Cost-effective removal of diffuse source nitrogen: the feasibility of treatment wetlands in Lake Rotorua catchment

K.D. Hamill*, R. MacGibbon*, J. Turner**

*Opus International Consultants, PO Box 800, Whakatane.
**AgResearch, Hamilton

Keywords: Treatment wetlands; cost-effectiveness; nitrogen

Wetlands are one of a range of interventions being considered to reduce nutrient loads to Lake Rotorua. We assessed the feasibility of using four different types of wetlands to reduce nitrogen (N) and phosphorus (P) loads to Lake Rotorua, these were: constructed treatment wetlands, restoring natural surface flow wetlands, restoring seepage wetlands and floating wetlands.

A long term, sustainable rate of nitrogen and phosphorus attenuation was estimated using a first order, tanks-in-series', kinetic model (Kadlec and Wallace 2009) and literature values for a range of hydraulic loads. The cost-effectiveness of wetlands to attenuate nitrogen loads in the Lake Rotorua catchment was estimated using whole-of-life costs annualised over a 50-year period. A model was built using @Risk software to quantify uncertainty associated with the estimates.

We found that the most effective (kg/ha/yr) wetland types for removing nitrogen were: floating wetlands > constructed wetlands > restoring seepage wetlands > restoring natural surface flow wetlands. However, after accounting for whole-of-life costs we found that the most cost-effective ($/kg) wetlands were (from cheapest to most expensive): protecting existing wetland systems > restoring seepage wetlands > restoring natural surface flow wetlands > constructed wetlands > floating wetlands (see Figure 1). The per hectare cost reduced with higher loading rates and if constructing larger wetlands.

Two $1 million wetland packages were developed. An 'optimum' package consisting of 50% seepage wetlands and 50% natural SF wetlands (by area) was estimated to remove 2.2 (+/- 22%) tonnes N/year per $1 million (net present value). A 'practical' package consisting of 54% constructed, 22% natural SF and 24% seepage wetlands was estimated to remove 1.3 (+/- 16%) tonnes N/year per $1 million (NPV) (see Figure 2). This is comparable to the budgeted target for removing N by the Lake Taupo Protection Project.

We identified areas in the Rotorua catchment that might be suitable for treatment wetlands. Utilising all identified wetland sites (a 'maximum' package) would cost about $54.4 million (+/- 11%) and remove about 59.1 (+/-15%) tonnes nitrogen per year, corresponding to 26% of the nitrogen reduction target sought from the catchment. Despite uncertainty about the actual amount of land available for creation of treatment wetlands, our analysis shows that wetlands can be a realistic option within a package of interventions to reduce nutrient loads to Lake Rotorua.

Wetlands are not only a cost-effective way to prevent nitrogen from entering Lake Rotorua, but also allow for more intensive land use compared to an alternative of land retirement. However their widespread and voluntary construction in the landscape will largely depend on the policy framework; reverse auctions would need to allow for the purchase of small units, and flexibility is needed in the policy and/or modelling tools to account for N attenuation by wetlands.

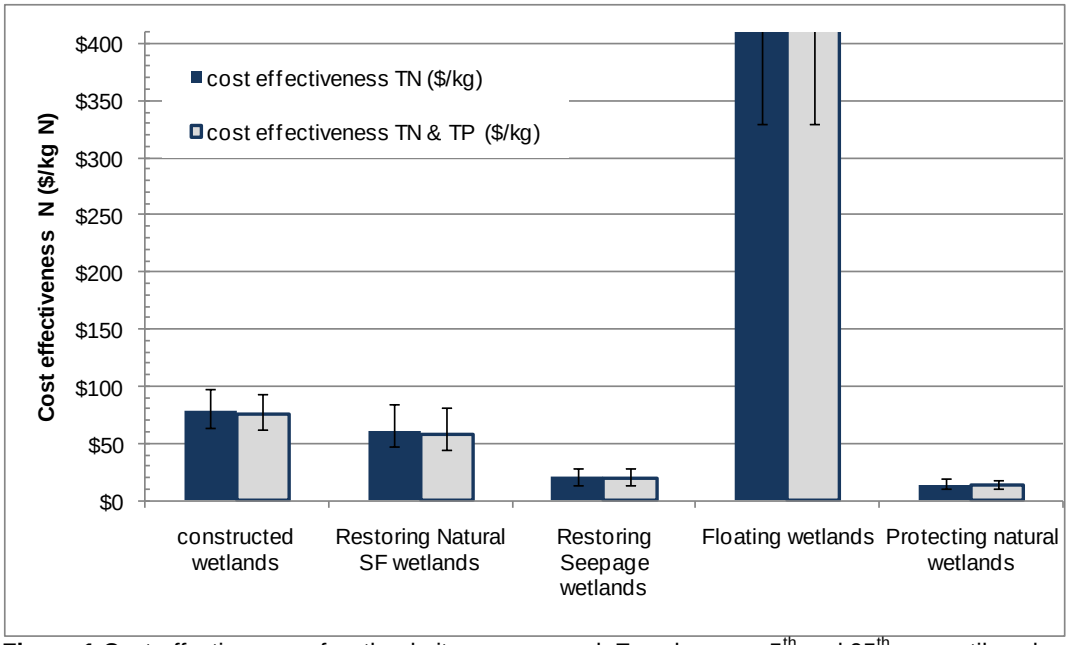

Figure 1 Cost-effectiveness of wetland nitrogen removal. Error bars are 5th and 95th percentile values.

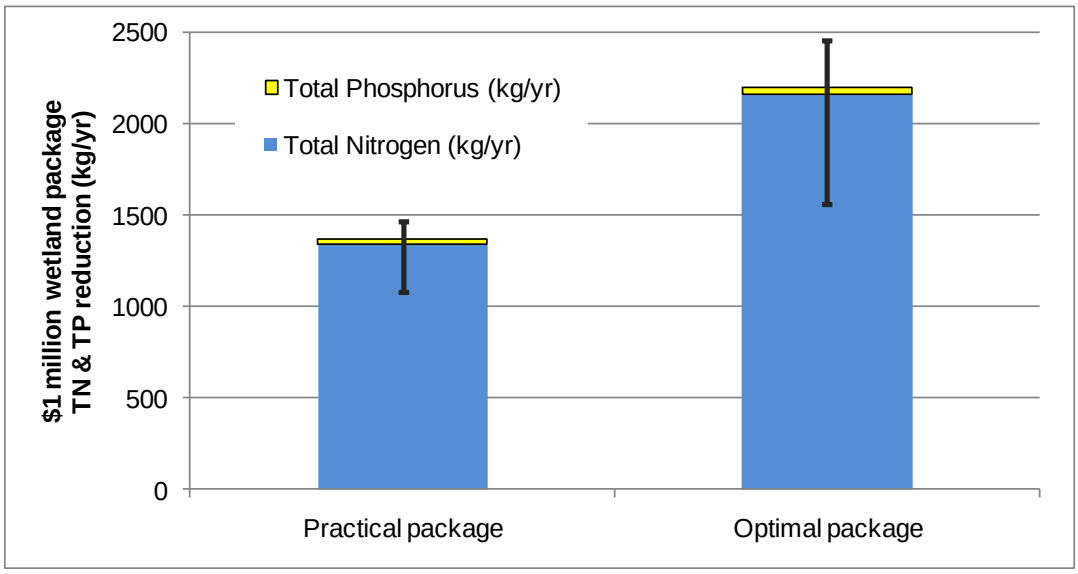

Figure 2. Nitrogen and phosphorus reduction from applying the 'optimal' and 'practical' $1 million (NPV) wetland package to Lake Rotorua. Error bars are 5th and 95th percentiles values.

References

Kadlec, R.H. and Wallace, S. (2009) *Treatment wetlands*. 2nd Edition. CRC Press.