Harvest Reserves in Indonesian River Fisheries

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Abstract

This paper introduces a new project based in Indonesia entitled 'Selection Criteria and Co-Management Guidelines for Harvest Reserves in Tropical River Fisheries'. The project started in November 1997, and is funded by the UK Department for International Development (DFID). It will identify ecological and institutional criteria for the selection and beneficial use of harvest reserves in tropical, artisanal river fisheries; and develop guidelines for their co-management. In this study, the term 'harvest reserve' refers to a spatially defined area of water managed with any specified set of technical regulations, intended to sustain or increase the potential fish yield of existing, natural fish stocks, for the benefit of fishers. Project activities are divided into the following five main phases: (1) an inception and legal workshop, (2) a regional reserve survey (RRS) (reserve identification and fieldwork planning), (3) a monitoring programme (biological, socio-economic and institutional surveys), (4) analysis of reserve benefits (estimation of reserve benefits, and their causes), and (5) dissemination and training (preparation and presentation of guidelines). This paper describes the results of the first two phases.

The RRS identified 22 existing harvest reserves in three provinces studied, i.e., West Kalimantan, Jambi and South Sumatra. In West Kalimantan, 'community reserves' were used by at least three of the forty fishing villages in the Danau Sentarum Wildlife Reserve (DSWR) to maintain their own local fish stocks. These reserves appeared to be effectively managed by application of strong, traditional institutions restricting certain gears or certain seasons, leading to the fact that local fish stocks still comprised many large, valuable fish species compared to some other villages without reserves. In both Jambi and South Sumatra, reserves were more often imposed 'top-down' by Provincial Fisheries Services (PFS) intended to give benefits to the catchment as a whole. The regulations for these reserves usually forbid all fishing activities for the whole year, and were sometimes enforced by local guards. Both Jambi and South Sumatra PFS have plans for developing many more river reserves for the near future. During the RRS, a reserve categorisation system was developed, by which the identified reserves were classified according to their (a) intended beneficiaries (local or catchment), (b) catchment position (upland or floodplain), (c) habitat type (river section or lake), (d) management agencies (set up / managed mainly by government or by community), and (e) management regulations (3 categories of partial reserves or full reserves). Eleven reserves, representing the main combinations of these categories, have been selected for further study in the project's monitoring programme.

KEYWORDS: Harvest reserves, Indonesia, rivers, inland fisheries management, co-management

1 Introduction

Floodplain river fisheries are among the most valuable inland natural resources of tropical countries. At the same time, however, they are also among the most vulnerable natural resources due to the increasing impacts from many different production and exploitation sectors. Their main contribution to fishing communities are as source of cash income, employment opportunities and cheap animal protein. However, it is believed that their management is complicated by their multi-species fish stocks, the multitude of artisanal gear types used for their exploitation, the widely separated dispersion of the fisheries across rural areas, and the strong spatial and temporal variability in the environment. This is compounded by the fact that there is a general lack of understanding about how to properly manage floodplain river fisheries. Specifically, the issue in management regime is the uncertainty on how to select, design and manage reserves as a component of a generalised management strategy.

Reserves, refuges, closed areas, marine protected areas and the like are becoming increasingly popular throughout the world (Polunin *et al*. 1983; Roberts and Polunin 1991; Dugan and Davis 1993; Shackell and Willison 1995). For fishery managers, such area-based approaches provide a visible, easily understandable and relatively enforceable means of controlling fishing effort (Hoggarth *et al.* 1998). However, though closed areas do have clear biological advantages, their social and economic advantages and broader actual impacts are still not well understood for many types of fishery. For example, by taking less fish now, larger fish may be caught at a later time; however, investment problem may occur whenever the weight increment yield a rate of return greater than the going rate of interest (Koeshendrajana 1997).

This paper introduces a new project based in Indonesia entitled 'Selection Criteria and Co-Management Guidelines for Harvest Reserves in Tropical River Fisheries', known in short as the 'River Fishery Reserves' project. The project started in November 1997, and is funded by the UK Department for International Development (DFID). The project is investigating the basic factors which influence the success of reserves in artisanal river fisheries. Such knowledge should at least ensure selection of reasonably promising reserve locations in the future. It will identify ecological and institutional criteria for the selection and beneficial use of harvest reserves in tropical, artisanal river fisheries and develop guidelines for their co-management.

2 The project

In the River Fishery Reserves project, a 'harvest reserve' or a 'fishery production reserve' is flexibly defined as a spatially-recognisable area of water, managed with any specified set of technical regulations, intended to sustain or increase the potential fish yield from existing, natural fish stocks, for the benefit of fishers (Aeron-Thomas *et al*. 1998; Hoggarth and Aeron-Thomas 1998). Previously, reserves were generally understood to refer only to areas totally closed to exploitation for the purpose of nature conservation. The adopted project definition thus allowed increased flexibility in the types of protected areas definable as harvest reserves, and emphasised the importance of giving benefits to fishers, by any natural biological mechanism. The definition also recognises that poor fishers are probably not really interested in 'biodiversity' itself, but rather in their own catches and profits, both in the short and the long term.

2.1 Project purpose and goal

This project is designed to answer the following two broad questions:

- Which types of reserves provide the greatest benefits in which circumstances (i.e. the reserve selection criteria)?
- What management institutions and arrangements are needed to achieve a given objective or

potentially available outcome (i.e. the co-management guidelines)?

Finding the answers to these questions would result in the achievement of the 'purpose' of the project, as specified in the Project Memorandum Logical Framework. At this level of achievement, the project will have produced advice on how to manage floodplain river fisheries. At a higher level, the 'goal' of the project is the achievement of actual benefits for the project's target population of Indonesian, the artisanal river fishing communities. Achievement of this higher goal depends on (1) the guidelines being practically beneficial (i.e. they would give a benefit if implemented), and (2) their subsequent adoption and effective use by the target institutes.

The full objectives of the project may thus be stated in two parts. To achieve the purpose, the project aims to answer the two questions stated above, as accurately as possible. To achieve the goal, the project also aims to provide the target institutes with a good understanding of (1) the biological and socio-economic dynamics of river floodplain fisheries, (2) how these vary within local conditions, and (3) how the project outputs (the '*Guidelines*') may be incorporated into the existing systems to give real benefits to fishing communities. This kind of understanding would enable the target institutes to implement the project recommendations in the context of their existing, local management systems. There is a particular requirement here to indicate how reserves might be integrated with alternative systems of allocating access to fishing, such as waterbody auctions or lotteries of fishing positions.

2.2 Project approaches and activities

The overall approach of the study can be conceptually modelled and simplified as in Figure 1. The figure shows the three main sets of local system characteristics: those of the natural resource (biology, ecology and hydrology), technology (represented by the economics of gear use) and fisheries management institutions (particularly rules of resource use and the factors that support their application). The interaction of these elements determines the patterns of gear use and the catch characteristics: what is to be caught , by whom, at what time and at what level of effort (or cost). This, in turn, determines the *outcomes* in relation to the three principal fisheries management objectives: sustainability, the level of economic surplus and its distribution among different stakeholder groups. This system does not operate in isolation. This is emphasised by the outside influences on the components of the local system: the intersectoral effects, such as changes of adjacent land use or pollution that might affect hydrology or ecology; the influence of prices or alternative wage earning opportunities on the household's costs of gear operation; and the effect of changes in national/regional fisheries policy that may influence what rules can or cannot be adopted at the local level.

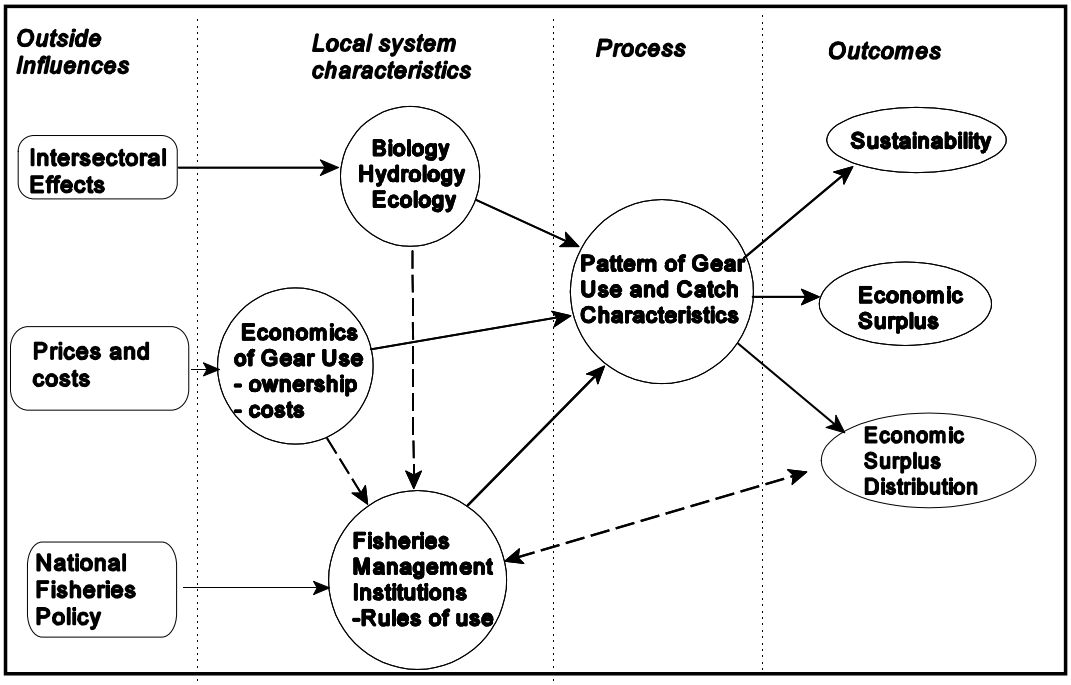

Figure 1. Conceptual framework for a floodplain capture fishery

Given the above brief conceptual approach, the project includes following five activities:

1. Inception and Legal Workshop

To plan project activities and determine the scope for a locally-specific fisheries co-management strategy in Indonesia

2. Regional Reserve Survey

To examine the types of fishery reserves currently used in Indonesia and plan a programme of investigations to determine the criteria for their success

3. Monitoring Programmes

Data sampling and interview-based surveys of fish stock abundances and structures in selected categories of reserves and the economic surplus generated by fishing and its distribution in associated communities. Institutional analyses of the mechanisms whereby reserve benefits may be successfully gained, and those conditions leading to failure.

4. Analysis of Reserve Benefits

Qualitative, interdisciplinary comparison of the ecological and socio-economic benefits from five different ecological and institutional categories of reserves.

5. Dissemination and Training

Development of a set of participatory guidelines for the selection and co-management

of reserves in the broad context of inland capture fisheries development which will be translated into Indonesian for use by PFS and associated agricultural extension agencies. Training of three PFS collaborating offices, and of DGF trainers for wider promotion.

2.3 Collaborators and target institutes

The project involves a collaboration between MRAG Ltd (UK), CRIFI and three Provincial Fisheries Services (*Dinas Perikanan*) offices in West Kalimantan, Jambi and South Sumatra in Indonesia. MRAG and CRIFI have worked together previously on two other Fisheries Management Science Programme (FMSP) projects, both mainly located in South Sumatra, with the second also briefly located in Jambi. Results from these projects have provided a strong understanding of the underlying production dynamics of the river systems.

The PFS are responsible for regional management and development of both capture and culture fisheries under the national guidance of the Directorate General for Fisheries (DGF). Selected PFS are both research collaborators of the project (coordinating local activities and providing local knowledge) and 'target institutes', who hopefully will use the outputs of the project. DGF is also considered a target institute due to its potential role in promoting the project guidelines to many more of Indonesia's 27 provinces.

2.4 Intended project impacts

2.4.1 Production Impacts

The impacts of fully closed reserves on their *protected* (inside) fish stocks have been reviewed for coastal areas by both Roberts and Polunin (1991) and Dugan and Davis (1993). Reserves have been observed to have fish abundances 2-25 times higher, and individual fish sizes 12-200% larger than those outside. Hence, reproductive output may clearly be expected to increase in such situations, but this has proven difficult to demonstrate in field situations. Production impacts are extremely difficult to estimate either by use of model or by empirical / comparative studies due to the complexity of the floodplain environment, fish stocks and fisheries. The present trend in Indonesian inland fisheries, however, is clearly downward. Several of the more valuable fish species (such as *Notopterus chitala, Osphronemus gourami, Scleropages formosus* and *Oxyeleotris marmorotus*) have already become locally extinct in some heavily exploited fisheries such as in the River Lempuing in South Sumatra. In relation to this, the production impacts of the project may be seen from the possibility of preventing further declines in the fishery by the adoption and application of the project guidelines.

2.4.2 Social and Community Impacts

Fishing communities have a deep understanding of the waterbodies on which they work. The project aims to develop a system for providing a wider context for their local knowledge and to give them a greater awareness of alternative management options available to them. The project will be conducted by collaborating researchers (CRIFI and MRAG), decision makers and extension workers (PFS) and local people at each selected village. Hence, it is hoped that by using this approach they can be encouraged to learn from the experience of other communities and to experiment more freely in developing locally appropriate solutions to common fisheries problems.

This will foster a greater sense of empowerment among fishers. Problems will no longer be something which must be passively endured or accepted. Rather they will become a challenge for which a collective solution may be found.

2.4.3 Environmental Impacts

The project is expected to have strongly positive impacts on environmental quality and resource

biodiversity. By encouraging fishing communities to focus on how they may maintain their own resource benefits in the long term, the sustainability of fish stocks must become a more important factor in their values and priorities. The above impact has been investigated by Watson *et al.* (1997) indicating that fish catches outside reserves may be improved, but only where illegal fishing is adequately controlled. In other words, their studies emphasise the need to take stakeholders, and inter-disciplinary factors into account in reserve design and management.

2.4.4 Institutional Impacts

The institutional development of the PFS target institutes is a primary output of the project. The PFS will essentially be encouraged to move from:

- their current strategy, mainly based on top-down implementation of theoretically-appropriate (often externally devised) management tools without assessment of their impacts,

to:

- a new 'adaptive co-management' strategy, based on the joint, participatory determination of local management requirements by fishing communities and the PFS regional managers, with continuous monitoring and assessment of the impacts of their activities.

It is recognised that this change may be seen as a very significant step for the target institutes, requiring significantly more effort for consultation and communication, and a much higher component of local investigation and innovation. Both CRIFI and the *BPTP/LPTP/IPPTP* offices will assist PFS during this stage, and the project will provide in written form clear pilot project designs showing how the guidelines may be implemented.

3. Floodplain river fishery characteristics

All fisheries are based on an interaction between the environment, the fish which live in that environment, and the fishers who catch the fish. The complexity of each of these factors is at a maximum for floodplain fisheries, as described in the following sections.

3.1 The floodplain river environment

Floodplain river systems are highly variable, both spatially and temporally. Their habitats may include flooded grasslands, flooded forests, small and large river channels, and permanent and temporary lakes and pools. Each of these habitats is used by different fish species for their essential life processes, such as spawning and feeding. The combination of habitats varies significantly between localities and determines which types of management measures are likely to be of appropriate. Seasonal variations occur both within the year, and between years. The annual cycle divides the year into periods of high fish productivity during the flood season and relative inactivity and hardship during the dry season. This variability in the size and duration of the seasons affects the productivity of the floodplain and the effectiveness and profitability of the fishery.

In addition to this natural variability, the demands for irrigation water, power generation and flood control as resulted in the fact that floodplains are increasingly being modified on both a local and a catchment-wide scale (Dudgeon, 1992). Any of the various competing activities may affect the natural functioning of floodplain systems, and their potential for fish production. Fisheries interests must thus be well represented in a responsible, integrated catchment management. Both the quantity and quality of flood water must be maintained for high fish productivity; the diversity of floodplain habitats must be maintained for high fish biodiversity; and river channels must be maintained to enable the migrations of fish to their spawning grounds. These environmental characteristics of floodplain rivers necessitate a locally-specific and flexible approach to management, supported by a clear recognition of the need for catchment developments and their influences.

3.2 Floodplain river fish

Floodplains are inhabited by many different types of fish, including strongly migratory 'whitefish' and more locally-resident 'blackfish' able to tolerate the low oxygen conditions of the dry season. As with any fishery, whitefish and blackfish must be managed in spatial units appropriate to their distribution patterns: most whitefish will require a catchment focus, while blackfish may be managed more by villagers for their own local benefits. The spatial relationships between waterbodies and the surrounding communities will determine first who may be able to manage blackfish effectively in each locality.

Heavy fishing of floodplain fish stocks mainly affects the species of fish caught, rather than the total weight of the catch. The catch of most valuable fish species usually decline with heavy fishing, leaving the small, fast-growing fish species which breed rapidly with each new flood period. Though total catch weights may remain high in a heavily exploited floodplain fishery, their values usually decline. Managers must thus choose whether to allow heavy fishing for very little profit (e.g. where the objective is to generate employment or provide nutrition for poor people), or to restrain the amount and type of fishing to improve the types of fish caught and the profitability of the fishery.

3.3 Fishing and fishery management

The wide habitat and species diversity of floodplains is reflected in the complexity of their fisheries. Many different types of fishing gears are used, from simple hooks and traps to much more elaborate, expensive and effective structures. 'Hoovering gears', such as fish drives, dewatering, poison and electric fishing all attempt to catch any remaining fish stranded in dry season waterbodies. In the most vulnerable waterbodies, these gears may need restriction to ensure the survival of blackfish preparing to spawn with the new flood period. Barrier gears must also be particularly controlled to ensure the access of whitefish to their spawning grounds.

Floodplain fishing communities often comprise a complex network of 'stakeholders', leaseholders, middle-men and fishers at various levels of authority and dependency. Access rights for fishing are leased in auctions in many places, usually for a one-year period. Bidding such auctions may be free to all, or restricted to community members. In other localities, fishing places for gears such as barrier traps are allocated by lotteries for just fifteen days at a time. Such alternative mechanisms influence the distribution of fishery benefits among community members, the degree of control held over the fishers and the likely difficulties of managing tools such as reserves. Where they exist, however, such management networks may serve as valuable starting points for improving control of the fishery.

4 Reserve categorisation system

As previously mentioned, a 'reserve' seems to be generally understood to mean a specified area completely closed to any form of exploitation. Broadening this general perception, this project recognises many different types and definitions of reserves varying in both their objectives and their ecological and management characteristics. The project is designed to investigate the benefits of a specified sub-set of such reserves. Depending on the objectives, it is possible that the traditional type of reserve (permanently and completely closed) may not always give the maximum benefits.

The actual differences between waterbodies considered as 'reserves' (and proposed as such by the local Indonesian collaborators) are many and complicated. While recognising that such complexity is important, it is also considered necessary to classify reserves in a relatively simple way that allowed for the sub-selection and comparison of the main types of management strategies.

This section describes the various types of reserves found in Indonesia within the following classifications: intended benefits, ecology and management institutions.

4.1 Intended beneficiary categories

Given the working 'harvest reserve' definition mentioned earlier, it may be intended to benefit either the nation's people as a whole, or a specified group of fishermen. In spatial terms, riverine harvest reserves may be designed to benefit either catchment-wide or local users of fish resources. In general, it is understood that reserves established by the PFS are meant to maintain fish stocks for the overall benefit of a whole catchment. (Hartoto *et al.* 1998). In Jambi province, for example, four upland fish reserves have been established during the 1990's to provide undisturbed spawning areas for fish species such as sampah (the barbel, *Tor douronensis*) whose fry then migrate throughout many downstream fishing grounds (Dinas Perikanan Propinsi Jambi 1996). In contrast, reserves are also sometimes established by local communities specifically to maintain their own local fish stocks. Such communities presumably hope that the extra fish produced by their management efforts will stay mainly within their own waters. The intended beneficiary of a reserve is thus the first classification variable proposed for investigation by this project, with the following two categories of harvest reserves: local fishers (usually within a single village), or catchment-wide fishers as in Figure 2.

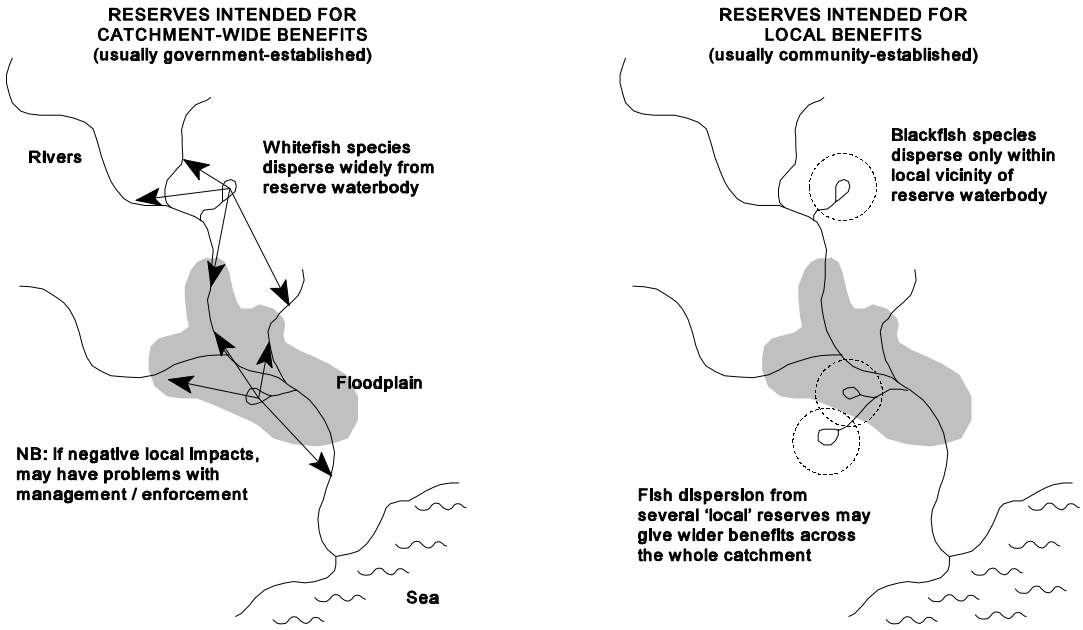

Figure 2. Reserve categorisation according to intended beneficiaries

As discussed in the following section, it would be far more difficult to estimate catchment-wide benefits of harvest reserves than local benefits, or dis-benefits. It may also be more difficult to predict the best places for catchment-focussed reserves (e.g. the spawning grounds) due to the lack of scientific information on the spatial life history patterns of the many different species involved.

A further category of reserves must also be mentioned in this section - those designed to give recreational benefits to sport fishermen and other tourists. Such 'reserves' are currently being actively promoted by the Indonesian Ministry of Agriculture in several provinces including Java, Jambi and South Sumatra. At least one of the 'reserves' examined (D. Kongar in Jambi) was partially established as a 'put and take' fishery with stocking of fish being followed by their removal by paying sport fishermen. This enclosed and dammed reservoir does not interact with the remainder of the commercially fished stock, and is not considered a harvest reserve under the above definition.

4.2 Ecological categories

A river system is a complex combination of many different habitats. Riverine habitats include the fast-flowing upland streams, often with waterfalls and rapids; middle reaches with riffles and glides (often called the 'barbel zone'), and the slow-flowing, meandering lowland rivers. Still-water habitats include various forms of lakes such as floodplain depressions and ox-bow lakes, and the extensive lateral floodplains around some lowland river reaches. Reserves may be created in any one of these habitats or a combination of them or covering a full sub-catchment area or even a whole remote river system.

To simplify the potentially wide diversity of habitats, the ecological types of the reserves studied have been categorised under the following two classes: (1) catchment position (upland or floodplain), and (2) habitat type (lake or river).

As illustrated below, reserves in upland areas are mostly intended to protect spawning grounds for strongly migratory 'whitefish' species, whose fry benefit the overall stocks of the catchment. They may also have some local impacts depending on their institutional structure. Reserves in the floodplain areas may serve the same catchment purpose, or may be intended more to conserve local 'blackfish' stocks mainly those caught close to the reserve. The species protected by the two types are likely to be quite different though some interactions may occur.

Riverine reserves generally comprise sub-sections of secondary river tributaries, often including (and sometimes limited to) the deepest pools known as '*lubuks*'. A given river catchment could thus include many separate 'river' reserves scattered around the various tributaries. Riverine reserves may be located in either the upland or the floodplain parts of the catchment.

Harvest reserves in lakes are usually located within the floodplain region of the river. To be useful as a harvest reserve, such lakes must either be harvested at some time, or by some gears, or be connected to the surrounding exploited areas sufficiently for fish to emigrate from the reserve to the fished areas at some time during the year. Such emigration may include the movements of adult fish from the reserve, or the dispersion of eggs, fry or young fish spawned in the reserve, usually during the flood season.

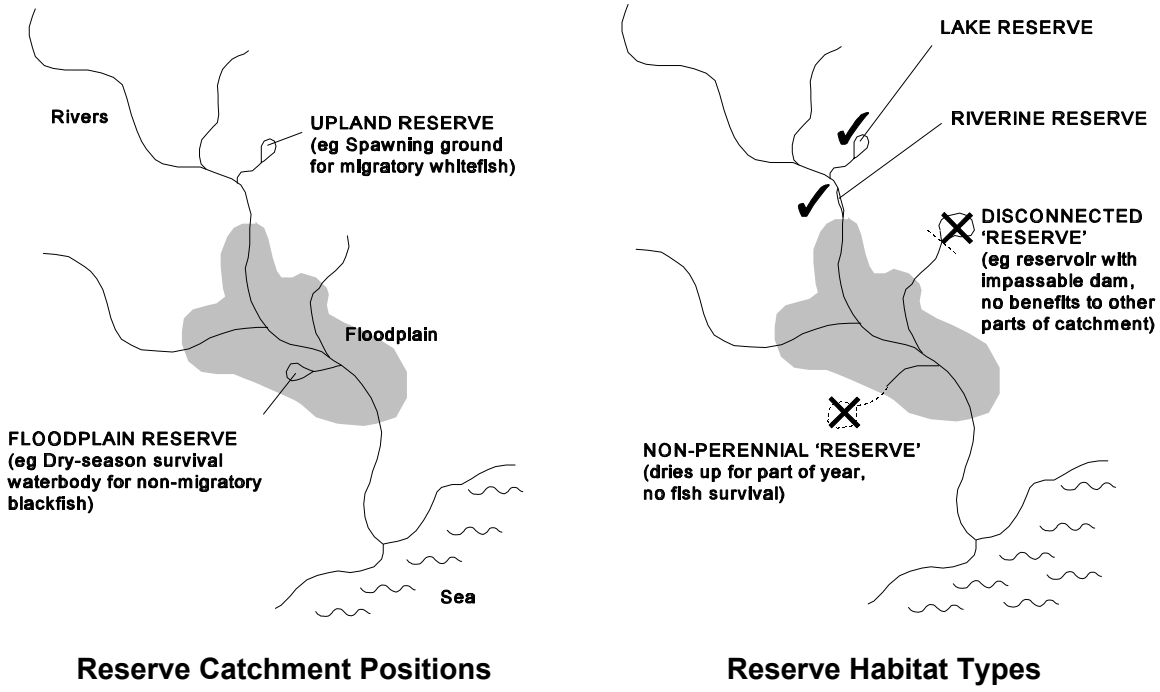

Figure 3. Reserves categorisation according to ecological type

An obvious and important ecological criteria for reserves in either lakes or river is that they must be 'perennial' waterbodies which keep reasonable depths of water over the whole year. In particular, water depths and water quality must remain high enough over the dry season period to enable fish to survive the high mortality rates experienced at this time both from natural causes and fishing. All the reserves investigated during this survey were in perennial waterbodies, though not always in the deepest local waterbodies.

The availability of local habitat types may limit the choice of reserves within many local areas. Some of the villages visited, for example had only rivers within their local fishing grounds and did not have the option of selecting a lake as a reserve.

4.3 Management institution categories

Management institutions are discussed here in the sense of the full system of rules and regulations by which a fishery is managed, including the relationships between the agencies involved.

The management institutions of the reserves investigated differed in many ways. Different reserves were managed by different types of regulations, by different agencies and under different systems of authority. Some reserves were traditional institutions while others were newly imposed under the guidance of agencies such as the PFS. Of the various possible criteria for classifying these institutions, two main variables were chosen, namely, the regulations used to manage the reserve, and the agencies involved in management.

4.3.1 Management Regulations

Regulations for the management of a fishery may be clasified under two broad types, namely, 'technical' rules which promote the sustainability of the fishery; and 'access' rules which allocate fishing rights. Access rules in this sense include systems such as auctions (as in South Sumatra and Jambi) and lotteries (as in West Kalimantan) which determine who may fish in which waterbodies. They may also include regulations on the use of barrier gears which could limit the accessibility of fish to fishermen on the downstream side of such gears.

Reserves are one component of a suite of alternative technical rules by which a fishery may be managed. Such technical rules, may include closed areas (reserves), closed seasons, and bans on those gear types felt (or known) to endanger the fishery. These types of rules may be combined in various ways to achieve the best possible outcome. However, due to the complexities of floodplain fisheries, it is difficult to predict exactly which combination may give the maximum sustainable benefits. The optimum solution for a given locality is also likely to be highly dependent on its local hydrological and ecological characteristics.

As illustrated below, it is worth noting that some waterbodies may also be 'natural reserves', in which particular hydrological characteristics prevent the total capture of fish stocks. Usually, there should be no need for additional restrictive management regulations on such waters.

In addition to the types of management regulations associated with reserves, it would also have been interesting to investigate the importance of the relative sizes of reserves, for example as a percentage of the total fished area or the dry season water area. The lack of suitable replicate study sites and the difficulty of accurately estimating fished and reserved areas prevented this investigation.

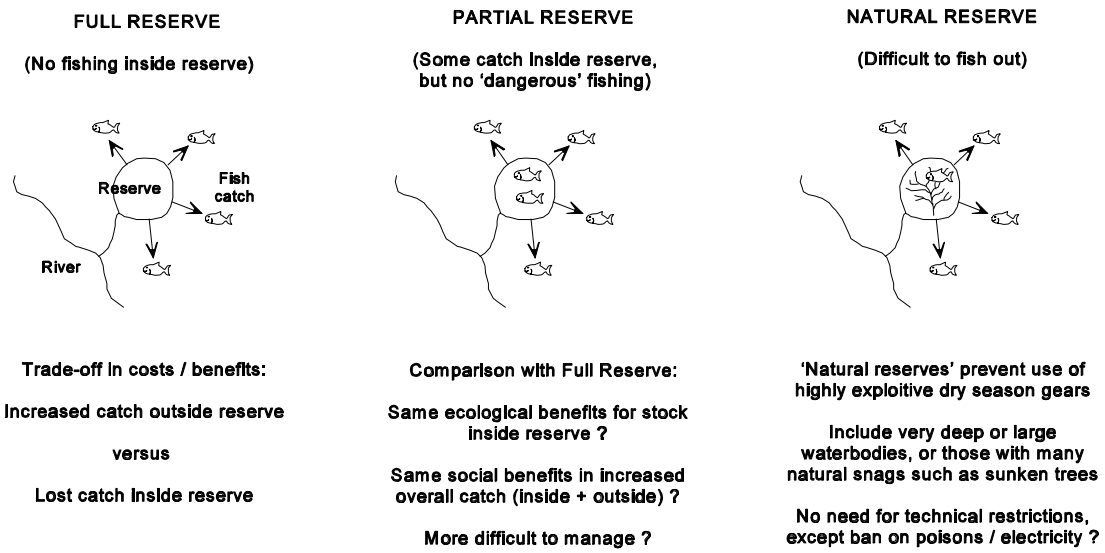

Figure 4. Reserves categorisation according to technical management regulation

4.3.2 Management responsibilities

One of the major outputs of this project will be a set of guidelines for the co-management of harvest reserves, i.e. how government and local resource users could best co-ordinate to manage natural fishery resources as reserves. Given this focus it was decided that, of the many key features of management that could have been selected as criteria, the most appropriate was the level of local/government involvement in management.

When developing guidelines for the co-management of reserves, two of the fundamental institutional questions are, firstly, how reserves can be set up (i.e. how new institutions can be devised) and, secondly, how management of reserves can be maintained once they have been set up. The current and potential roles of local resource users and government will largely depend on the existing institutional arrangements for dealing with resource management, and the social, economic and institutional context in which they operate. To make sure that the widest range of these current arrangements could be studied, the reserves were classified by the degree of local and government involvement in both their set up and ongoing management. It is hoped that studies on the current range of institutional arrangements and their outcomes will provide insights on the future opportunities and constraints for reserve management.

On this basis, reserve sites were classified based on two criteria: (1) whether the creation of the reserve had been mainly initiated by government or by local resource users; and (2) whether management (particularly monitoring and enforcement) was mainly carried out by government or by local resource users. The possible categories were limited to two in each case for the sake of simplicity. As there were no cases where the reserve was created by local resource users and then managed by government, this led to the following three categories of management agency involvement:

Table 1. Reserves categories according to management responsibility

Category	Main force behind the creation of the reserve	Main agents responsible for reserve management
G-G	government	government
G-C	government	local resource users (community)
C-C	local resource users (community)	local resource users (community)

During the checklist interviews, it was found that the study sites differed greatly with respect to the perceived effectiveness of their management. The actual effectiveness of the management regulations attempted was also considered for inclusion as a classification variable. However, given the objectives of the research, it was decided that such management effectiveness was too difficult to classify from the preliminary data available, and would be better studied as one of the outcomes of management, in the next Monitoring Phase.

4.4 Categorisation of selected reserves waterbodies in the study provinces

Given the categorisation system developed above, a matrix of possible combinations of reserve types is limited to those waterbodies intended as *harvest reserves*. It does not include the Danau Sentarum Wildlife Reserve intended primarily for nature conservation, though it does include the three villages within Danau Sentarum which use reserves for their own local benefits. The matrix also does not include the Danau Kongar dam in Jambi, managed as a 'put-and-take' sport fishery.

Table 2. Categorisation of selected reserve waterbodies in the study provinces in each category

		Intended for Local (Village) Benefits		Intended for Catchment Benefits		
		Floodplain		Upland	Floodplain	
Management Agencies	Management Regulations	Lake	River	River	Lake	River
C-C	PR-sg	D. Seliban D. Arang Arang D. Teluk Kenali	D. Teluk Kenali L. Jambi Kecil			
	PR-Sg	D. Belaram				
	PR-sG	D. Batuk				
G-C	FR		D. Mahligai	L. Sahap L. Taman Ciri L. Ngaol L. Manik		L. T.K. Puti D. Mahligai
G-G	PR-Sg				D. Cala	
	FR			L. Sahap L. Taman Ciri L. Ngaol L. Manik	D. Teluk Rasau D. L. Karangan D. Teluk Gelam D. Teluk Nilam D. Air Hitam D. Ulak Lia D. Sidowali D. Gaslam	L. T.K. Puti

Note: D : *Danau* (lake)
L : *Lubuk*

The shaded areas in the above table indicate the (usually) incompatible combinations of management agencies and intended beneficiaries, since village agencies (C-C) do not use reserves for the benefit of the wider catchment, and government agencies (G-G) rarely focus exclusively on programmes to help single villages.

Within the other possible combinations, there are some regional concentrations of reserve types. For example, the C-C reserves are all found in Kalbar and Jambi, while all of the South Sumatra reserves are of the G-G type. The combined G-C category was only found in Jambi province, suggesting that Jambi's

PFS may have the most consultative management style. Upland reserves were only found in Jambi province, all of them being intended for catchment beneficiaries. Such reserves were not visited during the Regional Reserve Survey, due to time constraints, hence the uncertainty in their categorisation shown above.

5 Assessment of reserve benefits

Where protected areas are established to conserve fish species, habitats or ecosystems, their benefits should be measured on the basis of the reserve boundaries. In contrast, the benefits of harvest reserves should be measured in terms of the socio-economic benefits received by fishers from the reserve. Such benefits may be measured in the catches outside fully closed reserves, or in the combined catches from both the fished and the reserved areas, where some exploitation is allowed inside the reserve.

During 1998 and 1999, the River Fishery Reserve project is investigating both the status of fish stocks inside different categories of harvest reserves, and the socio-economic benefits and their distribution among stakeholders within their associated fisheries. The choice of study sites was restricted by the existence of the different combinations of reserve categories, while the 'control' sites were restricted by the lack of nearby water bodies with similar ecological characteristics.

It is intended that these comparisons will provide insights into the factors which affect the success or failure of reserves, both with regard to their protected fish stocks and their socio-economic benefits. It is also clear, however, that these 'with-without' comparisons will not produce accurate estimates of the true impacts of the reserves. While the use of a categorisation system has ensured that a range of different reserve types are studied, it oversimplifies the real factors affecting the state of the resources at each site. The productivity of a given local fishery depends not only the presence or absence of a reserve, but also on a wide range of other factors, including resource ecology (the habitats available and their degradation by any external influences); river hydrology (i.e., flooding durations, depths and areas); fish ecology (the species available, and their potential productivity and resilience to overexploitation); fishing practices (the intensity of fishing, the gear types in use and their seasonality); and historical changes in any of these factors. Though the 'control' sites were selected to be as close as possible to the study sites (geographically, physically and ecologically), there are essentially no adequate control sites for such with-without studies in floodplain rivers.

As an alternative to with-without studies, the use of 'edge effect' approaches was also considered, as used to infer the 'spillover of adults' from marine reserves by Sluka *et al.* (1997). These approaches are considered invalid in floodplain systems due to their high spatial variations in habitat. A reserve in a floodplain lake may have good fish stocks in its surrounding floodplains simply because they are deeper than those further away, and not because they are closest to the reserve.

Biological and social and economic benefits of reserve will be assessed by a means of monitoring. The monitoring of the selected sites would be undertaken as a collaboration between the fishing community and the management agency (PFS and local fishing community). Involvement of the fishing community in the monitoring programme has the following advantages: (1) fishers will be able to see, for themselves, the impact of the management strategy; (2) fishers will be more likely to believe the data produced, if they are involved in its collection, and (3) fishers may supplement the capacity of government management agencies, who usually have insufficient resources and staff to monitor fisheries on their own. The biological routine sampling (monitoring) would collect quantitative data enabling to calculate indices of abundance of fish and composition of fish stock (by species and sizes of fish). The social and economic monitoring would collect quantitative data enabling to estimate economic surplus generated by the fishery and its distribution among different categories of stakeholder.

Apart from those annual cycle routine sampling, supported interviews would also be used. Biologically, the supporting interviews will collect more qualitative data on the historical trends in terms of overall

changes in fish abundances over time and any particular declines or extinctions of individual species. Social and economic supporting interviews will collect a more detail social and economic performance of fishers such as institutional setting and cost structure of fishing.

6 Summary and concluding remarks

In summary, it is obvious that the productivity of a given local fishery depends not only the presence or absence of a 'reserve', but also on a wide range of other factors, including resource ecology (the habitats available and their degradation by any external influences); river hydrology (flooding durations, depths and areas etc.); fish ecology (the species available, and their potential productivity and resilience to overexploitation); fishing practices (the intensity of fishing, the gear types in use and their seasonality); and historical changes in any of these factors. The approaches use in this study is based on the appropriate use of simple and understandable tools, and the ongoing monitoring of biological and social and economic impacts of fishing by which intended to ensure the achievement of selected stakeholder objectives. The approaches avoid the use of any underlying population dynamics model, as such tools may never fully account for the local, ecological complexities of floodplain river fisheries**.**

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