Water and Ecosystem Resources in Regional Development: Balancing Societal Needs and Wants and natural Resources Systems Sustainability in International River Basins

Work Package 4 – Socio-economic and Environmental Change

Sub –Topic: Trends in Fisheries Development and Fish Utilization in the Okavango Delta.

By

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1. The fishery within a physical and socio-economic setting

In the words of an old BaYei fisherman, " where there is no water, there is no fish, where there is water there is fish." Therefore, this paper will briefly discuss the physical and ecological attributes of the Okavango delta system, to provide the background for this inviolable logic. After providing this biotic and abiotic setting for the fishery, the paper will then provide a historical overview of fisheries development in the Okavango delta. Worth noting is the observation that the Okavango delta fishery has been the subject of potential yield estimates and economic forecasts about its viability. These forecasts perhaps provided the impetus for government to commercialise the fishery through loans and credit schemes. However, fish utilization and production were invariably linked to market availability, whereby periods of high yields correspond to market availability and vice versa. Moreover species utilization was tied to demand for the highly valued *Tilapia* while catfish and tigerfish are caught as by-catches. Fish yield in the Okavango since the early 1970s was based on estimates until the mid 1990s, when efficient data collection was incorporated into the activities of the Fisheries Section (Ministry of Agriculture, Botswana). The major factor countervailing development of the fishery sector is lack of a national policy on fisheries. Therefore, the development of the Okavango delta fishery and its current status needs to be discussed within this background.

Hence, this paper will discuss the various trends in fisheries development and utilisation in the Okavango Delta by covering two broad areas (the natural science aspect of the fishery and the social sciences attributes of the fishery):

- The physical attributes of the system paying particular reference to their impact on fishermen numbers in the delta.
- Trends in development and utilization with specific reference to property rights, commercialisation of the fishery through credit schemes and income generating potential of the fishery.

1.1. Background

This study is a synthesis of information from various sources that discuss trends in fisheries development and fish utilization in the Okavango delta from the past into the present. The Okavango Delta is the largest available freshwater body in Botswana (Merron, 1993). It is found in north-western Botswana (figure 1), and is perceived to be an extension of the East African Rift Valley system (Gieske, 1996). The delta is a major tourist attraction in Botswana (Anon, 1975;

Kolding, 1996; Mbaiwa, 2002) receiving approximately 50 000 tourists annually (Mbaiwa, 2002), a main water source for north central Botswana (Lund, 1970; McCarthy, 1992), and also supports a small–scale commercial, subsistence, and recreational fishery (Merron and Bruton. 1995; Mosepele, 2000, 2001a; Mosepele and Kolding, 2002). Tourist facilities including hotels, lodges and camps in and around the Okavango delta have increased from around 30 to 63 between 1989 and 2001 (Kolding, 1996; Masundire *et al*., 1998; Mbaiwa, 2002).

1.2. Physical attributes of the system

1.1.1. Upper Delta

Embedded in the otherwise arid and parched Kalahari Desert is the delta of the Okavango River, which, with an area of 16835 sq. km, is the largest inland delta in the world (Allanson *et al*, 1990). The Okavango River is created by the confluence of the Cubango and Cuito rivers in Angola before crossing into Namibia and finally entering Botswana at Mohembo (McCarthy, 1992; Giske, 1996) (see figure 1). Mean annual inflow is about 11000 million m^3, which is augmented by 5000 million m^3 of rainfall. Of this, 15400 million m^3 is lost to the atmosphere through evapo-transpiration annually (McCarthy, 1992; Giske, 1996) while approximately 2% of the input appears as output at the distal end of the Delta (Wilson and Dincer, 1976). As a green oasis in the arid Botswana, the Okavango is aptly named "The Jewel Of The Kalahari" (Ross, 1987). At Mohembo, the river is about 90 m wide with depths ranging from 2 to 8 m. There is hardly any floodplain at Mohembo and in the first hundred kilometres, the meandering river spills seasonally into a vegetated flood plain up to 16 km wide until just south of Seronga where the Delta opens out wide to the southwest and east (figure 1). This upper portion of the Delta is called the Panhandle (Wilson and Dincer, 1976). Therefore, the permanence of water in this area does not only maintain a higher species diversity (Bruton *et al*., 1984; Merron and Bruton, 1988; Merron, 1991; Aquarap, 2000), but it also supports the highest concentration of fishermen compared to the lower delta (Mosepele, 2000, 2001a).

1.1.2. The Lower Delta

The annual floods peak in Mohembo between February and April and this peak reaches the distal end of the delta in Maun between June and August, five months later (McCarthy, 1992; Gieske, 1996). The hydrology of the delta wetland is complex due to the seasonal flood regime whose extent and magnitude is capricious. The river bifurcates into two channels just below Sepopa (figure 1) whence the waters spread into a vast area of seasonal swamp (SMEC, 1986a; Lund,

1970). One of the two channels is the Thaoge, which is moribund (Porter and Muzila, 1989), while the Nqoga remains one of the main outflow rivers from the delta. The Boro then separates from the Nqoga and remains a clear channel through to the base of the delta. In years of good floods, other channel systems which contribute to outflow from the delta are the Moanatshira/ Kwai/ Mababe, the Mboroga/ Santantadibe and the Matsebe/ Xudum/ Kunyere. The Moanatshira/ Kwai/ Mababe channel system terminates in the Mababe depression, while the Mboroga/ Santantadibe and Boro feed into the Thamalakane River, which then flows into the Boteti River. In good flood years, the Matsebe/ Xudum/ Kunyere system feeds into Lake Ngami (SMEC, 1986a; Porter and Muzila, 1989).

The flow of the Boteti River is dependent on floods from the Okavango delta by receiving water via the Thamalakane River for onward transmission to the Makgadikgadi pans. Therefore, flow into the Boteti River has been intermittent for the past several years due to little water arriving into Thamalakane from upstream. Consequently, fishing activities have scaled down in the river

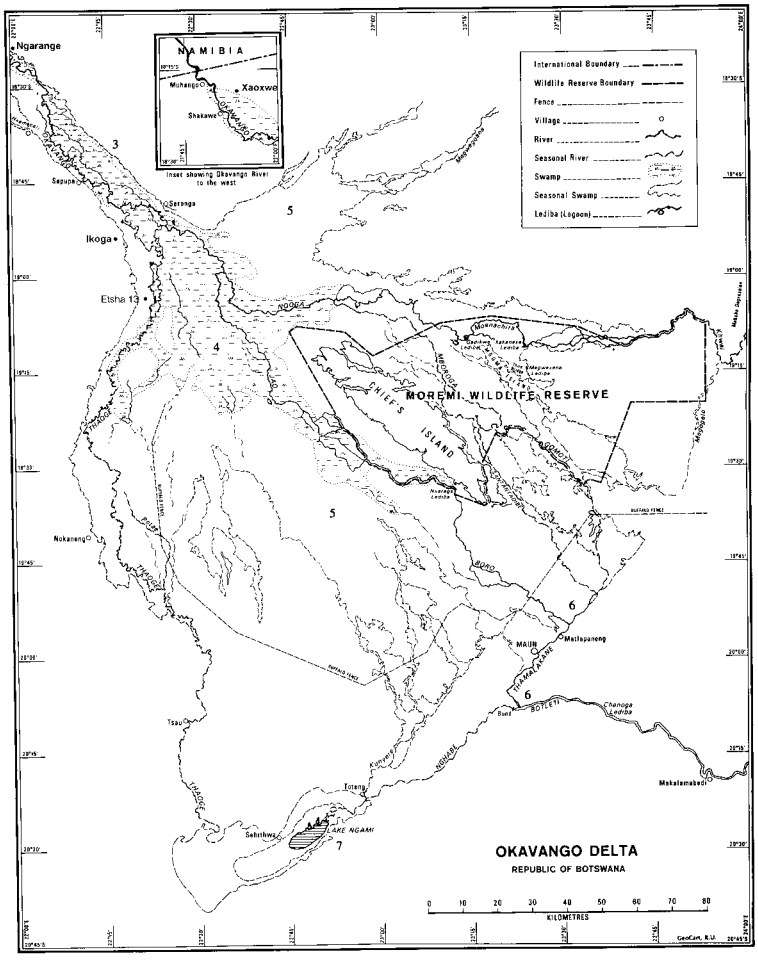

Fig. 1: The Okavango delta in Botswana. The main fishing villages in the upper delta are shown. Shakawe and Xaoxwe are shown in the inset. The numbers indicate the major biomes of the delta. 3: Okavango riverine floodplain. 4: Permanent swamp. 5: Seasonal swamp. 6: Drainage rivers. 7: Lake Ngami.

resulting in a significant reduction in the total number of fishers in this system. Moreover, a dry Boteti River suggests that lakes Xau and the Mopipi reservoir will also remain dry, both of which used to sustain substantial fisheries when flooded (Masundire *et al.*, 1998). This capricious nature of the floods in the lower delta and impermanence of waters has resulted in a lower species diversity (Bruton *et al*., 1984; Merron and Bruton, 1988; Merron 1991; Aquarap, 2000) and hence lower fisherman concentration (Mosepele, 2000, 2001a).

According to Masundire *et al.*, (1998), Lake Ngami at full capacity could have had a length of 275 km which has progressively decreased in size over time due to intermittent inflows ever since its major inflow channel, Thaoge, dried out about 50 years ago (Wilson and Dincer 1976; McCarthy *et al*., 1998; McCarthy and Ellery, 1995). The unstable nature of this lake therefore suggests that even fishing activities have not been stable (Silitshena and McLeod, 1989), and hitherto, the old fishermen in this lake have either given up fishing altogether or have migrated to northern Okavango (Mmopelwa, 1989). Needless to say, the lake sustained a large-scale fishery in 1979 when it was full (Merron and Bruton, 1988). However, this fishery was reduced from 26 species to two catfish species (*Clarias gariepinus* and *C.ngamensis*) in late 1982 when the lake was drying up, while other pools in the lake supported a thriving artisanal fishery (Anon, 1982Bruton *et al*.,?; Skelton *et al*., 1983). A small-scale fishery was briefly resuscitated in 1984 when the lake received some water in 1984 (and was re-colonized with 12 species), but died again when it dried up (Merron and Bruton, 1988; Merron, 1991). Lake Ngami is presently dry.

Therefore, the upper delta is hydrologically more stable, supports a high species diversity, and has a high fishermen density. Conversely, the lower delta, which is unstable, maintains lower fish species diversity, and supports lower fishermen numbers. Moreover, over time, fishermen numbers are expected to decline as more fishing areas dry up. On this basis, it can therefore be assumed that the hydrological character of the system influences the number of fishermen per given time. However, the physico-ecological nature of the system also influences fishermen numbers in the delta.

1.1.3. Physico-chemistry and aquatic ecology

Smith (1976) described five main vegetative communities in the perennial swamp: Papyrus in the deeper waters, *Miscanthus* in the shallow- flooded sites, and between these two, another species of reed, *Phragmites australis*, bullrush (*Typha latifolia* and *T. capensis*) and *Pycreus* communities occur. Several ferns are also evident, mostly *Thelypteriss interruptus*, and also other plants such as *Polygonum pulchrum* and various *Commelinaceae*. The papyrus is restricted to low-conductivity waters, not exceeding 45-60 µmhos/ cm^{-1}, except in moribund and abandoned channels. Thompson (1976) observed that while the papyrus (*Cyperus papyrus*), enriches proximal waters with nutrients, it nevertheless behaves more like a "septic tank" by depositing nutrients below the floating root mat. This "nutrient trap" could possibly be one of the reasons for the oligotrophic nature of the Delta, especially the Panhandle area as discussed by Gronberg *et al*, (1995).

Several studies have shown that the upper channel (or main channel waters) has a lower primary productivity than the seasonal floodplains (Thompson, 1976; Hart, 1986; McCarthy, 1992; Cronberg *et al*., 1995). This spatial variation in productivity is possibly associated with higher catch rates in the seasonal floodplains (or lower delta) observed by Fox (1976) and Mosepele (2000, 2001a). Notwithstanding, there is a higher density of fishermen in the upper delta than in the lower delta (Mosepele 2000, 2001a; Mmopelwa *et al*., 2002). Therefore, this observation suggests that there is a coterie of factors that determines fishermen distribution/ density in and around the delta. These factors will be discussed in the following sections.

1.3. Trends in development and utilization

This section discusses various issues/factors that circumscribe fisheries development and utilization in the Okavango delta.

1.1.11 Property rights and stakeholder conflicts

Tlou (1985) discusses that special laws regulated fishing activities among the BaYei and Bambukushu people of Ngamiland. According to Campbell (1976) and Tlou (1985), each village held exclusive fishing rights to designated areas whence poaching was punished by either heavy fines or confiscation of fishing equipment. It is possible that failure by government to acknowledge these traditional management regimes, and the eventual commercialisation of the fishery eroded these exclusive rights regimes. Moreover, save for an outdated Fisheries Act, there

are currently neither regulations in the fishery (Nengu, 1995; Bills, 1996; Mosepele, 1997) nor a national fisheries policy (Nengu, 1995; Mosepele, 2001a,b). While lack of regulations, predicated by lack of a national fisheries policy (Mosepele, 2001a) created an open access regime in the fishery, it has also created friction among the stakeholders.

Currently, the Okavango fishery is open access, which in the past few years has fuelled friction between the various resource stakeholders (Nengu, 1995; Bills, 1996; Mosepele, 2001a; Mosepele and Kolding, 2002; NRP, 2001a, 2001). This friction was founded on the premise that commercial gill net fishing is causing fish stock decline in the Okavango delta. The recreational fishery has alleged that there are declining stock levels due to over-exploitation by gill-netters (Nengu, 1995; Bills, 1996; Ramberg and van der Waal, 1997; Hagget, 1999). However, decreased stock levels may not only be due to an increase in commercial, recreational, and subsistence fishing but also the drought of the 1980's (Merron, 1993). Spraying for tsetse fly (*Glossina morsitans*) control, and burning riverine vegetation for cattle grazing might have also contributed to the alleged fish stock decline (Merron and Bruton, 1988). Furthermore, some of the threats facing the Okavango system include, pollution and erosion caused by outboard-powered boats, increased fishing pressure, decreased fertilization of the water by game populations, disruption of natural food webs by the removal of crocodiles and other predators, and potential alterations to the flood regime (Skelton *et al.,* 1985; AQUARAP, 2000)

While friction between competing users is normal in the exploitation of common property resources (Samples, 1989; Welcomme, 1998) it is accentuated by the open access regime in the Okavango (Mosepele 2001a). The artisanal fishermen have always argued that fish yields are correlated to the flood regime (Bills, 1996; Ramberg and van der Waal, 1997), while the recreational fishery has consistently argued that fish stocks are declining due to the commercial fishery (Bills, 1996; Hagget, 1999; NRP, 2001a, 2001b). A direct relationship between flood levels and ecosystem productivity has been determined in other African water-bodies (Gulland, 1978; Welcomme, 1992; Kolding, 1994; Lae´, 1995; Sanyanga, 1996), where fish yield is directly correlated to flood levels, assuming a one or two year time lag. It is possible that the Okavango delta fishery might also obey this rule. Furthermore, catches from exploited populations have been observed to fluctuate over time in response to variations in effort (Boerema, 1978; Gulland, 1983; Hillborn and Walters, 1992; Welcomme, 1992). These fluctuations in yield could be another factor that might have contributed to the friction between the stakeholders creating the perception that the stocks were declining.

The demarcation of the Okavango delta into wildlife management areas (WMA) and controlled hunting areas (CHA) is also at the core of current fisheries management problems in the delta. Fishermen have always argued that tourist operators, especially in the WMAs claim exclusive rights to fish resources within their concessions (Ramberg and van der Waal, 1997). The tour operators perhaps base their arguments on the tourism policy (Government white paper no.2 of 1990 cited from van der Haiden, 1991), which confers certain rights on them within their concessions. Tour operators are given certain exclusive rights except for situations where citizens have legal or traditional rights as stated in the tourism policy (van der Haiden, 1991; Ecosurv, 1996). While this problem of exclusive use rights might predominate fisheries issues in the Panhandle, it is more entrenched in the lower delta where, according to Serurubele (pers. comm. Maun commercial fisherman, 1997) fishing by local fishermen (for both subsistence and commercial) is strictly forbidden in most concessions (either WMAs or CHAs). Incidentally, commercial fishing is strictly forbidden in Moremi game reserve, which incorporates most of the Boro system. This then offers fewer opportunities for either commercial or subsistence fishing in the area.

Notwithstanding, fishing (subsistence) in allowed in the WMAs, while exclusive rights are granted only for tourism and other commercial use of the areas (van der Haiden, 1991; Ecosurv, 1996). Only commercial harvesting for thatching grass is allowed (Ecosurv, 1996), thereby suggesting that commercial fishing is excluded from the WMAs. Interestingly, while the authority for wildlife management within the WMAs is clearly and unambiguously invested on the DWNP, recommendations for fisheries management within the WMAs are nebulous and ambiguous (Ramberg and van der Waal, 1997). Therefore, wildlife management within the WMAs is the responsibility of the DWNP, while lessees of the WMA are *presumably* mandated the authority to manage fish resources within their concessions (Ecosurv, 1996; Ramberg and van der Waal, 1997). Undoubtedly, if authority is conferred upon tour operators for fisheries management, access problems for local inhabitants will indeed arise. Tour operators have a vested interest to maintain a *pristine environment* within their WMAs (defined as effectively excluding local fishermen) for their clients, and would therefore be under no obligation to allow free access to fishermen. Moreover, user conflicts (recreational versus subsistence/ commercial fishing) between the tour operators (recreational fishing) and the local fishers (subsistence and commercial fishing) provide enough incentives for the concessionaires/ tour operators to exclude fishermen from the WMAs. Hence, these user conflicts, coupled with the highly variable and

indeterminate floods, have contributed to lower fisherman numbers in the area. According to Mosepele (2001a), access is at the core of stakeholder conflicts in the Panhandle area. Therefore, conferring exclusive management rights to concessionaires is tantamount to wrenching away this traditional source of livelihood from local fishermen.

1.1.4. Development of the fishery

Tlou (1972, 1985) and Campbell (1976) provide the best historical account of the Okavango Delta fishery. They highlight that the River San people, who were the first inhabitants of the area, poisoned lagoons/ *madiba* with the rubber hedge (*Euphorbia tirucalli*), speared fish, and also used funnel-shaped fishing traps. According to Tlou (1972, 1985), the immigration of Zambesian peoples in the area starting from around the 1750's was a turning point in the fishery. The BaYei (Zambesian people) used nets made from the bowstring hemp (*Sansevieria spp*), and the dark-eyed hibiscus (*Hibiscus caesius*) soaked in a solution from the sweet thorn (*Acacia karoo*) to which were attached floats made from buoyant reeds. They also built long fences across rivers made of reeds (*Phragmites spp*) closely bound with string from the bowstring hemp. The fences contained a series of traps with tubular baskets closed at one end and a funnel of sharp sticks at the other, through which the fish forcing their way going up stream were thus caught. They also fished with iron-barbed spears. The BaYei also introduced some form of trawling which was hitherto unknown in the delta (Tlou, 1976, 1985). Tlou (1985) concluded that these fishing methods (especially the net) resulted in an efficient utilization of the swamp fisheries. More fish could be caught, and the surplus sun-dried or smoked and either eaten in days of poor catches or barted for other commodities.

Earliest fishing activities in the Okavango delta involved traditional fish traps (Kay, 1962). Maar (1965a,b), observed very few fishing activities in the Okavango delta, which he attributed to lack of modern fishing gear. According to Maar (1965a), fishers built weirs across channels to trap fish. Fish traps were also used at low flood levels. Moreover, Maar (1965a) also points out that gill net (from locally woven nylon twine) fishing was practiced, albeit at a very low scale. Spear fishing was common among the river San people, while angling was practiced by children using a baited hook tied to one end of a string (Maar, 1965).

The fishery has however, largely retained its traditional flavour, despite the passage of time. According to Mosepele (2000, 2001a), most traditional fishing gear is still in use in the fishery. He identified five different kinds of fishers in the Okavango delta fishery; Hook and line fishers

(45.9%), basket fishers (41.8%), gill net fishers (13.6%), spear fishers (9.4%) and trap fishers (6.1%). Several other studies have also highlighted the widespread use of traditional fishing gear in the Okavango delta (Norplan, 1985; Norfico, 1986, 1987; Merron, 1989, 1991; van Hoof *et al*., 1993). Modern fishing gear (gill nets and powered boats) was introduced into the fishery in the early 1980s through the provision of government grants and credit schemes (Nengu, 1995). However, the relatively low percentage of gill net fishers (13.6%) in the Okavango delta (Mosepele, 2000, 2001a; Mmopelwa *et al*, 2002) suggests that the Okavango delta has a primarily artisanal fishery. According to Hillborn and Walters (1992), artisanal fisheries are characterized by a predominance of crude gear with low fishing efficiency. Despite the relatively low proportion of modern gear in the fishery (only 13.6% gill net fishermen), it can be tentatively concluded that fishery development in the delta has remained fairly dynamic in the past several decades.

1.1.5. Structure of the Fishery

According to Mosepele (2001a), 13% of the Ngamiland population are fishers, while approximately 65% of the population in the area (excluding the villages of Gumare and Nokaneng) depends on fish directly either as part of their diet or income, assuming an average family size of 5 (Scudder *et al*., 1993). Of the total number of fishers identified, 44 % (1431) were women while men accounted for 56% (1812) of the fishing population. Five tribes are involved in fishing in the Okavango delta. According to Table 1, the Bambukushu are the most numerous in the fishery while the Barotsi are the least involved. Merron (1989) also observed that the BaYei and Bambukushu are the dominant peoples in the artisanal fishery.

Table 1. Total number of fishers by tribe in the Okavango delta

Tribe	*Total Number*	*Percentage*
Bayei	748	23.1
Bambukushu	2231	68.8
Basarwa	160	4.9
Bakgalagadi	83	2.6
Barotsi	21	0.6
Sum	3243	100

Adapted from Mosepele (2001)

The highest proportion of fishers are aged 11-20 (average 16 years) years (36.7%) while there are very few fishers aged more than 80 years in the fishery (0.2%). Most of the fishers have 10 or less

years fishing experience (44.2%) compared to only 2.9 % of the fishers who have been fishing for between 71 and 80 years (Mosepele, 2001a).

Table 2. Total number of fishers in the Okavango delta by category from two data sources

	Data Source	
Fisher Category	Mosepele (2001a)	Anon (1989)
Basket Fishers	1431	3000
Hook and Line fishers	1490	6000
Subsistence fishers	200	2000
Commercial fishers	41	695

Mosepele's (2001a) description of the fishery structure differs from Anon (1989) as illustrated in table 2 above. Anon's (1989) estimates are generally higher than Mosepele's (2001a). The major discrepancy between these two studies might be attributed to differences in data collection and interpretation. Anon (1989) and other reports (Norplan, 1985; Norfico, 1986, 1987; Mmopelwa, 1988, 1989, 1990, 1991), used total number of approved FAP or AE10 fishing projects as a proxy for total number of (commercial) fishermen in the fishery, while Mosepele (2001a) used fishing activity from catch and effort (C/E) data over one year (1999) to classify gill net fishermen into different categories. According to Mosepele (2001a), the most active fishermen (gill net settings $\geq$ 200 per annum) were classified as commercial while the least active (gill net settings < 200 per annum) were classified as subsistence fishermen. Notwithstanding, commercial fishers are most likely to be recipients of government financial aid (e.g. FAP) and they have access to modern fishing equipment (e.g. motorized boats, gill nets etc). Conversely, subsistence fishers would most likely own one or two badly damaged gill nets (including home-made gill nets), and might or might not own a canoe (*mokoro*). Nevertheless, considering that fishing is a secondary activity to farming (van Hoof, *et al*., 1991, 1993), the total number of people involved in the fishery is therefore bound to have temporal fluctuations.

1.1.6. Temporal variations in fisher numbers

Various sources have different estimates of the total number of fishers in the Okavango delta fishery as indicated in Table 3. The total number of people involved in fishing in the Okavango delta ranged between 700 and 5000 fishers from the mid 1970's to the late 1990's (Table 3). It is interesting to note that while the proportion of subsistence fishers appears to have increased over time that of the commercial fishers has decreased. Several reasons might account for these observed variations: 1. Subsistence fishers might be increasing with population size in the area.

Since women and children constitute the highest proportion of subsistence fishers (Mosepele, 2001a) and since the proportion of women is generally higher than men in the area (CSO, 1994, 2002a), it follows that the number of subsistence fishers would increase. 2. Fishing is generally not considered to be a primary activity by most people in the area (van Hoof, *et al*., 1991, 1993), whence fishing has been regarded as a social safety net (Mosepele, 2001a; Mmopelwa, 2001). Since a higher proportion of households in the area are female led with limited access to a cash income (CSO, 1994), it therefore follows that most women and children would be engaged in subsistence fishing to augment their diet. Moreover, women and children are less likely to be involved in wage earning jobs, and would hence have time for subsistence activities.

Table 3. Table illustrating the differences in fisher numbers of the Okavango delta from various sources.

Data Source	*Total Fishers*	*Subsistence Fishers*		*Commercial Fishers*		*Gill-net Fishers*
	Numbers	Numbers	Percentage	Numbers	Percentage	Numbers
Anon (1975)	1000					
Norplan (1985)	1200-2000	400	25			
Norfico (1986)				150		
Skjønsberg and Merafe, (1987)	5000					
Anon (1989)	12000	2000	17	695	6	
Silitsena and McLeod (1989)[1]	700	637	91	63	9	
Kolding (1996)						300
Mosepele (2001a)	3200	3159	99	41	1	332

1. These are fishermen estimates for the 1986/ 87 period.

Variations in fisher numbers in the delta might also be attributed to the structure of the fishery and its artisanal nature as already discussed. Norfico (1986) identified three different kinds of fishers in the delta; occasional, seasonal and professional. According to Norfico (1986), occasional fishermen are casual fishers who fish for subsistence (using simple apparatus from the river banks or by wading into the water) during the hiatus between sowing and harvesting seasons, while seasonal fishers are sedentary people living in floodplains who fish during part of the year. Norfico (1986) highlights that seasonal fishing is caused by the need to either supplement diet or to generate extra income. This normally results in heightened fishing activity

at receding and low water levels. Conversely, professional fishermen fish regularly and at times follow fish stock movements around the Delta using motorized craft.

The commercial fishery is an important source of informal sector employment since the fishermen normally employ boys (Norfico, 1986). Fisher numbers are therefore bound to have a temporal variation due to the occasional and seasonal fishers (who might use traditional fishing gear such as baskets, traps etc), while the number of professional fishers (who might use modern fishing gear such as gill nets and motorized boats) is bound to remain constant. This conclusion is based on Mosepele's (2001a) observation that entry into the commercial fishery is cost prohibitive, therefore only a small number of dedicated individuals can enter. Therefore, this suggests that FAP funded commercial fishermen progressively leave the fishery as their FAP grant slowly erodes away over time. Only the hardest working and most committed individuals remain in the fishery, hence resulting in a decrease in commercial fishermen numbers over time. Moreover, Bills (1996) argues that commercial fishing projects in the Okavango delta are not sustainable in the long term.

Mosepele (2001a) discusses that out of the estimated 332-gill net fishers in the Okavango delta fishery, there are a core 41 commercial (or professional) fishermen who are generally active year round. The rest of the fishers are involved in farming activities during other parts of the year (Bills, 1996; Mosepele, 2000, 2001a). Furthermore, according to Mosepele (2001a), traditional fishing is a seasonal activity occurring for only four months of the year. Therefore, this suggests that there is a temporal pulse in fishing activity, which revolves around a core of professional fishers in the fishery. Moreover, Mosepele (2001a) observed that traditional fishermen are opportunistic fishers because they are only active during periods/ years of good floods. Good flood years suggest that peripheral (to areas of human settlement) lagoons, pools and floodplains receive water which provides fishing opportunities. Conversely, poor floods suggest less/no water reaching these *traditional fishing grounds* hence fewer people fishing.

There are several gear types in the fishery which are both gender and age specific and at times based on tribal/ ethnic grouping (van Hoof, *et al*., 1991, 1993; Mosepele, 2001a). According to Norfico (1986) and Mosepele (2000, 2001a), women and young girls use fishing baskets (funnel traps constructed from reeds), while men use barrier traps on riverbanks and in floodplains at high and receding water. According to Mosepele (2001a), hook and line fishing is a predominantly young boys activity even though some subsistence and professional fishermen use it to

supplement their catches, while gill nets are used exclusively by men. Mosepele (2001a) states that gill nets are cost prohibitive, therefore only men have the purchasing power to own them. Moreover, according to Mosepele (2001a), middle-aged BaYei men dominate the gill net fishery, while young Bambukushu women and men dominate the basket and hook and line fishery respectively. Bambukushu are predominantly arable farmers (Tlou, 1985), therefore they are bound to stop fishing during the ploughing season, which would then result in seasonal variations in fishermen numbers (Skjønsberg and Merafe, 1987; van Hoof, *et al*., 1991).

Apart from differences in fishermen numbers, Tables 2 and 3 suggest that there is a temporal variation in fishermen numbers. On the presumption of Mosepele (2001a) observations that fishing is a social safety net, a similar corollary can be made for temporal variations in fishermen numbers. The standard of living (in Botswana) has improved considerably between the 1980s and 1990s as illustrated in CSO (1999). According to CSO (1999), while the GDP per capita was US$2520 in 1988/89 (December 1989 rates), it rose to US$3142 in 1998/99 (August 1999 rates). While the relationship between per capita GDP and fishing in the Okavango delta might be flimsy at best, one general observation can however be made. Assuming that an increase in national prosperity suggests an increase in more livelihood options, it follows that fewer people will retain fishing as a major economic activity (especially for subsistence purposes).

1.1.7. Spatial variation

According to Norfico (1986) and van Hoof, *et al*., (1991), traditional fishing craft (canoe) severely limited the total distance travelled by fishermen on fishing forays into the delta. Merron and Bruton (1988) and Mosepele (2000) also observed that fewer fishermen who used *mekoro* (canoe) actively fished at low floods than higher floods. Therefore, this observation suggests that fisher numbers in the delta can vary both temporally and spatially. Moreover, van Hoof *et al*., (1991, 1993) found a spatial variation in fisher numbers around the delta. There are 589 fishing craft in the Okavango delta, where dugout canoes (*mekoro*) are the commonest fishing craft in the fishery (63.8%), fibreglass boats the second most common (28.5%) and aluminium the least common (7.7%)(Mosepele, 2001a). The preponderance of traditional fishing craft suggests that the greatest percentage of fishers is economically marginalized assuming that most of them cannot afford powered fishing craft (Mosepele, 2001a). Over and above that however, the high number of *mekoro* in the fishery suggests that more fishers are bound to be restricted in their

fishing excursions in the delta. This will subsequently affect a spatial distribution of fishers in the fishery.

According to van Hoof *et al*., (1991, 1993), 14% men in the eastern portion of the Okavango delta indicated fishing as their secondary activity while 22% of the men in the western portion indicated fishing as their secondary activity. Similarly, the 1999 C/E data (from Mosepele 2001a) indicates that 47% of gill net fishermen came from the eastern portion while 53% came from the western portion. A 1997 frame survey (Mosepele, 2001a) also showed that only 39% of total fishers in the Okavango delta fishery came from the eastern portion of the delta while the remaining 61% of fishers came from the western and lower portion of the delta. While population size (in a given locality) might account for this spatial variation in fisher numbers as shown in Mosepele (2001a), van Hoof et al., (1991, 1993) attributed the higher fisher numbers in the western portion to market availability. Market availability is a prerequisite for commercial fish harvesting, therefore market fluctuations would invariably effect variations in fisher numbers in the delta (i.e. gill net fishers).

Presently, there is one cold storage facility in the Okavango delta fishery at Samochima village, on the western Okavango. Initially there was a similar facility at Ngarange in eastern Okavango, which is now non-operational, and has been for several years (Mmopelwa, 2000, 2001; Mosepele, 2000, 2001a). Two main factors might account for its continued existence v*is a' vis* the broken Ngarange cold storage facility on the eastern bank of the delta (Mosepele, 2001a). Firstly, the accessibility of an uninterrupted power supply could have contributed to the longetivity of the Samochima facility. Secondly, its proximity to an all-weather road enhanced its market accessibility, which subsequently contributed to its sound financial position. Furthermore, of the 24 Fap funded fishing projects in 2000/2001, 19 are in western Okavango (Mmopelwa, 2001); and of the 31 FAP funded fishing projects in 2001/2002, 27 are in western Okavango (Mmopelwa, 2002). These observations buttress the argument that western Okavango appears to have a comparative advantage in fish production than eastern Okavango, which has contributed to higher fishermen numbers in the area than in eastern Okavango.

2. The fishery as a source of livelihood for local communities

2.1 Government financing and the commercialisation of the fishery

Little progress in fishing activity occurred between the 18th century and the early 1960s, when the BaYei introduced new fishing methods into the fishery. In 1963/64, a consultancy by the Oxford Committee for Famine Relief (OXFAM) led to the establishment of a Fisheries Extension Service on recommendation by Maar (1965a). Its main objective was to popularise improved fishing techniques by introducing modern fishing gear to the fishing community. However, fishing remained a subsistence activity in the Okavango, except for tiger fish (*Hydrocynus vittatus*) sport fishing at Shakawe (Potten, 1975).

Notwithstanding, government was interested in developing the fishery potential of the delta through attempts to initiate commercial fish production at Lake Ngami and other groups in various areas of the Okavango delta. Furthermore, plans were also made to develop the Okavango delta fishery into a viable subsistence fishery (Norplan, 1985). The Ngamiland district development plan (1977-1982) (quoted from Norplan, 1985) acknowledged that while the instability of Lake Ngami prohibited the development of a commercial fishery, it was nonetheless prudent to encourage local production by enhancing a proper market infrastructure. It was on this background that the Botswana Development Corporation set up a commercial fishing operation at Lake Ngami in 1970 which however, subsequently collapsed due to the lake's periodic dry spells (Potten, 1975).

Government grants and a market for dried salted fish facilitated the emergence of a commercial fishery in the Okavango that effectively replaced the hitherto prevailing subsistence fishery (Silitshena and McLeod, 1989; van Hoof *et al*., 1991, 1993). The Financial Assistance Policy (FAP) assisted individual fishermen while the Agricultural Extension Small Projects Programme (AE10) aided fishermen groups or syndicates to finance fishing projects/ operations. Through the FAP grant scheme, fishermen contributed 30% of the total project investment while AE10 group projects contributed only 10% of the total project costs. Successful fishermen then went through a government provided training course on gear technology and post harvest preservation (Norfico 1986; Mmopelwa, 1991; Nengu, 1995). However, a collage of factors (uncooperative members, declining water levels in some areas, lack of commitment by members, financial mismanagement etc) precipitated the collapse of AE 10 fishing groups (Mmopelwa, 1991, 1992; Norfico, 1986, 1987; Mmopelwa, 1995), which could have subsequently contributed to a decline in active fisher numbers in the region. Incidentally, the bulk of production from the lower delta (e.g. Lake Ngami and Mopipi reservoir) came from AE10 fishing groups. Therefore, the demise/ disintegration of

these groups (due to a host of factors) result in a consequent decrease in fishermen numbers of the lower delta

2.2 Market Infrastructure and Fish utilization

According to Norfico (1986), cattle farming and other agricultural activities have been the main traditional sources of income for the river communities due to the low demand for fish. Moreover, lack of a market infrastructure and transportation facilities resulted in low fish exploitation levels. The major limiting factor towards the development of the fishery sector was lack of a market infrastructure for sale of fresh fish in lieu of a dried salted product whose demand was very low (Mmopelwa, 1990, 1991, 1992; Hoof et al., 1993; Nengu, 1995) while lack of motorized fishing craft was also a contributory factor (Norfico, 1986, 1987).

The fate of the fishery is intimately tied to market success, as illustrated by the collapse of a government market for dried salted fish at the end of the 1980s (Mmopelwa 1990, 1991, 1992; Nengu, 1995) which not only curtailed total production but also caused a general decrease in numbers of FAP funded fishermen (Mmopelwa 1993; Mosepele 2000, 2001a). Table 4 below summarizes approved FAP fish projects in the Okavango delta fishery between 1988/89 and 2001. It is interesting to note that few FAP were approved in 1991/ 92, whereas approved FAP projects increased again from 1996 until 2001.This low number of approved FAP projects in 1991/92 was attributed to lack of a market infrastructure which undermined the viability of such projects (Mmopelwa, 1991, 1992). Mmopelwa (1989) stated that 400 FAP fisheries funded projects were approved for funding at the end of the 1988/89 reporting period (cumulatively from 1982), while 600 FAP projects were approved by the end of the 1989/ 90 period (Mmopelwa, 1990). However, according to Mmopelwa (1989), less than half of the 400 FAP projects were operational, due to various problems such as failure to replace old or lost equipment. Moreover, poor financial management by fishermen was advanced as the main reason for business failure (Mmopelwa, 1989). Coincidentally, Mmopelwa's (1989) observation is validated by Bills (1996) who argued (in section 1.1.6) that commercial fishing is not economically viable in the long term.

Table 4. FAP funded fishing and marketing projects between 1988 and 2001 in the Okavango delta.

FAP Projects	*Year*									
	1988/89	1989/90	1990/91	1991/92	1996	1997	1998	1999	2000	2001
Fishing	28[1]	16[1]	11[2]	3[3]	19[4]	8[4]	7[4]	14[4]	11[4]	42[4]
Marketing	0	0	0	0	0	0	0	4[4]	3[4]	13[4]

Data Sources: 1.Anon 1989, 2. Mmopelwa 1991, 3. Mmopelwa 1992, 4. Nengu 2001.

With technical assistance from the Fisheries Section, the fishery then switched to a fresh/frozen product in the mid 1990s, after the collapse of the dried salted fish market. Funds procured from FAP to buy gas refrigerators, nets, boats, engines, and camping tents, allowed fishers to venture further into the delta, and spend extended fishing periods before transporting their product to the market. It was hoped that the existence of the two cold facilities (discussed in previous section) would alleviate the marketing problem that has consistently plagued the commercial fishery in the delta (Mmopelwa 1995; Nengu, 1995). However, while these facilities made it possible to introduce a new product in the market (fresh/frozen fish), marketing remains a headache to most fishers (Mmopelwa, 2001, 2002). This dovetails into van Hoof's *et al*., (1991) observation that the provision of cooling facilities would not necessarily improve fish sales. The other major hurdle was to transport the product to market centres. It was therefore a welcome transformation in the fishery when FAP funded fish marketing projects (Table 4) to alleviate the market problem (Mmopelwa, 2002).

2.2.1 Principal commercial species.

The main commercially exploited species are Three-spot *Tilapia* (*Oreochromis andersonii*), Green-head *Tilapia* (*O.macrochir*), Large-mouth speckle-face *Tilapia* (*Serranochromis angusticeps*), Red-breast Tilapia (*Tilapia rendalli*), Sharp-tooth catfish (*Clarias gariepinus*), Blunt-tooth catfish (*C. ngamensis*) and tigerfish (*Hydrocynus vittatus*) (Merron and Bruton, 1988; Mosepele 2000, 2001a; Mmopelwa *et al*., 2002; Mosepele and Kolding, 2002). However, religious and cultural taboos against eating catfish and tiger-fish have resulted in a low demand for the two species (Mosepele, 2000, 2001a). According to Mosepele (2000), most fishers believe that eating catfish causes either ear infections or leprosy. Moreover, eating catfish is strictly forbidden for religious reasons, the paramount reason being that it associated with a snake because it is scale-less. Mosepele (2000) also discusses that most fishers believe that a tigerfish is similar to a dog (because of its sharp canine-like teeth), therefore some people do not eat it. Likewise, eating tigerfish is also forbidden for religious reasons.

Therefore, the *Tilapia* (or bream) species are the main commercially exploited species in the Okavango delta (currently valued at approximately \$1.50 kg^{-1} (Mosepele, 2001a)), while the other species (i.e. catfish, tigerfish) are normally either bartered for grain, or sold at low prices (van Hoof, *et al*., 1993; Mosepele, 2000, 2001a) at approximately \$0.60 kg^{-1} (Mosepele, 2001a). Therefore, because of their high market value, bream species constitute the largest share of total

catches by weight (Figure 2) due to targeted fishing (Mosepele, 2000, 2001a). *Tilapia* (bream) catches appear to have increased between 1996/97 and 1997/98 whence they reached some threshold around 80-100 tons per annum to the present. Catfish catches on the other hand appear to have been fluctuating widely since 1998/99. This pattern could be influenced by either error in catch records or disposal of catfish due to their low market value (Mosepele, 2000). Catches for the other species (tigerfish, silver catfish, and others category) is relatively constant, albeit at very low levels relative to *Tilapia* or catfish catches.

It is interesting to note that silver catfish catches are very low despite its estimated high biomass in the system (Merron and Bruton, 1985, 1988). Merron and Bruton (1985, 1988) recommended that other species such as silver catfish (*Schilbe intermedius*); squeakers (*Synodontis spp*) and smaller *Cyprinids* (e.g. *Brycinus lateralis*) constitute a potentially good-sized biomass that needs to be harvested to relieve pressure from the commercial species. These recommendations have however, not yet been followed which has therefore resulted in relatively low silver catfish (*Schilbe intermedius*) catches, while *B. lateralis* is not harvested at all by the commercial fishery. This choice of species by the commercial fishery is by design due to targeted fishing that has been perfected by commercial fishermen (Mosepele 2000, 2001a), similar to the Bangweulu fishermen in Zambia (Kolding *et al*., 1996). Furthermore, the large gill net mesh sizes in the fishery select out smaller sized species (Merron and Bruton 1988; Mosepele 2000, 2001a), which are however harvested, albeit at low levels, by the artisanal fishery (Mmopelwa *et al*., 2002).

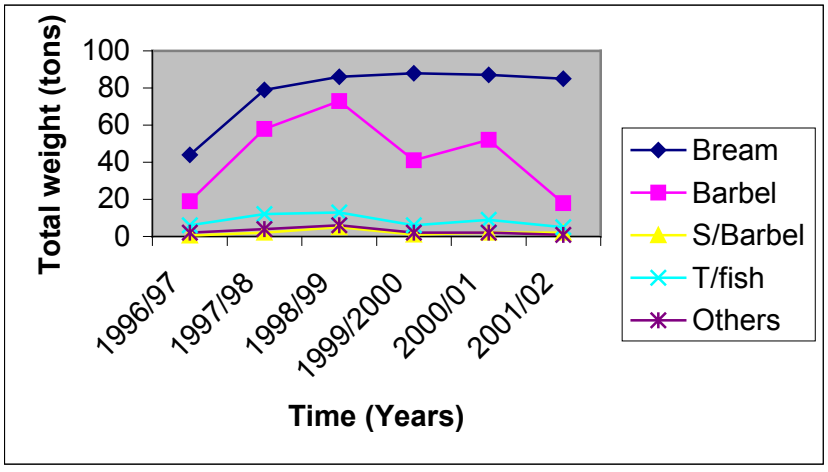

Figure2. Total annual catches by species group from the Okavango delta gill net fishery from 1996/97 to 2001/02. These annual catches are data collected from the gill net fishery only, and do not therefore include catches from the traditional fishery.

2.2.2 Principal subsistence and recreational species.

Artisanal utilization of the Okavango delta fishery has been documented in several studies (Randall, 1957; Kay, 1962; Maar, 1965a,b; Tlou, 1976, 1985). However, most of the earliest records of artisanal fishing in the Okavango system have little information either on fishing rates or principal species. Nonetheless, *Momyrids, Cyprinids* and *Cichlids* are the commonest families (in the Namibian portion of the system) caught in traditional fishing gear, with *marcusenius macrolepidotus* and *pseudocranilabrous philander* constituting the highest proportion of artisanal catches (van der Waal, 1991; Hay *et al*., 2000). Hay *et al*., (2000) also observed that *Synodontis spp* and *Tilapia sparmanni* were important artisanal species. According to Mmopelwa *et al*., (2002), *O.andersonni* and Johnstonni's topminnow (*Aplocheilichthys johnstoni*) are also important species in the artisanal fishery. According to Mosepele (2001a), the artisanal fishery harvests approximately 270 tons annually, primarily for subsistence, with a little surplus sold.

Very little information exists on recreational fishing in the Okavango delta. However, according to Merron (1989, 1993) and Mmopelwa *et al*., (2002), the tigerfish and various Tilapia/ Cichlids (especially species such as *Oreochromis andersonni* and *Serranochromis robustus*) species are the most important species in the recreational fishery. Mmopelwa et al., (2002) calculated an overall mean CPUE (kg/set) of approximately **15.85** kg/set.

2.3 Fish utilisation and yield estimations

Several estimates of potential yield have been estimated for the Okavango delta over the past three decades (Maar, 1965; Welcomme, 1975, 1979; Fox, 1976; Bruton *et al*., 1984; Norplan, 1985; Norfico, 1986; Merron and Bruton, 1988; Scudder *et al*., 1993; Kolding, 1996). Table 5 below summarizes the various potential fish yield estimates from the Okavango delta fishery and potential per capita yield estimated for the fishery. It is worth noting that a substantial amount of cheap and yet high valuable protein can potentially benefit the Okavango delta fishers where fishers would harvest between one and two tons of fish per annum (Table 5). Moreover, it is also important to highlight the potential financial rewards that might potentially accrue to an enterprising commercial fisher. At current prices, one ton of fish per annum might produce approximately US$6000 to US$12000 per fisher per annum in the fishery (assuming that current fish price is approximately an average US$1 kg^{-1} by aggregating both low and high valued species). Considering the entire fishery, the potential yield can range from US$8000 to US$9 million per annum (again assuming current fish price of US$1/kg). This simplified valuation of

the fishery suggests that the Okavango delta fishery has a huge potential to uplift the socio-economic standards of the local fishermen.

Table 5. Potential yield (and MSY) estimates and estimated per capita yield (i.e. potential yield per fisher in the fishery) on the Okavango delta fishery from several sources between 1965 and 1996.

Source	*Potential Yield (Tons yr^{-1})*	*Estimated fisher per capita yield for Okavango Delta (tons yr^{-1})* [2]
Maar, 1965	4500	1.149
Welcomme, 1975, 1979	7900[1]	2.017
Fox, 1976	858[1]	0.219
Norplan, 1985	8000	2.043
Norfico, 1986	8500	2.170
Merron and Bruton, 1988	6000[1]	1.532
Scudder et al., 1993	5600	1.430
Kolding, 1996	6000	1.532

1. An average estimate. 2. An average of 3917 (estimated from total fishers in table 3) fishers was used to estimate potential per capita yield

Lack of a proper and efficient data collection system during the early stages of fishery development has made it difficult to ascertain early annual off-take from the fishery (Gilmore, 1976; Mmopelwa 1989; Nengu, 1995). Initially, annual production from the delta was primarily based on estimates, until the mid 1990s when efficient data collection was initiated (Mmopelwa, 2000). Moreover, fish sales were used as a proxy for annual production from the fishery in lieu of C/E data during the 1980s (Norplan 1985; Norfico 1986, 1987; Mmopelwa 1989, 1990, 1991, 1992). These uncertainties in total annual yield are illustrated in figure 3 below, which if true, validates some arguments/ concerns about declining fish stock levels (e.g. Hagget 1999). However, current indicators suggest that the fishery is still in good condition (Bills, 1996; Mosepele 2000; Kgathi *et al*., 2002; Mosepele and Kolding, 2002). Moreover, Welcomme (1999) discusses that an over-utilised fishery is characterised by a reduction in net mesh size, a shift/ change in fish species composition (i.e. landed fish), which has been proven to be not the case (Mosepele 2000; Mosepele and Kolding, 2002). Therefore, it can be argued that figure 3 does not reflect an accurate picture of the current status of the delta's fish stocks. Conversely, figure 4, which illustrates increasing yields, is representative of the current status of the stocks.

Table 6 below summarizes total annual fish production from the Okavango delta fishery, with the estimated fisher per capita production. This is rather a simplistic picture of catch per unit of effort in the delta, where effort is assumed to be an average of estimated total fishers in the fishery between 1975 and 2001. Estimated fisher catch per capita is approximately one tenth (0.1) to one hundredth (0.01) of the potential fisher per capita from the fishery. It can be deduced from Table

6 that fisher catch per capita production was higher in the 1970s until the mid 1980s and then gradually decreased from the late 1980s until the end of the 1990s. However, taking into account Welcomme's (1979) production estimates for the Okavango delta suggests that initial production from the fishery was substantially higher. While most of the productive fishing areas such as Lake Ngami, Mopipi Reservoir and Boteti River still sustained some fisheries, it is doubtful whether production reached these levels.

Table 6. Total annual yield (estimated and calculated) and estimated per capita fish catch production from the Okavango delta fishery between 1974 and 1999.

Year	*Total Production (tons yr^{-1})* [6]	*Estimated Catch Per Capita Production (tons yr^{-1} $fisher^{-1}$)*
1974[1]	1200	0.306
1976[1]	400	0.102
1985[2]	500	0.128
1987[3]	360	0.092
1988[3]	231	0.059
1989/90[4]	350	0.089
1999[5]	346	0.088

1. Gilmore, 1976. 2. Norplan, 1985. 3. Mmopelwa, 1989. 4. Scudder *et al*., 1993. 5. Mosepele, 2001a.
2. These production figures are estimated for the entire fishery (subsistence (especially fishers using traditional fishing gear like baskets and traps) and commercial)

Recent research has shown that the Okavango delta's fish stocks are not declining (Bills 1996), but could be under-utilised (Mosepele 2000; Mosepele and Kolding, 2002). Mmopelwa (1989) attributed decreases in total annual fisheries production to good rains whence most potential fishers resort to arable farming. In this case, fishing is regarded as a socio-economic safety net for bad times (Mmopelwa, 1989; Mosepele 2000); therefore fishing activity (and hence total production) in the Okavango delta should be evaluated within this perspective. Moreover, consistent low floods and drought spells caused some productive fishing areas such as Lake Ngami to dry up, and this had a detrimental impact on the productive viability of the fishery (Mmopelwa, 1989, 1991, 1992; Okacom, 1998).

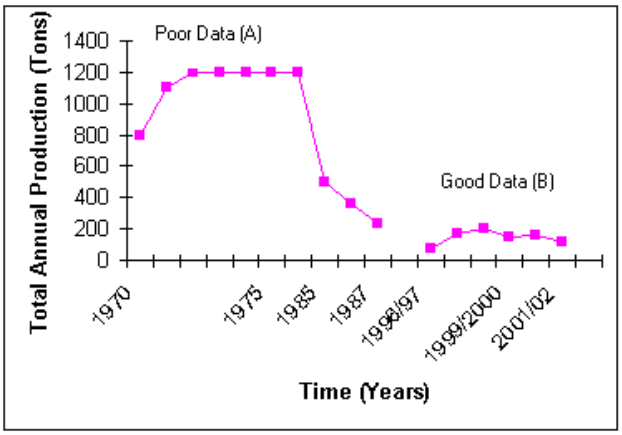

Figure 3. Total annual production from the Okavango delta fishery from 1970 to 2002. Data from 1970 to 1987 is regarded as poor/ uncertain data (period A) based on estimates while data from 1996/97 to 2001/ 02 (period B) is data collected from the gill net fishery. The break between the two periods was created to show the differences in fish production trend between the two periods.

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2.4 Income Generation from the Fishery

2.4.1 Dried Salted Fish

Anon (1989) reported that while the Okavango delta fishery might have had an insignificant impact on the overall economy (approximately 0.002% of the GDP at market prices) of Botswana, it had local importance in the northwest/ Ngamiland area. Therefore, the socio-economic value of the Okavango delta fishery will be discussed within this regional context.

Government provided a market for dried salted fish in the 1980s (drought period) whence the fish were consequently re-distributed in the region. The resource was therefore a major source of livelihoods for the people during this period. Accounts of the value of the Okavango delta fishery to the local communities during the dried salted period have been described in several reports (Norplan, 1985; Norfico, 1986, 1987; Mmopelwa, 1988, 1989, 1990; Anon, 1989; Merron 1989; Silitshena and McLeod, 1989). van Hoof *et al*., (1991, 1993) and Mmopelwa (1990, 1991, 1992, 1995) give a socio-economic account of the fishery during the hiatus between the two phases of development . Furthermore, Norplan (1985) stated that the socio-economic status of local communities was enhanced by commercial fishing during the dried salted fish period whence fishermen could now afford clothing for families and pay school fees for their children.

According to Silitshena and McLeod (1989), 140 commercial fishermen, (70 commercial fishermen and 10 fishing groups comprising of an average 7 members) made approximately P528.00 per fisherman (or approximately $265.00 per fisherman). Moreover, commercial fishermen were/ are seen as integral sources of informal sector employment (Norplan, 1985; Norfico, 1986; Mmopelwa, 2001; Mosepele, 2001a). Therefore, Silitshena and McLeod (1989) indicated that the monetary income for fishermen in 1986/87 was relatively sufficient as shown in table 7 below. Interestingly, Table 8 (Silithena and McLeod, 1989) implies that more fishermen were active in eastern Okavango (62) than the western region (26) which contradicts van Hoof *et al's.*, (1991, 1993). This observation could suggest that generally, there was a higher fisher population in eastern Okavango (62) than western (26), who however were less active/ efficient than the westerners considering average income earned (Table 7). Nevertheless, Table 7 illustrates a spatial variation in revenues from the fishery, whence southern Okavango was the most productive (in terms of revenue).

Table 7. Gross fishermen income in 1986/87 broken down by area in the Okavango delta. Amount in () is $US estimate for the period assuming that $US1.00 was equivalent to BWP2.00

Area	*Number of fishermen*	*Average Revenue per Fisher (P)*	*Total Revenues (P)*
Boteti	32	620 (310)	19840 (9920)
Southern Okavango	36	925 (463)	33300 (16668)
Eastern Okavango	62	355 (178)	22010 (11036)
Western Okavango	26	867 (434)	22542 (11284)
Unspecified	3	439 (220)	1317 (3951)
Average		641 (321)	

Source: Silitshena and McLeod, 1989

Table 8 summarizes the total fish income (and estimated revenue per fisher) that accrued to the Okavango delta fishery between 1983 and 1991. It is worth noting that while average revenue per fisher were quite low in the 1983/84 period (US$53.00), they had increased quite substantially by the end of the 1980s (US$345) as shown in table 8 below. Average cattle revenue per farm in the Okavango region is shown for comparison between cattle and fish revenue, where average cattle revenue was approximately 4x higher than average fish revenue. However, fishing was the second most important economic activity after cattle farming in the Okavango delta in 1993, 1995, 1996 (CSO, 1995, 1999, 2000). This of course contradicts Fidzani *et al's*., (1999) that fish did not feature among the 10 most important economic activities in Ngamiland in 1997. However, this source of income dried up with Lake Ngami (from southern Okavango region) and Boteti River due to environmental changes. Hence, not only was there a reduction in fishermen numbers (from the lower delta), but there was also a consequent loss in livelihood options.

Table 8. Dried and salted fish sales from the Okavango delta between 1983 and 1991. Amount in () is $US estimate for the period assuming that $US1.00 was equivalent to BWP2.00 at current prices.

Year	*Amount Allocated/ Used*	*Estimated Avg. Revenue per Fisher (P)*	*Average Cattle Revenue per farm*
1983 – 1984[1]	30 000	106 (53)	941 (471)[3]
1984 – 1985[1]	74 000	261 (131)	1123 (562)[4]
1985 – 1986[1]	74 000	261 (131)	1156 (578)[5]
1986 – 1987[1]	100 000	353 (177)	1944 (972)[6]
1988 – 1989[2]	146 000	516 (258)	1734 (867)[7]
1989 – 1990[2]	195 000	689 (345)	
1990 – 1991[2]	150 000	530 (265)	
Average		388 (194)	1380 (690)

1. Silitshena and McLeod, 1989.2 Mmopelwa, 1989, 1990, 1991.

2.4.2 Fresh/ Frozen Fish Period

Mosepele (2000, 2001a) and Mmopelwa (2001, 2002) provide the best account of the current value of the fishery. Table 9 below summarises the estimated value of the Okavango delta gill net fishery from 1996/97 to 2001/02. There were no cattle sales between 1996 and 1997 due to cattle eradication from the area because of a contagious cattle lung disease. It is therefore worth noting that fish revenues would have contributed substantially to household earnings assuming that fish constituted an important secondary source of income in the region as discussed above. Average cattle revenue per farm in 1995 was BWP 4721.00 (approximately US$ 1180) (CSO, 1999), there were no cattle revenues in 1996, 1997 (CSO, 2000, 2002a), while average cattle revenue per farm in 1998 from local sales amounted to BWP 5403.00. Estimated average fish revenues between 1996 and 2002 (Table 9) compare very well with cattle revenues, which certainly highlights the socio-economic importance of fish in the region

Table 9. Total annual fish catch production, total annual fish revenues and estimated annual income per fisher, per annum in the Okavango delta from 1996/97 to 2001/02. Amount in () is $US estimate for the period assuming that $US1.00 was equivalent to BWP5.00 at current prices.

Year	Est. Total Annual Fish Production	Est. Total Revenue (BWP)	Est./ Total Revenues (US$)	Est. Revenue/ fisher (BWP)	Est. Revenues/ Fisher (US$)
1996/97[1]	71196.2	622967	124593	1971	394
1997/98[1]	155065.3	1356821	271364	4294	859

1998/99[1]	182054.1	1592974	318595	5041	1008
1999/2000[1]	137863.8	1206308	241262	3817	763
2000/01[1]	151984.4	1329864	265973	4208	842
2001/02[1]	111069.23	971856	194371	3075	615
Sum	809233.03	7080790	1416158	22406	4481
Average	134872.1717	1180131.667	236026.3333	3734.333333	746.8333333

1. Data from Mosepele, 2001a. 2. Fish prices from Mosepele, 2001a. 3. Average income is estimated by assuming that there are approximately 316-gill net fishers in the delta (i.e. average between Kolding, 1996 and Mosepele, 2001a estimates as shown in table 3)

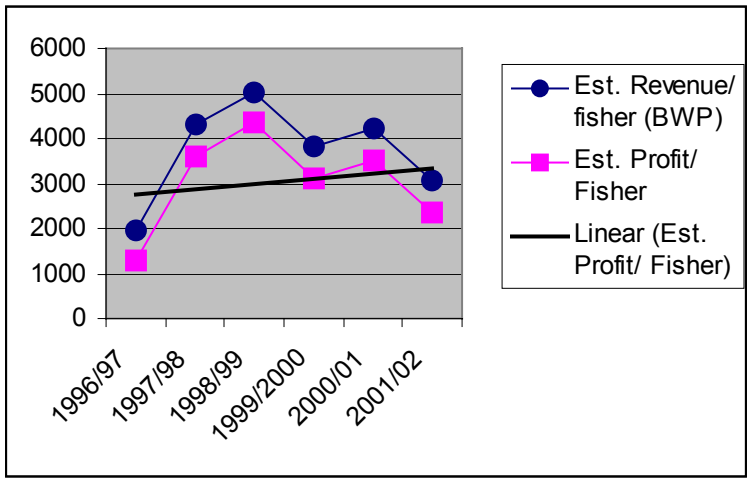

Figure5. Estimated revenues and profit per fisher between 1996 and 2002 exhibits a gradual increase. Assuming that all factors remain constant (e.g. no sudden sharp increases in fuel and labour costs), monthly costs for the fishermen was estimated at BWP700.00

The value of the Okavango delta fishery does not only rest on financial benefits that accrue from commercial fishing, but also in the provision of protein to the rural poor (Merron 1989; Mosepele 2001a). This observation agrees with Anon (1989) who indicated that fisheries are a major source of animal protein for the people of Ngamiland. Notwithstanding, Mosepele (2001a) showed that a gill net fisherman (131 fishermen in total) in the Okavango delta fishery earned approximately \$106.00 month^{-1} in 1999, which was approximately the minimum government wage in Botswana for that year (i.e. both subsistence and commercial gill net fishermen). Mosepele (2001a) further showed that the 41 commercial fishermen in the fishery earned approximately \$256.00 month^{-1}, while the 90 subsistence fishers earned approximately \$ 50.00 month^{-1} (at current prices)[1]. Moreover, figure 5 illustrates that estimated annual profit per fisher has been gradually increasing since 1996. This suggests that the fishery is still viable and will continue to sustain local livelihoods. Mosepele (2001a) highlights that while only a small percentage of the fishermen might appear to earn relatively good salaries from fish sales, this money is ploughed back into the local economy thereby contributing substantially towards rural development and economic empowerment. According to Mosepele (2001a), some of the money is invested in purchasing

livestock (cattle mostly), operating kiosk's (small multi-purpose stores) and brewing traditional beer (for sale) are among the commonest economic activities fishermen invest their income in.

2.5 Future prospects

There are countless other species that are currently under-utilised in the Okavango delta fishery. The full potential of species such as *B. lateralis, S.intermedius, C.gariepinus*, and *C.ngamensis* (to name but a few) has never really been tapped into. Moreover there is a possible aquarium trade in *Cyprinids, Synodontis spp*, smaller sized cichlids such as *P.philander, Hemichromis elongatus, Pharyngochromis acuticeps*. This and the previous sections suggest that the Okavango delta fishery poses a substantial untapped potential that can uplift the socio-economic conditions of the rural poor in Ngamiland. As already discussed by Mosepele (2001a) and Mmopelwa (2001), the fishery is presently regarded as a safety net that Ngamiland people turn towards when in dire socio-economic straits. However, while the fishery's full potential still remains untapped, it is nevertheless subjected to the whims and caprices of environmental perturbations which pose the greatest danger to the sustainability of this resource.

The Botswana government has done very little to ensure and guarantee effective utilization of the fish resource for the benefit of the rural poor. According to Mosepele (2001a,b), lack of a national fisheries policy has effectively placed a stranglehold on fisheries development in Botswana. Mosepele (2001a) argues that the full economic potential of this resource will remain elusive until a national fisheries policy is enacted. And as already discussed, the stakeholder conflict that currently prevails is largely exacerbated by lack of a sector specific policy. Furthermore, it is indeed a pity that local communities who depend on fish as a major source of livelihood are being inexorably denied their traditional right in WMA's and CHA's. These issues, however, can only be comprehensively addressed within a management plan (fisheries) designed within the confines of a national fisheries policy, which unfortunately is non-existent at present.

3. Conclusion

Several conclusions can be made from the preceding discussion.

- There is a direct relationship between the hydro-ecological nature of the Okavango delta and the productive potential of the fishery. The upper delta supports the highest diversity

of fish species and the highest concentration of fishers, and the opposite is true for the lower delta. Most importantly, some fishing areas have dried up in the lower delta (Lake Ngami, Boteti River, Lake Xau, Mopipi Reservoir) with a consequent decrease in fisher numbers over time.

- Fish is currently a social safety net during lean economic times, therefore only few people are involved in the fishery on a full-time commercial basis. The fishery appears to be primarily artisanal, as evidenced by the preponderance of traditional fishing gear. Since traditional fishing is opportunistic, the number of people in the fishery over time is bound to fluctuate due to a collage of factors such as lack of peripheral fishing grounds due to poor floods, employment opportunities elsewhere, farming activities.

- Government credit schemes played an integral part in the commercialisation of the fishery, and continue to do so. Dried salted fish and the fresh/ frozen product constitute the two major phases in fisheries development in the delta. A shift in the fishery from the dried salted phase to the current fresh/ frozen phase has effectively reduced fisher numbers due to the high capital investments needed in the latter fishery as opposed to the former.

- Currently, the major problem facing the fishery is lack of a national fisheries policy, and absence of regulations. Subsequently, this open access regime has fuelled friction between the major resource stakeholders. Moreover, the zoning of the delta into WMAs and CHAs without due consideration to the needs of the fishers has contributed to this friction between the stakeholders. These factors, especially lack of a national fisheries policy, have stifled development of the sector as a viable alternative towards economic diversification in the tourism sector.

- Various factors such as access to credit, market availability, accessibility to modern fishing gear and alternative forms of employment control the number of active fishers in the fishery at a given time. Assuming that fishing is regarded as some form of social security, it is expected that few people will remain in the fishery due to enhanced economic empowerment as Botswana's overall economy increases.

- Over and above all these, the Okavango delta fishery is a major repository of RURAL household income and a crucial source of cheap protein for the rural poor. Therefore, the fate of most rural poor IN Ngamiland is tied to the fishery, whose viability over time is subject to environmental perturbations.

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