is more useful to accept the lack of predictive power, and investigate strategies to cope with it.

There have been few studies on how fishers cope with resource fluctuations. Vestegaard (1996) suggests that, before the advent of centralised national government and EU management of fish stocks, Danish fishermen accepted income variability, maintained diverse livelihoods, adjusted investment levels to cope with uncertainty, and were prepared to move to different fisheries and areas in order to secure their livelihoods. These 'coping' strategies have been replaced by a dependence on stability of catches, encouraged by government promises to deliver this stability (e.g. Shepherd, 1991).

In developing countries, several studies have suggested that fishers cope with fluctuations through geographical and occupational mobility (Bailey, 1982; Haakonsen, 1992). There may be conflicts or mutualities between mobile fishers and settled farmer-fishers. This project will investigate factors enabling and restricting mobility. An understanding of these factors may provide means of targeting development interventions aimed at securing fishers' livelihoods.

'Modern' fisheries management has often consisted of setting stock conservation objectives, and then finding means of modifying fishers' behaviour or investment to fit these objectives (Mahon, 1997). This has usually meant imposing closed seasons, closed areas, size limits, gear restrictions, access or 'fishing effort' restrictions. While there has been concern for the effects of different regulatory options on fishing communities, there has usually been little systematic research on their effects on fishers livelihoods. Fisheries management is becoming more consultative, and fishing communities now have greater participation in management, sometimes through co-management arrangements (Pomeroy & Berkes, 1997). There is still little systematic discussion of the effects of different management options. There is a requirement for both participatory research to help to identify acceptable management solutions to fishery problems, and a study of livelihoods to understand how fishers cope with and react to both inherent fluctuations and changing externalities.

A livelihoods approach is increasingly being adopted to achieve a more accurate understanding of natural resource management systems (Carney, 1998). Its chief benefit is to avoid undue preoccupation with a particular source of survival, in this instance fishing, to the neglect of other components that make their own demands on the resources available to the household (Ellis, 1998). A livelihoods approach should improve rural development policy and practice by recognising the seasonal and cyclical complexity of household survival strategies, helping to remove constraints to access to activities that complement existing patterns, and identifying ways of making livelihoods as a whole more able to cope with adverse trends or sudden shocks.

The livelihoods approach centres on the links between individual or household assets, the activities in which households can engage with a given asset profile, and the mediating processes (institutions, regulations etc.) which govern access to assets and to alternative activities (Carney, 1998; Moser, 1998; Scoones, 1998). While still in its early stages, it is understood that the livelihood perspective is being introduced as a guiding principle for natural resource programmes in DFID, following its introduction as the key theme at the Natural Resource Advisers Conference in July 1998 (Carney, 1998).

The concepts and methods of livelihoods analysis have seldom been applied in fisheries (Townsley, 1998). This project will present one of the first examples of integrating livelihoods analysis with other fishery investigation techniques.

2.6. Background to target fisheries

2.6.1. Indonesia

The pelagic marine fisheries of Indonesia yield over 1.7 million tonnes per year, from a total fishery of 3.7 million tonnes (FAO, 2000) making Indonesia the world's sixth largest fishing nation. Given the vast size of the archipelago, this research focuses on the province of West Java, where population pressure on fishery resources is likely to be most intense. The fisheries for small pelagic species off the south coast of Java are based mainly on two species of *Sardinella* and the Indian Mackerel (*Rastrelliger kanaguria).* The stocks of sardines in the eastern part of Java are known to vary both spatially and temporally but recommendations for the management of the purse-seine fishery have been based on a calculated equilibrium MSY (Pet et al., 1997) and involve substantial effort reduction to meet this target. Coastal pelagic fisheries off South Java are prosecuted both by semi-industrial seiners (70 ft vessels) and smaller non-

mechanised fisheries. The seine fleet has increased greatly since the ban on bottom-trawling in 1981 (Bailey, 1997). In east Java, >50% of sardine catches were taken by the purse-seine fishery. There is interest in decentralising fisheries management, supported by ICLARM work in support of community-based coastal zone management (Pido et al., 1997).

All these changes imply a dynamic fishery, with involvement of people at differential levels of investment. When this is taken in the context of recent economic upheaval in the region, these fisheries provide an interesting study in the nature of access to coastal resources and of livelihoods based on these resources, and of the impacts of changing exploitation levels on the pelagic resources.

2.6.2. Malawi

In Malawi, small pelagic fish provide the mainstay of small-scale artisanal fisheries in many parts of the lake, with utaka (*Copadichromis* species) and usipa (*Engraulicypris sardella*) being the most important species. Landings statistics are thought to be unreliable and to underestimate the true importance of the fishery, which, in the case of usipa, may reach 50 000 tonnes in good years (Lewis & Tweddle, 1990). The fisheries are known to fluctuate extensively, with fishers able to identify and refer to 'good' and 'bad' years for usipa. These seem to be linked to interannual differences in productivity (Tweddle & Lewis, 1990) which in turn are generated by variations in the strength of upwelling caused by variations in wind stress (Allison et al., 1995). The fisheries for both usipa and utaka, the most important in the lake in terms of landings, are not thought to be overexploited (GOM, 1999), yet highly restrictive fisheries management is being discussed because of over-exploitation of inshore demersal cichlids, and some larger, high-value species.

Usipa and utaka are marketed largely in sun-dried form and, together with the small pelagic species of other African lakes, contribute significantly to dietary protein throughout Central and Southern Africa. The fishery is quite seasonal, and exploitation of 'usipa' in particular is likely to form only part of the livelihoods of those catching them. Coupled with its interannual variability, this makes this species a useful case-study of a fluctuating fishery.

Management at present is mainly by restrictions on gear types and mesh sizes, but community-based management is being implemented, following the drafting of a new fisheries act (Sholtz et al., 1998). The effectiveness of existing management is unknown, but is likely to be low. The existing fisheries are commonly regarded as being fully exploited (e.g. Turner et al, 1995).

2.7. Summary and identification of demand

The thinking behind this project represents a departure from conventional fisheries management goals, which aim to stabilise catches and catch rates. We believe these goals to be unachievable in certain types of fishery, and wish to explore the design of management systems and development interventions that assist fishers in coping with the realities of unpredictable resource fluctuations.

The identification of a demand for a study of peoples' responses to fishery fluctuation arose from awareness that conventional fishery models were failing to provide an adequate basis for management, and that there was a considerable interest in finding ways of incorporating an understanding of variability in fish stocks into fisheries management planning, as demonstrated by two recent international workshops on

Uncertainty in Fisheries (Flaaten et al., 1998; Stokes et al., 1999). What has been missing from this recent preoccupation on the problems of fluctuating fisheries was any discussion or analysis of how fisherfolk coped with fluctuations, and how these coping-strategies could be accommodated in fisheries management.

Specific demand for this type of research in Malawi and Indonesia was identified through the previous involvement of two of the research team (Frank Ellis and Eddie Allison) in fisheries and rural development policy research in these countries. Both Malawi and Indonesia are categorised by DFID as Group 1 (Priority countries for support of sustainable natural resource use and conservation, identified in the Rio Earth Summit). Fisheries are specified as a sectoral priority in Indonesia. DFID's indicative outputs are developed in consultation with the national governments. The research is therefore relevant to government priorities.

Malawi is currently revising its fishery management plans and priorities, with support from GTZ (German Government). The plan will incorporate initiatives for community and co-management measures for Malawian waterbodies. Much of the thinking on fisheries management in Malawi has been driven by concern about the effects of artisanal fisheries on the conservation of cichlid fish diversity, and on the overfishing of large, high-value species in the south of Lake Malawi and Lake Malombe. The most important fisheries – the artisanal fisheries for small pelagic species such as 'usipa' and 'utaka' were not receiving attention by researchers and policy-makers at the time this project was started. The new fisheries policy and legislation that was developed at this time was therefore not guided by knowledge of the status and issues around management of these stocks. We perceived a danger that the interests of the small-scale fisherfolk, traders and low-income consumers that depend on these resources would not be adequately taken into account.

Fisheries issues are poorly represented in national poverty alleviation strategies in Malawi, but policy researchers at the Centre for Social Research have recently been involved in fisheries-related studies – the first Malawian social scientists to do so in over 50 years of fisheries research and development. A dialogue with CSR around the need for social science research on the fisheries sector led to the present partnership.

Concerns about the lack of information on the livelihoods of small-scale fisherfolk exploiting small pelagic species were shared by some in Fisheries Department, but, as we have reported since (Allison et al., 2002), the fisheries department is not politically powerful, and tends to take its lead on policy issues from the agendas of whichever external agents are funding research and development activities.

In Indonesia, the research was designed with the support of representatives from a small rural business advisory NGO (Tina Musa, Wahana Biri Mandina Foundation) with links to the Department of Fisheries and the Institute for Coastal Zone Management at the Agricultural University of Bogor. The issue of fluctuating fisheries was of importance in the context of moves to decentralise fisheries management in Indonesia as part of the democratisation process following recent elections. The research also takes place in the context of perceptions of overexploitation in the seas around Java, and a vigorous drive to increase fisheries landings and revenue, under the leadership of the new Ministry for Marine Affairs and Fisheries.

DFID's adoption of the livelihoods approach to poverty alleviation also influenced the design of this project. At the start of this project, there were no empirical studies of fisherfolks' livelihoods available. The demand for such empirical studies of livelihoods in different NR systems was identified through Frank Ellis' involvement on the DFID

livelihoods advisory panel. The demand has since been reinforced by recent calls for more information on the economic status of fishing communities (Malawi National Fisheries Management Symposium, 2001) and on the viability of different approaches to coastal fisheries management in Indonesia (Dr Rokhmin Dahuri, Minister for Marine Affairs and Fisheries, personal communication, 2001).

3 PROJECT PURPOSE

Much fishery management is based on the assumption that there can be established an equilibrium between fish stock productivity and the catching capacity of a fishery. This assumption has been questioned, in light of the weight of evidence suggesting that fisheries fluctuate extensively and unpredictably – often independently of the effects of fishing.

The project purpose is to identify management regimes and development policies that are appropriate to the delivery of maximum benefits (income or food security) to subsistence and small-scale commercial fishers dependent on fish stocks that fluctuate extensively, so that livelihoods may be sustained and improved, and poverty in fishing communities reduced.

4 RESEARCH ACTIVITIES

4.1 Fisheries typology

This study aims to critically examine past attempts to develop a system of classifying fisheries on the basis of patterns in variability in biomass or catch time series. The rationale for this analysis was to build on well-known 'accepted wisdom' in fisheries management that small-pelagic stocks are inherently variable, and long-lived demersal stocks tend towards stability in population size and therefore catch. The objective of the analysis was to see if different fishery 'types' could be identified from analysing patterns of variability in catch-series, so that management approaches appropriate to the different types of stocks could be considered. By attempting to link patterns of variability in stocks with simple indicators of ecological features, a typology of fisheries could be developed. This approach has been attempted qualitatively and conceptually by Caddy and Gulland (1983) and Kawasaki (1983). Spencer and Collie (1997) have attempted to test Caddy and Gulland's categorisation statistically, but did not attempt to link their categories with ecological features of fish stocks. This study presents a statistical analysis, using time series of different patterns of variability. We then explore the linkages between different patterns of catches and biomass with main ecological characteristics of stocks, using discriminant analysis.

4.1.1. Data Sources

Catch and biomass time series were obtained from a database available on the internet (Myers et al. 2000). A sub-set of 33 catch and biomass series was selected for the analysis. Selection was based on time series length (at least 30 years); the inclusion of all the tropical and sub-tropical fish stocks in the database (due to the focus of our research on developing-country fisheries) and the exclusion of shellfish (so that we could use maximum body length as a comparable measure of size when exploring correlation between patterns of variability and life-history features). We included some stocks from higher latitudes, selected to provide maximum contrast in life-history features and to include those used by Caddy and Gulland (1983) and Spencer and Collie (1997) in previous typologies, for comparative purposes. Because of the geographical focus of our research project, we included additional data on fisheries of Malawian waters, including Lake Malawi and Lake Malombe, and on fisheries of Indonesian coastal waters. These were obtained from official government statistics (GOM, 1999; GOI, 2000). The summary features of the chosen datasets are given in Annex 1.

Data on ecological features of stocks were obtained from FISHBASE (Froese and Pauly, 2000). Data include the maximum length, parameters of the von Bertalanffy growth model (L_∞, K), natural mortality (M), length at maturity (L_{mat}), approximate life span and whether the species occupies a predominantly pelagic or demersal habitat. These data are also available in Annex 1.

4.1.2. Methods

In classifying fish catch and biomass time series by patterns of variability, we followed the methods used by Spencer and Collie (1997). However, unlike in Spencer and

Collie's study, biomass data and catch data were analysed separately, since we considered that it was inappropriate to conduct the analyses on a combination of biomass and catch time series. Furthermore, both biomass and catch time series were available for 20 of the 51 fish stocks included in our study, which allowed us to compare the results obtained.

The 71 time series of marine and freshwater fish stock biomass and catch, including 32 biomass time series and 39 catch time series, were each analysed using a crude form of spectral analysis that enabled us to calculate parameters that distinguish extent of variability, long-term trends, short-term variability and possible longer-term periodicity. The parameters calculated were:

- Linear trend in catch or biomass – (direction, significance and R^2 value recorded)
- CV - the coefficient of variation in recorded catch or biomass
- R^2_{lo} – R^2 value of LOWESS-smoothed fit to the data – a measure of high-frequency (year to year) variations
- R_k – autocorrelation function – a measure of low-frequency variations (interpretable as periodic variations)

Calculated values of CV, R^2_{lo} and R_k (from de-trended time series) were then used in a cluster analysis that aimed to distinguish groups of stocks with similar patterns of variability. An attempt was then made to establish a link between clusters corresponding to different patterns of variability and indicators of life-history patterns (Length at maturity, longevity, natural mortality rate, maximum length, von Bertalanffy growth coefficient, pelagic/benthic habitat) using a discriminant analysis. All statistical analyses were done using the SPSS software. Further technical details of the analytical methodology are given in Annex 1.

4.2. Development of theoretical bioeconomic models

The fisheries of primary interest are characterised by a relatively poor level of knowledge of key parameters and variables, including stock size and harvesting capacity, with infrequent and unreliable data. Therefore management strategies must be simple, not heavily data dependent, and ideally robust to a wide range of possible realities.

While standard models which determine an optimal threshold above which all stock is to be harvested can yield interesting theoretical results, it is clear that such policies cannot practically be implemented in poorly observed and fluctuating fisheries.

Therefore the approach taken in the bioeconomic simulation modelling is to create a simple underlying model with a number of possible forms, with the actual form and parameters of the model unknown from the perspective of management. Different strategies are tested against the suite of possible underlying models in a series of simulations. This approach is further driven by the absence of data with which to construct a coupled economic-ecological model representing one of the actual fisheries under consideration.

The models tested in this project build on the early work in this field of, *inter alia*, Beddington and May (1977), Ludwig (1980) and May *et al.* (1978), who identified that "what seems really needed is not further mathematical refinement, but rather robustly self-correcting strategies that can operate with only fuzzy knowledge about stock levels

and recruitment curves". It is this thinking that also underpins the International Whaling Commission's management procedures, where there is an acceptance of uncertainties, and testing through Monte Carlo simulation of the robustness of strategies in dealing with uncertainty (Kirkwood 1997).

McAllister et al (1999) note that the use of structurally different operating models to account for fundamental uncertainties about model form is becoming more widespread. The approach of management strategy evaluation using simulations is reviewed more fully in the technical annex.

The simulation approach provides a complementary methodology to the practical alternative of 'adaptive management'. Its major advantages over true adaptive management include rapidity and vastly greater sample size relative to field trials, the ease of diagnosis of causes for observed failure, and the lack of costs connected with failure (Cooke, 1999).

The approach adopted here is similar in many respects to that used by the Scientific Committee of the IWC, except in that it is based on a theoretical fisheries model rather than on a model derived from data for the fisheries of interest, simply because the required data is not available. There is therefore no "base case" as such. Rather the intention is to look at a fairly wide range of possible scenarios, partly to determine the conditions under which given policies function acceptably, and partly to check the robustness of policies to a wide range of possible scenarios.

There are a huge number of potential questions on the general theme of how to manage fluctuating fisheries in the absence of good data, but here we test the specific, hypothesis put forward by Cochrane (2000) that "the greater the uncertainty, the more conservative should be the harvesting approach". Cochrane suggests specifically that the realised yield as a proportion of estimated maximum average yield should be lower when uncertainty is greater. This clearly has a large potential to impact heavily on fishing communities and on the supply of fish from fluctuating resources, which may include the high volume, low-value small pelagic fish that form such an important part of low-income consumers protein intake in less developed countries. This makes it important to test the conditions under which Cochrane's proposition is appropriate, and this is the main thrust of the simulation studies presented here.

4.2.1. The model

The model used as the underlying fishery is a fairly simple single species model. There are six growth variants, via three different possible relationships: recruitment independent of stock; a shallow-domed Ricker curve; and a steeply-domed Ricker curve, coupled with two possible thresholds for recruitment failure: 1% and 5% of the theoretical virgin stock. Recruitment is subject to mutiplicative stochastic fluctuations which may be autocorrelated. In addition to the recruitment, there is survivorship from the previous year's escapement. The stock is harvested using a simple function relating harvest to stock and effort.

In the model, stock is normalised such that a pristine stock under "mean" environmental conditions is measured as 1, and the price variable is likewise 1. This facilitates analysis and comparison, and helps interpretation of statistics such as net present value.

The estimates for thresholds of 1% and 5% are based on the American Fisheries Society decline thresholds for classifying as "vulnerable" a distinct population segment of a high or medium productivity species respectively. The criteria used to define high

or medium productivity are intended to be conservative, and there are two levels of threat beyond "vulnerable", namely "threatened" and "endangered".

The variables which take different values according to the scenario are as follows:

- the cost of effort (normalised for catchability): 0.02, 0.06, 0.1.
- the stock concentration coefficient in the harvest function: 1, 0.85, 0.7
- the level of poaching beyond policy targets: 0.25, 0.75
- the threshold for recruitment failure : 0.01, 0.05
- the form of recruitment: independent, or normalised Ricker parameter (3,12)
- the stochastic influence distribution and error in estimating the optimal policy for the "equivalent" deterministic system: Uniform[0.9,1.1] for both, Uniform[0.9,1.1] fluctuations and Uniform[0.6,1.4] error estimate, Uniform[0.6,1.4] for both.
- the degree of autocorrelation: 0 or 0.4

In addition there are a number of parameters which have not been varied. The parameters are discussed more fully in the technical annex.

The bioeconomic model presented is at a fairly early stage of development. The results are interesting but a wider range of simulations is needed before firm conclusions can be drawn. And it is important to bear in mind that the model relates only to a small subset of fisheries which display the resilience characteristics modelled.

4.3. Development and dissemination of livelihoods research methods for small-scale fisheries

Much fisheries and aquatic resource management research and development intervention in the past has been product, rather than process, orientated (Allison, in press). Recent emphasis on participatory processes, research partnerships, stakeholder involvement and institutional capacity building have all led to greater recognition of the importance of paying attention to process issues to ensure maximal benefits from research. Although this research project was largely strategic in nature it had secondary aims to develop livelihood research methodologies and build awareness of livelihood approaches in target institutions (mainly fisheries departments).

The livelihoods framework is often criticised for failing to provide methodological direction. We are often asked: how do you 'do' a livelihoods analysis? Our response to this question was to draft a set of guidelines that aimed to provide a solid methodological basis, but without being overly prescriptive. These methodological guidelines, which combine qualitative investigation at community, group or village level with a quantitative household survey, are outlined in Annex 3. It is emphasised that the exact choice of methods should depend on the purpose of the investigation.

We took as our guiding framework the DFID livelihoods approach, as interpreted by Ellis (2000). The framework is presented in tabular form overleaf (Table 4.1)

Process-orientated research activities conducted within the project were:

- Developing and testing of a livelihoods research methodology previously used in agricultural research. The rationale and outline of methodologies adopted is given in Annex 3. These methods were developed in an adaptive way, while conducting

study site selection visits with research partners in Malawi and Indonesia. They were also pilot-tested before application to selected case-study villages.

- Training and awareness-building in the use of livelihoods research methodologies. The project partners in Malawi and Indonesia acted as trainers within their institutes, so that other researchers, development workers and field assistants were aware of the livelihoods approach and its associated research and planning tools.

- Awareness-building among the wider science, policy and natural resource management community through review, publication and presentation of theoretical overviews on the potential utility of bringing a livelihoods perspective into the arena of fisheries policy-making.

The outcomes of these research processes are reported mainly in section 6, as they are more readily considered under 'dissemination pathways', than research 'outputs' in the conventional sense of empirical 'results'.

4.4. Case studies of fishing livelihoods in Malawi and Indonesia

This section outlines the fieldwork methods utilised to investigate the livelihoods of artisanal fishing families, in the context of investigating responses to fluctuating pelagic fisheries. A Fieldwork Manual for conducting this type of research on artisanal fishing households is written up as a separate document (see Annex 3). Livelihoods analysis requires a judicious mixture of qualitative and quantitative data methods, as well as identifying methods that are best applied at community or group level compared to those that are more appropriate at household level.

In general a sample survey approach works well for discovering patterns of asset holding at household level, the different activities in which household members are engaged, the contribution of these activities to the overall livelihood portfolio of the household, and critical factors at household level that lead to increased vulnerability to unexpected crises or shocks. On the other hand, group and community level PRA/RRA methods are better adapted to discovering general perceptions about fisheries resources, the way these are changing over time, trends and cyclical experiences in fish catches, widely held views about the application of fisheries management regulations and similar topics. While PRA methods can also, of course, be applied at household level this can result in unwieldy volumes of qualitative information that is difficult to synthesise in a meaningful way.

It was considered that gaining an accurate picture of the institutional context of fisheries livelihoods was crucial to the success of the research. This comprises all those factors that determine "access" to the fishery resource by different people at different times in different places. Access may be by virtue of residence, or by arrangement; it may "include" certain types of people and "exclude" others; it will be subject to formal regulations and compliance (Fisheries Department rules), and informal regulations and exchanges (community, social norms and so on). It may, or may not, involve reciprocal agreements between migrant fishermen and residents that are beneficial to both parties. It may be entirely opportunistic i.e. turning up at locations

Table 4.1. A framework for micro policy analysis of rural livelihoods (modified from Ellis, 2000, p 30)

A	B	C	D	E	F
Livelihood platform	Access modified by	In context of	Resulting in	Composed of	With effects on
assets natural capital physical capital human capital financial capital social capital	***social relations*** gender class age ethnicity ***institutions*** rules & customs land and sea tenure markets in practice ***organisations*** associations NGOs local admin state agencies	***trends*** population migration technological change relative prices macro policy national econ trends world econ trends ***shocks*** storms recruitment failures diseases civil war	**Livelihood Strategies**	***NR based activities*** fishing cultivation (food) cultivation (non-food) livestock nonfarm NR ***non-NR based*** rural trade other services rural manufacture remittances other transfers	***livelihood security*** income level income stability seasonality degrees of risk ***env. sustainability*** soils & land quality water fish stocks forests biodiversity

that are unclaimed and unregulated, and staying there until someone takes notice and then curtails or disbands the fishing groups that have been formed.

Investigations into fisheries management issues were informed by frameworks that distinguish the main types of formal (government-legislated) fisheries management (Table 4.2), and informal 'norms and practices'. The latter have recently been codified as 'taboos' (Colding and Folke, 2001; see Table 4.3)

Fishing as an activity poses particular challenges for investigation, due to the cyclical and seasonal nature of fish stocks and their varying location at different times. Fisherfolk tend to be more mobile than settled farmers and are sometimes a different ethnic group from the resident agriculturalists in shoreline villages. Owners of boats and gears may be different from users of those same assets, and wage (or catch-share) labour arrangements may be prevalent.

While there was some variation in the precise implementation of methods between Malawi and Indonesia, the same basic precepts applied in each case. The key features of the fieldwork methods common to each country were:

- purposive selection of 3 villages in each country, designed to provide contrasting experiences around the key theme of artisanal fishing in the context of fluctuating pelagic fisheries
- qualitative research in each village designed to examine broad details of fishing as a source of livelihood, its significance in the community, events and trends of the past decade, regulations and access as interpreted at community level, and mapping of migratory movements of fishermen
- livelihoods sample survey comprising 30 households in each village, stratified according to criteria that varied in different locations e.g. migrants Vs permanent residents, and aimed to discover the asset and activity patterns of artisanal fishing families

Table 4.2. The main tools that have been used for formal, government-legislated fisheries management (modified from Charles, 2001). Some of these tools are also used in informal or 'community-based' management.

Input controls (effort)	*Output controls (catch)*	*Technical Measures*
• Fleet size; no. of boats • Vessel capacity or catching power • Gear capacity - e.g. number of crab pots, trawl headline length • Days at sea or other time limits • Fishing area per boat	• Total allowable catches • Individual quotas • Community quotas • Escapement targets	• Closed areas (e.g. spawning grounds, nursery grounds) • Gear specifications (mesh or hook size, measures to increase selectivity or limit efficiency) • Closed seasons e.g. spawning season

Table 4.3. Resource and Habitat Taboos (from Colding and Folke, 2001) as a means of codifying informal management measures and institutions.

Taboo	Function	Method
Segment taboo	To regulate resource withdrawal	Bans the use of particular species for specific time period for a part of the human population
Temporal taboo	To regulate access to resources in time	Bans access to a resource for a certain time period
Method taboo	To regulate method of resource withdrawal	Bans the use of particular methods and techniques for resource withdrawal
Life history taboo	To regulate the withdrawal of species at vulnerable stages of their life	Bans the use of certain species at a vulnerable stage of their lives
Specific species taboo	To protect certain species at all times	Bans the killing and detrimental use of certain species both in time and space
Habitat taboo	To restrict access and use of resources	Bans access to and use of certain resources from particular habitats in time and space

4.4.1 Research in Malawi

In Malawi, the chief components of the research were as follows:

Regulatory framework and Lake Malawi background:

- Collection and assimilation of the history, catch data, and past research on the Lake Malawi fishery (with special attention to the *usipa* fishery due to the importance of this species to artisanal fisheries and to low-income consumers in Malawi)
- Information on the regulatory framework, how it is applied, to what species it is applied, the individuals and institutions through which it is exercised
- New legislation and its implementation, how much of the previous legislation remains standing and which parts of it have been dropped, how well does the existing/new regulatory framework work in practice?

Mapping of seasonal migratory routes and locations:

An important component of this research was to conduct a mapping exercise of temporary migrations in the southern half of Lake Malawi. This did not involve "formal" research methods, but required visiting villages and beaches, at intervals, along the coast to find out where fishermen were from, and to ask them about the main places that they fished, when they visited those places and how often they stayed, and the nature of interactions with resident fisherfolk, local residents and village authorities. For beaches visited for PRA or sample survey purposes, this was done at the same time as the PRA. Some additional research was conducted on the longer-term migrations of the Tonga fisherfolk from northern Lake Malawi. This involved visits to villages in Northern Lake Malawi.

PRA/sample surveys:

Case-studies in three locations, representing differing broad characteristics and opportunities (remoteness, access to markets etc.) and comprising:

- 3 lake shore villages (residential households)
- fishing beachside/migrant groups, located at or adjacent to the villages
- fishing migrant groups not located at villages, selected by travelling to one or other side of the villages until a temporary “fishing camp” is encountered

The selected study sites are indicated in Figure 4.1, overleaf.

Associated with each of these villages, a sample of 30 resident fishing households was drawn, stratified by fishing status (e.g. permanent fishermen, fishing labour only h/hs). In addition, a sample of 10 individual migrant fishermen (located either at the village or in a temporary fishing camp away from the village) was selected. The total sample across all villages therefore consisted of 90 household surveys, and 30 individual migrant fishermen interviewed at beach fishing sites.

Background data was collected for each selected village: total number of permanent households, resident village population (if available), maps showing village location on the lake and relevant features like roads, rivers etc., schools, health centres, other social or community facilities available, cooperatives or associations or groups formed for particular purposes, local or international NGOs working in the village and the nature of their activities.

For the purpose of this research a fishing household is any household who has a member(s) whom regularly, or often, or permanently engages in fishing as an activity during the year. One type of fishing household is likely to have a member who is a permanent fisherman, owning fishing assets like nets and a boat. Another type of fishing household may provide “fishing labour” without owning fishing assets. A non-fishing household is one the members of which are never, or only very seldom, involved in fishing.

Figure 4.1. Location of village livelihoods surveys in southern and central Lake Malawi (bold text). Also indicated are the areas in northern Lake Malawi where follow-up research on fisherfolk's migrations was conducted.

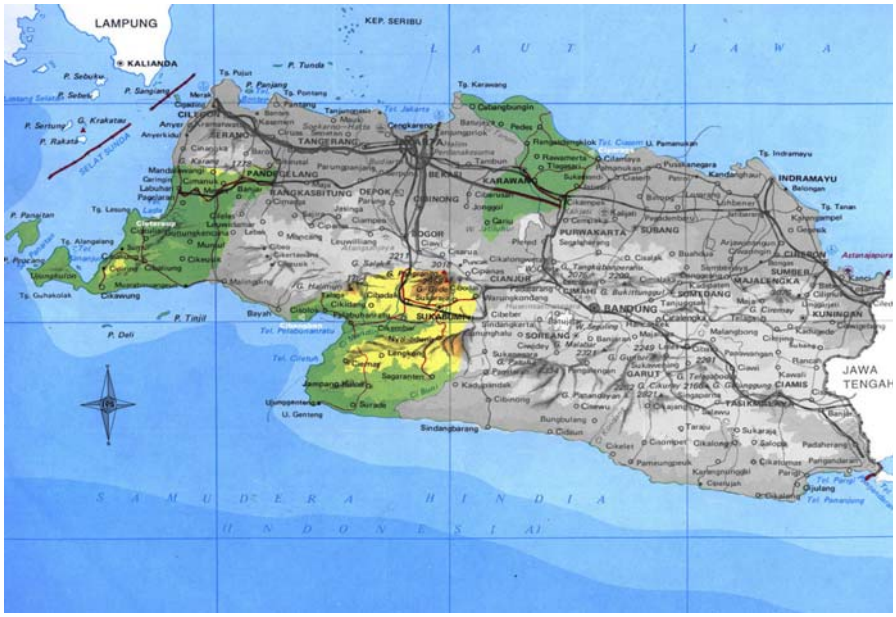
4.4.2 Indonesia

In Indonesia, the same basic components of the research were applied. The site of the research was the province of West Java in Indonesia which is bounded by the Java Sea to the north, the Sunda Straits between Java and Sumatra to the west, and the Indian Ocean to the south (Figure 4.2). The research comprised one study village in each of these differing fisheries, selected in order to ensure spatially distinct circumstances, and to allow for comparisons and contrasts that would illuminate the livelihood implications of fluctuating resources in the pelagic fishery.

The villages selected for research in Indonesia were:

- Ciparage, located in the district of Karawang, on the north coast of West Java (Java Sea)
- Cibangban, located in the district of Sukabumi, on south coast of West Java (Indian Ocean)
- Citeureup, located in the district of Padeglang, on the west coast of West Java (Sunda Straits)

Figure 4.2. Location of districts in West Java where villages were selected for livelihoods analysis.



Sampling procedures differed between these villages in order to take account of each village's special features. Thirty households in each village were selected for the sample survey, giving a total of 90 households altogether across the 3 villages. The household questionnaire was also implemented to 10 rice production households in Karawang district, so that some livelihood comparisons could be made between farming and fishing communities.

In Ciparage a total sample of 30 households consisting of 15 boat owners and 15 boat labourers was selected from a list of 226 boat owners available at the fish auction platform at the village. First, a random sample of 15 boat owners was taken, using a random number table. If the sample contained a non-fishing boat owner who was not resident in the village, then that owner was rejected and the next household chosen using the random number table selected instead. If an owner declined to be interviewed, then another was selected using the same procedure. Then, 15 boat crew members were selected from the same boats as the 15 boat owners, using random sampling within each crew of approximately 11 people in each boat.

In Citeureup, the total sample of 30 households were selected based on different types of fishing gears owned by local residents, applying the same random selection procedure as for Ciparage. The 30 selected respondents consist of 9 owners and 9 labourers of bagan apung (mobile lift net), 3 owners and 3 labourers of bagan tancap (stationary lift net), and 3 owners and 3 labourers of seros (guiding barrier).

In Cibangban, the number of fishermen and fish workers registered at the fish auction platform in June 1999 were 35 floating bagans that belonged to 35 owners and employed about 105 bagan crew members. There were 11 payangs owned by 11 owners who employed about 275 boat labourers and fish workers. Each payang had on average 25 crew members, more than twice the number of crew per payang in Ciparage. The other fishing boats were about 20 pancing (pole and line) boats belonging to about 20 owners who employ about 40 labourers. The last are about seven units of collecting boats owned by seven owners who employ about seven crew members.

From the above registered numbers, six bagan owners and six of their labourers, five pancing boat owners and five of their labourers, two payang owners and two of their labourers, and two collecting boat owners and two of their labours were randomly selected as the 30 respondents for this survey. A comparison between the total number of fishermen at the fish auction platform at Cibangban and the respondents selected for the study is given in the table below:

Table 4.4. Fishing Boats/Gears and Respondents at Cibangban Village

Type of Fishing Boats/Gears	Population of Fishers			Respondents	
	Unit	Owner	Crew	Owner	Crew
Floating bagans	35	35	105	6	6
Payang	11	10	275	2	2
Pancing (pole and line)	20	18	40	5	5
Collecting boats	7	7	7	2	2
Total	73	70	427	15	15

4.5. Management and policy implications of livelihoods approach to fisheries management and development

Micro-level livelihoods research and theoretically-informed analysis of patterns of fish stock fluctuations were linked to management and policy issues through review of policy and legislative documents, both in target countries, and more broadly within a framework of the changing nature of international fisheries governance (Allison, 2001).

Research activities centred on preparation of a series of reviews which were discussed with partners and individuals in target institutions during workshops and other, informal communication. This research has progressed further in Malawi than in Indonesia, thanks in part to close dialogue with the Malawi National Aquatic Resource Management Programme and involvement in complementary DFID-funded policy-level research on livelihood diversification (the ODG LADDER project). Such an analysis is, however, also in progress for Indonesia, but has not been completed in time to report in detail here. Dialogue with the new Indonesian Ministry of Fisheries and Marine Affairs over policy approaches to management of inshore fisheries continues.

5 OUTPUTS

The project outputs under each major research activity are given in the form of empirical findings and the implications of those findings for fisheries management and development. Management and policy inferences are drawn together in the concluding section.

5.1. Fisheries typology

5.1.1. Patterns of variability in biomass time series

Patterns of variability were analysed for biomass time-series for 32 stocks. The lowest value obtained for the CV was 0.12 for the East Pacific bigeye tuna stock and the highest value 1.10 for the California sardine The estimated biomass of 27 of the 32 stocks showed significant linear trends at the 0.05 level, with 19 of the 27 stocks being negatively correlated and therefore showing decreased biomass over time. Six stocks showed positive increases, In only 16 of the 32 stocks did variance explained by linear biomass trends exceed unexplained variability (R^2>0.5) around those trends, indicating the general importance of stock variability

A high R^2_{lo} value indicates that high-frequency or short-term variations (large year-to-year fluctuations) in biomass are relatively low for the majority of stocks, with 22 R^2_{lo} values > 0.75. Among these 22 stocks, 6 showed very small high-frequency variation with R^2_{lo} values over 0.95; these included the Atlantic bluefin tuna (West Atlantic), Pacific Ocean perch (Aleutian Islands), red snapper (U. S. Gulf of Mexico), Southern bluefin tuna (Southern Pacific), Southern bluefin tuna 2 (Southern Pacific) and Swordfish (North Atlantic). Two stocks, the Northern anchovy (California) and Yellowtail flounder (Southern New England), were found to have very large high-frequency variations in abundance over time with an R^2_{lo} of 0.16. The remaining 8 stocks, had R^2_{lo} values between 0.41 and 0.75, indicating that high and low frequency variation occurred almost equally for these stocks.
The analysis of the autocorrelation coefficients (R_k) showed apparent periodicity, significant at the 0.01 level for all the stocks except the grey mullet (Taiwan). The apparent period extended from 6 years for the red snapper (U.S. Gulf of Mexico) to 40 years for the pacific halibut (North Pacific). Because of the shortness of the time series relative to length of periodicity, however, this should be interpreted with caution. What it does show is that most fish stocks have shown major, multi-year variations that are present even when linear trend (increase or decrease) and the effects of short-term (year to year) variation are removed from the time-series.

Cluster analysis using CV, R^2_{lo} and R_k indicates six possible groupings (Fig 5.1):

These six clusters or groups are defined as follows:

Group 1: low-frequency, cyclic stocks All the stocks have high R^2_{lo} values and R_k values greater than 0.43, which indicates a cyclic behaviour for each stock occurring with low frequency. Stocks have CV values between 0.14 and 0.70. Examples include stocks of large pelagic fish (albacore, yellowfin and bluefin tuna), large demersal fish (pacific halibut and ocean perch, red snapper) and various small and medium sized

pelagic species (mackerel, Brazilian sardine, Gulf of Maine herring, South African anchovy).

Group 2: steady-state and/or irregular stocks The CV values for these stocks range from 0.12 to 0.54 which indicates low to moderate levels of variation. R_k values are low (between 0.29 and 0.34), suggesting no strong periodicity in biomass variations. The R^2_{lo} is between 0.77 and 0.98, indicating that most of the high-frequency variability is of low amplitude. Large tuna stocks are also found in this category, along with Grey mullet.

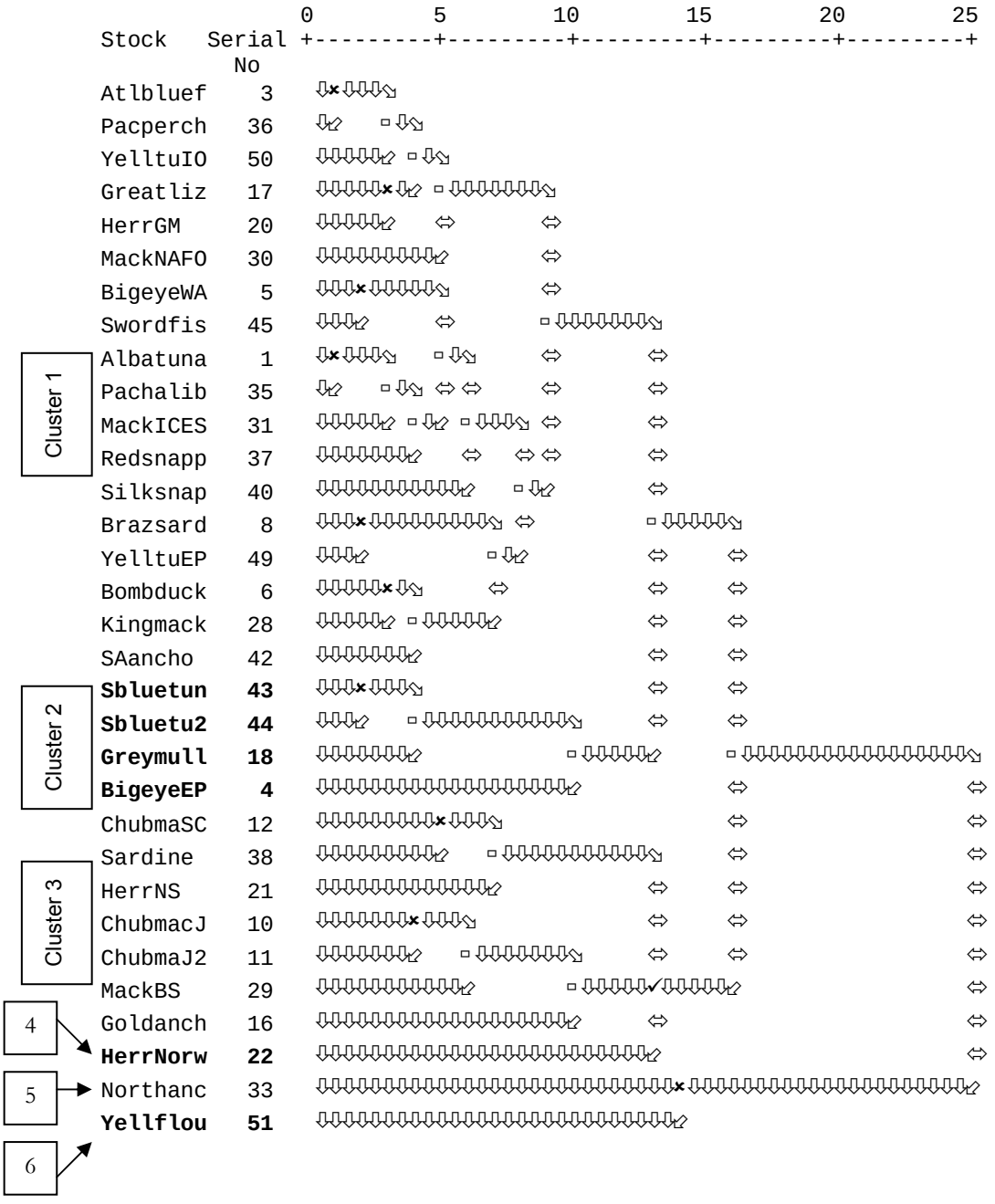
Group 3: spasmodic stocks These stocks have a very high level of variation (CV between 0.81 and 1.07) with strong low-frequency variations (R^2_{lo} between 0.60 and 0.92), indicating either periodicity or infrequent 'booms'. They include four stocks of mackerel species, North Sea herring and the gold-spotted grenadier anchovy. These appear to be the classic 'boom and bust' type species.

Group 4: very high variation, low frequency stock (Norway herring). This stock has a high CV value of 1.03 and a high R^2_{lo} value of 0.95, indicating little high-frequency variation. The large R_k value of this stock suggests a strong cyclic pattern that occurs with low frequency.

Groups 5 and 6 high variation, high frequency stocks (respectively northern anchovy and yellowtail flounder). The values of CV are quite high for these stocks (0.82 and 0.79) but with very low R^2_{lo} values of 0.16, indicating that they show high amplitude short-term fluctuations The main difference between these stocks is the R_k value, which is low for the northern anchovy (0.19) and relatively high for the yellowtail flounder (0.45). The latter suggests the existence of quite strong fluctuations at both high and low frequencies.

Reducing the number of groups does not lead to incorporation of Groups 4, 5 and 6 in any of the other identified clusters, but rather leads to one large cluster and three single-species ones.

Figure 5.1 Dendrogram of stock groups obtained from cluster analysis (using biomass time series). Serial numbers and stock codes are given in Annex 1.



The six different groups show a range of variation between the low-variability stocks (group 2) and highly variable stocks (groups 3 and 4). Scatterplots of CV against R^2_{lo} and Rk respectively, illustrate the characteristics of each group (Figures 5.2 and 5.3, overleaf). Groups 1 and 2 have similar CV and R^2_{lo} values, but very different R_k values, which are high for group 1 and therefore suggest a cyclic behaviour. Group 5 and 6 also present the same characteristics with similar CV and R^2_{lo} values, but with different R_k values. Group 4 has higher low-frequency components (high R^2_{lo} values) and variations (high CV values) than group 3 but similar R_k values.

Figure 5.2 Scatterplot of CV against R^2_{lo} for 32 fish stock biomass time series. Numbers represent stock groups.

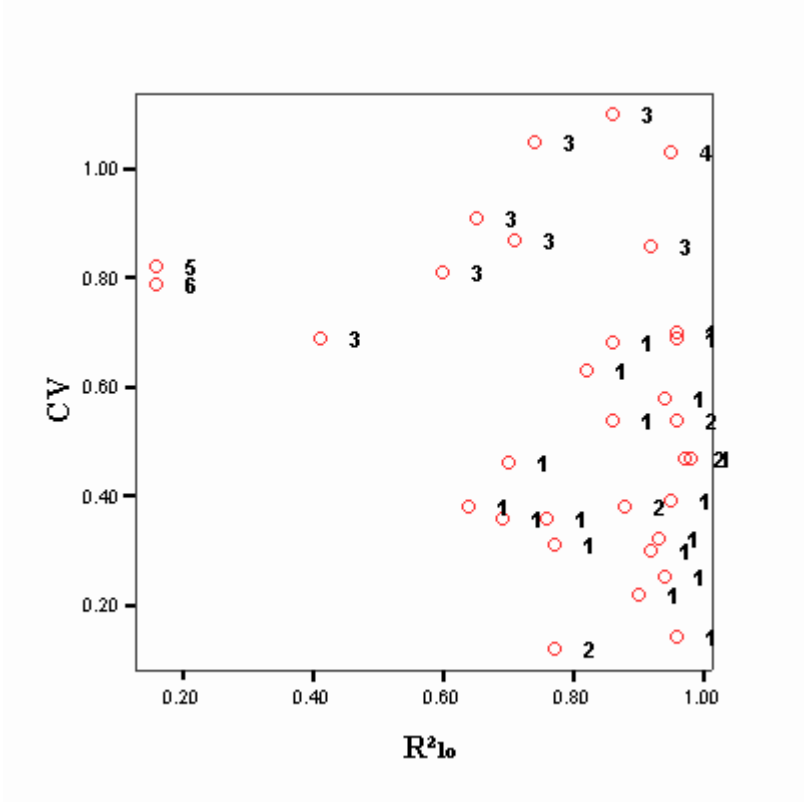
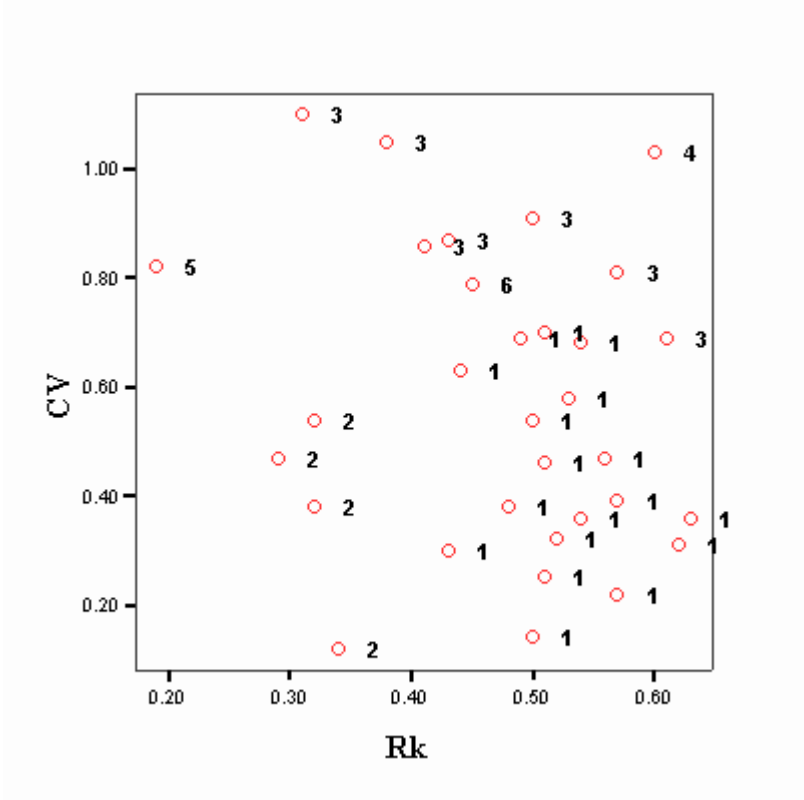


Figure 5.3 Scatterplot of CV against R_k for biomass time series



5.1.2. Patterns of variability in catch data series

A similar analysis for catch data series, again using six clusters, partitions stocks as follows (see Figure 5.4, overleaf):

Group 1: irregular stocks: albacore tuna, grey mullet, North Sea herring, Indian oil sardinella (Indonesia), usipa (Malawi) and yellowtail flounder.

Group 2: low variation, low frequency stocks: anchovy, eastern little tuna, fringescale sardinella, giant seaperch, grouper and Indian mackerel (all from Indonesian Catch statistics) plus 5 other medium/large pelagics

Group 3: high variation, high frequency stocks: chambo and kambusi (Lake Malawi and Malombe), several small pelagic stocks (gold-spotted grenadier anchovy, Norway herring, northern anchovy, Brazilian Sardine), medium and large pelagics (various tuna and mackerel stocks), and pacific ocean perch.

Group 4: low frequency, cyclic stocks: Bombay duck, Pacific cod, and Pacific halibut – all demersal species.

Group 5: steady state stocks: bombe and kampango (large catfish from Lake Malawi), utaka (small pelagic cichlid from Lake Malawi), Gulf of Maine herring.

Group 6: spasmodic stocks: California sardine.

These groups are similar to the groups identified in Spencer and Collie's (1997) study, which mixed biomass and catch data series. However, out of seven stocks common to both the studies, only four were found belonging to the same groups in each study, they include the North Sea herring and yellowtail flounder (irregular stocks), pacific halibut (low frequency, cyclic stocks), and sardine (spasmodic stocks). It is also important to note that most of the Indonesian and Malawian species belong to group 2 (low variation, low frequency stocks) or Group 5 (steady state stocks). This may indicate that catch data in these countries are 'guesstimates', likely not to reflect actual patterns of catch fluctuation. In the Indonesian case, it may also reflect the effects of aggregating catch statistics over the large spatial scales of the Indonesian archipelago, which may mean the pooling of several distinct stocks.

The scatterplots of CV against R^2_{lo} and R_k illustrate the characteristics of each group (Figure 5.5 and 5.6, following pages). Group 6 (California Sardine) is a very clear outlier, with exceptionally high CV. Most other groups are distinguishable in either one or the other of the bivariate plots, but there is considerable overlap, so that allocation to clusters is likely to include high levels of uncertainty.

Figure 5.4. Dendrogram of stock groups obtained from cluster analysis using catch time series, including landings data for species in Lakes Malawi and Malombe and Indonesia's coastal waters. The code and numbers refer to stocks

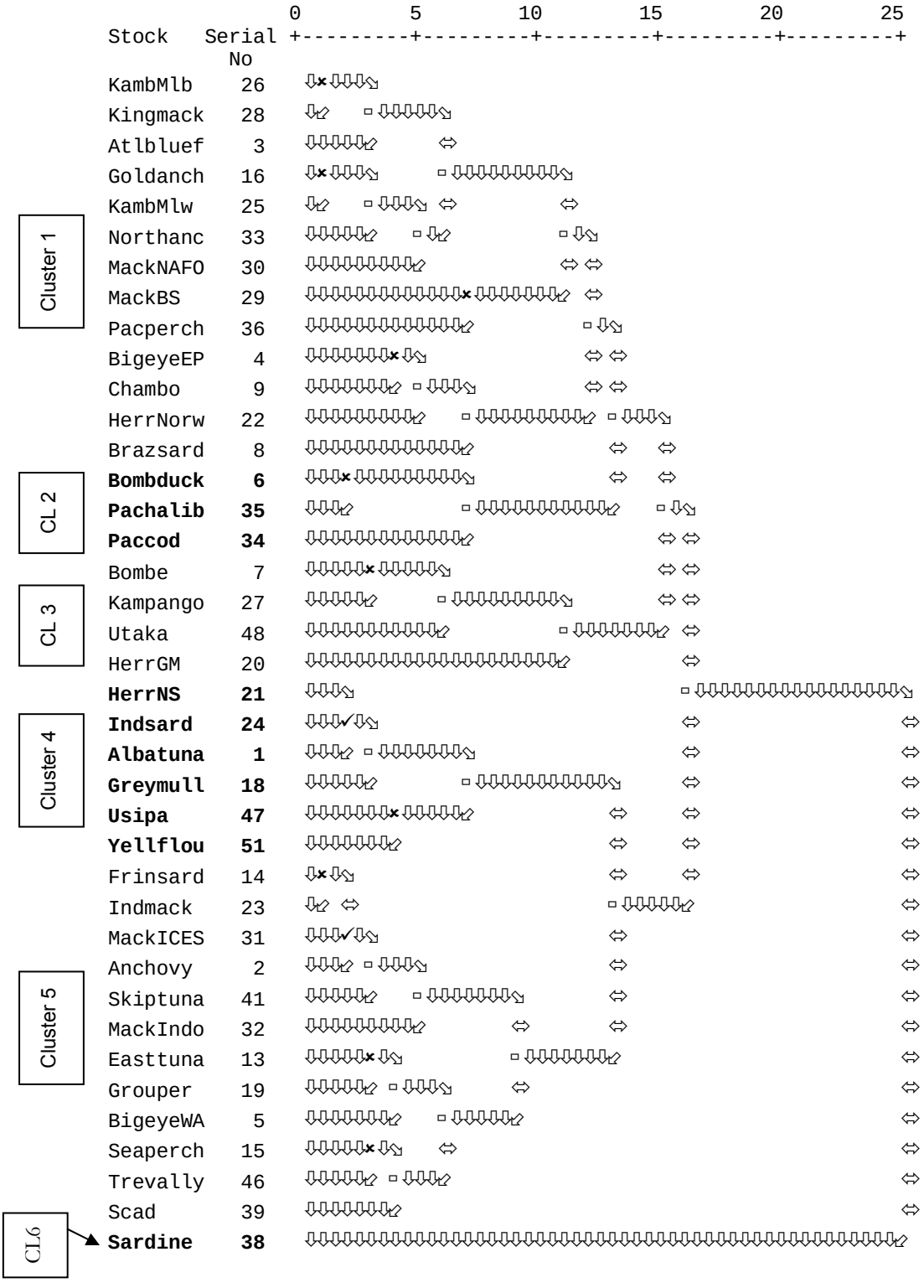


Figure 5.5 Scatterplot of CV against R^2_{lo} for 39 catch data series. Numbers represent stock groups.

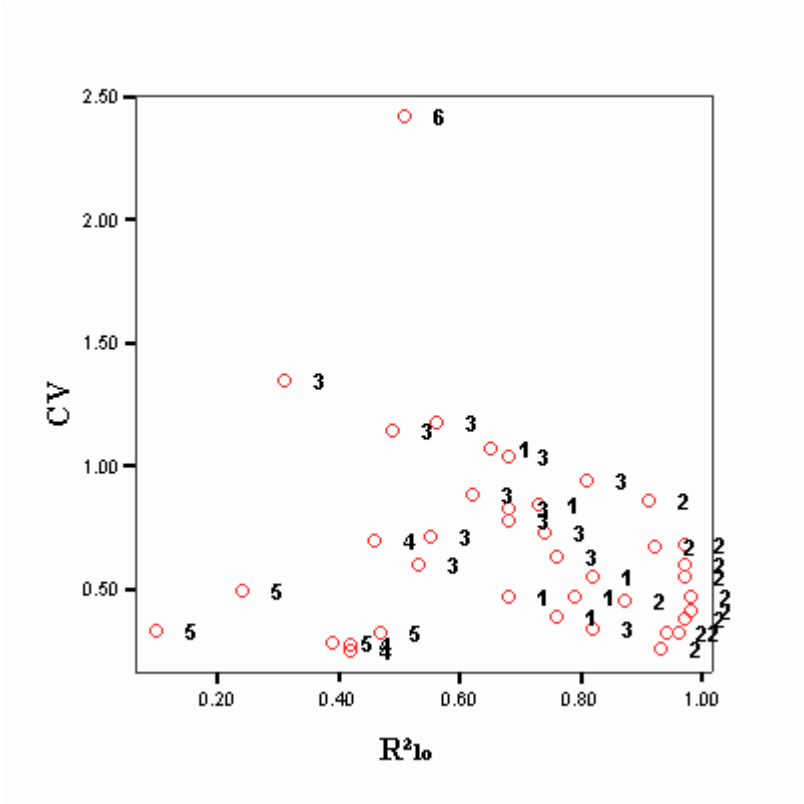
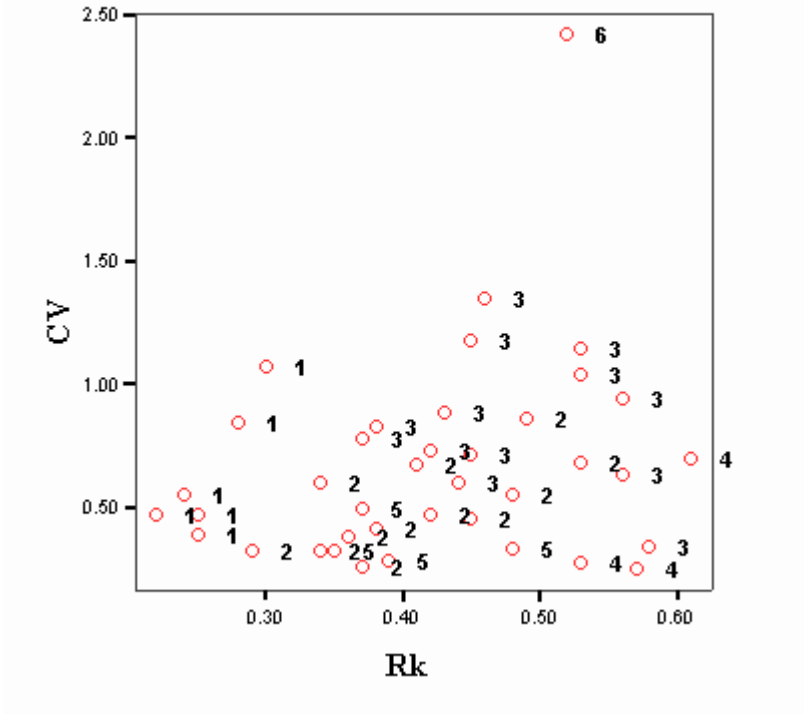


Figure 5.6 Scatterplot of CV against R_k values derived from catch data series.



5.1.3. Discriminant Function analysis

A stepwise discriminant analysis was applied to the parameters of the biomass time series, to establish if group membership could be predicted from data on ecological or population variables. Seven ecological variables including the maximum length, L∞ and K parameters, natural mortality, length at maturity approximate life span and habitat were used. The discriminant analysis was conducted on the stocks for which all the ecological data were available, due to the lack of data for some stocks.

The result of the stepwise discriminant analysis indicates that the overall success rate for predictions of membership of the grouping variable's categories using the discriminant functions developed in the analysis is 76%. The analysis demonstrates that groups 2 (low variation/irregular stocks), 4 (high variation, low frequency stocks), 5 and 6 (high variation, high frequency stocks) are the most accurately classified with 100% of the cases correct. However it is important to note that groups 4, 5 and 6 only contain one stock. Group 1 (cyclic stocks) is next with 69.2%, and group 3 (spasmodic stocks) is last with 60%. The results also provide an indication on whether there is a statistically significant difference among the dependent variable means (six different groups) for each independent variable (ecological characteristics). Four of the differences were found to be significant, including maximum length, L∞, life span (significant at the 0.05 level) and length at maturity (significant at the 0.01 level).

We can therefore conclude from the application of the discriminant analysis that different patterns of variability in biomass time series can be fairly well explained by variables related to body size and longevity of stocks

The discriminant analysis from catch time series is less successful overall (69%) Group 4 (cyclic stocks) and 6 (spasmodic stocks) appear to be the most accurately classified with 100% of the cases correct (but the latter is a single stock). Group 2 (low variation, low frequency stocks) is second with 90%, and group 5 (steady state stocks) is third with 66.7%. Group 3 (high variation, high frequency stocks) is next with 50%, and group 1 comes last with 25%. None of the differences in parameter values in the different groups is significant except 'habitat' (a binary variable pelagic/benthic), which was found to be significant at the 0.05 level.

We conclude that ecological characteristics alone cannot explain the classification on the basis of patterns of variability in catch data series obtained from the cluster analysis, as the use of catch data is likely to introduce too many confounding variables. While biomass data will of course be subject to the effects of past fishing activity in many cases (although not necessarily so for short-lived species), catch data are additionally subject to variations caused by management decisions (e.g. fishery closures, effort limitation) and exploitation patterns (e.g. diversion of effort to other fisheries). This type of analysis should therefore either use biomass data, or incorporate past fishing effort. Both will severely limit the scope for comparative analysis, as this type of data is not often available in tropical, mixed-species fisheries.

5.1.4 Conclusions

- The analysis suggests that few fisheries can be thought of as equilibrial, and that management and development planning must assume that individual fisheries of all types, from large demersal to small pelagic, are likely to undergo, to varying degrees, considerable short-term variations or long-term cycles – or indeed both.

- There is evidence of some correspondence between key ecological features of stocks and their patterns of biomass variability, but this is not sufficiently clear-cut to provide an obvious 'typology' of fluctuation based on such readily obtained parameters.

- Analysis of biomass time series provides only limited evidence for the conventional 'rule of thumb' that small pelagic species are more variable than other types of fish stock. Although all the stocks showing 'boom and bust' cycles are small or medium-sized pelagic fish, small and medium-sized pelagic fish are also found in most other variability groupings.

- Using catch data series (as opposed to biomass series) introduces too many confounding factors to expect any relationship to emerge between catch fluctuation patterns and ecological stock parameters. This is unfortunate, as catch-data are much more widely available than stock biomass data.

- While there is undoubtedly scope for more comprehensive analysis, the reliability of existing data and range of factors likely to contribute to observed patterns of biomass and catch data series suggest that robust 'rules' on patterns and extent of variability, correlated with ecological features of fish stocks, are likely to remain elusive.

- The proposed output of a 'typology of fluctuating fisheries' has therefore not been achieved, but we have the basis for an informed critique of past efforts (e.g. Caddy & Gulland, 1983; Kawasaki, 1983; Spencer & Collie, 1997).

- Future research in this area would benefit from finding a means to incorporate fishing effort and stock-recruitment data in such analyses, although to do so would move away from the original objective of finding a simple means of classifying fish stocks based on limited and widely-available information. Taking the analysis in this direction may provide important theoretical insight, but is unlikely to provide a simple diagnostic tool to help match management strategy to type of fish stock - the original intention in this analysis.

- The analysis does illustrate the importance of stock and catch fluctuations, highlighting the limitations of conventional equilibrium-based thinking in fisheries management and development policy. The key message is that management institutions and exploitations strategies have to be robust to these variations. The following sections of this report examine the relationship between exploitation strategies and informal management institutions adapted to maximise benefits from fluctuating stocks, and formal management institutions predicated on the goal of stability in fish catches.

5.2. Bioeconomic simulation modelling

Simulations indicate some of the following general conclusions, for the parameter ranges modelled.

It is very important to bear in mind that the model relates only to stocks which are highly resilient and which display strong recovery from low stock levels, and that these may be but a small subset of fisheries in general.

- In general, effort policies perform best for NPV, while quota policies perform best for lower variances in NPV (across runs) and in harvests (within runs).
- Moratorium polices tend either to perform well or very badly. They perform very well when the moratorium allows a remnant stock to recover to outside a 'collapse zone', and so could be warranted if recruitment failure is suspected. They do not perform so well where there is autocorrelation in the fluctuations. This must be because of the increased prospect of a run of bad years causing the moratorium to fail in its objectives.
- The performance of a precautionary strategy is highly dependent on the form of the model. In particular, high shoaling tends to favour caution does not perform well against the NPV criterion: the regular losses outstrip the occasional possible gains.
- If a Ricker stock-recruitment function is assumed (i.e. recruitment depends on parent-stock biomass), open access strategies perform poorly. They tend to perform well when recruitment is independent of stock.
- The stocks considered in this project would be classified as being of high resilience. In this category, stocks are considered at risk of extinction should the biomass fall below 1% of its virgin value for 10 years or 3 generations, whichever is longer. This is not particularly conservative, but reflects an assumption that while these stocks may not be vulnerable to biological extirpation (e.g. see Lake Chilwa, Box 1.3), economic overexploitation is entirely possible. So the veto level reported in the results of 5% is probably very conservative, so far as avoiding extinction risk for highly resilient stocks goes. Economic overexploitation is another matter, but is reflected in other statistics.
- Results from earlier simulations show that it takes a particular combination of low harvesting cost and high stock concentration to make harvesting to below 1% of the 'virgin stock possible. The question of interest in this context is which policy is successful in avoiding low escapements should these conditions hold in reality. In this respect, open access is the poorest performer, for the obvious reason that a zero profit level lying beneath the threshold will cause the threshold to be breached. Beyond that, it is clear that both caution and moratoria have a strong impact that does not seem to be related to degree of stochasticity or autocorrelation. The same is true of both independent and Ricker recruitment.
- While these fisheries may be thought relatively safe from biological overexploitation, if relative costs are being reduced over time (e.g. by rising sale prices or increased efficiency of exploitation) then it may be that open access will come to threaten the resilience criterion.
- The results of this preliminary analysis suggest that there is little evidence that cautionary approaches perform significantly better under increasing fluctuations per se.
- However there is evidence that wider error ranges in estimating policy favour precaution under certain conditions. These conditions include higher shoaling, a highly domed Ricker curve, and poaching in particular. so that if such errors go hand in hand with fluctuations there may indeed be justification for greater precaution with greater fluctuations.
- This last point warrants further investigation, as it suggests that even where stocks fluctuate highly it may be possible to reduce the precaution required if better understanding of the underlying processes can be gained, even though the fluctuations themselves may be irreducible.

Once again, these results are preliminary and require further investigation. In addition, the model relates only to stocks which are highly resilient and which display strong recovery from low stock levels, and that these may be but a small subset of fisheries in general.

5.3. Livelihoods and fisheries management in Malawi

Fieldwork conducted under the livelihoods framework quickly revealed five key features of villages along the lake Malawi shoreline:

I. The most important small-scale commercial (artisanal) fisheries of Malawi, those for *usipa* and *utaka*, are seasonal, with catches of fish also showing considerable spatial and interannual variability. Fisherfolk have adapted to this uncertainty either by remaining highly mobile, or by maintaining diverse livelihoods that include farming and other non-farm income generating activities.

II. Fishermen in Southern and Central Lake Malawi are often of a different ethnic group to the majority of residents of lakeshore villages. The Tonga, from the Nkhata Bay area in central/northern Lake Malawi dominate the *usipa* and *utaka* fisheries, and they are either long-term settlers or seasonal migrants.

III. The permanent residents of lakeshore villages in southern and central Malawi (Yao and Chewa people) are often not directly involved in fishing activities. They are sometimes hired as crew or fishing labour by Tonga owner/operators and may also be involved in processing and trading activities. Thus, the majority of the working population of a lakeshore village may be farmers and traders, rather than fisherfolk.

IV. Traditional village authorities in southern and central Malawi are drawn from the resident (and often non-fishing) community. Thus, institutions for 'community-based' fisheries management, such as newly introduced Beach Village Committees, that are created through traditional authorities, may not represent fishing interests.

V. Migrant fisherfolk bring economic benefits to lakeshore villages, in the form of increased fish trade activities, employment opportunities as crew labour, and markets for locally traded goods - particularly food as both short and long-term migrants seldom have local access to farm land. Migrant fisherfolk are comparatively wealthy in Malawian rural society.

The following analysis will first outline fisherfolks' livelihood strategies, then consider the relationships between fisherfolk and other lakeshore residents, and finally the implications of these findings for current moves towards community-based fisheries management in Malawi will be discussed.

5.3.1. Strategies for coping with variability: livelihood diversity and mobility.

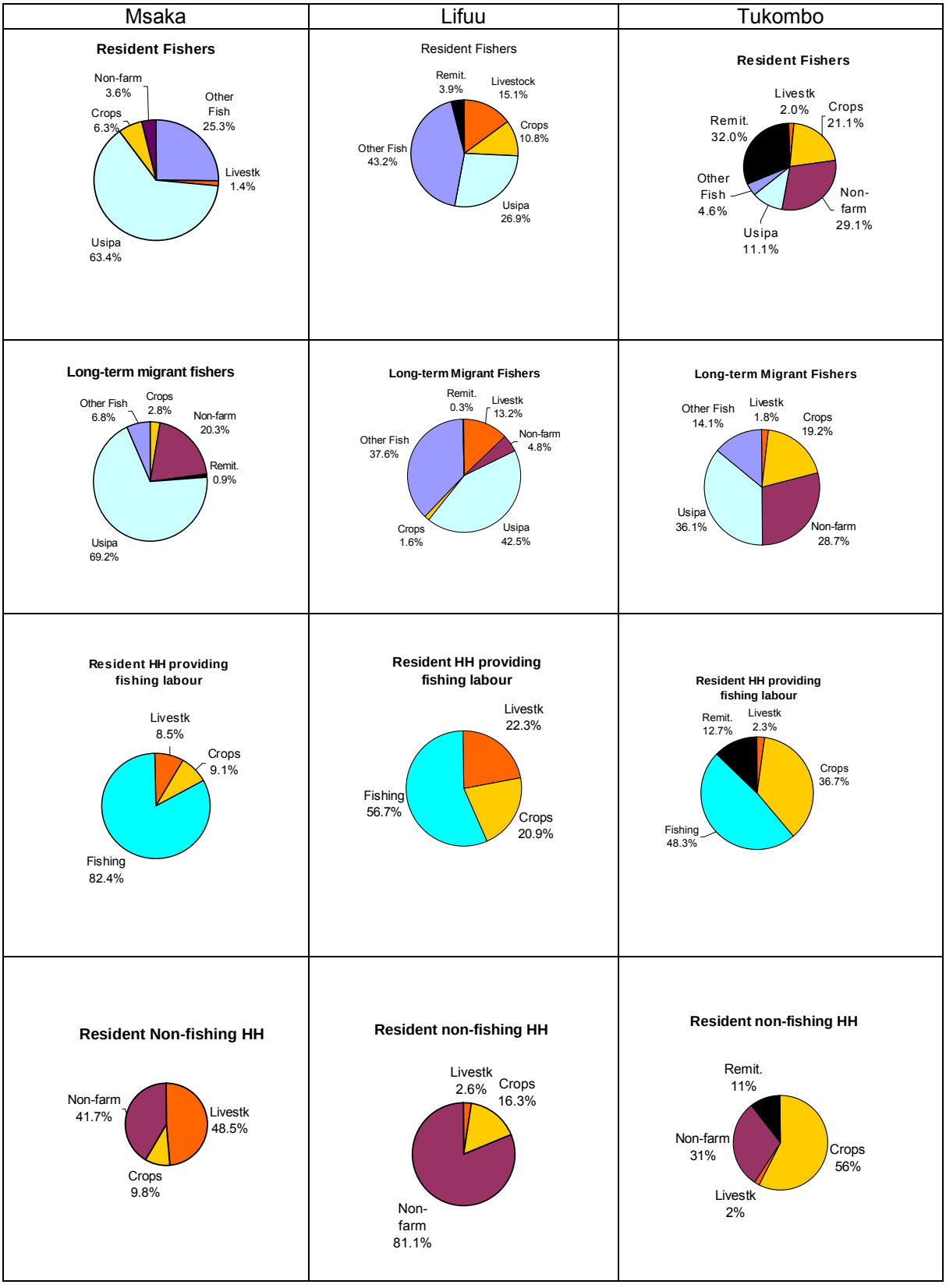
Looking at the sources of income to households living along shores of lake Malawi (Figure 5.7, overleaf) reveals the following patterns:

- Resident (non-immigrant) households in lakeshore villages that are involved in fishing as gear and boat owners or owner-operators have the highest diversity of

income sources. Dependence on fishing is highest at Msaka in the south, and lowest at Tukombo in the north. Typically, resident households have access to both land and lake resources

- Long-term migrant fishers, most of whom are Tonga people from central and northern Lake Malawi, are highly dependent on fisheries in the southern lakeshore villages where they have settled. This is typically because one condition of their settlement, imposed by traditional village authorities, is that they do not have access to farmland. This is particularly the case at Msaka, where the presence of Lake Malawi National Park restricts access to land as the coastal forests that surround the village are within the protected area, making land scarcity particularly acute. At Tukombo, where migrants and residents are sometimes of the same ethnic group, some long-term migrants have secured access to land, either through ownership or rental arrangements. Contributions of crops and livestock to household income is therefore higher.

Figure 5.7. Main income sources (% of total income, including good consumed in the home) to households of different main occupational categories. Data from questionnaire surveys, with averages based on data for 10 households from each category and village (approx 120 HH)



- Resident households that do not own fishing assets, but are involved in fishing as crew members or labour providers to migrant fishers, are typically headed by relatively young men. These households usually have some access to farmland (except at Msaka, where land is scarce), but provision of fishing labour provides the major source of income to these households (48-82%).
- It is evident that residents in lakeshore villages cannot survive by farming alone, and their incomes come from fishing or other non-farm sources. This is a finding replicated throughout rural Africa (Ellis, 2000, for review). Around Lake Malawi, fishing provides a major source on non-farm income to lakeshore households, even ones that would consider themselves to be farmers. Other non-farm income is either in provision of casual labour (*ganyu*) in the case of poorer households, or income from trading, transportation and other small businesses in the case of better-off households. These trading activities are typically linked to fishing in some way, either directly (fish selling) or indirectly (migrant fisherfolk and itinerant fish traders are the main customers for small businesses in lakeshore villages).
- Households in fishing villages do not seem to be recipients of high levels of remittances from household members living away from the villages, as is the case for many other rural households in sub-Saharan Africa (Ellis, 2000). Only at Tukombo do remittances feature significantly as a source of income to the households of residents.

While households resident in lakeshore villages appear to cope with uncertainties in both fish catches and farming by diversifying their livelihoods, this option is not always available to settlers, or long-term migrants. It is evident that many Tonga fisherfolk living along the southern and central lakeshore are highly dependent on fishing, making them potentially vulnerable to localised fishery resource fluctuations. The coping, or optimisation strategy of these fisherfolk is to retain flexibility through mobility. Figures 5.8 and 5.9 illustrate typical patterns of mobility, from which the following features can be generalised:

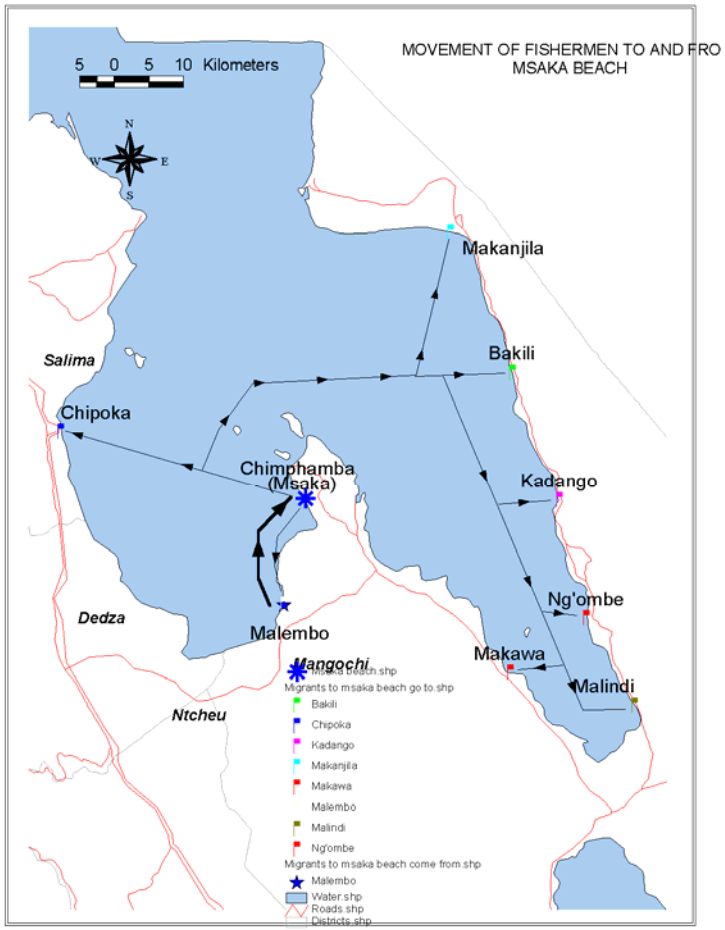
- Fisherfolk that are targeting the small pelagic fish *usipa* and *utaka*, are invariably mobile. Within a fishing season, they will move several times, in search of good catches or markets. These movements typically range over 50 km or so. (Figures 5.8 a-c).
- Many of the mobile fisherfolk can be found living in temporary fishing camps. The movements and origins of fisherfolk in these temporary camps are similar to the 'long-term migrants' interviewed in the sample survey villages (Figure 5.8d).
- The complex nature of short and long-term migrations of fisherfolk on Lake Malawi can best be understood through considering case-studies of the life-histories of fishermen interviewed in Northern Lake Malawi. Two examples are given in Fig 5.9.
- There is a net movement of fisherfolk from the north of the lake to the more productive fishing grounds of the south. There are suggestions that the movement is also driven by the opportunity to accumulate capital away from the constraints of the home village, and also allows fisherfolk from the north to profit from generally stronger markets for fish in the more populous and urbanised Southern and Central regions.

The observed patterns of livelihood diversity and migration have important implications for current moves towards community-based fisheries management in Lake Malawi.

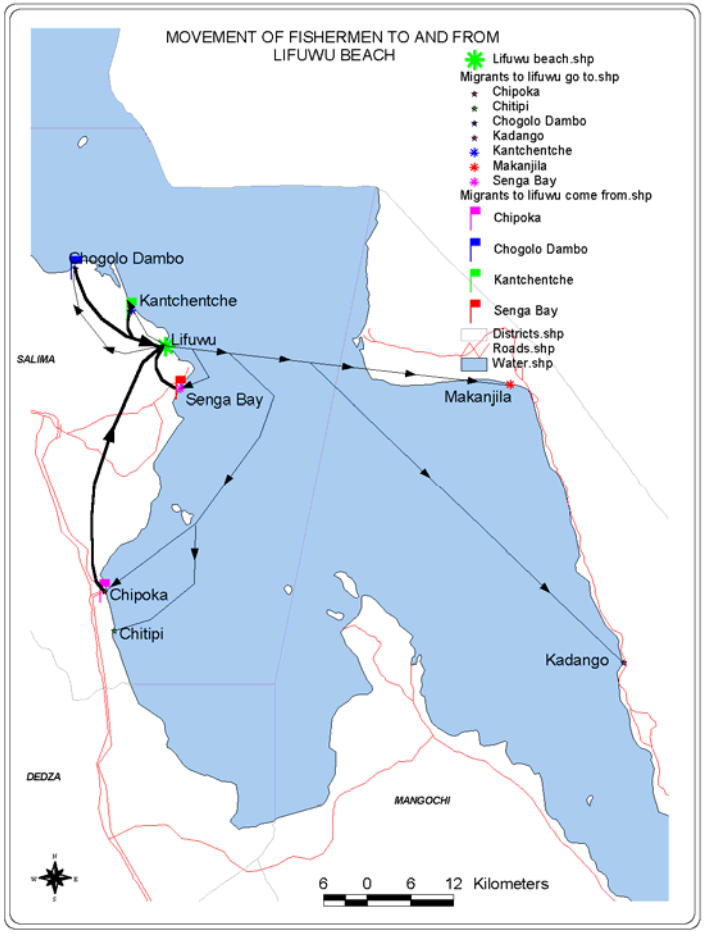
The challenges these livelihood strategies pose to fisheries management are outlined in the next section.

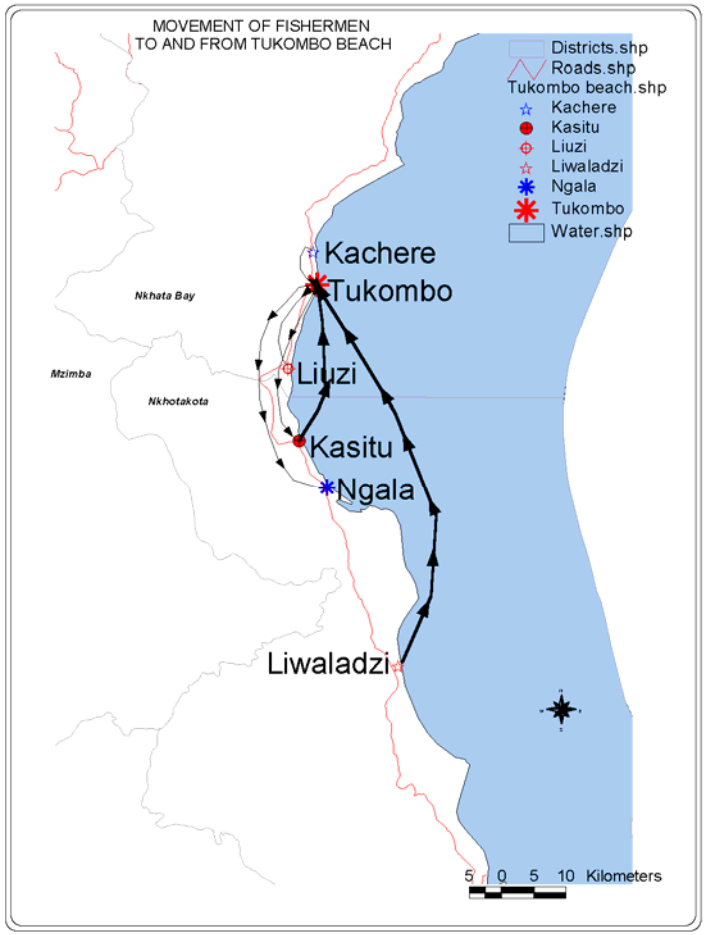
Figure 5.8. Main routes of short term (within-year) movements of fisherfolk, based on interviews with long-term migrants (those with homes in villages where livelihood surveys were conducted, but whose origins lie elsewhere) – (a), (b), (c) - and an example of the movements of migrant fisherfolk resident in temporary fishing camps (d). Several other temporary fishing camps were visited, and this represents just one typical example. The heavy arrows indicate the most common movements, undertaken by all those interviewed.

a)

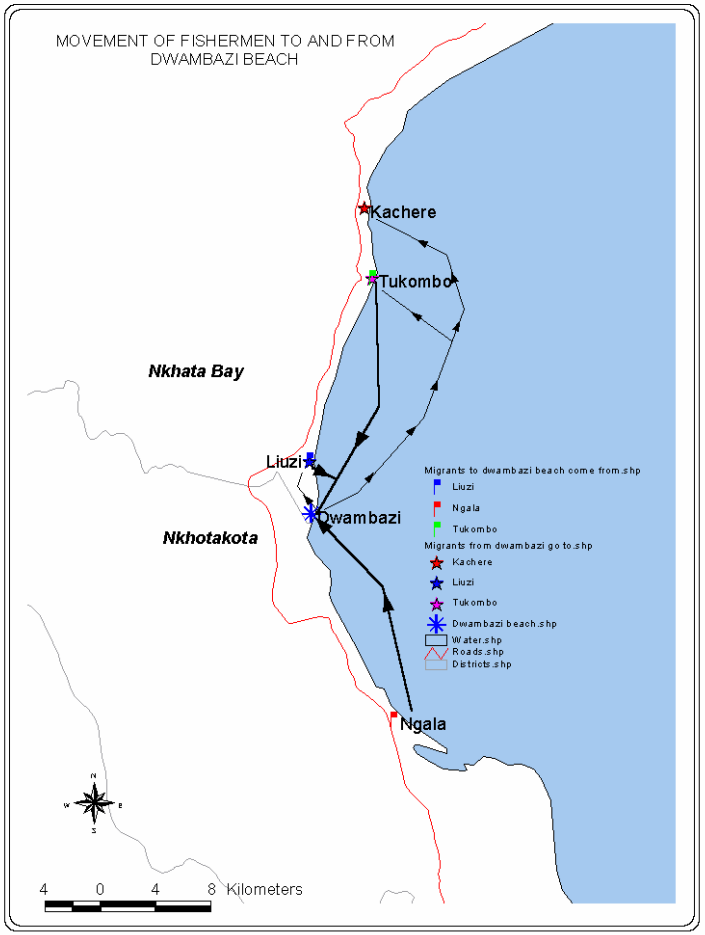


b)





c)

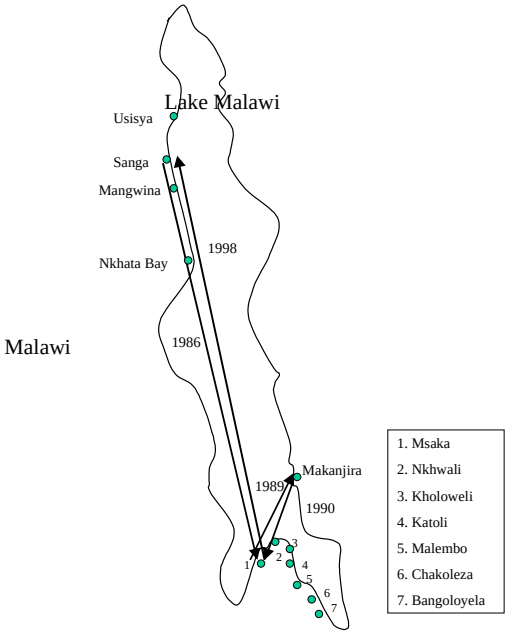


d)

Fig 5.x (Cont)

Figure 5.9. Long-term migratory patterns of two Tonga fishermen from the northern Lake Malawi villages of Sanga and Mangwina, based on group participatory mapping exercise, June 2001.

a) Sanga

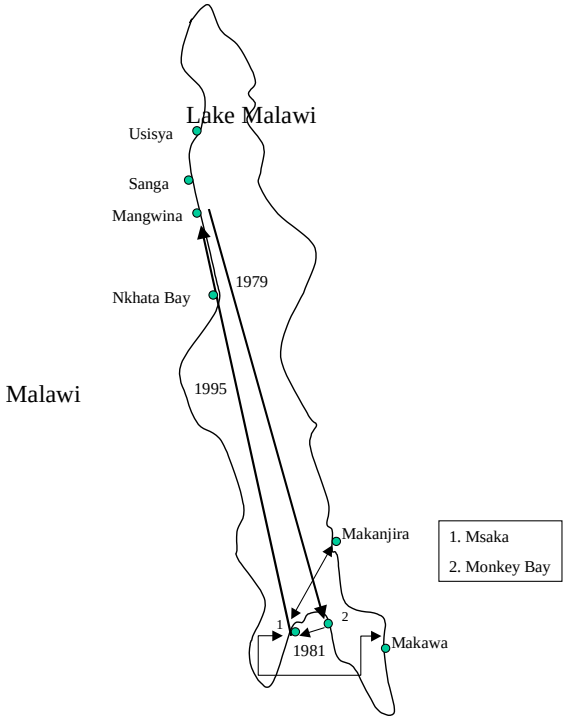


Fisherman A migrated from Sanga to Msaka in 1986, and returned home 12 years later. According to group interviews, most of the fishermen in Sanga migrate to Msaka during their youth but return to Sanga after ten to twenty years. Fisherman 'A' moved on to Makanjira in 1989 and returned to Msaka in 1990 another move common amongst fishermen from Sanga.

Although he had a house in Msaka, he only lived there from September to November every year. During the rest of the time, when fish was scarce in Msaka, he stayed for one or two months, depending on how much fish he could catch, in various villages (numbered 2 to 7).

Again, these short-term moves are common for migratory fishermen from Sanga. The group gave as the main reason for migration to the south the possibility for fishermen to make more money because of better fishing grounds there.

b) Mangwina



Fisherman B migrated from Mangwina to Monkey Bay in 1979, and to Msaka in 1981. He was based in Msaka until he returned to Mangwina in 1995.

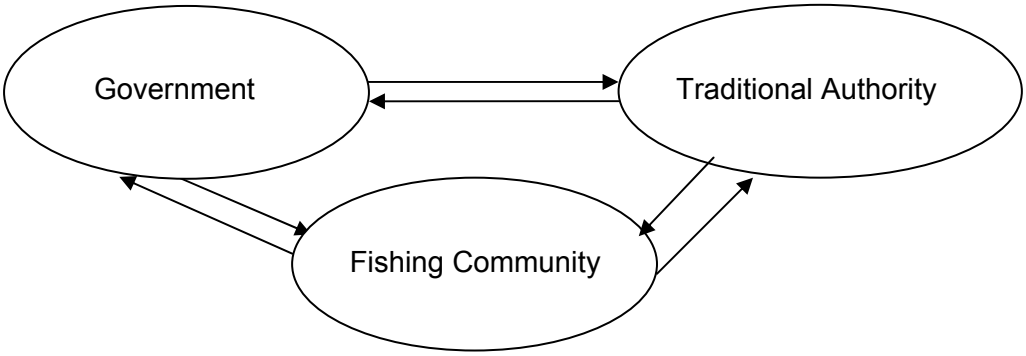
Again, this pattern of movement is common among Tonga fishermen. They migrate to the south because of better fishing grounds but also to do business. The group claimed that according to Tonga culture it is better to do business outside the village than within it because a successful businessman might cause other villagers to resent him.

Many migratory fishermen from Mangwina are based in Msaka but then follow the fish around during the year. Fisherman B, for example, was fishing in Makanjira from January to May of each year and then went to Makawa to fish from May to July after which he would return to Msaka for the rest of the year.

5.3.2. Migrants, residents and fisheries management in Lake Malawi

In Malawi an orthodox approach to limiting the catch for certain fish species, based on MSY-type objectives, and regulated by the Fisheries Department, is in process of being modified or replaced by a policy based on community fisheries management. The fundamental assumption is that the people who gain their livelihood from fishing are resident households, situated on the lake shore, in villages or "communities". Therefore, traditional forms of village authority and compliance, supplemented by the formation of new institutions such as beach fishing committees, can be utilised to manage sustainably the fishery resource (Figure 5.10). It is further assumed that equity issues (of access) do not arise, or can be solved by creating the "right" institutions at community level. The rather idealised picture of co-management mediated through traditional authority assumes that the linkages between fishing people, traditional authority and government are positive and reinforcing, rather than divisive. In Malawi, geographical origins, ethnicity and political allegiance are closely correlated, and beach village fishing committees have sometimes been politically sensitive, as they tend to highlight ethnic divisions between migrant fishers and resident villagers along Malawi's southern lakeshore. Far from minimising conflicts, BVCs have sometimes fuelled them.

Figure 5.10. Co-management in the African Context



Our research findings demonstrate that the assumptions about fishing and management institutions described above and in Fig 5.10 apply only weakly, or do not apply at all. It is evident that at Lake Malawi a significant proportion of the fish catch is opportunistic, and depends on the arrival at the lake shore of migrant fishermen. It is also evident that resident villages on the lake shore are only partly involved in fishing, and that overall, village livelihoods are predominantly derived from other sources. Furthermore, there are often important reciprocal arrangements formed between visiting migrant fishermen and local residents in villages, to the benefit of all parties concerned. For example, visiting fishermen may be allowed temporary residence in exchange for part of the fish catch, or involvement in trading of the catch, or a host of other possible arrangements.

To the extent that this picture is a more accurate representation of the reality of artisanal fishing on Lake Malawi than that informing the community management approach, then serious questions about poverty reduction, access and equity arise. Community management may inadvertently destroy existing reciprocal arrangements that work well; they may create barriers to entry to the resource by migrant fishermen; and they may result in the under-utilisation of a resource in certain periods of abundance that could be contributing to the improved nutrition and welfare of poor

Malawians. The fundamental difficulty here is that the community management approach assumes that the resource can be defined by geographical proximity to the resident village, whereas, of course, the resource may at any point in time be found at great distances from a particular shoreline village.

Realisation of the importance of fisherfolk's mobility is now leading to a move away from management based on beach village committees (Sholtz *et al*., 1998), towards larger spatial scales. Lake management areas are being defined in terms of the range of operations of artisanal fishers, and on ecological criteria (O. Weyl, personal communication, 2001). The mechanisms for governance of these lake spaces is still being discussed.

5.3.3. Fisheries and rural development along the Malawi shoreline

Prior to this project, there was no data on fisherfolk's income in Malawi, and no basis for understanding the contribution of fisheries to lakeshore livelihoods. We started with the common assumption that fisherfolk were likely to be the "poorest of the poor" [2] and that migrant fisherfolk with no access to farmland were likely to be the most vulnerable group within the fishery. The results of household income surveys overturn these notions completely (Table 5.1). While we must caution against drawing firm conclusions from small sample sizes, the consistency of the differences and similar findings in Uganda (LADDER project, unpublished data) and around Lake Chad (Béné et al, 2000) also challenge the conventional wisdom that fishing is an 'occupation of last resort', safety net for the poorest members of rural society and sink for excess labour.

Table 5.1. Mean annual household and per capita income for a range of household types (by occupational classification of household head). The data are from household survey questionnaires, implemented during 1999. The means are based on 10 households in each village-occupation category (total HH = 120). Exchange rate: US$ 1.00 = MK 54.40.

	Msaka	Lifuu	Tukombo
Household Income (MK)			
Resident Fishers (Gear/boat owners)	50,390	72,668	19,117
Long-term migrant Fishers	78,869	172,130	52,490
Resident Fishing Labour Providers	9,680	5,231	11,098
Resident Non-fishers	12,342	12,342	14,866
Per Capita Income (MK)			
Resident Fishers (Gear/boat owners)	7,845	11,125	3,197
Long-term migrant Fishers	24,978	39,691	6,405
Resident Fishing Labour Providers	4,606	1,212	3,101
Resident Non-fishers	3,305	3,190	3,391

Instead, income surveys of Malawian fisherfolk suggest the following:

- Long-term migrant fisherfolk (gear and boat owners, usually of the Tonga tribe) are the wealthiest group, in terms of both total household and per capita income, with most of their income coming from fishing (Figure 5.7).

[2] See Allison & Ellis (2001) for a review of literature that makes this claim.

- Resident fisherfolk (Chewa, Yao or Tonga, depending on the village) who own fishing gear are the next wealthiest group. Their income comes from a variety of sources (Figure 5.7).

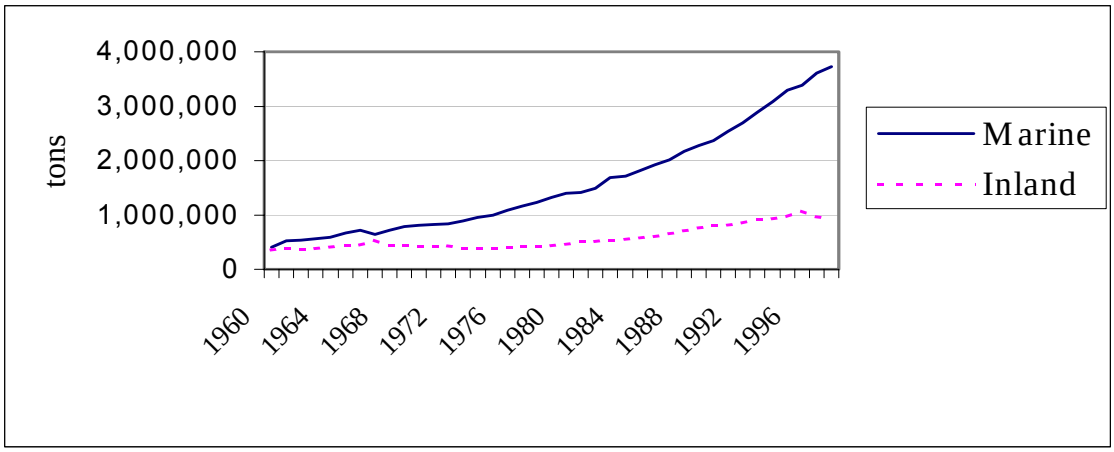
- Households providing fishing labour (often to migrant fisherfolk) have the lowest income, but these households are usually headed by young men, and are relatively small, so per capita income is comparable to non-fishing resident households, except in Lifuu, where other labouring opportunities are available, principally in rice and tomato cultivation.

These results cast fisheries in Malawi in a different light. It suggests that full-time fishing provides good returns on investment, and that part-time fishing is worth investing in for resident households. Households without access to fishing assets are poorer. The income differentials between fisherfolk and non-fisherfolk suggest that the access to fishing-based livelihoods is limited in some way. Interviews suggest that access to capital is the main limitation. As much fishing is boat-based, the number of people able to afford boats and fishing gear appears to be the major limitation on current fishing effort. Far from being 'the last resort', fishing still provides one of the few opportunities for low-income families in Malawi to move out of poverty. Management that disrupts the complex adaptive strategies that have evolved to enable some Malawians to benefit from fisheries risks removing this important livelihood option, with uncertain resource conservation benefits.

5.4. Livelihoods and fisheries management in Indonesia

According to recent Indonesian Government statistics, fish contribute 52% of animal protein to the diets of Indonesians. In 1998 there were more than 8 million people working either full- or part-time in the fisheries and aquaculture sector, of which 0.5 million regard themselves as full time marine fishermen. The vast majority are defined as small-scale; an estimated 326 000 boats either have just small outboard engines or no engines at all, compared with 87 000 boats with inboard engines. Most of these latter will be relatively small vessels (< 10 tonnes). Most marine fish entering the Indonesian diet are therefore caught by artisanal fishers whose average catch per fisher is about 1.5 tonnes annually (Salim and Rasdani, 1996). Fisheries were worth over US$ 3.7 billion in 1999, around 2% of total Indonesian GDP.

Figure 5.11 Marine and Inland Fish Production in Indonesia 1960-98



Trends in fish landings are given in Fig 5.11. While the growth rate of marine fisheries over the past four decade has been impressive, successive studies based on estimated maximum sustainable yields tend to suggest that annual output is still substantially below what could be sustianably achieved (given the caveats about the use of sustainable yield approaches alluded to in Section 2). MSY estimates for marine fisheries in Indonesia are conflicting and continuously debated, but nevertheless typically seem to come up with figures in excess of 6 million tonnes, while actual production in 1998 was 3.8 million tonnes. Most of this MSY potential (65%) is calculated to be within territorial waters (12 nm) and 50% of this potential is in small pelagic fish. Overall, utilisation in comparison to estimated MSY is 61%, with small pelagic fish thought to have the most potential for expansion, with current landings at only 44% of estimated MSY, although this does vary spatially with most of the unrealised potential coming from the more remote and less populated Islands. While there are suggestions that the small pelagic stocks of East Java and the Bali Straits are substantially overexploited by large purse-seiners (Pet et al., 1997), the exploitation status of stocks in West Java is uncertain, but assumed to be high.

5.4.1. Livelihood strategies and outcomes

The three selected study sites had differing biophysical characteristics that affected the available options for income-generating activities (Table 5.2).

Table 5.2. Background information on characteristics of the three study sites, West Java. Tempat Pelelangan Ikan (TPI) are the state-run fish auctions.

TPI Ciparage Karawang District	**TPI Cietereup Sukabumi District**	**TPI Cibangban Pandeglan District**
North Coast (Java Sea) coast : registered fishers at TPI mostly from one village: Ciparage Jaya	West Coast (Sunda Straits): registered fishers at TPI mostly from one village: Cietereup	South Coast (Indian Ocean): registered fishers at TPI mostly from several villages: Pasir Baru, Cikahuripan, Cilengka
Relatively shallow waters protected by several big islands. Most fishing gears are *payang*s (Danish Seines)	Strong currents, but bay protected by a small island, allowing year round safe use of *bagans and* or *seros* (lift-net platforms and barrier traps)	Several months in a year can not fish due to strong wind and waves; relatively deep waters. Gears consists of *pancing (hook and line or longline), payang and bagans.*
Occupations: highly depend on fishing based businesses. Fishers not involved in brackish-water fish culture	Occupations: several options like tree crops, food crops, tourism development	Occupations: several options like food crops, home industries, tourist attractions, and stone mining

Full-time artisanal fishermen, such as those working with *payang* (seine nets) from Karawang and Sukabumi Districts (Java Sea and Sunda Straits) migrate between fishing areas. Their movements are long-shore, and they land their catch everyday at the nearest places to the fishing grounds.

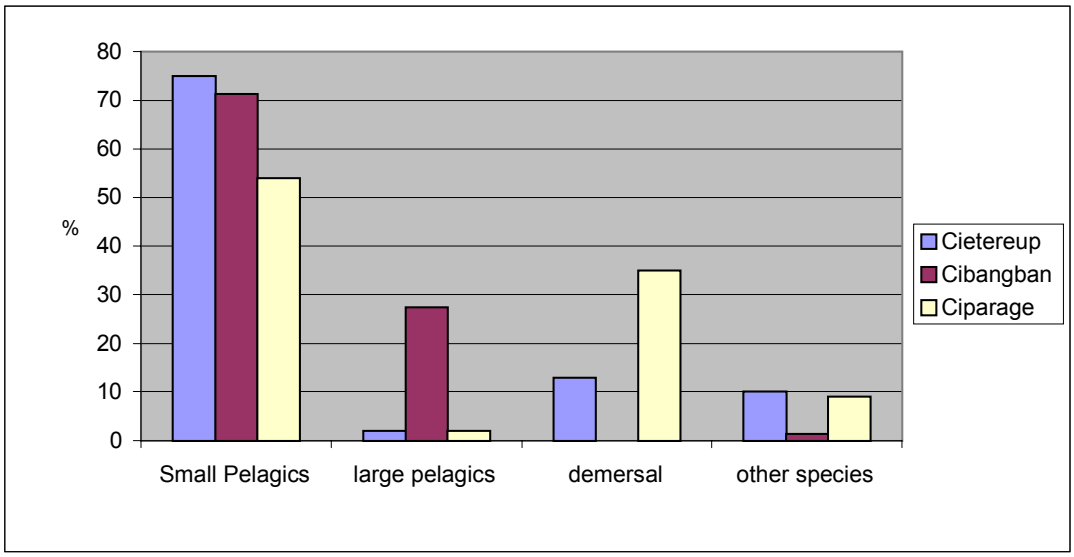
Although brackish water aquaculture (prawns and mullet mainly) dominates the coastal landscape at Ciparage and is present at Cietereup, fishing households are not involved in this income-generating activity. The reasons for this exclusion are mainly to do with

the fact that fisherfolk in these villages do not own land – in most cases, they do not even own the land that their houses are built on.

Most part-time fishermen such as those working with *seros* and *bagan* at Citereup and *pancing* and *payang* at Cibangban maintain diverse livelihoods from resources available in their village, or they move seasonally to work away from the village.

In all cases, small pelagic fish feature prominently in the catches landed in these areas (Fig 5.12) and the observed flexible livelihood strategies (either diversified or geographically mobile) are responses to fluctuations in availability of these species on various time-scales – daily, seasonal and inter-annual.

Figure 5.12. The percentage of fish auctioned through three TPIs, by market category.



Major sources of income in each village are given in Table 5.3. Households involved in fishing in Ciparage and Cietereup gain 74.4 and 68% respectively of their net income from fishing activities. In Cibangban, dependency of fishing is much lower (32.5%), with farming (17.4%) and non-farm labour, trading and tourism (lumped as 'other') being the major sources of income (49.4%) to households with involvement in fishing. Remittances feature significantly only at Ciparage, where several respondents had female HH members working in domestic service in the Gulf states (Saudi Arabia and UAE).

Average household incomes are comparable across the three villages, which were sampled in comparable ways. These do not reflect average village incomes, however as the samples were selected to include both fishing gear owners and crew members. However, the data do provide some indication that overall household incomes among fisherfolk may be higher than among farmers (Pacing village, near Ciparage)

When average monthly income is compared between boat owners and fishing crew or labour for *bagan* and *sero* operation is compared (Table 5.4), the differences within the fishery become apparent. Monthly income of a boat owner in Cietereup is the highest compared to two other sites. This may be because they can fish all year without being significantly disturbed by waves and weather and their operational costs are relatively low as they use non-motorized fishing techniques i.e. *bagan and sero*. Income for a boat crew in Cibangban is the lowest compared to the other two areas. Some of the reasons may be that they only fish part-time, even during main fishing seasons and the

catch shares from *payang* were divided among 25 boat crew compared to *payang* in Ciparage employing only about 10 crew.

Table 5.3. Main Income Sources averaged by village. Pacing is a farming villages in Karawang district, close to Ciparage, and is included for comparison with fishing. In 1999, 1 US $ = approx Rp. 7000.

	Ciparage	%	Cietereup	%	Cibangban	%	Pacing	%
Annual Income per HH (1000 Rp.)	12,817	100	13,206	100	11,150	100	6,304	100
- Fishing	9,536	74.4	8,994	68	3,624	32.5	0	0
- Farming	67	0.5	953	7.2	1,935	17.4	4,291	68
- Remittance	738	5.8	32	0.2	89	0.8	129	2
- Others	2,476	19.3	3,227	24	5,502	49.4	1,885	30

Table 5.4. Monthly net Income (Rp) from fishing by boat or gear owners and boat crews or fishing labour. Sample size = 15 HH in each case

		Mean	Std. Error
Cibangban	- owner	368,002	53,237
	- crew/labour	139,805	17,672
Cietereup	- owner	656,448	118,907
	- crew/labour	184,817	20,136
Ciparage	- owner	392,566	63,139
	- boat crew	189,528	42,075

5.4.2. Fisheries and Poverty in West Java

Conventional narratives suggest that fisherfolk are among the poorest of Indonesia's people, with incomes of less than US 150 per year (Chong, 1993). Sample survey data suggests a more complex picture, with owners of fishing assets being relatively well off, whether they are owner-operators (as at Ciparage) or owners with other business or occupational interests (as at Cibangban). There were seven out of 45 respondents (from the boat owners) who own up to three boats.

Comparison of the incomes and asset status of wealth-ranked groups within the sample survey population (Table 5.5) indicate that:

- The poorest group of fisherfolk in the sample had incomes around half that of a group of typical farmers in the region, but similar asset status (as indicated by estimated value of house and quantity of gold)

- Middle income groups of fisherfolk are considerably better off than small-scale farmers. These groups typically own some fishing assets (share of boats or nets), and may also have land and other business interests. The fact that there is still money to be made in fishing is illustrated by the fact that the highest income group within villages are often involved in fishing, alongside other business interests, and that fishing provides them with their largest source of income, on average.

Table 5.5. Income Sources and Asset by Income group tercile (Rp 1000)

	1st tercile (rich)	2nd tercile (middle)	3rd tercile (the poor)	Farmers (Pacing)
Income per HH	28,008	9,092	3,639	6,304
- Fishing	13,401	6,283	2,470	0
- Farming	4,817	1,173	532	4,291
- Remittance	601	172	87	129
- Others	9,190	1,464	551	1,885
Asset Value				
Boats and gears	15,364	8,322	1,858	0
Lands	1.07	0.12	0.38	0.69
House	29,533	4,967	12,250	12,678
Gold	60.00	28.00	18.67	7.28

With average incomes ranging from around US $500 to US $ 4 000 per year, the majority of fisherfolk captured by the sampling procedure are not among the poorest of the poor. Rather, fishing represents a viable, if risky, business and income generating opportunity. There is no suggestion that fishing is the dumping ground for excess unskilled labour from the landless peasantry, nor that people continue to fish because of the zero opportunity cost of fishing labour, as is often suggested (e.g. Pauly, 1997). More difficult to refute is the common assertion that fisherfolk's poverty and vulnerability is brought about by their patterns of consumption. Anecdotal tales of fishermen's' lifestyles are similar all over the world: fishermen can earn good money, but are apparently incapable of saving and investing it in housing, land, education, community projects etc, and instead spend it on luxury consumer goods, drink and women. The observation that many crew members progress to boat ownership partially refutes this, as does analysis of fisherfolks assets.

Table 5.6. Estimation Value of Houses Owned by fisherfolk and farmers

Estimated value of house (Rp.1,000,-)			
	boat owner	boat crew	farmer
minimum	5,000	2,000	4,000
maximum	100,000	40,000	35,000
Number of owners	28	27	18
Number in sample	45	45	18
Average (excluding non-owners)	42,357	8,019	12,678

That fisherfolk in Ciparage and Citeureup do not invest much in housing and village infrastructure is not surprising - they do not own the land their houses are built on, and are basically confined to the state-owned foreshore. Only half of fisherfolk (owners and crew) own their own houses (Table 5.6), most of whom are part-time fishers in Cibangban and Citeureup, while all farmers in the sample survey owned theirs.

The uncertain nature of fishing - its 'lumpy' earnings and expenditures put a premium on assets that can quickly be converted to cash. Thus, fisherfolk in Indonesia invest in gold, largely in the form of jewellery worn by female household members (Table 5.7). Boat owners and boat crew both have more of their assets in the form of gold than farmers.

Table 5.7. Gold owned by respondents (Grams)

	boat owner	boat crew	farmer
Minimum	10	5	3
Maximum	300	100	20
Number of owners	42	37	14
Number in sample	45	45	18
Average (including those owning none)	52.7	18.4	7.3
Range (excluding zero)	10-300	5-100	3-20

Such data highlight the fact that using asset status to compare wealth across groups that have different livelihood strategies may be problematic, and that it is important to establish patterns of expenditure, as well as income, before useful comparisons among different sectors can be made.

Overall, the conclusions suggest that dependence on fishing is not closely correlated with poverty, that fishing provides an income generating opportunity to those who have access to it, and that fisherfolk's consumption patterns reflect the 'lumpiness' of their income and expenditure. Moralistic judgements about drunken profligate fishermen that don't invest in their families' health, education and home tend to be uninformed and overly simplistic. When this is the case, there is usually a good reason - lack of security of land tenure or social marginalisation within land-based communities because of migrant status - similar issues to those found in the research in Malawi.

5.3.4. Livelihood opportunities.

PRA research revealed that over the last 10 years, a range of new livelihood opportunities have arisen in the sample survey villages (summarised in Table 5.8)

Table 5.8. Emergence of new activities in West Java fishing villages

	Now	**5 years ago**	**10 years ago**
Ciparage	• more buyers for fresh fish • more women in trading & home industry • working abroad still important	• better roads, more fresh fish traders • more women working abroad as domestic staff	• brackish water fish culture • more women processing fish
Cietereup	• more people involved in fishing • selling land and tourism services	• more people selling their land for tourist development, • more women working abroad	• agriculture, mostly food crops and tree crops
Cibangban	• making bricks, • women working abroad • fish processing	• selling their land for tourists, • more women working abroad • collecting semi-precious stones	• working as labour in towns and abroad

These new livelihood strategies are part response to new opportunities (pull factors) and part adjustment to changing access to natural resources (Table 5.9)

Table 5.9. Changes in access to natural resources, West Java coasts

Sites	Now	5 years ago	10 years ago
Ciparage	• no land for farming, • continuing need for better technology for fishing	• need higher capital for better technology to fish • prawn diseases in brackish waters	• lands still available for brackish waters • simple gears for good catches
Cietereup	• more local people fish • farming land highly reduced	• land uses shift from farming to tourist attraction • more people fish	• most fishers were outsiders, • available land for farming
Cibangban	• more local people fishing • farming land reduced	• land uses shift from farming to tourism development • more people fish	• most fishers were outsiders, • available land for farming reduced

Table 5.9 indicates that 10 years ago, most fishing in two of the sample sites was done by outsiders, but that local people have taken up fishing within the last decade, partly in response to declining land availability for farming. Some of this decline in land availability is due to pressure from other land uses - principally tourism development (mainly within-country tourism in the form of seaside weekend homes for wealthy Jakarta residents).

Thus, although there is some indications that closure of other options pushes people into fishing, there is countering evidence to suggest that sale of land and other assets provides the necessary capital to invest in profitable fishing assets. Despite one of the highest population densities in the world, fishing off the West Java coast continues to provide opportunities for income generation that are beyond mere subsistence or survival strategies. Fishing may not have been the occupation of first choice for all, but it is far from being the occupation of last resort.

5.4.4. Fisheries livelihoods and fisheries management in Indonesia

The influx of people into fishing over the last decade poses questions for fisheries management. It is interesting that the 'new' entrants to fisheries in this case are the resident fishers, while 'outsiders' dominated the fisheries before. This posits a dilemma for those promoting community-based management, as the community of fishers are mobile and sometimes retain a base elsewhere, while residents tend to be partially involved in fishing.

Traditional fisheries management systems in Indonesia such as the sasi system, are under considerable strain. In many villages throughout Maluku, for example, village leaders long ago opted for the expediency of contracting access rights to local reefs to itinerant fishermen from Sulawesi and Madura as a more efficient means of generating revenues (Benda-Beckmann et al., 1995; Banyar and Zerner, 1996). In most cases, the decision to sub-contract access rights was usually made by individual village government leaders, without first consulting the community at large (Novaczek and Harkes, 1999). Thus, the equity and sustainability of traditional fisheries management systems should not be over-romanticised.

Expansion of formal regulation and bureaucratic organisation may also have 'crowded out' informal institutions and networks, particularly under the highly centralised Suharto era (1965-1998). For example, all fishers have to work under the umbrella of HNSI (a fisher association formed and controlled by the government) and the KUD (Village Unit Cooperative) is the only co-operative system that was allowed in rural areas. The monopoly of KUDs was abolished in 1999 and this, coupled with a movement towards local autonomy at district level, is creating new space for local-level governance. Many policy observers worry, however that the move towards district autonomy may only shift top-down policy makers to a lower level.

For mobile artisanal fishers local autonomy has created problems, in that each district has different policies to translate the autonomy law. In some districts, local authorities prohibit fishers from other districts to fish in their waters, or impose punitive levies to discourage them. Sometimes, fishing communities use the cover of the new local autonomy to enforce their own de facto regulations.

Decentralised management poses challenges to co-ordination of inter-area differences. Since local autonomy was effectively implemented in January 2001, many fishing communities and local district authorities, have created their own regulations for certain fishing grounds. Some are trying to enforce the modified formal regulations set by central government such as trawler bans and bans of large vessels in near-shore waters (within 4 nm), some others have tried to implement new regulations such as levies for vessels from other districts. The levels of levies can be set at a level that either discourage outsiders, or encourage them but provide a means to generate benefits from their presence. These types of decision must be taken with highly uncertain information, which often takes the form of political pressure from local vested interests.

There are clearly general problems with the design of common property institutions that include heterogeneous communities, mobile fisherfolk and uncertain and evolving governance structures. The basis for success in stakeholder-based management is thought to include a range of defined characteristics (e.g. Ostrom, 1990), against which the current situation in West Java fisheries can be related:

Clearly defined Boundaries - The Autonomy law no.22/1999 assigns rights and responsibilities for district authorities to manage an area up to 4 nm; and for provincial government to manage areas from 4 up to 12 nautical miles. The central government's primary responsibility shifts to the EEZ outside 12 miles. Coastal belts established by an earlier Decree have also clearly defined areas for fishing based on sizes and type of gears. Up to 3 nm - no boats displacing more than 5 GT or having inboard engines over 10 hp may fish and purse-seines, encircling or drifting gillnets or beach seines longer than 120 m cannot be used. Harmonisation of district management and technical regulations to 4 nm is suggested. The laws do not, however, make any provision for mobile fishers crossing boundaries. Ecological boundaries are certainly not clear-cut, and small pelagic fish have no respect for politically defined space.

Clearly defined Membership - The legitimacy of claims to jurisdictional space by resident (often part-time) fisherfolk over those of non-resident mobile fisherfolk (often with long-term history of settlement or fishing in the areas studied) are not clear. Like migrants the world over, the mobile fisherfolk are used to having to adapt their activities to the laws and customs of the places they visit as is made clear in the Indonesian saying 'di mana bumi dipijak disitu langit dijunjung'.

Group Cohesion - The full time fishers in Ciparage show much greater levels of community cohesion and self-organisation than the part-time fishers of Cibangban, despite being migrants drawn from several places of origin (e.g. Madura, Sulawesi). Shared occupation may provide a stronger cohesive force than shared origins and residence.

Available existing organisation - The HNSI (Himpunan Nelayan Seluruh Indonesia, the National fishers association) is formally available in all areas. At local level it is known as Rukun Nelayan (fisher group) at TPI/village level. According to fishers, RN are representative, but at higher levels, HNSI chairs are not usually fishers, and their political interventions may not be motivated by fisherfolks' concerns.

Benefits of management exceed costs - For areas like Cibangban, the costs needed to implement stakeholder based management may exceed returns from this essentially part-time activity. For specialist fisherfolk who are mobile, investing in spatially restricted localised management that risks their exclusion from other areas is counter-productive. Given that catches of small pelagic fish stocks appear to be driven largely by environmental variability, the benefits of stock management are somewhat equivocal to start with.

Participation by those affected - Although fisherfolk are now closer to decision-makers under district autonomy, they do not currently have the legal right to make rules, and their involvement in formulating district government regulations may be quite limited in practice.

Management rules are enforced - District level governments have limited capacity to enforce rules. Fishers claim that they could do so, but currently have no legal mandate to enforce regulations in their district - a right they are lobbying for at present.

Legal rights to organise - Fisherfolk now have legal rights to organise their own cooperative organisations, but these organisations have limited political power, particularly when it comes to making and enforcing fisheries management regulations.

Decentralisation and delegation of authority - It is early days in Indonesia's process of democratisation and decentralisation, but the fact that 80% of the Ministry of Marine Affairs and Fisheries (MMAF) budget is to be spent at district level suggests strong commitment to this form of marine governance.

Coordination between government and community - The MMAF has been working to develop more effective coordination, not only between the government and fishing communities, but also with all coastal communities and other stakeholders. Communication problems are likely to remain, however, given the complex geography and ethic politics within Indonesia.

Dependency on the resource - Migrant fisherfolk are not dependent on the resource in any one place and part-timers act to reduce their dependency. It would be counter-productive to encourage greater dependency to encourage greater sense of ownership and responsibility for resource management

Many of the key conditions thought to be needed to develop successful stakeholder based management are not available. It would be an error to aim for a perfect or blueprint system based on a set of guiding principles for traditional common property based management. Instead, as in Malawi, a system that builds on existing formal and

informal institutions, however imperfect, and informed by a knowledge of livelihood strategies, is likely to be more sustainable.

The need for inter-district and provincial co-ordination is paramount. Decentralising management may seem cost-effective, but savings are eaten up in co-ordinating decentralised activities. This coordination is a daunting task in the Indonesian context, but it seems there is considerable political will to protect the interests of small-scale fishers, even within current production-orientated expansionist policies.

5.5. Policy and management conclusions

Much management thinking in fisheries is driven by a world-view that equates stability with sustainability. The research done on this project challenges this world view, showing that most fish stocks are not stable, and that adaptive and sustainable strategies to exploit and manage non-equilibrium stocks exist, and are worthy of policy support.

Studies of variability in fish stocks have always emphasised vulnerability to overfishing at low stock sizes, rather than economic wastage during periods of abundance. This emphasis has led to promotion of ideas, based on the precautionary principle, that allowable exploitation or catch levels must be set low, and benefits foregone in good years. On the other hand, the strategy among artisanal fishers seems to be to maintain excess capacity in order to maximise the potential of 'peaks', while responding rapidly to 'troughs' through diversifying into other activities or moving to other areas until stocks have returned.

The following quotation illustrates the conventional view that promises greater stability through science-based fisheries management:

> "Everybody agrees that stability in fisheries would be a Good Thing. Fish processors would like constant supplies, and the fishermen would like constant catches (or possibly constant earnings) so that they could plan their investments in new boats, and not get caught out on the loan repayments. The administrators would like the same TACs [total allowable catches] from year to year"
>
> (Shepherd, 1990: 6)

This viewpoint does not appear to recognise that generations of fishermen have expected, and learnt to live with, variability. It is 'modern' management systems and the full-time, capital-intensive, 'professionalised' industrialised fisheries supported by development and management policy that have problems with instability.

Recent recognition that uncertainties will remain in fisheries management in spite of the best available scientific advice (Flaaten et al, 1998) have led to interest in developing management systems for fisheries and other natural resources that are 'resilient' in the face of unknown future conditions (Berkes & Folke, 1998). Resilient institutions are likely to be those that take into account the flexible strategies used by fisherfolk to cope with resource variability.

Studies on small scale fisheries have tended to emphasise fisherfolk's dependence and vulnerability, and under-emphasise, or even fail to recognise, the resilience and adaptability of livelihood strategies pursued by small-scale fisherfolk:

> "Lack of occupational and geographical mobility [of fishermen] may result from long isolation, low formal education, advanced age, preference for a particular way of life, cultural taboos, caste restrictions, inability to liquidate one's assets, indebtedness or just lack of knowledge and exposure to opportunities. The consequence of immobility is that fishermen may continue fishing even if they earn far less than their opportunity costs."
>
> (Panayotou, 1982, p20)

Our research indicates that this is not the case. The majority of small-scale fishermen both in the sample survey villages in Malawi and Indonesia, and in fisheries elsewhere around the world (reviewed in Allison & Ellis, 2001) are either geographically mobile, occupationally mobile, or both. In very few cases can it be argued that the opportunity costs of fishing are zero. Indeed, fishing is often one of the more profitable alternatives for rural communities in coastal and lakeshore areas.

Similarly, the narrative that an influx of the landless, destitute and unskilled, is leading to 'Malthusian overfishing' (Pauly, 1997) is challenged by the finding that fisherfolk can be better educated than other rural people (Malawi) and often earn higher incomes than farmers (Indonesia and Malawi). More people are fishing and some people from non-traditional fishing backgrounds are turning to fisheries as an income-generating activity, but the numbers that do so are limited by the amount of capital available for investment. The poor can only enter a boat-based fishery as crew members, and opportunities as crew are dependent on the availability of capital and the choice to invest it in fisheries. Such investment decisions are likely to be informed choices among many options, particularly in Indonesia.

Fishing can therefore be seen, not only, or even primarily, as an occupation of last resort, and safety net for the rural poor, but as a dynamic and integral part of the coastal or lakeshore economy, a source of off-farm income for agrarian societies and an important provider of labour. This integration of fisheries studies with an understanding of the wider rural economy is long overdue.

These challenges to prevailing views on fishery dynamics and fishery management lead to the following suggestions for future policy and management intervention in support of sustainable livelihoods for small-scale fisherfolk:

- Livelihood diversification is a feature of many fishing communities. Policy and management that encourages or enables part-time fishing is preferable to approaches that seek to 'professionalise' small-scale fishers and ban part-timers.

- Development in rural areas where fishing is important may not be best served by intervention to increase fishing incomes, but rather to support complementary household activities. This does not mean encouraging people to leave the fishery altogether, as substituting one insecure income-source for another is no solution. Encouraging alternative livelihood sources raises the opportunity income of fishing, with potential conservation and economic benefits.

- Geographical mobility is necessary to sustain catches on mobile or fluctuating fish stocks. Mobility can also be beneficial to stock conservation in that it enables fishers to move away from locally depleted resources. When small-scale fisherfolk are operating outside their home area, they are generally resident in and landing to other ports or beaches in the vicinity. This generally conveys economic benefits to the area they are visiting. Existing arrangements for reciprocal access can be encouraged, but where stock conservation becomes an issue, the power of ports to

levy landing or berthing fees can be used to adjust incentives for other vessels to fish in that area or not.

- The remittance economy can be important in rural areas, and whether or not remittances are invested in fishing can act to regulate capitalisation in fisheries. Support for financial transfer mechanisms, together with support for flexible loans built on existing local financing schemes, can provide a means of appropriate capital investment in fisheries development.

- Within the fisheries sector, the FAO Code of Conduct for Responsible Fisheries, with its provisions to protect small-scale fishers' livelihoods from conflict with larger-scale commercial interests, provides the necessary framework for maintaining or enlarging small-scale fisherfolks' 'action space'. Many of its other provisions related to use of non-destructive fishing gear, withdrawal of subsidies for commercial fisheries etc, are also supportive of the sustainability of small-scale fisheries. Less supportive is its championing of the precautionary principle. In attempting to shield small-scale fisherfolk from risk, strict application of precautionary management may serve to increase vulnerability without increasing stability of fish stocks.

- A livelihoods approach does not imply that all technology development in fisheries is bad. Appropriate technologies are likely to include those related to fishing techniques that reduce by-catch, more efficient processing and storage and improved vessel safety/seaworthiness. Livelihoods analysis can help to target technologies that fit within peoples' constraints, opportunities and investment strategies.

- A livelihoods approach, emphasising the removal of barriers to entry and to mobility does not imply a *laissez-faire* approach to management. Institutions to regulate access to resources are still important, it is just that they do not necessarily take the form of fixed fishing territories and fixed licence numbers calculated on the basis of taking an economically optimal catch from a static equilibrium fish stock.

- Fisheries sector development analyses have tended to focus on what small-scale fisherfolk do not have – access to infrastructure, finance and technology – rather than what they do have - adaptable and flexible income-generating strategies, resilient resource management institutions, knowledge, skill and social capital. The key to sustainable fisheries management and development is to facilitate small-scale fisherfolk to find their own routes out of poverty by building on their existing capital and capabilities.

6 CONTRIBUTION OF OUTPUTS

6.1. Implications of outputs for DFID's development goals

The research aimed to contribute to the following indicative outputs of the FMSP:

1. New and improved biomathematical and bioeconomic methods and models for stock assessment and aquatic resource management, and appropriate data management systems developed and promoted.
2. Strategies for the allocation of use rights in small scale fisheries and for the communal management of aquatic resources developed and promoted
3. Strategies to maximise economic and social benefits from sustainable exploitation of highly migratory and coastal pelagic resources developed and promoted.
4. Mechanisms generating conflict between fisher groups and stakeholders understood and management tools for mitigation developed and promoted.

The bioeconomic modelling approaches and development of the livelihoods research framework contribute to the development of new assessment and management tools and models (1). The analysis of adaptive livelihood strategies based on mobility and diversity have contributed to knowledge on how communal management should be promoted and developed, and on how economic and social benefits from coastal pelagic resources should be developed and promoted (2 & 3). Understanding the relationship between full and part-time fishers, and between migrants and residents, should help design management systems that build on existing reciprocities, thereby helping to minimise conflicts (4).

6.2. Dissemination of research outputs to target institutions and beneficiaries

We have been able to achieve our dissemination aims for some of the conceptual and theoretical parts of the research within the project period. We have been able to present preliminary empirical findings and policy advice to target institutions in Malawi and Indonesia. Our research has contributed to process and policy development, particularly in Malawi.

6.2.1. Target institutions and dissemination pathways

The target institutions for the research outputs are:

- Government fishery management agencies in Indonesia and Malawi
- Community management organisations in fisheries in Indonesia and Malawi
- Fisheries and rural development NGOs working in Indonesia and Malawi
- Donor organisations involved in fisheries management and development in developing countries, e.g. FAO, ICLARM
- Research organisations and members of the academic community involved in providing advice for fisheries management in developing countries e.g. Universities and Natural Resources research organisations in Indonesia, Malawi, the UK and internationally.

The research outputs have reached these target groups through the dissemination pathways detailed in the following sections.

6.2.2. Seminars/Workshops/Conferences

The projects' research approaches and preliminary results were discussed and disseminated through a number of local, regional and national workshops.

A National-level dissemination workshop was organised to coincide with a National Symposium on Fisheries Management in Malawi, sponsored by GTZ NARMAP, with supporting funds from this project's dissemination budget. Delegates included Mr S. Mapila, the Director of the Department of Fisheries, and representatives of National and International development agencies and research organisations. The project presented three talks, by Allison, Mvula and Ellis, who also participated in a panel discussion on the livelihoods approach and management of fisheries in Malawi, chaired by Dr Wiseman Chirwa of the Centre for Social Research (see Annex 4, for details). A paper based on the three talks is published in the symposium proceedings:

Allison, E.H., F. Ellis, P.M. Mvula and L. Mathieu, (2001). Fisheries management and uncertainty: the causes and consequences of variability in inland fisheries in Africa, with special reference to Malawi. In*:* O. Weyl, (Ed.), *Proceedings of the National Fisheries Management Symposium, Lilongwe, Malawi, June 5-9th, 2001.* Published on CD-ROM, available from National Aquatic Resource Management Programme (NARMAP), Malawi. (email narmapbay@malawi.net).

In order to discuss project findings and explore views of resource-users on their management implications preliminary project findings were disseminated at workshop sessions in the three villages (see Annex 4, for further details).

In Indonesia, a National Workshop was held in July 2001, to disseminate and discuss research findings with policy makers, managers and researchers involved in fisheries and coastal zone management in Indonesia. The meeting was attended by the newly appointed Minister for Marine Affairs and Fisheries. The workshop programme, text of the Minister's keynote speech and outline of a presentation by Agustina Musa are given in Annex 5. Allison and Ellis presented a paper based on their overview of the livelihoods approach, now published in *Marine Policy*.

The National Workshop was preceded by three District-level workshops and meetings to discuss project findings in all three case-study villages. These brought to light potential synergies between the projects findings on the importance of flexibility and resilience in reducing livelihoods of fisherfolk, and new plans for decentralised fisheries management that could use landing taxes as a means of adjusting incentive structures for movement and migration, according to local perceptions of resource scarcity.

Additionally, project ideas were presented jointly with Dr M-T. Sarch (from FMSP-funded Lake Chad programme) at a major international fisheries conference:

Sarch, M-T. & E.H. Allison (2000) Fluctuating fisheries in Africa's Inland Waters: Well-adapted livelihoods, maladapted management. *Proceedings of the 10th International Conference of the Institute of Fisheries Economics and Trade.* Corvallis, Oregon, July 9-14th 2000, 11 pp. http://osu.orst.edu/dept/IIFET/2000/papers/sarch.pdf

6.2.3. Internal Technical Reports

In addition to project quarterly and annual reports, two major studies have been carried out by project collaborators:

Musa, T., 2001. *Fishing livelihoods in West Java, Indonesia*, 253 pp. WBM Consulting, Jakarta (unpublished) .

Mvula, P.M., 2001. *Sustainable livelihoods from fluctuating fisheries in Lake Malawi* Centre for Social Research, Zomba. 193 pp (unpublished).

Preliminary findings from these studies are used in this report, but these studies are currently being edited for further dissemination, using projects partners' own funds, and supplementary funding from UNDP (Mvula) and WBM Consulting (Musa). Both research partners are spending the period October – December 2001 at UEA, working on dissemination of findings in these reports.

6.2.4. Publications

The following papers related to project research activities have been published, or are in press:

Allison, E.H. (1999). Opinion: Contributions to ecology from the study of recruitment in fish populations. *Hydrobiologia* **416**:1-11. ISSN 0018-8158

Allison, E.H., (2001). Big laws, small catches: global ocean governance and the fisheries crisis. *Journal of International Development* 13 (7): 933-950. ISSN 0954-1748

Allison, E.H., and F. Ellis (2001). The livelihoods approach and management of small-scale fisheries. *Marine Policy* 25 (5) (*publication in November*) ISSN 0308-597X

Allison, E.H., P. M. Mvula and F. Ellis (2002). Competing agendas in the development and management of fisheries in Lake Malawi. In K. Geheb & M-T. Sarch (Eds). *Broaching the management impasse: perspectives on fisheries and their management from the inland waters of Africa*. Kampala, Uganda, Foundation (Heinemann/James Currey) (publication Feb 2002)

6.2.5 Other dissemination pathways

The project has established a website:

http://www.uea.ac.uk/dev/odg/ffish

This will be activated once the final technical report has been reviewed, and all documents and datasets will be made available through this website, as will a selective bibliography on fishing livelihoods and fisheries management under uncertainty. There are also links to relevant data and to management and policy information sources, and to 'Livelihoods Connect'.

Brief details of the project are included in an overview of DEV/ODG work in fisheries and aquatic resource management:

Allison, E.H. (2000). 'Twixt Development and the Deep blue Sea' [On the global fisheries crisis and DEV/ODG research on fisheries issues] *Development,* Vol 15: 2-3, DEV/ODG, UEA. http://www.uea.ac.uk/dev/newsletter/article5.htm#allison

This magazine reaches development practitioners and policy-makers and DEV/ODG alumni around the world.

The project has also been mentioned in an overview of fisheries research at UEA, published in the magazine of the Fisheries Society of the British Isles.

6.3. Plans for future dissemination

Two papers have been submitted for publication:

Allison, E.H. Sustainable management in the African Great Lakes. It ain't what you do it's the way that you do it. *Journal of Aquatic Ecosystem Health & Management.* ISSN 1463-4988

Darwall, W. & E.H. Allison Monitoring, assessing and managing fish stocks in Lake Malawi: Current approaches and future possibilities. *Journal of Aquatic Ecosystem Health & Management.* ISSN 1463-4988

A paper based on the bioeconomic modelling work (Tinch, "Management strategies for highly fluctuating fisheries") has been accepted for presentation at the conference "Risk and Uncertainty in Environmental and Resource Economics" in Wageningen, 5-7 June 2002.

Several other papers and reports are in preparation:

- Allison, Mvula and Wouterse The geography of fishing communties in Malawi- Implications of migrations for community-based management.
- Mathieu, Allison, Tinch. Fisheries typology analysis
- Mathieu, Allison, Tinch Review of instruments for fisheries management under uncertainty
- Mvula, Allison and Ellis. Fisheries, livelihoods and poverty in Malawi
- Musa, Allison and Ellis, Fisheries livelihoods and management of the small pelagic fisheries in West Java Indonesia
- Allison, Mvula, Musa et al Are fishermen the poorest of the poor? Evidence from livelihoods research in Indonesia, Malawi, Mexico and Uganda

These will target both academic journals in fisheries, natural resource management, development studies and applied geography, and outlets such as SAMUDRA and NAGA (ICLARM) which reach NGOs and others involved in small-scale fisheries development.

A book on fishing livelihoods and small-scale fisheries management is planned, but this is contingent on securing additional funding to allocate the time required.

Dissemination will also occur through:

- Presentation by Allison at the DFID meeting on the livelihoods approach and fisheries management, November 28-29, 2001.
- Preparation of policy brief (perhaps in ODI NR policy brief series) on the implications of mobility and livelihood diversity for community-based management in fisheries
- Continued research collaboration between project partners and continued dialogue with policy makers in Malawi and and Indonesia

6.4 Follow-up action and research

Research on fishing livelihoods and poverty in Malawi continues through a project on Livelihood Diversification Directions Explored by Research (LADDER), conducted by ODG and the National Economic Council (Office of the President and Cabinet, Lilongwe), funded under the DFID Rural Livelihoods Policy Research Programme. This project will link micro-level studies of the type conducted in this project with macro-level policies, such as current moves towards decentralisation and the adoption of National Poverty Reduction Strategy Plans (PRSPs). Similar research is taking place in Uganda (Lake Kyoga) under the same project.

DFID has no plans to become directly involved with support for fisheries in Malawi (H. Potter, DFID Lilongwe, Personal Communication, 2001), so the outputs of these projects are most likely to feed into policy and programme intervention through GTZ or World Bank-funded programmes in the fishery sector.

A request has been received for the provision of policy and management advice to the new Ministry for Marine Affairs and Fisheries. The new Ministry have ambitious plans for fishery and mariculture expansion, but these seem likely to fall foul of current political instability in the region. This request will be forwarded to DFID for their consideration. Indonesia is no longer a target of the FMSP programme, but as the world's sixth largest fishing nation (and the largest developing country fishery after Peru), it retains an obvious international priority for fisheries management.

The following are suggested as potential priority areas for further research related to the topics covered in this project:

1. Current moves towards co-management and community-based management are too closely wedded to romanticised ideas of 'community' and 'tradition'. The ideals for functional commons, as proposed by Ostrom (1990) do not apply in many current small-scale fisheries. Increased participation in market economies and the breakdown of traditional value systems are commonly cited reasons for the breakdown of traditional common-property systems (Goodland et al., 1989) Turning back the clock is not an option for these systems. Helping to strengthen nascent, evolving and adapted responses to current resource management problems into viable rule-making institutions is a more realistic development goal than recreating traditional commons. Understanding the conditions under which functional resource management institutions develop around access rights, conflict resolution and enforcement of rules is the key area for developing effective governance of small-scale fisheries. The basic research question is – how do management rules get made and enforced in non-traditional commons?

2. There is now almost a decade of experience in promotion of community-based fisheries management . The time has come to review that experience and extract lessons for the best way to assist the process towards decentralised fisheries governance. Why have some programmes succeeded while others have failed? Past reviews have tended to focus on structural issues, such as institutional preconditions (e.g. small isolated, homogenous communities) and resource characteristics (e.g. clearly defined boundaries) that tend to be associated with successful common property management (Ostrom, 1990, p90). Much less studied are process issues. Did the way in which community-management was initially conceived, implemented and promoted have an influence on eventual outcomes?

3. The research on adaptation of fisherfolk to resource fluctuations presented here has been done on fisheries where data is limited. While it suggests that these fisheries can be managed using fisherfolks' adaptive strategies as a conceptual basis for management, it does not allow rigorous testing of the propositions we have made about the economic and ecological optimality of these strategies. These have been investigated to some extent through simulation analysis, but the ideas remain unverified in practice. As the ideas have far-reaching consequences (including the rejection of much current doctrine on precautionary management) and apply to some of the world's most important fisheries, further investigation is warranted. This should be done by studying a fishery with a good economic and fishery database, so that the simulation approaches adopted here can be properly parameterised.

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