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AN EVALUATION OF MANAGEMENT ASPECTS OF A HYPERTROPHIC AFRICAN IMPOUNDMENT

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SUMMARY

Simple empirical models were used to evaluate the potential impact of a number of eutrophication management strategies on a hypertrophic man-made lake, Hartbeespoort Dam, South Africa (25 ° 43'S, 27° 51'E). Both the traditional approach of using point source control of nutrients to restore a system to a less enriched state, and a more pragmatic approach of productively utilising an enriched system, were considered.

Hartbeespoort Dam (area = 20 km^2; volume = 194 x 10^6 m^3), a multi-purpose impoundment, is typical of many man-made lakes in the region. Nutrient loads to the lake are point-source dominated; hence, a 1 mg/ℓ orthophosphate-phosphorus standard for the discharge of treated wastewater has been promulgated for the Hartbeespoort Dam catchment and is scheduled to be fully implemented by mid-1985. The potential impact of this standard is examined in this poster together with those of other management techniques aimed at productively utilising an enriched environment; namely, harvesting of fish and algal protein, and food chain manipulation.

Predictions of the present conditions in the lake were made to establish the validity of the models used (Table 1). Because of the general agreement between predicted and observed values, it was felt that the models chosen could be applied in a predictive capacity. Predictions of post-effluent standard conditions in the lake are also given in Table 1. The most obvious effect of the standard is the decrease in point source load leading to a reduction of the in-lake nutrient concentrations. The large overlap of the 95% confidence intervals before and after implementation of the standard may mean little real change in the in-lake nutrient concentrations. However, the lower mean leads to a projected decrease in productivity throughout the food chain. The effect of the effluent phosphate standard on nitrogen concentrations is less well-defined, but a reduction of phosphorus relative to nitrogen shifts the N:P ratio upwards. Nutrient limitation is unlikely to occur due to the relative abundance of both nutrients even after diversion ([P] = 150 μg/ℓ, [N] = 3 - 4 mg/ℓ; Table 1).

Alternative management strategies of food chain manipulation, protein harvesting and N:P ratio modification were assessed in the light of the anticipated altered state of the impoundment. However, the present findings indicate that such

TABLE 1. Predicted and Observed Values of Model Parameters

Parameter		Observed values ± 95% confidence intervals	Predicted values ± 95% confidence intervals	Model reference
P-loading ($g/m^2/yr$)	b[1]	14.3	12.8	OECD, 1982
	a[1]	-	7.1	
[P] (μg/ℓ)	b	564 ± 13	120 - 320 - 740	OECD, 1982
	a	-	65 - 150 - 400	
[N] (μg/ℓ)	b	1132 ± 50	1400 - 3290 - 6800	OECD, 1982
	a	-	1300 - 2890 - 6000	
N:P ratio	b	2	10	
	a	-	19	
[Chlorophyll] (μg/ℓ)	b	52 ± 6	18 - 63 - 210	OECD, 1982
	a	-	10 - 29 - 120	
Primary Production	b	1470	400 - 1036 - 2900	OECD, 1982
($gC/m^2/yr$)	a	-	210 - 639 - 1600	
Zooplankton Production	b	21	36	McCauley and
($gC/m^2/yr$)	a	-	24	Kalff, 1981
Fish Standing Crop	b	875	353	Hanson and
(kg/ha)	a	-	206	Leggett, 1982
Fish Yield (kg/ha/yr)	b	217	107	Oglesby, 1977
	a	-	41	

[1]b = before 1 mg/ℓ P standard (1980-82); a = after 1 mg/ℓ P standard (c. 1986)
[2][N] predicted uncorrected for denitrification (± 50%; Ashton, 1983 - pers. comm.)

alternative management options are probably not viable for the impoundment under prevailing economic conditions. The results of this analysis illustrate the limitations of empirical models and emphasise the need for more sophisticated ecosystem models for the detailed and accurate predictions required for evaluating biological management options. Nevertheless, empirical models still represent a useful predictive tool for water management authorities and, if supplemented by a sound limnological background, can provide a reasonable basis upon which to make lake management decisions.

REFERENCES

Hanson, J.M. and Leggett, W.C. (1982). Empirical prediction of fish biomass and yield. *Can. J. Fish. aquat. Sci.*, 39 257-263.

McCauley, E. and Kalff, J. (1981). Empirical relationships between phytoplankton and zooplankton biomass in lakes. *Can. J. Fish. aquat. Sci.*, 38, 458-463.

OECD (1982). *Eutrophication of Waters: Monitoring, Assessment and Control.* Organisation for Economic Cooperation and Development, Paris.

Oglesby, R.T. (1977). Relationships of fish yield to lake phytoplankton standing crop, production and morphoedaphic factors. *J. Fish Res. Bd. Can.*, 34, 2271-2279.