The East Caprivi Floodplain Fishery –

An Assessment of the health and value of a local level resource.

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February 1999.

Abstract

The livelihoods of the East Caprivi floodplain communities are based on a multi-pursuit strategy to maintain their economic and food security. Fishing is a valuable component of this approach, both for subsistence food and as an income generating resource. Presently, the community-fishing sector is in poor health and would appear to be unsustainable. The decrease in use of traditional methods and equipment and the growth of the fishing sector have increased the pressure upon the fish resource. In addition, smaller floods during the 1990s have also proved detrimental to a healthy fishery, by having a critical impact on the regeneration of the fish stock. Heavy burning regimes to promote pasturage and overstocking of the floodplains in the dry season with cattle are causing damage to the environment and effecting the integrity of the ecosystem. The future of the fishery as viable economic pursuit or as a subsistence livelihood is dependant upon the implementation of management strategies regulating stock numbers, burning programmes, resource access and fishing techniques and equipment. The continued existence of an angling-based tourism industry to the area, and the maintenance of the important biodiversity in the region are also dependent upon and sustainable local-level fishery, and a healthy floodplain ecosystem.

Keywords: Local-level resource use, multi-pursuit livelihood strategies, economics, sustainability, RAPFISH.

Introduction.

Background.

The Zambezi River system is a major resource feature across central-southern Africa for both the human population and what is an internationally important, yet still poorly known, biodiversity (Timberlake, 1997). As with all such ecoregions, the Zambezi basin is sensitive to changes, especially hydrological, such as water catchment schemes, pollution, changes in agricultural practises or wetland drainage (Schrader, 1990). Like many wetlands globally, the Zambezi system, is being damaged and depleted at an alarming rate, probably, in part, due to ignorance over its value as a sustainable subsistence and consumptive resource (Barbier *et al.*, 1997). The system is relied upon by large numbers of people in Zambia, Namibia, Botswana, Malawi and Mozambique (Turpie *et al.*, 1998) as a socio-economic resource base. The deterioration of the wetlands is of considerable concern both to the welfare of these communities, and for the conservation of the biodiversity. It is therefore important to evaluate the actual and perceived value of the floodplains and the ecological processes, to the local communities, in order to attune community development and conservation goals (Turpie *et al.*, 1998) and to maintain the functional integrity of the complete system.

Inland fisheries are an important renewable resource from wetlands throughout Africa, especially for rural communities with no other sources of income or animal protein (Holtzhausen, 1991). The majority of the Zambezi -Chobe wetlands, that comprise the floodplains of the eastern Caprivi, are designated communal land. This means that individuals are not responsible for the long-term protection of the resource, so it is of no particular benefit to individuals to limit their use in order to achieve overall sustainability (Schrader, 1990). This can lead to a "Tragedy of the Commons"

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type scenario (Hardin, 1968), where initial individual benefits are borne by the rest of the community, resulting in long-term detrimental effects to the quality and persistence of the resource. If the wetlands have little real or perceived value to the community, or to individuals, then there is little or no incentive to conserve them or to maintain the resource sustainably (Schrader, 1990).

The Caprivi floodplains are heavily utilised by the local communities, providing them with many aspects of their livelihoods, including fertile soils for arable farming, grazing for stock, fishing opportunities, and plant materials for food, construction and household needs. Within the region there is a widespread multi-pursuit strategy, where most households rely on more than one of these practises for food and economic security (Tvedten *et al.*, 1994). Although the dominant pursuit is agriculture, the fishery component is an important and, currently, renewable resource for the floodplain community.

The economic value of most of these resources in the wetlands is still unclear: not only are the market values vague, but so are their values as part of a subsistence based lifestyle. To understand the livelihoods of the floodplain community, and the importance of the fishery within the local economy, it is necessary to recognise the full value of the fishery both as a commercial venture and for its subsistence value.

The value of the fishery is not only limited to the current annual income and financial return to the fishing community. It is also important to assess the present and future health of the fishing industry. By estimating a value or measure of its sustainable use, the cumulative value of the fishery over time can be calculated. This sustainable aspect comprises two components: the ecological factors, including habitat quality, the reproductive success of the fish, and catch sizes; and also a socio-cultural foundation which incorporates the economic pressures and demands with the standard

of living of the communities involved. It is by achieving and maintaining a balance between these two, often contradictory, pressures that a healthy resource base is maintained (Charles, 1994).

An assessment of the health of the fishery will also provide an indicator of the state of the aquatic ecosystems of the area. The Caprivi has 72 species of fish, occurring in the main river channels and throughout the floodplain. These species comprise two-thirds of the recognised freshwater ichthyofauna of Namibia (Bethune & Roberts, 1991). Almost 78% of these species are closely associated with the floodplain, for at least some stage in their life-history (Holtzhausen, 1991). Two species are classified as rare Red Data Book species: the Ocellated Spiny Eel, *Aethiomastacembelus vanderwaali*, the Broadheaded Catfish, *Clariallabes platyprosopos*. Whilst the endemic Striped Killifish, *Notobranchius* sp. is endemic to Namibia (Bethune & Roberts, 1991). Although none of these species appears to feature directly in the fishery, changes to the environment due to the fishery, or changes to fishery practices, may affect them adversely.

Aims.

The aim of the study was to assess the value and sustainability of the fishery as a commercial and livelihood resource on the floodplains. This was achieved by assessing the annual income and importance of fishing to the local economy, and by examining the economic, ecological, technological and sociological attributes of the fishery.

The specific objectives were: -

- To provide an assessment of the size of the East Caprivi floodplain fishery;

- To assess the utilisation of the fishery, in terms of quantity, effort and tenure;

- To describe temporal and spatial distribution of the fishery;

- To estimate an economic value of the fishery;

- To determine the status of the fishery in relation to its long-term sustainability;

- Recommend management strategies and policies.

Methods

The Study Area

The study was carried out in the wetlands situated in the eastern district of the Caprivi, Namibia. The region is bounded by the Zambezi River to the north, the Chobe River to the south, and their convergence at Impalila Island. The western delineation is the Katima Mulilo to Ngoma road (Figure 1).

The Caprivi is a flat, sand filled, basin with a gradient of only 1:7 000 between Katima Mulilo and Kasane (Der Waal, 1990). As a result, large areas of floodplain are formed across the riverine grassland following the annual inundation. The study area comprises an estimated 170 000 ha of seasonally inundated wetlands (Turpie *et al.*, 1998), a dynamic mosaic of wet and dry habitats. As much as 35% of the Caprivi is covered by water in March and April, when the floods are at their greatest (Tvedten *et al.*, 1994). In drier periods the plains are crossed by a large number of streams, channels and canals, which maintain a permanent (or semi-permanent) water presence. These include the Kasaya, Lisikili, and Mpukano channels, which act as refugia for

LISIKILI

SCHUCKMANNSBERG

Lisikili

MUZII

Muzii

Kabe

Itomba

KABE

IMPALILA

Kasika

KASIKA

Lake Liambezi

N

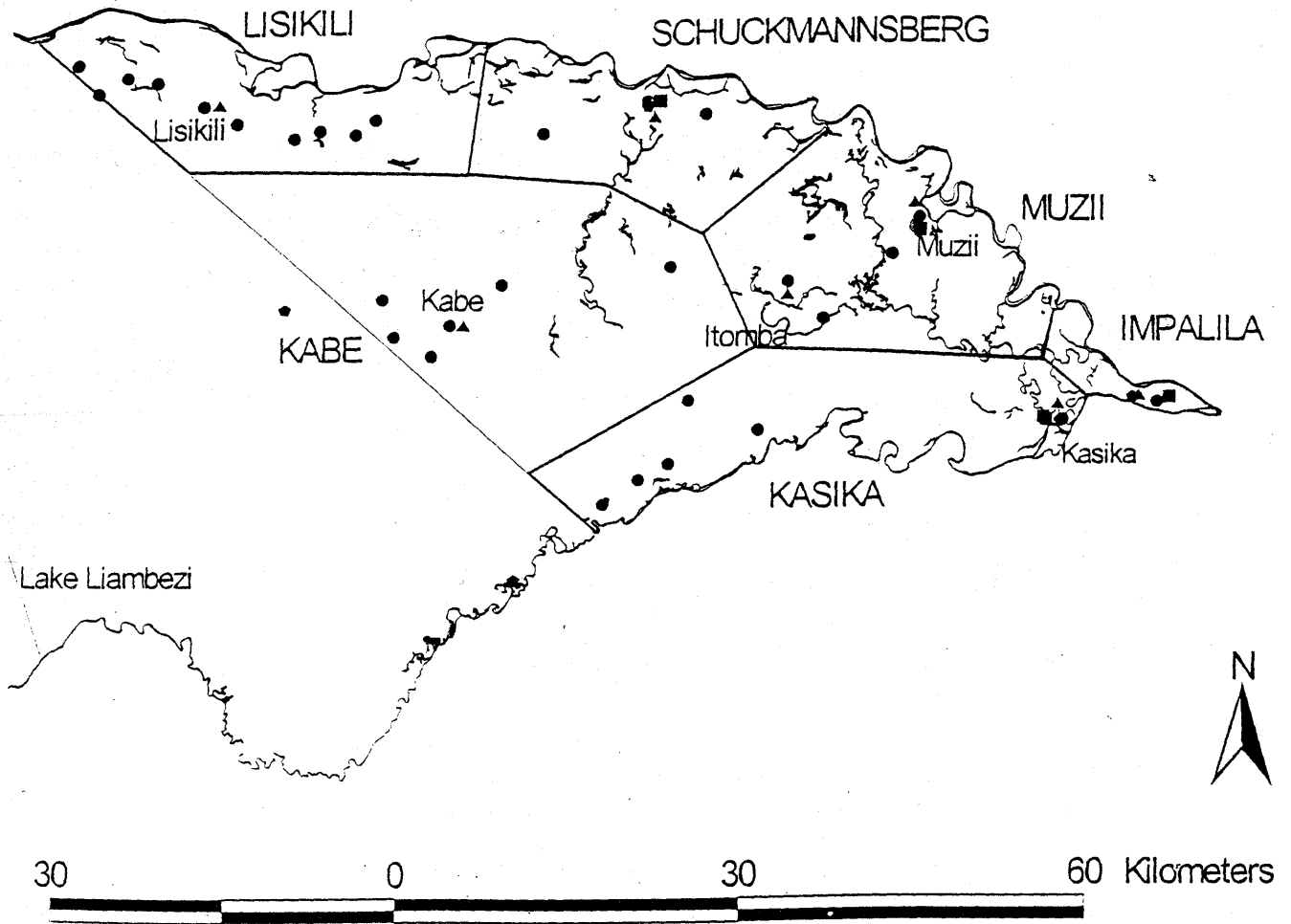30   0   30   60 Kilometers

Figure 1. The Study Area. The East Caprivi floodplains, showing the sub-fishery divisions and the location of field sites (from Mendelsohn & Roberts 1997).

aquatic fauna between the floods (Tvedten *et al.,* 1994).

The Caprivi receives an average rainfall of 550-700 mm a year, mainly between October and May (Turpie *et al.,* 1998), with the peak rainfall in January and February. The hydrological regime of the area is mostly affected by the rainfall further up the catchment in Angola and Zambia. The levels of precipitation in these areas govern the height and extent of the flooding in the eastern Caprivi. There is a lag phase of 2- 3 months between the rains in the north and the floodwaters rising in the Caprivi.

In years of high flooding the plain, as far inland as Bukalo, will be covered in water (Figure 2). When the floods are low the water may only spread as far as Itomba or Lusese (V. Simona, Water Affairs, pers. comm.). The river regimes are also affected by the amount of floodwater. The water in the Chobe is of Zambezian origin, flowing west towards Lake Liambezi when the Zambezi is at its height and then reversing the flow back eastwards when the flood levels retreat. Again, the strength and duration of this flow pattern is dependent upon the rainfall/flood patterns at the time.

Lake Liambezi, to the east of the study area, used to support a large fishery, with an annual production of over 600 tonnes in the mid 1970s (Der Waal, 1990). The lake, fed by floodwater from the Zambezi, Chobe and Kwando rivers, has been dry since 1985, and is now mainly an expanse of agricultural fields and grassland (Mendelsohn & Roberts, 1997). When water levels are sufficiently high the lake acts as a link between the Zambezi-Chobe system and the Kwando-Linyanti catchment (Schlettwein *et al.,* 1994).

The study area is covered politically by the Kabe constituency. Local

Flood Level
☐ Low
▨ Medium
▰ High
■ Very High

Schuckmannsberg

Lisikili

Muzii

Iiomba

Bukalo

Kabe

Impalila

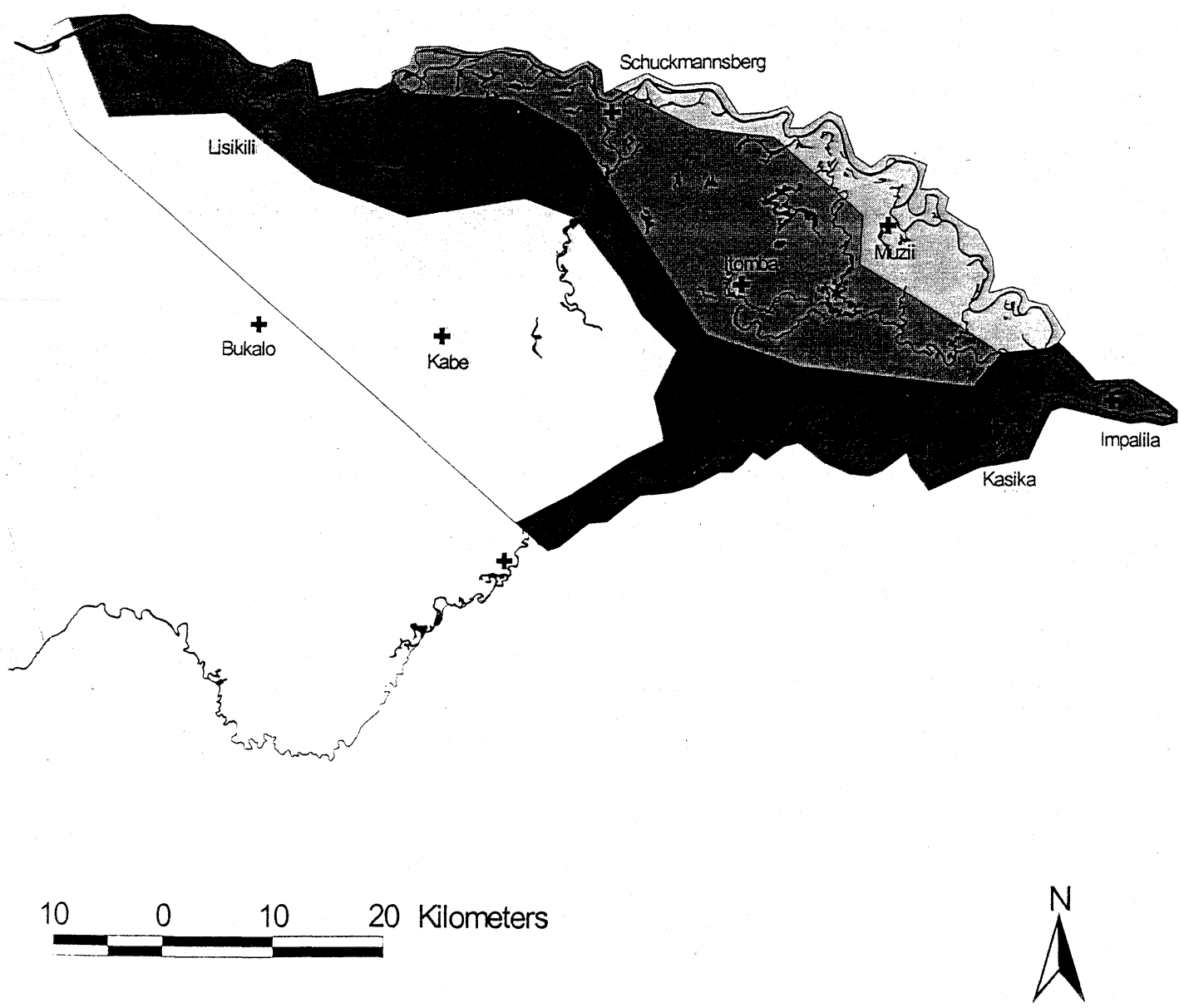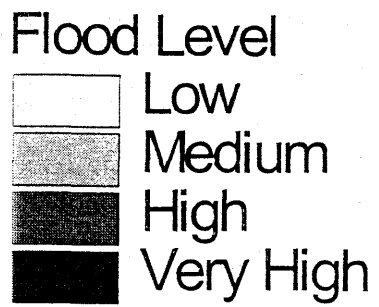Kasika

10   0   10   20 Kilometers

N

Figure 2. Map of flooding patterns across the East Caprivi floodplains (derived from
Mendelsohn & Roberts 1997).

government is represented by one councillor for the area, whilst at a regional level, the Caprivi is served by a governor. These two authorities are responsible for providing health and education services, and the necessary infrastructure to the region. The Lozi people who live on the floodplain also have a tribal authority structure, based on village and senior headmen (*indunas*) who select a chief councillor (*ngambela*) who conveys the wishes of the tribal head to the people and *vice versa* (Mendelsohn & Roberts, 1997). The main tribal council, *kuta*, is based at the Munitenge royal establishment at Bukalo.

The population of the floodplain lives in a mixture of small villages and isolated households, usually upon raised ground to avoid the floodwater. There are more than 3000 households in the Kabe constituency, with an estimated population of 17000 people (Mendelsohn & Roberts, 1997). In addition to this, the resources of the floodplain are also utilised by communities living as far as the Ngoma Bridge Rd and Katima Mulilo.

Field Survey.

The study was carried out during November and December 1998. Sociological and economic assessments were performed through village meetings, focus groups, and household and individual interviews (Appendix 1-3). The locations of the sites used for this data collection are shown on the map of the study area (Figure1). The data collection points were spread throughout the region, to obtain as representative a sample as possible. To achieve this the village meetings were held at Schuckmannsberg on the northern Zambezi, Muzii on the middle Zambezi, Impalila at the convergence of the Zambezi with the Chobe, and in Kasika, on the Chobe itself, to give the southern perspective. These villages also hosted focus groups on the fishery

aspects, as did locations in the rest of the floodplain such as Lisikili and Itomba. Household surveys were performed throughout the region and included communities as far west as the Ngoma Bridge Rd (Figure 1). Interviews were also conducted at fishing lodges to assess the state, impact and interaction of game fishing on the area.

Having obtained the permission of the tribal authority, the Bukalo *kuta*, meetings were arranged through the regional *indunas*. The village meetings took the form of large gatherings of community members. An area map was created through the use of aerial photographs, observation and from local input. The community, by identifying the locations where the resources are utilised, refined this map. The relative importance of a number of activities (e.g. crop and livestock farming, fishing, plant harvesting) was assessed using matrix ranking exercises. Seasonal calendars for each pursuit were produced, and the techniques used and the costs and profits of each activity identified. Concepts of tenure, trends and changes in catch quality and quantity, and the state of the environment were discussed and perceptions recorded.

Focus groups of the community fishermen were derived from these larger gatherings. As a group, they were asked to give their opinions on the state of the fishery, trends in fish numbers, size and catches, changes in the habitat, details of the equipment used and information on the role and importance of the fishery within the community. Further details on the fishery were obtained from a limited survey of actual daily catches ($n=18$), throughout the study area. Individual fishermen were interviewed, and the total net for a day was identified, measured and weighed in order to provide basic information about which species were caught, the frequency that each species were caught, and the variability in sizes and abundance. Comparisons were then drawn with similar catch data from previous studies in 1975/6 (Der Waal, 1990) and 1994 (SSD Freshwater Fishery Survey in Tvedten *et al.*, 1994).

The Economic Value of the Fishery.

The usual approach to environmental economic evaluation is to examine the microeconomic situation, focusing on the prices and trying to internalise external environmental costs (Daly, 1991), using cost/benefit analysis to obtain the full-cost prices. It is by using this basic premise that an economic value has been attempted. It must be noted that concepts such as ecosystem services, which include water supply and regulation, soil formation and cultural and non-commercial uses (Constanza, 1998), have not been formally appraised.

A basic value for the fishery can be estimated by using data by a variety of methods. Data from meetings and interviews was used to establish the value of fishing in terms of individual household catches and the amount of income (both weekly and monthly throughout the different seasons). The costs and inputs required to maintain this level of income, i.e. expenditure on nets, canoes, processing and travel to the markets, were also recorded.

To obtain representative figures for the whole of the floodplain, household distribution data, recorded by Mendelsohn & Roberts (1997), was regionalised through the GIS ArcView package. The floodplain was divided into six distinct sub-regions (Figure 1), based upon data on flooding, vegetation and distribution of, and distance to, fishing grounds (Mendelsohn & Roberts, 1997). The figures collected through this survey were then extrapolated across the households within these areas, taking into account information on the numbers of households involved in fishing and the amount of the catch sold or retained. The different levels of fishing that households were involved in were obtained from previous literature (Tvedten *et al.,* 1994), and these figures were utilised to improve the economic assessment.

The State of the Fisheries.

A preliminary assessment of the state of the floodplain fishery was estimated using an ordination technique derived from the RAPFISH analysis (Pitcher & Preikshot, 1998). RAPFISH is a new multivariate, multidisciplinary and interdisciplinary technique developed for the rapid appraisal of the state of a fishery and to identify the problems within it (Pitcher *et al.,* 1998). It examines and scores attributes covering ecological, economic, technological and sociological sectors of the fishery. By comparing these figures for the Caprivi with hypothetical best and worse scenarios, plotted along the horizontal axis of the ordination, it is possible to determine whether the fishery is in a good state or not (Pitcher *et al.,* 1998).

Analysis of this data was then carried out using the computer package PRIMER (Plymouth Routines In Multivariate Ecological Research). Multidimensional scaling (MDS) was the preferred method of ordination as it produces easily interpretable two-dimensional results. However, since ordinations reduce intrinsically high dimensional data to a low dimensional plot, some distortion is involved. A stress function was therefore computed to evaluate how well the samples are represented in the 2 – dimensional plot. The lower the stress value, the more accurate the sample representation in the MDS (Clarke & Warwick, 1994). A value of lower than 0.25 is considered a valid ordination under the RAPFISH system (T. Pitcher, pers. comm.).

Twenty random fisheries were also created within the parameters of the extreme fisheries to examine whether the attribute evaluations are significant or whether they could have been arisen by chance (Pitcher & Preikshot, 1998). These are plotted as a cross approximating to the 95% statistical confidence limits. The vertical axis of the ordination represents differences among the fisheries that are not related to

goodness or badness (T. Pitcher, pers. comm.).

The factors considered are divided into four sub-sections: economic, ecological, technological and sociological. The attributes appraised under each section, and the scoring system used for each, are shown in Table 1. The economic attributes include price, employment rate, tenure, market destination and equipment origin. The ecological discipline examines environmental factors such as changes in habitat quality and flood patterns and fish population data, including recruitment variability, catch maturity and the levels of by-catch and waste. The style of the fishery, recreational, commercial or subsistence is the main factor in the technological assessment, examining factors such as the type and selectivity of the equipment used, the time input and the dispersal of the sector across the resource base. Finally, the sociological factors include the community involvement, the growth and age of the fishery and the fishery's social importance (Pitcher et al., 1998).

The information used to power this system was collected through the village meetings, focus group discussions, creel surveys and key informant interviews, throughout the study region, and from literature sources. This data was then placed into the attribute system for each individual location to give sub-regional states and then combined to give an overall ordination for the fishery.

Table1. Criteria used for the Rapid Appraisal of the Fishery (based upon Pitcher & Preikshot, 1998 & Pitcher *et al.*, 1998).

Ecological

		Good	Bad	
Catch		Low	High	Kilos/fisher/year
Exploitation	(0:1:2:3)	0	3	Under: fully: heavy: over.
Recruitment Variability	(0:1:2)	0	2	COV
Trophic level	(1:2:3:4)	4	1	Of target species
Range	(0:1:2)	0	2	No. of jurisdictions over range.
Catch Maturity	(0:1)	0	1	% of catch < maturity
Discarded Bycatch	(0:1:2)	0	2	% of catch discarded
Primary Production	(0:1:2)	2	0	ln g C/m^2/year
Species Caught	(0:1:2)	0	2	No. of species caught
Catch trend	(0:1:2)	0	2	None: some: significant change in fishery in last 10yrs.
Flooding	(0:1:2)	2	0	None: Seasonal: Constant
Habitat Status	(0:1:2)	0	2	None: Some: serious impact

Economic

		Good	Bad	
Price		Low	High	Namibian dollars/kg
Importance	(0:1:2)	2	0	Importance within area.
Tenure	(0:1:2)	2	0	None:some:strong entry control
Other Income	(0:1:2)	0	2	Casual, part time or full time.
Sector employment	(0:1:2)	0	2	% of employment in fishery
Ownership	(0:1:2)	0	2	local: mixed: foreign
Market	(0:1:2)	0	2	local: regional: foreign
Equipment origin	(0:1:2)	0	2	local: mixed: imported
Cost	(0:1:2)	0	2	% of profit

Technological

		Good	Bad	
Type of Fishery:				
Subsistence	(0:1)	0	1	Important as food for fisher
Commercial	(0:1)	0	1	Sell catch / important income
Recreational	(0:1)	1	0	Sport fishery
Time Input	(1:24)	1	24	Hours/Day fishing
Landing Sites	(0:1:2)	0	2	dispersed: mixed: centralised
Gear	(0:1)	0	1	passive: active
Selectivity of gear	(0:1:2)	2	0	none: some: very selective
Processing	(0:1:2)	0	2	none: some: lots
Interaction	(0:1)	0	1	no/yes with other sector

Sociological

		Good	Bad	
Socialisation	(0:1:2)	2	0	alone: kin: community
Growth of fishery	(0:1:2)	0	2	% growth in last 10 years
Households	(0:1:2)	0	2	% households involved
Education	(0:1:2)	2	0	below: same: above average
Conflict status	(0:1:2)	0	2	none: some: lots
Information sharing	(0:1:2)	2	0	none: some: lots
Influence on Control	(0:1:2)	2	0	none: weak: strong
Fishing Income	(0:1:2)	0	2	% of total income
Fishery age	(0:1:2)	2	0	Age of fishing community

Results.

The Current State of the Fishery.

Existing data for the biology of the freshwater fishery in the Caprivi is scarce. Only recently have agencies begun surveying the area, with a Freshwater team carrying out a number of field studies a year (J. Koekemoer, pers. comm.). The most recent fishery data is from Van der Waal (1990) and a Social Science Department Freshwater Fish Survey in 1994 (in Tvedten *et al.*, 1994). There is a body of literature on wetland fish ecology in general, (e.g. Bruton and Jackson, 1983). The conclusions that are reached concerning the value of the fishery from these earlier studies can be used as important comparisons and validations to the information collected during this short-term case study, and may provide useful indicators for any trends in the system. A summary of the information obtained through the Focus Groups is presented in Table 2.

The fishery sector plays a prominent role in the socio-economic welfare of the floodplain community. The magnitude of this role alters through the year, from the dry season when the only available fishing grounds are the rivers and the permanent channels, through to the high floods where as much as 80% of the study area could become inundated (GIS data - Mendelsohn & Roberts, 1997). Therefore, the flood regime has a significant effect on the size of the fishery, by determining who has easy access to the resource and by influencing and refreshing the productivity of the system (Bruton & Jackson, 1983). In addition, high flood levels effect the current agricultural practices, hence increasing the importance of the fishery in terms of food security. The

Table 2. Main Observations obtained from Fishery Focus Groups.

Uses of Fish	Food security on a daily/weekly basis. Important income generation.
Number of Fish	Decrease in numbers on the Zambezi. Poor fishing up near Katima Mulilo. No changes noted for the Chobe region.
Size of Fish	Fewer big fish caught than 3 - 5 years ago.
Catch Composition	Mainly the same species. Increase in catfish (Kabe), disappearance of bottlenose (Kasika).
Seasonality	Good fishing follows a good flood.
Type of Fishery	Some commercial, mainly part of multi-strand livelihood strategy.
Size of Fishery	79% of households involved in fishing. Except for inland, more people fishing than 10 years ago.
State of the Habitat	Major changes due to burning, grazing & low flood levels. Zambian side of river burnt.
Concerns of the Fishermen	Nets destroyed by crocodiles. Lack of regulation in the fishery, bad fishing (drag netting) practices are reducing the available catch. Interference from Zambian Fishery.

recent flood regime is, on average, 5.0m above the low water level, though extremes of more than 8.0m have been recorded. The average flood level may be decreasing, the level between 1984 and 1993, was 13% lower than that recorded for the previous decade (Tvedten *et al.,* 1994).

This decrease in the flood levels may account for some of the floodplain communities' perceptions of how fish numbers have changed (Fig 3.). With low flood levels over the last decade or so, fish numbers are thought to have
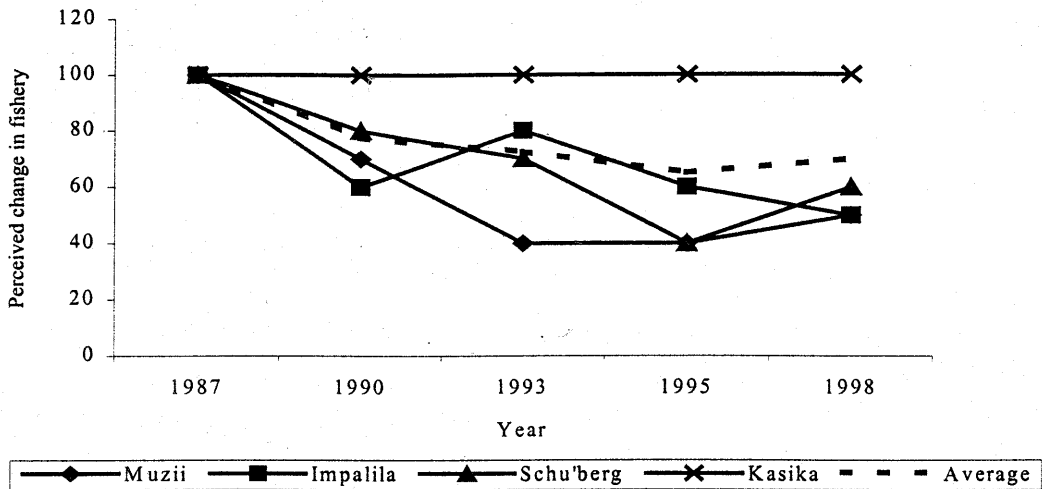
Figure 3. A Representation of the Perceived Changes in the Number of Fish between 1987 and 1998, based on responses provided in the Fishery Focus Groups.

declined in a number of areas. Fish abundance may have increased again with the more extensive floods of the last two years (Fisherman Focus Groups). Three-quarters of the people questioned in the focus groups believed that present fish numbers were noticeably less than five or ten years ago, whilst 84% held that belief in 1994 (Tvedten *et al.,* 1994).

The focus groups were asked to either represent their perceived changes or to highlight years of significant changes. The greatest observed alterations were in the last three or four years. These perceptions have been evaluated and represented in Figure 3. This pattern is well established in the literature. Welcomme (1979) showed that 57% of the variability in the seasonal catch in the Kafue River and 82% in the Shire was attributable to the flood history of the previous two years. Seasonal fluctuation in water level in the Everglades was shown to be the critical factor affecting the demography of the fish community (Kushlan, 1976). Bruton and Jackson (1983) go further and make the link between the size and duration of the flooding and

the recruitment, growth and survival rates of the fish stock. According to the Caprivi fishermen, fewer big fish (of all species) are caught now than 5 years ago. This is probably due to the increase in small net mesh sizes, as fishermen alter their equipment to maintain a decent catch per unit effort, or change from a subsistence lifestyle to a greater commercial-orientated fishery.

Evidence suggests that the composition of catches has changed (Table 3). A comparison in percentage composition between 1976 and the 1990's showed that although the main species in the catch remain the same, the species importance within the catch has changed. A comparison of the data, using a rank correlation, showed that there were no significant differences between the results of the surveys ($r_s = 0.479$, p (0.05) = 0.417). The differences that are apparent maybe due to the small sample size of the recent study but they could indicate changes in fishing technique and the status of the fishery. Rather than the strong concentration of the fishery upon one or two species (*Oreochromis* sp. & *Clarias gariepinus*), the fishery now encompasses other species, suggesting a lessening in the selectivity of the equipment. It must also be noted that Der Waal looked primarily at the commercial fishery, whilst the current data was a coverage of both commercial and subsistence fisheries, however, both focused on catches using gillnets. A comparison between the average catch statistics though, seems to support the perceptions that there is a decline in both fish abundance and size. The average weight of catch in 1998 was only 10.74 kg (S.D. = 3.5 kg, *n*=18), whilst Der Waal recorded a figure of 13.8 kg. The number of fish caught was also considerably less, with the examined catches on average containing 50 and 100 fish for a night's work, in comparison to 250 in the 1975/76 study (der Waal, 1990).

Table 3. Comparison of Species Caught in Different Fishery Surveys, Van der Waal 1975/76[1] (Van der Waal, 1991), SSD FW Fishery Survey[2] (Tvedten et al., 1994) and this study, 1998.

Scientific Name	English name	Lozi Name	Catch Composition 1975/6 %	Catch Composition 1994 %	Catch Composition 1998 %
Oreochromis andersooni	Threespot Tilapia	Njini	34	21	16.2
Oreochromis macrochir	Greenhead Tilapia	Muu	20.2	16	13.1
Tilapia rendalli	Redbreast Tilapia	Mbufu	4.2	15	12.1
Tilapia sparrmanii	Banded Tilapia	Situhu	0	-----	11.5
Serranochromis longimanus	Longfin Largemouth	Njenja	7.1	-----	10.8
Clarias gariepinus	Sharptooth Catfish	Ndombe	10.3	17	5.6
Hepsetus odoe	African Pike	Molumesi	2.9	6	5.2
Serranochromis robustus & S. thumbergi	Nembwe	Nembwe	2.1	-----	5.2
Brycinus lateralis & Barbus poechii	Stripped Robber/ Dashtail Barb	Mbaala	0	-----	3.6
Schilbe intermedius	Silver Catfish	Lubango	0.5	-----	3.4
Synodontis spp.	Squeakers	Singongi	1	------	3
Serranochromis angusticeps	Thinface Largemouth	Mushuna	8.7	------	3
Marcusenius macrolepidotus	Bulldog	Nembele	0	------	2.4
Sargochromis giardi	Pink Happy	Siyeo	6.5	------	2
Clarias ngamensis	Blunttooth Catfish	Nkoma	0.1	------	1.8
Mormyrus lacerda	Western Bottlenose	Ndikusi	0.6	------	0.5
Hydrocynus vittatus	Tigerfish	Ngweshi	1.7	10	0

[1] Based on mean percentage composition of the Chobe & Zambezi catch composition (De Waal, 1990).
[2] Based on partial 1994 SSD Freshwater Fishery Survey data. ----- means that no data was provided, not that the species was not recorded (Tvedten et al., 1994)

Most fishermen felt there was no noticeable differences to the fish fauna on the floodplains. The exceptions being in the inner floodplains round Kabe, where there was less silver catfish (Schilbe intermedius) and more sharptooth catfish (Clarias gariepinus), a more habitat generalist species (Skelton, 1993), and along the Chobe where numbers of western bottlenose (Mormyrus lacerda) seem to have declined (Fishery Focus Group).

With these apparent trends in the biological state of the fishery, it is likely any changes will be reflected in the socio-economic configuration on the floodplain. Fishing, at some level, is practised by an estimated 79% of the households within the study area (Focus Groups & Household Surveys). The majority of this is subsistence fishing, but from the household surveys, 36% of respondents indicated that this was their main form of income. This was in comparison to recent studies for the whole of the Caprivi region, which found that only 15% of households used fishing as the important source of income (Tvedten et al., 1994). This difference may be due to regional variation, for example, fishing is seen to be less important in the Kwando area of Caprivi than farther east in the floodplains (Tvedten et al., 1994). Alternatively, it could reflect changes in food security and lifestyle practices due to changes to the environment. On Impalila, for example, the reduced level of rainfall over the last few years has made maize production untenable, and hence more people are turning to fishing for food security (senior headman, pers. comm.).

These changes in the fish resource are reflected within the growth of the fishing communities in the sub-regions. In the southern half of the floodplains, the communities have grown, with Muzii, for example, increasing from 25 fishermen in 1987 to over 200 fishermen in 1998 (Fishery Focus Group). Similar trends are recorded for Impalila and Kasika, where increases of between 15% and 30% are perceived over the last 10 years (Fishery Focus Groups). The fishery is also growing in Lisikili, but for Schuckmannsberg and Kabe the number of people involved in fishing has either remained the same or has actually decreased, as other pursuits become more worthwhile. The movement of former Liambezi fishermen, since the lake dried up, onto the Chobe may account for further growth in the southern sector (Schlettwein et al., 1991). A common report through out the fishery focus groups and

interviews was the utilisation of the floodplains and the rivers by Zambian fishermen. These people operate outside the traditional structure of the floodplains, so tenurial issues become cloudy. The Zambian bank of the Zambezi is also heavily burnt, as the vegetation interferes with the hauling in off the nets (Key Informant Interview), leaving the riparian habitat severely degraded.

Further analysis of the household surveys shows that men (92% of people who fish are male) dominate the fishery. The remainder are women from households where there are no men available to do the work (either female headed households or where the men work elsewhere or are either too young, in school or too old to fish (Household Survey)). During the flood season, women from all different types of households fish the backwaters, using traditional techniques, such as basket trapping.

The basket-fishing sector is a reflection of the bigger, seasonal picture of resource use within the fishery. The level and intensity of fishing is dependent on a number of factors, including the strength and duration of the flood and also the geographical location of the communities and households. Those on the rivers and permanent water bodies have fairly consistent levels of fishing throughout the year. With the floods, however, more use is made of the backwaters and the newly created flood zones and more people and households become involved in fishing including, the basket wielding women, and men and boys spear fishing. Further inland, dry season fishing is dependent upon the permanent waters, such as the Kasaya and the Mpukano. The flood acts as a refresher to these systems, bringing in more stock, thus encouraging greater resource use. Those communities living in the central and western regions of the floodplains, such as beyond Itomba, Lusese and Kabe are almost entirely dependant on floodwater fishing, so the use of the floodplain is generally restricted to the period March to May (Kabe Focus Group). In a comparison of

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household effort towards the fishery, Tvedten *et al.* (1994) estimated that 20% were fishing full-time and 40% each for part-time and occasional fishing households.

The style of fishing also changes seasonally. Between June and November, when water levels are low, the predominate form of fishing is with gillnets. These tend to be between 25 and 50 metres long and of at least the regulatory 8.5-cm mesh size (pers. obs.), and strung along or across the channels or rivers. However, as these waters get fished out, the frequency of drag netting increases. With the rising water, gill nets are again utilised as fish move from the main water channels, and the use of baskets, traps and spear fishing also increases in the shallower waters on the plains (Key Informant Interviews).

Gillnet fishing is the encouraged style of fishing as it is considered less destructive than the "active" style of drag netting. However, it appears that drag netting is increasing in some areas as fish numbers decrease, and that the mesh sizes being used are getting smaller. Numerous fishermen around the floodplains reported hearing stories of people in other areas drag netting extensively and even using shade or mosquito nets (Focus Groups & Informant Interviews), which will not only remove the larger size classes but have the further detrimental effect of removing fry and eggs.

The Value of the Fishery.

From the focus groups, household surveys and key informant interviews, the basic economic data of the fishery was collated and analysed. Weekly and monthly totals of fishing catch were recorded and the changes in the income over the months noted. From these figures an annual income could be calculated (Table 4.). It must be remembered, however, that there was considerable variation in the data collected due to the selection of people questioned and their perception of what their monthly and

seasonal incomes really were. Although emphasis was put on income patterns over the last twelve months, any extrapolations of this data to other years must take into account the different flood patterns and changes in biotic conditions on the floodplain.

The six original sub-regions were further divided to take into account geographical position (i.e. distance to permanent water) and the pattern and risk of flooding (using the GIS data from Mendelsohn & Roberts, 1997). Natural groupings of communities, as mapped through the GIS package and further defined in household

Table 4. Economic Breakdown of Sub-Regional Fishery. Values were obtained through Fishery Focus Groups and Household Surveys. These were regionalised (according to Fig. 1.) and the fishing community proportions applied across the number of households. The values do not account for subsistence consumption, purely reported income.

Region	Number of Households	Households Involved in Fishing	Average Monthly Income[1] N$	Average Annual Income N$	Annual Inputs[2] N$	Net Household Income N$	Net Sub-Region Total N$
Lisikili	557	60%	1033	12400	2420	9980	2639130
Schu'berg	407	95%	511	6134	2961	3173	961730
Nakabungo	102	70%	217	2608	1675	933	51450
Muzii	447	95%	975	9567	3077	6490	2040850
Itomba	192	80%	444	5325	2038	3287	337125
Impalila	143	75%	740	8883	1850	7033	599940
Kasika	395	90%	638	7650	2117	5533	1629095
Inner Chobe	169	75%	417	5000	2352	2648	265055
Kabe	611	70%	104	1250	450	800	274400
Total							8524375

[1] The average income was calculated from the different reported monthly income values obtained for full-time, part-time and occasional fishing.
[2] The Annual Inputs is an average value for equipment replacement and travel & preparation costs.

responses, were also used to define the sub-regions. Those communities along the Chobe, for example, were classed as "Kasika" whilst those from further inland were grouped as "Inner Chobe". This further division allowed the economic model being used greater sensitivity and definition for the different socio-economic regimes upon

the floodplain. Using the proportions for the fishery calculated by Tvedten (1994) for full-time, part-time and occasional fishermen (20%, 40% and 40% respectively), further sensitivity was added to the estimated totals. The totals were calculated by taking the weekly and monthly values, as discussed at focus groups for each region, and calculating an average annual income. Generally, more money was earned between March and May, with good fishing on the flow and ebb of the flood. The amount earned decreased through the drier months, with a stable "base" value for November and December when only the permanent waters and rivers were available for fishing.

The costs of fishing were also valued through information gathered in the communities. Although a large proportion of the catch is sold, either fresh or dried, locally or at the markets in Katima Mulilo, Bukalo or Kasane (Botswana), the commercial component of the fishery is still small. As the floodplain fishery is a mixture of subsistence and non-collective entrepreneur style sectors, with no formal organisation, there are few paid fishermen within the sector. Large-scale commercial fishing does not appear to be a major component of the actual floodplain fishery (Focus Groups), thus the fish reaching the market place does so through the efforts of individual households, and occasionally communities.

The financial costs involved in fishing are, therefore, those of the equipment required and the preparation for and the transportation of the produce to the market. Most fishing recorded in the communities is net fishing, i.e. gill net or drag net. For both of these, the basic requirement is a net, or set of nets, and some form of water transport, almost always a wooden canoe (*mukora*). In gill netting, the nets are suspended across or along a channel and left overnight and the catch consists of those fish that have swum into the mesh and become entangled. The nets, are bought in

either Botswana or Zambia, due to a lack of a suitable local source, and the consensus was that each 100 yards of net cost N$50. Local materials are used to float and weight the net, either reeds or wood for the top and stones, bricks or clay weights to sink the lower edge. The costs of these are negligible. These nets can also be used for the drag netting, when an arc of netting is laid out through the water and then the two ends pulled together and the net closed in. The costs of baskets and spears for fishing are also negligible as they are made from predominantly local natural materials. Thus the only input cost is labour time, which is minimal when considered over the lifetime of the equipment.

The cost of nets per year is dependent on the size of the households fishing operation, and the turnover and replacement rate. As well as having to replace nets due to normal wear and tear, there is a widely reported problem, mainly in the gill net sector, of nets being damaged by crocodiles, *Crocodylus niloticus* and hippopotamus, *Hippopotamus amphibius*. Animals moving through the channels rip nets left out overnight. Crocodiles also damage the nets whilst taking fish entrapped by the mesh, thus reducing the value of the catch. The cost of actual damage to the catch, by crocodile predation, and the cost of the catch lost when the nets are damaged, by either species, was calculated. The damage caused by these animals varied throughout the regions (Table 5.). There are more animals present in the Chobe and the southern regions than there are in the Lisikili area (B. Sezane, IRDNC, pers. comm.), and these concentrations are reflected in the costs to each sub-fishery. In total, these two species cost the region just less than an estimated one and a half million Namibian dollars a year in replacement nets or in damage to the catch.

The net household balance for each region reflects the resource availability to the communities. The Lisikili region has the highest annual income from the fishery

Table 5. Estimated Cost to the Fishery from Crocodile & Hippopotamus. Values derived from Fishery Focus Groups and Household Surveys and applied across the regions and the different levels of fishing effort (Tvedten et al., 1994).

Region	Crocodile		Hippopotamus		Total
	Nets N$	Catch N$	Nets N$	Catch N$	N$
Lisikili	133600	100200	8350	15030	257180
Schuck'berg	114500	114500	11450	17175	257625
Muzii	159225	130275	28950	19541	337991
Impalila	18725	50825	16050	7624	93224
Kasika	72300	228950	72300	34342	407892
Kabe	42700	17080	0	0	59780
Total	541050	641830	137100	93712	1,413,692

as it has permanent access to the Zambezi River and to a number of permanent channels, such as Lake Lisikili. The proximity to Katima Mulilo also works in the sector's favour in two ways. Not only can it provide the freshest fish to the town's market, but the proximity of other employment opportunities means that the number of households involved in the fishery is less, so increasing the individual value for those utilising the resource. Not surprisingly the Kabe region and the other inland zones all had small annual incomes from fishing, as they are restricted for the most part to the flood season.

The individual figures were then multiplied by the number of households involved in fishing within that area. This gave an annual income to each jurisdiction for fishing, which when consolidated gave a total of N$8,524,375 being generated for the local economy. Finally, the sub-regional totals were adjusted to account for the proportion of the catch not sold (i.e. subsistence food), giving an overall value of the fishery of N$ 9,447,850. In addition, revenue generated through recreational fishing was valued at N$ 420,000 in 1994 (Barnes, 1995), which can be incorporated into the

value for fish as a resource.

On a household level, the variance in effort towards fishing is reflected in the annual income. Those households for which fishing is a full-time activity can earn more than N$ 3500 per month (in areas such as Lisikili), though the average annual income of full-time fishermen across the study area was N$12,240. This compared to the lower incomes from the part-time and occasional fishing households; who on average earned between N$4 - 500 a month and had an average annual income of between N$ 2 - 5000 a year. These figures remain in the same magnitude as those of the earlier studies, where the income ranged from N$474 to N$3941 per month (Tvedten *et al.,* 1994), which suggests that the market value of fish has not changed much in the last 5 years.

These figures do not, however, account for the opportunity benefit accrued by the fishermen who keep a portion of the catch for consumption, at least once a week. This small amount could be considered a type of "bonus wage". Opportunity and labour costs have not been incorporated into the calculations. As the fishery is still mainly a small-scale entrepreneurial operation or on a subsistence level, operating as one strand of the multi-pursuit strategy, it was felt that such costs were minimal.

With the high unemployment rate in the region, it is probable that formal employment is not an available option, especially in the deep floodplains where the opportunity to do other activities does not occur. Fishing is only one of the components of the multi-pursuit economic strategy of the floodplain communities. In addition to the wages of formal employment, and pensions, which provide income to 15-20% of rural households (Ashley & La Franchi, 1997), the main activities are crop and stock farming and vegetation collection. Fishing occupies only a few hours of the day, depending on the season, and does not prevent the individual from performing

more profitable work. When they need to plough or harvest the fishing regime is altered to accommodate this need; herding is delegated to young boys and vegetation collection is mainly the realm of the female members of the household. All these pursuits are, therefore, fairly complementary and so do not reduce other earning opportunities.

The importance of each of these reflects food security, resource availability and cultural significance. For example, over 37,500 cattle are kept on the floodplains (Vet Services, Katima Mulilo), an increase of 15% in the last 3 years, yet only 5% of these are utilised for meat each year. Most of these are sold to MeatCo, a meat processing company in Katima

Table 6. Estimated Economic Contributions of Floodplain Livelihoods. Household Incomes are derived from Household surveys. The Total Economic Worth includes subsistence values calculated from data collected in this study and information from Turpie *et al.,* (1998).

Income Source	Average Household Income (N$)	Estimated Financial Value (N$)	Contribution to Local Economy	Total Economic Worth (N$)	Contribution to Total Worth
Crops	1274	3851302	24%	19256510	42%
Cattle	598	1807089	11%	16458460	31%
Fish	2897	8524375	52%	9447850	21%
Vegetation	1267	2071309	13%	3033244	7%
Total	5496	16254075		46049308	

Mulilo, usually in November and December (Household Surveys), but some are kept for food and ceremonial purposes (Turpie *et al.,* 1998). As well as providing milk and transport power cattle are held as symbolic of wealth within the Lozi communities, and so herds are large and increasing in size (Key Informant Interview). Cattle are seen as a reliable sources of food and as an insurance policy, for when income is

needed quickly, and so are valued as both food and economic security (senior headman: pers. comm.).

When economic value alone is considered, it can be seen that in terms of real capital flowing through the floodplains, the fishery sector contributes the most (Table 6.). When non-market values are considered, however, agriculture is by far the most important and fishing drops lower than the value of cattle. Only 20% of the maize crop is sold to the mill in Katima Mulilo (Mendelsohn & Roberts, 1997), the rest being kept for staple food and for food security. If this reserved amount, and the sorghum, millet and other subsistence crops, is valued at mill and market prices, the value of the crop sector is worth almost half of the total amount being derived from floodplain services. Cattle, which provides only 11 % of actual income, have an overall worth of almost a third of the local economy, once the value of milk production and haulage are considered (a large proportion of their estimated total economic worth in Turpie *et al.,* (1998).

The Health of the Fishery.

The state of the fishery was examined through the RAPFISH system (Pitcher *et al.,* 1998) which takes into account the complex bio-socio-economic interactions inherent in a fishery (Charles, 1994) such as the one found on the Caprivi floodplains. From this, a clear overall picture can be derived concerning the present state and the future health of the fishery, and by examining the attributes which compose the analysis, the major effects and driving forces behind the fishery can be determined.

The fishery, as noted before, mainly comprises a local-level resource base, utilised by the floodplain communities for both income and subsistence food. It is therefore important for these communities that such a significant resource is

sustainable if this food security and their livelihoods are to be maintained or even improved. A comparison is also drawn with three regional recreational fishing organisations to examine how they affect the fishery and the future sustainability of such businesses.

The overall appraisal of the floodplain fishery (Fig. 4a) shows the current state of the sector. From this, it would appear that the sustainability of floodplain fishing at the moment is at a critical point. Although none of the community sub-fisheries are "worst-case" scenarios, there are evidently problems. The combined ordination for the community fisheries produce an overall rating of 39%, showing that the floodplain is in a fairly poor state of health, i.e. that the current practises are probably unsustainable in their present form. There are, however, regional differences as shown in Table7. The biggest problems appear to be along the Chobe, in Kasika (41%) and Impalila (36%). Muzii is the "healthiest" of the community fishing regions, but is still at less than two-thirds of the health of an ideal fishery. In comparison, the recreational fishing sector was at a more encouraging 58% of optimum health. The true picture of the health of the region is shown in the breakdown of the attribute groupings at the different scales of fishing (Figure 4b.). The attributes are a complex combination of interactions, with a number of factors, such as access rights and flooding patterns, influencing different sectors.

The economic sector examines the cost-benefit balance of pursuing fishing, the strength of tenure and the importance of the sector to the economy of that area. Those areas such as Muzii, which are far from the markets, trade fish locally rather than utilising it as a major income generator. Kasika and Impalila, for example, where crop production has fallen rely more heavily upon fish for financial gains. This reliance

Table 7. Health of the Sub-Fisheries and Sector Fisheries. These are expressed as percentage values as calculated from the position between the "good" (100%) and "bad" (0%) fisheries. All ordinations are significant with the stress values for each <0.25. (From RAPFISH (Ver. 2.2) 1999) T. Pitcher, pers. comm.).

Sub-Fishery	Economical Attributes (%)	Ecological Attributes (%)	Technological Attributes (%)	Sociological Attributes(%)	Overall (%)
Lisikili	48*	56	66	25	45
Schuck'berg	40*	50*	22	54	57
Muzii	24*	72	38	60	63
Impalila	45	66	63	25	36
Kasika	46	26*	68	26	41
Kabe	28	36	48	49	45
Zambezi	58	47	65	47	50
Impalila	66	55	66	55	48
Chobe	81	59	68	59	53
Community	65*	68*	62	44	39
Recreational	82	86	71	53	58

* Values of attributes which fall below the 95% confidence limits as generated by the random fisheries.

will, to some extent, determine the levels of effort committed by the communities into fishing, and hence the possibility of unsustainable fishing levels. The occurrence of overfishing and detrimental fishing techniques is related to the degree of control over access to the resource that is expressed within each area. The deep floodplains reported strong tribal control over fishing rights (Muzii Village Meeting). Communication with the local headmen suggested their awareness of the problems generated by too much fishing and the use of the wrong equipment and also that some local control and measures were used
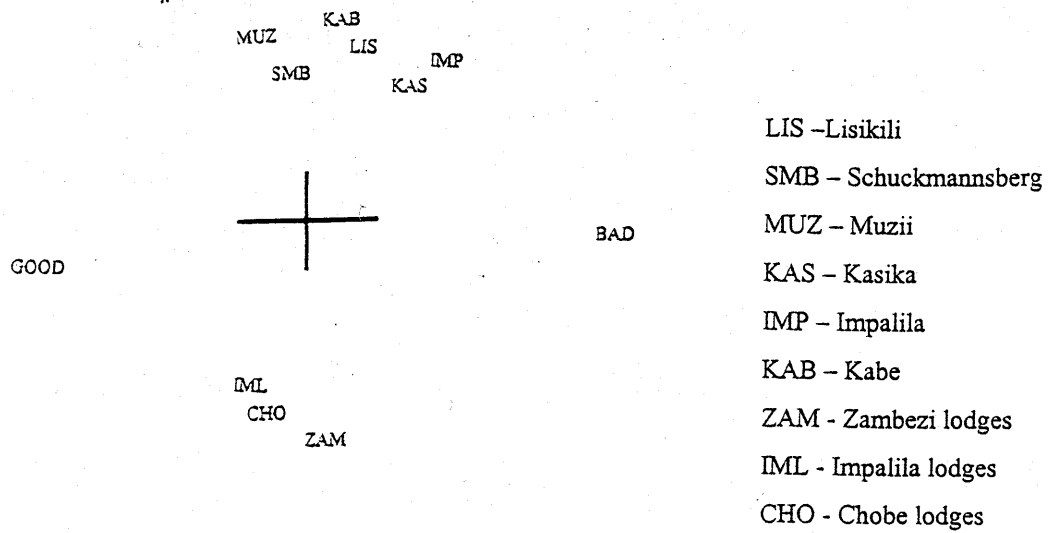
LIS –Lisikili

SMB – Schuckmannsberg

MUZ – Muzii

KAS – Kasika

IMP – Impalila

KAB – Kabe

ZAM - Zambezi lodges

IML - Impalila lodges

CHO - Chobe lodges

Figure 4a. The Health of the Sub-Fisheries. Ordination of the 9 Regional Fisheries using multidimensional scaling of the four disciplinary attribute groups. Locations labelled as 'good' and 'bad' represent locations of constructed, hypothetical fisheries all of whose attributes represent the best or worst scores in terms of sustainability. The cross shows the 95% limits of the mean scores of 20 randomly constructed fisheries. (Pritcher *et al.*, 1998).
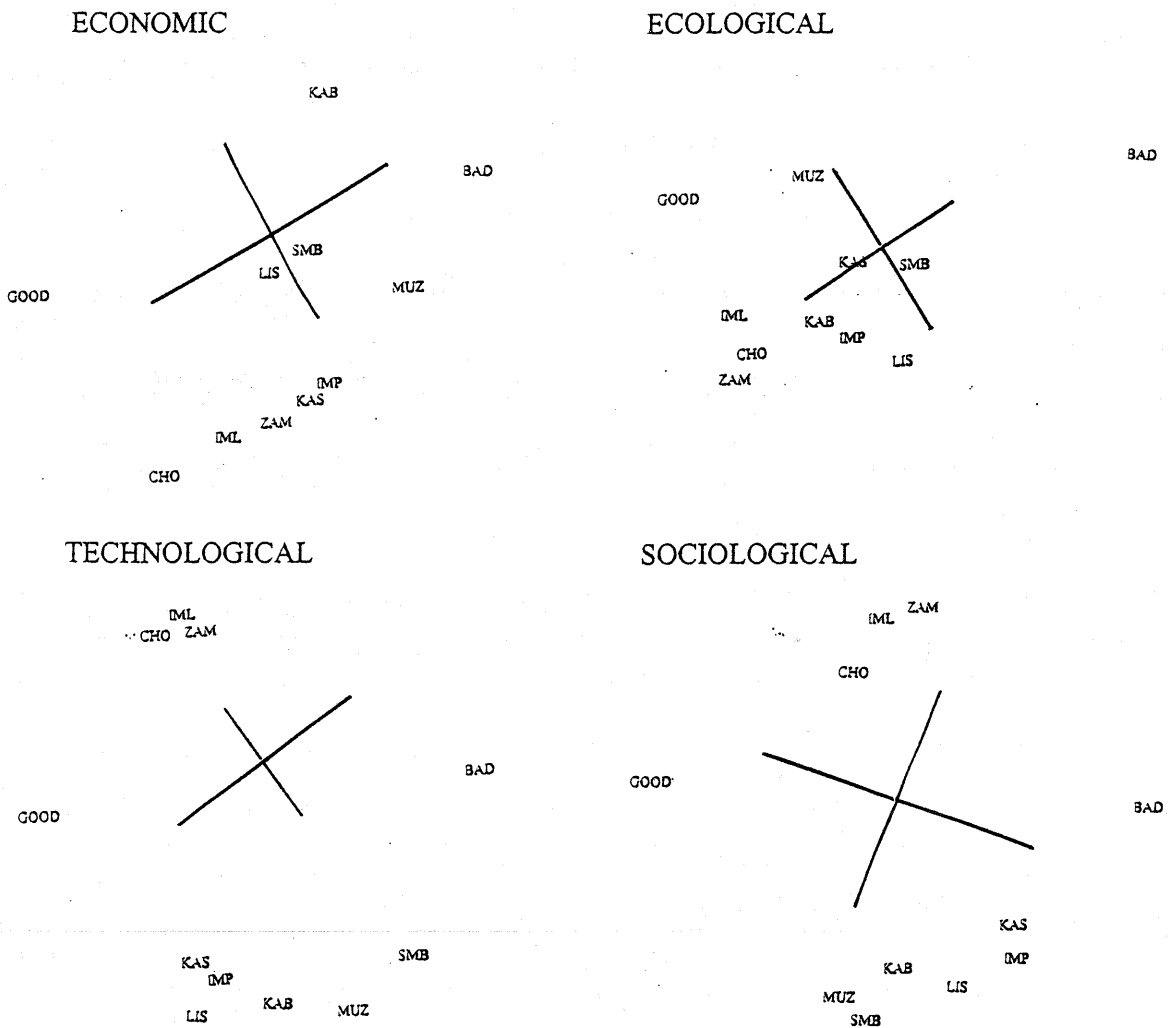
Fig. 4b. Ordination of the 9 Fisheries using multidimensional scaling of the separate disciplinary sectors.

to limit them (Key Informant Interviews). The areas in the south, along the Chobe, reported less formal local control, and this coupled with the higher reliance on fish for income may contribute to the poor performances of these two regions in the overall sustainability ordination.

The ecological differentiation is a reflection of the pressure imposed upon the resource within the environmental setting, both by direct human utilisation and through indirect effects. The size of catches and how they have changed over the last ten years is a measure of the change in fishing pressure and effort. In Kabe, where less people are fishing and less fish are being caught, there is less of an impact upon the ecosystem than in Lisikili, where more people are fishing than ten years ago and more fish is being caught. Many of the ecological factors, though, are consistent across the region. The biology of the fish caught, their reproduction rates and trophic levels, are uniform across all the regions, except perhaps Kabe, where the species involved in the true floodwater areas may differ from those found mainly in the deeper permanent channels. This though is minimal, as the reported and observed catch composition species was very similar (Focus Groups & Interviews).

The environmental conditions hold a similar consistency. A high flood occurs along all the Zambezi and raises the water level in the Chobe region. The extent of the flood, and hence its effect as a restorer of productivity and replenisher of fish stocks (Bruton & Jackson, 1983) will be most keenly felt inland, with smaller floods not reaching so far towards Kabe. This will result in those areas being resource depauperate for the following season or two. The effects of external factors, such as burning and overgrazing, are also incorporated through the examination of the habitat status. The environment seems to have been most degraded in areas where fishing is a secondary pursuit, such as in Kabe and Schuckmannsberg, where more focus is put on

crops and cattle.

Pressure, effort and effectiveness are the measures analysed under the sociological and technological sectors. The type of fishery, commercial, subsistence or recreational, has different effects upon the sustainability, with the recreational sector being the least detrimental. The use of traditional techniques, such as baskets, or modern equipment, such as nets, and the passive/active use of the equipment, gillnetting or drag fishing, all influence the levels of effectiveness, effort and pressure, as does the time commitment. The economically important fishing areas, such as Lisikili, on average spend more time fishing actively with modern equipment than do the inland fishermen near Kabe, or the pastoral-orientated communities of Schuckmannsberg (Focus Groups).

The differences between the recreational sector and the community fisheries are apparent through all the ordinations. The recreational side is much healthier than the floodplain pursuit over all four sections of the attribute analysis (Figures 5a. & 5b.). It is especially strong on the ecological and economical sectors. The latter is due to the fact that it is a leisure business set-up, attracting richer sections of the tourism trade, often foreigners, yet paying wages and costs at local rates (Informant Interviews). In the ecological sector, a catch and release policy at all the lodges reduces fish catch mortality to an estimated 20% (Informant Interview). However, most of the target fish, such as the Tigerfish *(Hydrocynus vittatus)*, are high trophic level species and their removal may effect the dynamics of the system. Furthermore, it is the larger individual fish that are sought as trophies, and in species such as Tigerfish and Nembwe *(Serrancochromis robustus)*, these are the breeding individuals, often the females (Skelton, 1993). Hence, by concentrating on these individuals, the population dynamics of the species and the system are distorted.
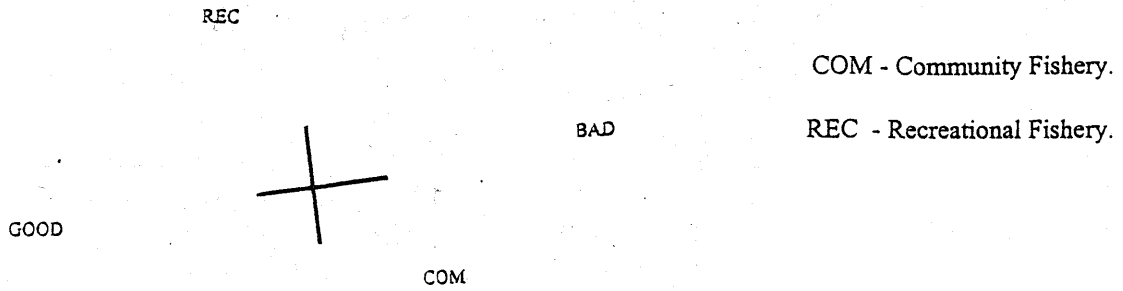
REC

COM - Community Fishery.

BAD

REC - Recreational Fishery.

GOOD

COM

Figure 5a. The Health of the Community & Recreational Fisheries. Ordination of the 2 Fishery styles using multidimensional scaling of the four disciplinary attribute groups. Locations labelled as 'good' and 'bad' represent locations of constructed, hypothetical fisheries all of whose attributes represent the best or worst scores in terms of sustainability. The cross shows the 95% limits of the mean scores of 20 randomly constructed fisheries. (Pritcher *et al.*, 1998).

ECONOMIC

ECOLOGICAL

REC

GOOD

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BAD

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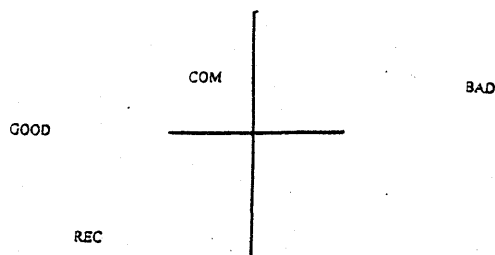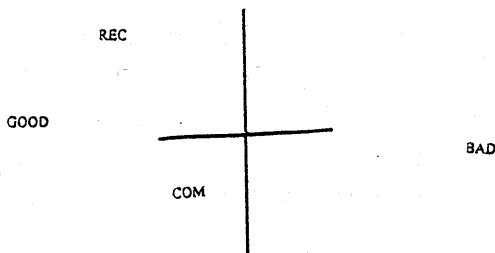
TECHNOLOGICAL

SOCIOLOGICAL

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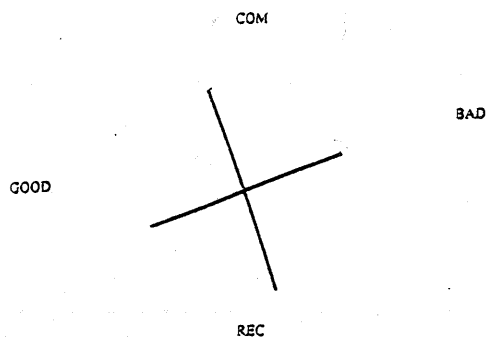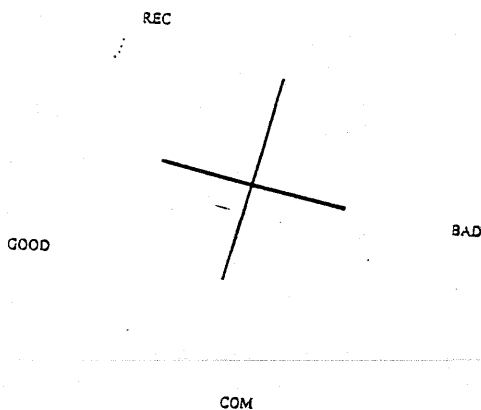
COM

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COM

REC

Fig. 5b. Ordination of the Community & Recreational Fisheries using multidimensional scaling of the separate disciplinary sectors.

Discussion.

Fishing is represented at most levels of the economy in the floodplain communities, from subsistence level, where it is basic food security (and vital animal protein), to the commercial fishing households where it becomes an important income earner. It is practised by almost 80% of the households to some degree.

Because of the reliability and resilience of the hydrological regime, due in part to the lack of major impoundment or developments on the Zambezi in Zambia or Angola, the state of the fishery changes less dramatically than that of other livelihood activities. Whereas cattle and agriculture are quickly affected by such environmental events as drought, locusts or low flooding, the availability of permanent waters, such as the rivers, ensure that there is always some fishing available to a significant proportion of the floodplain community. Even if the floods are low, those households that are most dependent upon the fishery are usually located where the impact of losing access to the fishery is the least. The communities of Kabe, for example, are more likely to survive the lack of fishing as, due to their location near to Bukalo, their reliance on fishing is less than those communities living along the river in Muzii or Mpukano.

The monthly income from fishing follows the flood regime, with greatest income accruing between March and May. In most regions, full-time commitment to fishing provides a sufficient monthly income. Where it falls short or where fishing is not the major livelihood operation, cattle are sold at the end of the year to provide the necessary income, until the floodwaters improve the fishing rewards. The agricultural patterns also seem to complement the piscatory habits of the communities. Ground is prepared and planted in September and October, when fishing is least profitable and

therefore time can be spent to better effect on other activities, and harvested in April and May. This provides a range of basic foods for when the flood has receded.

Fish are seen as important food security, but this is only really reflected in years when other food sources are short. In years when crops fail or cattle suffer due to drought, levels and efforts of fishing increase to compensate for both the loss of food and the loss of income. Fish, because it has always been an available and abundant resource, is seen, generally, as the underlying base resource (senior headman: pers. comm).

Currently, there would seem to be a division across the floodplain as the people in the south increase their dependence upon fishing, whilst the north moves away from the more traditional lifestyle. Impalila, which has seen a decrease in rainfall such that maize production is no longer profitable, reports more households returning to the fishery sector. This is in comparison to Schuckmannsberg and Kabe, where there is little financial return from fishing, when compared to cattle and agriculture, and so the size of the fishing sector has remained unchanged or actually decreased.

The exception to the north-south dichotomy in changing fishery perceptions is Lisikili. Due to its proximity to Katima Mulilo and the daily fish market, the fishery is still growing. This is due to the all year presence of permanent water in the Zambezi, Lake Lisikili and a number of smaller channels and lakes. The growth in fishing sector may also have attracted people from the town, especially young unemployed men, who may see fishing as an easy and quick income-earner and the Lisikili area as the closest and most accessible source.

The basic extents of the dependable resource, available throughout the year, are the permanent waters, such as the Zambezi and Chobe rivers and the inland

channels and lakes such as the Kasaya, and Lisikili. The size and extent of the flooding determines any additional fishing areas. As well as reaching areas which are mainly dry, such as Itomba and Kabe, the flood water also refreshes the fish stock present in permanent waters, and initiates the breeding cycles of many species of fish (Bruton & Jackson, 1983). The value and importance of the fishery, especially inland, is therefore closely linked to the magnitude of the flood.

Following a good flood, fish numbers will increase in the following two years, illustrating that a good flood improves breeding opportunities and success. This in turn increases the fish resource available to the fishery. The flood is not the only factor that will effect fish numbers. There are other environmental effects, such as the levels of grazing and burning in the dry season, which could prove detrimental to the fish stock. Cattle numbers have increased by 15% on the floodplains since 1995, when they were already considered overstocked (Mendelsohn & Roberts, 1997). This has led to an increase in burning, as herders attempt to promote better grazing by burning older vegetation. In some years over 60% of the grassland is burnt (Mendelsohn & Roberts, 1997). Many fish species, such as the bulldog (*Marcusenius macrolepidotus*) and the redbreast tilapia (*Tilapia rendalii*) require well-vegetated backwaters for breeding (Skelton 1993). If these areas are over grazed or burnt, leading to erosion during the rains and flooding (Schlettwein *et al.*, 1991) then there would probably be less suitable habitats for fish to breed in. This has yet to be investigated properly. The Forestry Department has started education programmes and constructing fire breaks, in an attempt to limit this damage (M. Jurvelius. pers. comm.).

The size of fish is perceived to be decreasing as well. No precise figures could be ascertained, but the general feeling throughout the floodplains was that there were not as many of the larger fish of all the species, i.e. that the mature fish were being

fished out in previously unrecorded quantities. This is thought to be because of the decreasing size of mesh being used, and the increased occurrence of drag netting. Moreover, for some species, such as tigerfish, which are prime targets for the recreational fishing industry, the larger individuals are the target trophy fish. Although current policy in the lodges in the Caprivi is a catch and release system, an estimated 25% of the catch die (Key Informant Interviews), and this may have an effect on the demographics of those species.

Regulation of the fishery exists upon two levels. Firstly, the area is covered by the regulations imposed by the Inland Fisheries Act. On a broad scale, the aims of this Act are to conserve and promote the sustainable use of the fishery; the ecosystems and habitats upon which the freshwater fish depend and to ensure an equitable distribution of the benefits accrued from the fishery (MFMR 1997).

In finer detail, the Ministry of Fisheries and Marine Resources (MFMR) produced a White Paper entitled "Responsible Management of the Inland Fisheries of Namibia" in December 1995. This paper supported the Inland Fisheries Act, to an extent, on the sustainable use, but focused on provisions to protect biodiversity. This protection was to be achieved by introducing closed seasons and closed areas, by banning certain fishing techniques and by encouraging the use of "passive"[1] and traditional equipment over "active" and modern gear. Provision was also made to protect the interests of subsistence households and to include the local communities in sharing the income generated from fish. Finally, fishing activities and regulations were to be monitored and enforced by police officers and Fishery Ministry officials (Day, 1997).

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[1] Traditional equipment is defined as "gear manufactured by the local population in an artisanal manner making use of natural materials available from the local environment" (MFMR 1995).

A number of these goals have not been met or enforced in the Caprivi. Responses to focus group questions and fishermen's interviews suggest that some regions of the floodplain only see an enforcement agent once in six months, some cannot even remember the last visit. Net and other equipment inspections were cursory, when they occurred (Focus Groups), and there was no indication of any attempts being made to educate or promote the environmental strategies or the more sustainable methods of fishing. Indeed the use of modern equipment and techniques, such as gill netting and drag netting, often with destructively small mesh sizes, seemed to be on the increase despite obvious local knowledge of the long term damage these activities cause. It would appear that the opportunity and rewards to be gained in the short-term outweigh the notion of sustainability within the community.

This problem is further exacerbated by the lack of a factor or government agent in the Caprivi to promote or assist in the fishery. A central organisation that could provide the correct equipment and which could monitor and regulate the fishery was suggested by numerous communities as a positive development. At present, most nets are purchased in either Zambia or Botswana, where the regulation of an 8.5-cm mesh size is not in place, so a proportion of nets in use are below the recommended standard. The extreme example of this situation is the reported occurrence of shade nets being used in drag fishing (Key Informant Interviews).

The second focus for control of the fishery, and indeed all the resources on the floodplain is through the community structure, the *kutas*. As the land is all under communal ownership, the tribal hierarchy have the power to decide on most aspects of floodplain existence, such as grazing rights, which areas can be burnt and by whom, and who can fish and where. The different water bodies have different piscary enforcement. The perennial rivers are controlled through a ward system under the

jurisdiction of the local *induna*; for example, the Chobe is divided into six wards, Ngoma, Massikilli, Ihaha, Ibilibizi, Mbalasinte and Kasika. People from outside the ward must seek the permission of the *induna* if they wish to fish within the area. Permission is granted first to those from neighbouring wards and then to those of similar ethno-linguistic origin (Nawa, 1996). Access rights to the channels and seasonal waters on the floodplain itself rest with the local households and individuals in those areas. Infringements of these tenurial arrangements are tried at the local District Court or at the Royal Establishment *kuta* in Bukalo (*kuta* senior headman: pers. comm.). Control over immigrant and Zambian fishermen is unclear however, and this growing component of the fishing population could constitute a threat to the success of a regulated fishery.

In terms of regulation, the local communities appear to be split. Many of the indunas recognised the need for control in the fishery and the banning of destructive equipment, such as drag nets, yet others felt that if their community was benefiting from these techniques economically then it should be allowed to continue (*kuta* senior headmen: pers. comm.). With no support from Windhoek, in terms of finance or man power, many indunas and community *kuta*s were unwilling to enforce the regulations or police their own communities, despite acknowledging the possible future problems for the fishery (*kuta* senior headman: pers. comm.).

These problems are clearly emphasised in the results obtained through the RAPFISH analysis. The state of the fishery is not good and it requires a change in direction if it is to be sustained as a viable resource option at commercial, subsistence or recreational levels. The recreational fishery at the moment appears to have a long-term future, as it is mainly ecologically friendly, economically sound and does not use destructive technology or detrimental sociological policies. It is, however, totally

dependent on a resource base under threat by the utilisation practices of the communities it exists within. The changes observed in the recreational fishing, such as the decrease in catch sizes and frequencies, can be used as valuable indicators for changes in the overall state of the fishery. However, the size of the recreational sector must be monitored for it may effect the ecology of certain target species. These alterations to the ecosystem could become important as the industry continues to expand, and with political stability and improved infrastructure to the Caprivi region, tourism to the area is growing annually. The proximity to Victoria Falls, in Zimbabwe, also improves the tourism trade, especially for the lodges on the Chobe and on Impalila

Recreational fishing is a small proportion of the fishery in the Caprivi, both in terms of impact and economic contribution. The main focus for fish resource management must be at the local-level resource base. With the changes in fishing pressure, as crop production falls, or the fishing community grows, positive action needs to be taken. The continued shift towards net fishing, especially drag netting, and the use of smaller mesh sizes which decreases the selectivity of the fishing process needs to be addressed. Everything and anything is hauled in, as it has some value, as subsistence food or for whatever money it can bring. This concept approaches the "Rationalisation Paradigm" (Charles, 1994) where the emphasis is on maximum economic yield: the obtaining of the greatest resource share as possible with no concern for the future, or economic sustainability. This short-term approach will see the resource base stripped and with a two-year phase for fish recruitment (Bruton & Jackson, 1983), the chances of a full ecological recovery are slim.

Other problems, such as the evident over-stocking of cattle upon the plains must also be addressed, though the cultural aspects of this may be hard to change.

Burning to improve grazing must be controlled, and the Forestry Department appear to have a programme that is meeting with some success. These two "external" factors appear to be serious threats to the environmental integrity of the floodplains and further research into the magnitude of their consequences is needed. On a different scale, the importance of maintaining a natural flood regime cannot be over emphasised. Attempts to modify the flood patterns by developments further up the catchment or along the rivers themselves will have major detrimental effects on the fish populations, but also upon the ecological processes, such as nutrient recycling, and thus effect crop productivity.

The *kutas*, however, offer the best possibility of creating a viable regulatory structure for a sustainable community fishery. At the moment fishing is seen as almost an open-access communal resource, with little enforced formal regulation, and this is leading to over-fishing and the use of unsound techniques and equipment. The fisherman and his household are not concerned with the full costs when time and effort of the pursuit are included, but merely with the return from their catch, i.e. the gross income. Across the fishing community, this produces a negative impact in the long term, yet only effects the individual fishermen themselves minimally. By empowering the tribal authorities and by educating communities in the best fishery practices, this detrimental impact may be reduced, so protecting and maintaining the value of the fishery as a sustainable resource. However, this empowerment needs to be supported both legally and scientifically by bodies outside the traditional authorities.

Without a change in the management of the fishery soon, then the livelihood and existence of a subsistence style community upon the floodplains will be bought into question. And, if the population currently utilising the area are forced off, this opens up questions of support for them in an area with high formal unemployment

already. It is therefore necessary to make the gradual and minimal changes now to protect, and hopefully enhance, the state of the fishery, whilst it is still possible, rather than attempting to make wholesale changes after further degradation has taken it too far. It is also important, in conservation terms, that the system is treated in a sustainable manner if the full complement of biodiversity is to be maintained.

The findings of this survey contain a number of inaccuracies and inherent biases due to time limitation, the season and the limited access to a representative sample population. Information was only collected at one stage of the year, at the start of the rainy season, but pre-flood and this may effect the species caught, the number of people fishing and their perceptions of the state of the sector. Due to the limited time frame of the fieldwork, only a certain number of village surveys and household interviews could be conducted. Furthermore, the quality of responses is questionable. Whilst every effort was made to provide clear and unbiased questions and discussion, concepts of comparative worth or sustainability were unclear to some groups and individuals, whilst the habit of "scoping" (magnifying perceptions) in some of the interviews was also evident. Most of these problems could be corrected by more visits to the study area and a greater familiarity with the communities and environment.

Conclusions.

The floodplain fishery of the East Caprivi is a vital component of the multi-pursuit livelihood of the communities living there, for it's contribution to the economy at both regional and household levels, and as subsistence food produce and basic food security. Fishing also supports a growing tourism industry, which is also providing important economic benefits to the region.

A decline in the quality of the fishery is evident. Numbers and sizes of the fish

caught appear to have declined over the last ten years, and the sustainable long-term outlook for the fishery is not good. The direct causes of this decline are not clear, whether it is due mainly to environment factors, such as reduced flood sizes in the last decade, or whether human interactions are the cause. Burning and grazing pressures are having a detrimental effect upon the environment, though the magnitude of these impacts needs further research. Changes in the size of the fishing communities and the decline in traditional fishing methods have also increased the pressure on the resource stock.

If the fishery is to survive as a sustainable resource then changes in the management of the fishery must be implemented in the near future. This is best done through the existing traditional tribal authority, but would require the correct governmental and scientific support in both financial and logistical terms. The implementation of close seasons or closed areas would help preserve the stock, but the main emphasis must be on controlling the fishing pressure. An improved system of access regulation is important. Access to the correct equipment and to advice and education systems would decrease the detrimental practices currently employed within the sector. This could be achieved through the creation of a governmental fisheries position to work in conjunction with the local authorities. Improved local, regional and even foreign marketing for the fish is also necessary to improve the economic security for the region and reduce the pressure to overfish.

Finally, any developments to the watershed either locally or in Zambia or Angola must be treated carefully and their full environmental impact assessed. The floodplain is totally reliant on the natural annual flooding regime and changes to this will detrimentally affect the ecosystem and the fishery, no matter the management strategies in place.

Acknowledgements.

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Appendix 1: The Locations used for Village Surveys, Fishery Focus Group Meetings and Household Surveys.

Village Surveys (n = 4):

Schuckmannsberg.
Muzzi.
Impalila.
Kasika.

Fishery Focus Group Meetings (n = 7):

Lisikili.
Schuckmannsberg.
Muzii.
Itomba.
Impalila.
Kasika.
Kabe.

Household Surveys (n = 42):

Musanga	Itomba
Mukisa	Mpukano
Mfuta	Muzzi
Kakissa	Impalila
Lisikili	Kasika
Saili	Ihaha
Kalimbeza	Kabula
Nasisangani	Masikili
Isize	Lachindo
Mafuza	Kavula
Malindi	Kasheshe
Schuckmannsberg	Neu Kabe
Namyundu	Luvanda
Nsundwa	Kabe
Kalonda	Mwengamo

Appendix 2 : Questionaire Base for the Fishery Focus Groups. (This served as a framework for a discussion group covering these aspects of the fishery)

Section 1: The Fish.

What species do you catch? Does this change with the season? If so, how?

Which species do you catch most of?

Which are the most important for food or to sell?

Have the types you catch changed in the last 2/5/10 years?

Have the numbers caught changed in the last 2/5/10 years?

Has the size of the fish caught in the last 2/5/10 years?

Section 2: Fishing.

What equipment do you use? How does this change through the year?

How much does the equipment cost?

How long does it last?

Where does it come from?

How much time does fishing involve? The catch? The preperation? Selling? How does   this change through the year?

How much of the catch is sold? How does this change through the year?

Do households work together or individually?

Section 3 : The Community

Is fishing access controlled? If so, by whom?

How long has this communiuty been here?

How many people are involved in fishing from this village?

How important do you think fishing is in this area? In comparison to crops and cattle?

Are more or fewer people fishing now than 5 or 10 years ago?

Section 4: Other Matters.

Do you have problems with crocs or hippos? If so, what is the effect? The cost?

Has the habitat changed much in the last 5/10/15 years?

Do you have problems with other communities, the lodges or any other activity?

Any other problems, observations or suggestions you wish to make?

Appendix 3: Household Survey Instrument for the Eastern Floodplains, Caprivi

Date: Time:

Location: GPS :

Gender of interviewee: Age:

My name is .... and I am doing some research for the Department of Environmental affairs. We are interested in how the people of this region live and what they gain from the floodplains. We would like to ask you some questions about you and the people in your household.

1) How many people live in this household?

2) How many children (under 16) regularly stay in this house?

3) How many of them are attending school?

4) How many senior people (over 60) regularly stay in this house?

5) How many male/female adults are in the household?   M___ F____

6) What does your household get from the following activities?

      Farming -   _____

      Fishing (types of fish)   _____

      Plant collection   _____

      Handiworks (crafts made, i.e. mats)   _____

      Other household activities _____

7) Do you sell any of the products from the following activities? If so, where? (i.e. To which villages and markets)

      Farming — livestock   _____

             - crops   _____

      Fishing   _____

      Plant collection   _____

      Handiworks   _____

      Other activities_____

(If they do not sell anything to outside markets it may be considered that they are subsistence and do not need to answer question 8).

8) What are your sources of household income? *(circle selection)* How much money per year do you get from each?

Formal Employment   _____

(Example: teaching or shop-owner)

Farming – livestock   _____

       - crops   _____

Selling fish   _____

Selling plant materials (i.e. Mataka)   _____

Selling handiworks and crafts   _____

Other activities _____

9) What is the main activity of the household?

Farming - livestock

       - growing crops

Fishing

Plant collection

Handiworks and crafts

Other activities_____

10) How much time does each activity involve? (per day/how many months per year)

Farming –– livestock   _____

       - crops   _____

Fishing   _____

Plant collection   _____

Handiworks   _____

Other activities   _____

11) How much does each activity cost you financially (per year)? (i.e. Equipment or casual labor)

Farming –– livestock   _____

       - crops (eg. seed)   _____

Fishing (eg. nets, mokoros)-   _____

Plant collection (eg. oxen for collection)   _____

Handiworks and crafts (eg. buying plant materials)   _____

Other activities   _____

12) How many and what members of the household are involved in these activities?

Farming — livestock   _____

           - crops   _____

Fishing   _____

Plant collection   _____

Handiworks and crafts   _____

Other activities_____

13) Is anyone in your household working in another region?

If so, where? _____ Doing what? _____

Do they contribute to your household income?

Thank you for your help.