EXECUTIVE SUMMARY

This report documents the findings of a two-year investigation that has examined the fish assemblages of six South African dams. This works stems from the hypothesis, developed during the Hartbeespoort Dam Remediation Project (DH Environmental Consulting, 2004), that impounded eutrophic waters tend to be dominated by coarse fish, such as carp and barbel, with such species imparting a generally-negative impact on the ecosystem structure (foodweb). The nature of individual or combined impacts brought about by coarse fish in enriched dams would be to exacerbate the effects of eutrophication. Furthermore, it is proposed that the ecological state and water quality of eutrophic dams can be improved through the re-shaping of imbalanced fish populations, brought about by the deliberate harvesting of target species. This process would, initially, remove bulk quantities of fish within a relatively-short period, followed by maintenance fishing in the long term. Removal of problematical, coarse fish, would allow populations of desirable species to resurge and to provide both an increased measure of natural controls within the ecosystem, as well as providing higher value game fish. The manner in which the fisheries of such dams could be sustainably and financially exploited so as to benefit ecosystem health remain to be determined while, at the same time, offering potential for income and food security.

The proposal on which this project is founded is intended to investigate the options for fishdirected biomanipulation of eutrophic dams as an in-lake management intervention. The rationale for the partial relief of eutrophication-induced pressures in enriched South African dams is founded on the following premises:

- The fish populations in these dams are imbalanced and dominated by what this study terms “coarse” species, either numerically or in terms of biomass. In the dams examined, coarse species are considered to be common carp (*Cyprinus carpio*), sharptooth catfish (*Clarais gariepinus*) and/or canary kurper (*Chetia flaviventris*);
- These coarse fish, when present in excess, are likely to exert either a top-down impact and/or a bottom-up disturbance in the lake foodweb, specifically:
  - ❖ The coarse fish species are typified as facultative zooplanktivores or have zooplanktivorous juvenile stages, i.e. species that may exert a top-down effect on the reservoir-lake foodweb. However, it is conceded that these feeding modes have not been demonstrated in South African dams and are belied by the phenomenal success of sharptooth catfish in dominating riverine systems;
  - ❖ Are species with a predominantly-benthic feeding behaviour will variously, increase turbidity, promote nutrient recycling and/or prevent the establishment of lake-stabilizing rooted aquatic macrophytes
  - ❖ Large populations of coarse species are expected to accelerate recycling of dissolved nutrients to the water column via excretion;
- These fish-induced imbalances augment and contribute to the eutrophication pressures within the dam, inclusive of the suppression of desirable fish species;
- The combined effect of this imbalance is a depleted zooplankton component and an increased availability of water column nutrients, as a consequence of increased excretion and bioturbation;
- The selective removal of the problem fish species, firstly by bulk removal and then maintenance fishing, will allow re-establishment of a more-balanced fish community and a measure of relief of the aforementioned pressures.

This project has examined the fish assemblages in six dams (Rietvlei, Roodeplaat, Bon Accord, Koster River, Lindleyspoort and Rust de Winter – with the last two serving as ‘control’ environments). Also included are comparative data from a similar, earlier study conducted at Hartbeespoort Dam and which provided the framework for this investigation. These dams were selected based on (a) their trophic condition and without any prior

knowledge of the assemblage of fish present in each, and (b) their location within the same geographic region, to remove potentially confounding biophysical and zoogeographical influences.

The findings of this research project may be summarized as follows

FINDINGS

Dams in the test set

The characteristics of the seven impoundments, including Hartbeespoort Dam, are summarized in **Table 1**:

Table 1: Summarized characteristics for each dam (Data from Harding, 2008; Van Ginkel et al., 2007 and DWAF, 2004 – NEMP). The data are ranked according on the basis of increasing median annual Total Phosphorus (TP). Nutrient and chlorophyll-a data are annual medians.

		Rust de Winter	Lindleyspoort	Koster	Hartbeespoort	Roodeplaat	Bon Accord	Rietvlei
Parameter	Units							
Vol (FSL)	MCM	28	14	12	193	41.2	4.4	12.3
Mean depth	m	5.7	7.4	4.8	9.6	10.6	3.6	6.2
Max depth	m	18	22	13	33	43	7.4	19
HRT	yr	0.3	0.5	-	0.81	1.28	-	0.4
Surface area	km^2	4.9	1.9	2.6	20	3.97	1.7	2.06
Min water temp	deg C	17	13	14	14	15	11	10
Max water temp	deg C	28	28	27	26	28	29	31
Sediment Content	% Volume	4.4	12.3	1.7	16	4.4	33	4.6
Total P	ppb	42	44	68	104	208	285	360
Ortho-P	ppb	20	20	24	55	118	102	223
Chlorophyll-a	ppb	2	4	4	12	33	113	27
Trophy		Mesotrophic	Mesotrophic	Eutrophic	Eutrophic	Hypertrophic	Hypertrophic	Hypertrophic

Fish populations

The fish assemblages found in the seven reservoirs are summarized in **Table 2**. The number of fish species per dam ranged from seven (Koster River) to thirteen (Lindleyspoort), with an average of 10 species per dam. Only three species, common carp (*C. carpio*), sharptooth catfish (*Clarias gariepinus*) and Mozambique tilapia (*Oreochromis mossambicus*) were found in all seven dams. The two biogenically clearwater control dams, Lindleyspoort and Rust de Winter, had the highest species diversity with, respectively, thirteen and twelve species. Koster River Dam, the turbid dam, had seven species, the lowest number in the set of seven dams. Although over a narrow range and with the exception of the highly-turbid Koster River Dam, there was a general progression of declining species number with increasing trophy. Numerical density per species, as corrected for Catch per Unit Effort (CPUE) and expressed as a percentage of the total survey catch, is shown in **Table 3**, whilst biomass, similarlycorrected, is shown in **Table 4**. Graphical representations of both datasets are provided in **Figures 1 and 2**.

From **Figure 1** it is apparent that there was no trend in numerical dominance across all seven dams. Canary kurper (*Chetia flaviventris*) was dominant in Hartbeespoort and Rietvlei (55% and 42% of total catch, respectively), whereas the sharptooth catfish dominated in the shallower, sediment-rich Bon Accord and Koster River systems (respectively 61% and 41% of total catch). The numbers of these species were considerably less in the two control dams, as well as in Roodeplaat (a hypertrophic system).

A clear inter-reservoir pattern is apparent from the biomass data (**Figure 2**). The sharptooth catfish dominated the biomass in all seven dams, exceeding 50% in all but two (Rust de Winter, 34% and Bon Accord, 24%) and amounting to a maximum of 73% of total biomass in Koster River Dam. By contrast, common carp ranged from 2% in Rietvlei to 15% in Bon Accord. Despite its numerical predominance in Rietvlei and Hartbeespoort Dams, the small size of the canary kurper resulted in this species contributing only 3% and 6% of total

biomass in these two reservoirs, respectively. Mozambique tilapia was the dominant in Rust de Winter (41% total biomass), as well as in Bon Accord (35% total biomass).
Fish biomass, expressed per unit area (see **Table 5**), considerably exceeded 200 kg/ha in six of the seven dams assessed, i.e. exceeding the threshold above which algal-dominance is expected to prevail). The seventh dam, the turbid Koster River, had an areal biomass of 202 kg/ha.