

A qualitative and quantitative analysis of historic commercial fisheries in the Free State Province in South Africa

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ABSTRACT

There is a general lack of information on inland commercial fisheries in South Africa. The primary objective of this study was to provide a retrospective assessment of commercial fisheries in the Free State Province based on the assessment of catch data from fisheries operating for the period 1979–2014. Permits were issued for commercial operators on 11 dams but catch data were only available for Bloemhof, Kalkfontein, Gariep, Vaal, Erfenis, Rustfontein and Koppies Dams. A total of 9 036 t of fish were harvested over the 35-year period, equating to an average (\pm SE) of 282 ± 185 t·yr⁻¹. Catch composition differed between dams but comprised mainly of common carp *Cyprinus carpio* and the Labeos, *Labeo capensis* and *Labeo umbratus*. Based on an assessment of the available catch data, the only successful fisheries that were sustained for more than 10 years were on Bloemhof Dam (mean \pm S.E.: 201 ± 25 t·yr⁻¹ since 1981) and Kalkfontein Dam, where 127 ± 30 t·yr⁻¹ was harvested (by an operator from Bloemhof Dam). All other fisheries appear to have failed with individual enterprises lasting between 1 and 10 years and generally yielding less than 25 t·yr⁻¹ when operational. Success at Bloemhof Dam appears to have been dependent on the ability to harvest > 100 t·yr⁻¹ and the long-term fisheries experience of the operators.

Keywords: commercial, fisheries, catch, rates, composition, qualitative, quantitative, analysis

INTRODUCTION

There is significant political pressure to develop commercial fisheries on freshwater impoundments as vehicles for poverty eradication, employment generation and economic development in South Africa (see Britz, 2015; Britz et al., 2015). This is because inland fisheries are perceived to be poorly developed from a food security and harvesting perspective (for review see McCafferty et al., 2012). Despite periodic attempts to establish commercial fisheries, the lack of information on these initiatives and on actual harvests is a severe bottleneck to understanding the constraints to inland fisheries development (McCafferty et al., 2012). The Free State Province, unlike other provinces, has a relatively long history of approved commercial fishing on inland waters, with development attempts on 11 impoundments since 1979 (Fig. 1). According to provincial legislation of its environmental affairs department (NCO, 1969; NCR, 1983), permit conditions for commercial fisheries include prohibited species, size limit for some species, catch quotas, gear restrictions, access restrictions within protected areas, concession fees payable to government, boating regulations and the submission of catch returns. As these data have never been collated nor assessed, the primary objective of this paper was to provide a retrospective assessment of commercial fisheries in the Free State Province coupled with a retrospective assessment of the factors that resulted in successes and failures of individual enterprises. This first assessment of inland commercial fisheries in South Africa will be useful in developing guiding principles for inland fisheries development and the emerging inland fisheries policy (see Britz, 2015).

MATERIALS AND METHODS

We consulted all provincial nature reserves and the permit office of the Department of Economic, Small Business Development, Tourism and Environmental Affairs (DESTEA) of the Free State Province to determine whether historic catch data of commercial fisheries were available and, if so, to retrieve and digitize these data which included the total number and weight of each species landed. Permits to commercially harvest fishes had been issued for 11 dams, namely, Bloemhof, Kalkfontein, Koppies, Rustfontein, Erfenis, Gariep, Allemanskraal, Rhoodepoort, Krugersdrift, Witpan and Vaal Dams (See Fig. 1).

Exploratory analyses revealed that the quality of catch data varied between localities. For some impoundments monthly and actual disaggregated catch data were available in hard copy, while for others these data were available only as collated tables in internal reports. In some cases a lack of administration control and management resulted in incomplete datasets, despite reported attempts to develop fisheries. As a result of the variability in the quality of data, only catch data that had been reviewed by DESTEA reserve personnel were used for the assessment of catch and species composition. To complement permit and catch data, interviews were conducted with key informants. These included former and current reserve managers, as well as permit holders at Bloemhof and Gariep Dams.

RESULTS

Available data and permit conditions

Of the 11 impoundments for which permits were issued, data on harvest were available for 7 impoundments. These were Bloemhof, Kalkfontein, Gariep, Vaal, Erfenis, Rustfontein and Koppies Dams (see Table 1).

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All commercial fishing operations were managed and controlled based on permit conditions. These permit conditions included:

- Annual quotas ranging between 10 and 200 t·yr⁻¹ depending on operation and a concession fee based on catch volume payable to government.
- Immediate release of largemouth yellowfish *Labeobarbus kimberleyensis* and smallmouth yellowfish *Labeobarbus aeneus*. These two species are deemed protected species in the Free State Province and were never allowed to be caught and if killed had to be reported.
- Allowable gear, which from 1979 until 2005 included long lines, boat-based electro-fishers, gill nets with stretched mesh size of 100 mm and larger; seine nets with stretched mesh size of 50 mm and larger. Since 2005, only seine nets with a stretched mesh size of 50 mm and larger were allowed.
- Rules regarding entrance and access to fishing grounds within protected areas.
- Adherence to national legislation with regards to use of small vessels on inland waters according to the South African Maritime Safety Authority (SAMSA).
- The permit conditions stipulated that daily and monthly summaries had to be captured on prescribed record forms and submitted to reserve offices.

Harvest

A total of 9 036 t of fish were harvested over the 35-year period, equating to an average (\pm S.E.) of 282 \pm 185 t·yr⁻¹. Catch composition differed between dams (see Table 1). At Bloemhof, Vaal

and Gariep Dams catches comprised mainly of common carp *Cyprinus carpio* (> 53%), while in the other impoundments the Labeos, Orange River mudfish *Labeo capensis* and moggel *Labeo umbratus*, dominated (> 66%) catch assemblages. Based on an assessment of the available catch data, the only successful fisheries that were sustained for more than 10 years were on Bloemhof Dam (mean \pm S.E.: 201 \pm 25 t·yr⁻¹ since 1981) and Kalkfontein Dam, where 127 \pm 30 t·yr⁻¹ was harvested (by an operator from Bloemhof Dam). All other fisheries appear to have failed with individual enterprises lasting between 1 and 10 years and generally yielding less than 25 t·yr⁻¹ when operational (see Table 2).

Commercial fisheries

Key informant interviews confirmed that most attempts at developing formal fisheries failed soon after their initiation (e.g. at Erfenis, Rustfontein and Vaal Dams). Interview data with the previous reserve manager at Koppies Dam, where a fishery operated for 12 years (1981–1993), revealed that this fishery closed down as it was no longer financially viable (Joubert, 2014).

The success of the two operators at Bloemhof Dam appears to have been dependent on the ability to harvest > 100 t·yr⁻¹, and long-term fisheries experience. One of the operators (Master Fishing) had been in operation since the initiation of commercial fisheries on Darlington Dam in the Eastern Cape in the early 1970s from where he moved to Kalkfontein Dam (Bok, 2014) and subsequently to Bloemhof Dam after failed attempts to develop fisheries at Krugersdrift and Vaal Dams. This enterprise also supplemented catches by making opportunistic use of periodically available resources during low water levels at Kalkfontein Dam.

Comparison of catch and quota data for Bloemhof Dam operators demonstrates that the 200 t·yr⁻¹ quota was almost never attained. Key informant interviews with the proprietors of these

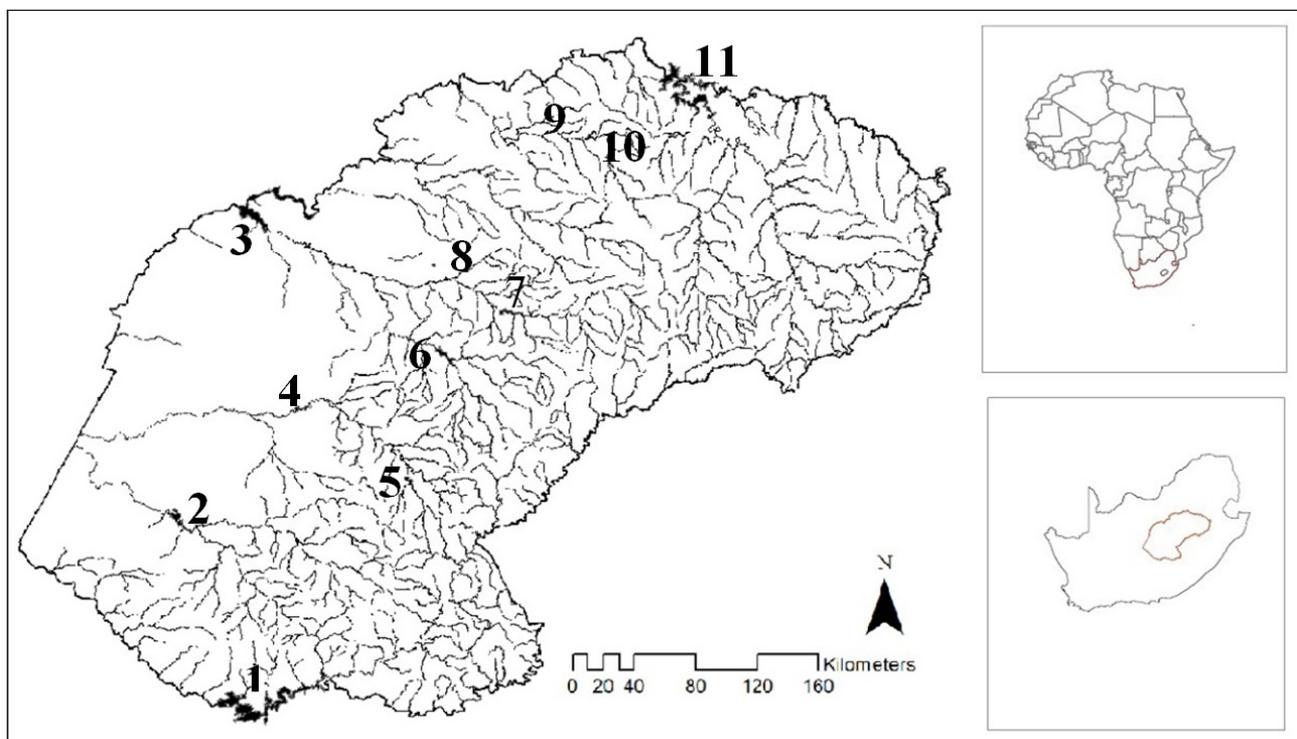


Figure 1

Locality of dams in the Free State Province where commercial fishing took place: 1 – Gariep Dam; 2 – Kalkfontein Dam; 3 – Bloemhof Dam; 4 – Krugersdrift Dam; 5 – Rustfontein Dam; 6 – Erfenis Dam; 7 – Allemanskraal Dam; 8 – Witpan; 9 – Rhoodepoort Dam; 10 – Koppies Dam; 11 – Vaal Dam

enterprises revealed that this was the result of constraints to their ability to process, store and sell their catch, as well as due to operational issues. For example, one operator who produced sun-dried salted fish which was exported via Cape Town to central Africa, reported erratic demand as a constraint. For the second operator, who mainly sold fresh and frozen fish, harvests were limited by refrigeration capacity and local demand for freshwater fish.

Both fisheries experienced major challenges to their operations as a result of water-level fluctuations (see Fig. 2) and invasive weeds. When the water levels at Bloemhof Dam were above 80%, seine netting was hampered by inundated terrestrial plants that colonised the exposed littoral zones during low water level. At full supply level, dense reed beds within the areas zoned for commercial fishing were flooded, making access to the water extremely difficult. Finally, the invasion and rapid spread of water hyacinth *Eichhornia crassipes* posed further problems for the fisheries and restricted operations and affected catches in 1988, 1989, 1996, 2001 and 2008–2012 (Fig. 2).

Information on the number of people employed by the different commercial fisheries was scant. It could, however, be determined that no permanent jobs were ever created. Inspections at the two fisheries at Bloemhof Dam during 2011–2013 revealed that both fisheries employed casual labour. One fishery employed 8 people who were paid minimum wage (80 ZAR·d⁻¹) while the other enterprise employed from 8 to 12 people who were paid a commission based on the day's catch. When operational at Kalkfontein Dam, the fishery employed between 20 and 30 people on a temporary basis, but it is not known how much they earned.

State-supported fisheries

Attempts to develop a small-scale fishery at Gariep Dam make an interesting case study. After 2 independent attempts to develop fisheries failed, government provided support to 3 fisheries projects. None operated for more than a few months in the year and the total reported harvest for all initiatives was < 49.2 t. Although failures were for a variety of reasons, unrealistic expectations of yields, inadequate management capacity and market constraints all appear to have contributed towards these failures.

Analysis of the outcomes of the fisheries project initiated in 1998 at Bethulie near Gariep Dam, to provide employment for 50 people, provides further insights. The government grant included equipment and all infrastructure (fishing gear, a boat and a building for fish processing) to the value of 216 000 ZAR. An initial quota of 50 t·yr⁻¹ was allocated but operationalisation of the project proved problematic resulting in strict monitoring and record keeping from January to December 2000. Despite the 50 t·yr⁻¹ quota only 11.2 t of fish were harvested and sold at 1.90 ZAR·kg⁻¹. The total income from selling fish was 21 438 ZAR and operating expenses for this period were 9 750 ZAR, leaving a balance of 11 688 ZAR for the project beneficiaries. By the end of 2000, only 12 people remained in the project which meant each had earned 81 ZAR·month⁻¹. Attempts to start similar projects in Venterstad and Oviston (Eastern Cape side of Gariep Dam) also failed despite considerable investment of more than 1 million ZAR over a 10-year period.

TABLE 1
Summary of the commercial fisheries licensed at 11 impoundments in the Free State Province between 1979 and 2014

Impoundment	Surface area (km ²)	Permits issued	Quota (t·yr ⁻¹)	Harvest (t·yr ⁻¹)	Target species	Category of fisheries
Bloemhof	231	2	400	207±142	Carp 59%; Labeo 31%; others 10%	Seine net fishery with 2 long-term operators with individual quotas of 200 t·yr ⁻¹ . Each enterprise employed 8–12 people on a casual basis. Fish was sold dried, fresh and frozen.
Kalkfontein	38	2	450	136±117	Labeo 85%; Carp 13%; others 2%	Opportunistic fishery using seine nets only at low water level by operator from Bloemhof Dam. Yearly quotas ranged from 100–250 t·yr ⁻¹ . When operational fishery employed 20–30 casual labourers.
Koppies	14	1	50	16±7	Labeo 78%; Carp 5%; others 17%	Failed after 12 years (1982–1993) of operation using seine nets and gill nets. Quotas ranged from 25–50 t·yr ⁻¹ .
Rustfontein	12	1	100	8±10	Labeo 73%; Carp 15%; others 12%	Failed after operating from 1982–1986 with a quota of between 50 and 100 t·yr ⁻¹ .
Erfenis	33	2	200	2±0	Labeo 66%; Carp 10%; others 24%	Failed within 2 years.
Gariep	352	7	200	5±7	Carp 53%; Labeo 31%; others 16%	Various development attempts by private entrepreneurs and through Government LED projects, all of which failed. Private enterprises used gill net, seine nets with individual quotas of 10–50 t·yr ⁻¹ but all failed. Four community-based projects initiated between 1998 and 2008 for up to 50 beneficiaries and individual quotas of between 20 and 200 t·yr ⁻¹ failed despite equipment, running and labour subsidies and multiple re-investments.
Alleenskraal	27	2	No data	No data		Failed. No catch data available.
Rhoodepoort	0.8	1	5	No data		Once-off permit to a commercial operator as dam dried up.
Krugerdrift	18	1	No quota	No data		Once-off permit to a commercial operator as dam dried up.
Witpan	-	1	No data	No data		Failed in experimental stage. Operator moved to Bloemhof Dam.
Vaal	323	7	200	16±29	Carp 69%; Labeo 16%; others 15%	All attempts failed. Individual quotas up to 200 t·yr ⁻¹ . Catch data scant.

DISCUSSION

The retrospective analysis presented here, demonstrates that attempts to develop commercial fisheries in the Free State Province have largely failed. As the average harvests per impoundment were very low ($< 33 \text{ kg}\cdot\text{ha}^{-1}\cdot\text{y}^{-1}$) when compared with the mean annual yield from other fisheries in small water bodies in southern Africa ($329 \text{ kg}\cdot\text{ha}^{-1}\cdot\text{y}^{-1}$) (Marshall and Maes, 1994), failure was unlikely to have been as a result of overfishing but rather as a result of a failure of fisheries to yield the desired return on investment. Those fisheries that persisted did so as small-scale commercial enterprises that were unable to fill their relatively small quotas, nor were they able to provide full-time employment. This stark reality differs dramatically from the initial optimistic yields derived from empirical approaches used to estimate potential yields in the absence of a-priori catch data (e.g. Weyl et al., 2007; Britz et al., 2015). In the absence of data, the lack of developed commercial fisheries in South African dams has been misinterpreted as a result of restrictions to physical access, a lack of developmental initiatives and a lack of an enabling policy (Britz, 2015). The current assessment, however, demonstrates that opportunities to establish commercial fisheries in the Free State Province have been available for 35 years. Despite this, only 2 small-scale enterprises were financially sustainable and their operations have been severely constrained by environmental fluctuations, invasive weeds that impede harvest efficiency, small local markets and demand and fluctuations in export market demand. As a result, the contribution of

small-scale commercial fisheries to employment and economic empowerment in the Free State Province has been limited.

A lack of an established market and low value of freshwater cyprinids is demonstrated by the low level of success by individual enterprises. Particularly interesting are the attempts to develop fisheries on Gariep Dam. Here a variety of attempts to develop fisheries failed. Despite information of prior failures of commercial enterprises, provincial government supported several community projects by providing support to development consultants, fishing gear, operation and labour cost. All attempts failed completely with a total combined harvest of only 49 t by all fisheries initiatives on the dam (see Table 2).

In contrast, surveys by Ellender et al. (2009; 2010a; 2010b) demonstrated that subsistence and recreational anglers harvested $80 \text{ t}\cdot\text{yr}^{-1}$ from Gariep Dam and that some 448 people from the towns of Venterstad, Oviston, Bethulie and Hydropark regularly harvested fish from the dam for subsistence while using artisanal gear. These subsistence anglers sold excess fish at a relatively low price ($6 \text{ ZAR}\cdot\text{kg}^{-1}$), providing not only

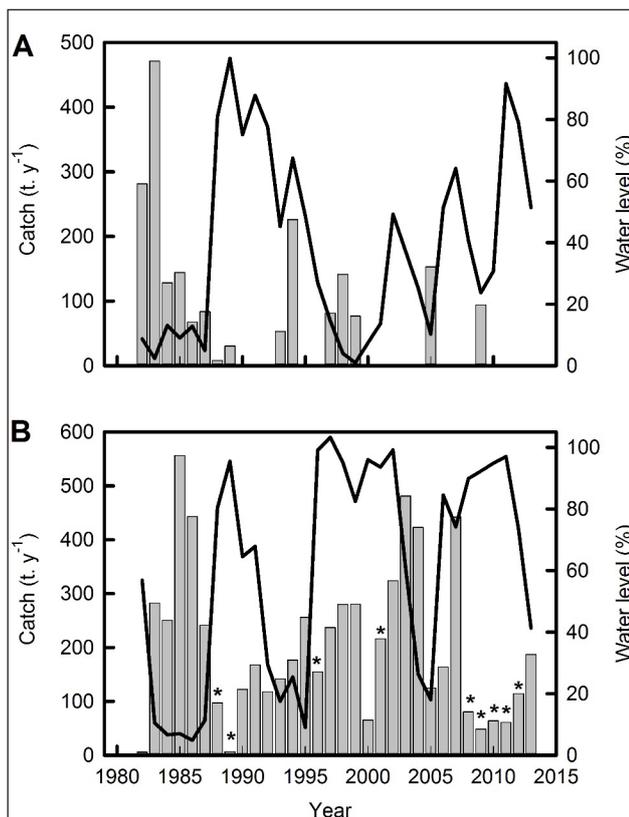


Figure 2

Annual catch in tons (grey bars) and mean water level expressed as percentage of full capacity (solid line) at (A) Kalkfontein Dam and (B) Bloemhof Dam in the Free State Province, South Africa.

*denotes years when fishing operations were affected by dense reed beds and water hyacinth *Eichhornia crassipes*.

TABLE 2
Summary of available commercial fisheries catch data for the Free State Province dams from 1982–2013. Numbers in bold signify years in which quotas were attained.

Year	Kalkfontein	Bloemhof	Koppies	Rustfontein	Erfenis	Gariep	Vaal	Total (t)
1982	281.3	5.8	6.3	15.6	1.7	0	0	310.7
1983	471.3	282.5	21.2	2.8	1.6	0	0	779.4
1984	128.3	250.6	22.3	3.8	0	0	0	405
1985	144.1	556.2	21.7	25.9	0	0	0	747.9
1986	67.4	442.9	20.9	2.6	0	0	0	533.8
1987	83.6	241.4	23.2	0	0	0	0	348.2
1988	7.8	97.3	18.1	0	0	0	58.9	182.1
1989	30.5	6.7	11.5	0	0	0	5.1	53.8
1990	0	122.4	17.3	0	0	0	0	139.7
1991	0	167.9	14.7	0	0	0	0	182.6
1992	0	117.8	13.9	0	0	0	0.2	131.9
1993	53.1	142	1.6	0	0	0	0.4	197.1
1994	226.1	176.7	0	0	0	0	0	402.8
1995	0	256.1	0	0	0	0	0	256.1
1996	0	154.9	0	0	0	0	0	154.9
1997	81.4	237.1	0	0	0	0	0	318.5
1998	141.3	280	0	0	0	2.3	0	423.6
1999	76.8	280.4	0	0	0	8.6	0	365.8
2000	0	65.3	0	0.2	0	10.9	0	76.4
2001	0	216.2	0	0	0	0.9	0	217.1
2002	0	324	0	0	0	0	0	324
2003	0	481.2	0	0	0	0	0	481.2
2004	0	422.9	0	0	0	1	0	422.9
2005	152.9	124.7	0	0	0	0	0	277.6
2006	0	163.8	0	0	0	0	0	163.8
2007	0	442.1	0	0	0	0	0	442.1
2008	0	80.6	0	0	0	0	0	80.6
2009	94.4	48.5	0	0	0	1.3	0	144.2
2010	0	64	0	0	0	20.3	0	84.3
2011	0	60.8	0	0	0	3	0	63.8
2012	0	114.6	0	0	0	0	0	114.6
2013	0	186.9	0	0	0	0.9	0	187.8
TOTAL	2 041.7	6 633.2	192.7	50.9	3.3	49.2	64.6	9 035.6

supplementary income for fishers but also an important source of low-cost protein to the predominantly poor population within the area. As a result of the importance of subsistence angling to food security in the local community, Ellender et al. (2010a) recommended caution when developing commercial fisheries as these could compete for fish and market share with an already vulnerable sector of the population.

It is also evident that fisheries are unlikely to provide permanent employment in rural communities. This is because even the two most successful operators only used casual labour because fluctuating harvests and relatively low catch value constrained permanent employment in these small enterprises.

Britz et al. (2015) concluded their report on the scoping study on the development and sustainable utilisation of inland fisheries in South Africa by noting that the value of inland fisheries does not lie with the tonnage of fish caught, but rather in the benefits it provides for the rural poor in sustaining their livelihoods. Due to the limited success of commercial fisheries in the Free State Province, it is the opinion of the authors that the development of formal commercial enterprises is unlikely to be successful. Instead, efforts should be made to better understand existing utilization and develop small-scale fisheries using technologies that are locally appropriate and affordable. While such informal uses are likely to be less popular with government than the formal 'project' approaches with clear-cut budget lines and monitorable indicators such as 'number of beneficiaries', prioritizing angling (both subsistence and recreational) could ensure the availability of these resources as food-security safety nets when needed and provide for employment in associated service industries. As subsistence fishers include some of the most vulnerable members of society (Béné et al., 2015), we agree with Ellender et al. (2010a) that subsistence and recreational angling should be prioritized with regards to an inland fisheries policy.

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