Supplemental Material

Integrating Economic and Biophysical Data in Assessing Cost Effectiveness of Buffer Strip Placement

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1. Rescobie Loch mass balance for P

The annual mean total P concentration entering the Loch water column $[TP]_{in}$ (in kg/m^3) is given by:

$$[TP]in = \frac{P_{land} + P_{ST} + P_{FS} + P_{bird} + P_{STW} + P_{internal}}{A_{catchment} D} \quad (1)$$

Where $A_{catchment}$= catchment area (km^2), D= area mean excess rainfall draining to the Loch (m^3/km^2), and P_{land}, P_{ST}, P_{FS}, P_{bird}, P_{STW}, *and* $P_{internal}$ refer to the various P sources.

P_{ST} : P inputs from septic tanks. In line with Carvalho et al. (2004) we assume export from the 82 septic tanks in the catchment (J. Bowes, personal communication) is 0.3 kg/person/year, and that each is used by 4 persons.

P_{FS} : P inputs from fishstocking of Rescobie Loch with trout for recreational fishing have been estimated from weights of fish stocked minus weight of fish caught, using unpublished data from the Rescobie Loch Development Association.

P_{bird} : P inputs from birds. We have no data on bird inputs; we have made the assumption that the usage of Rescobie Loch by wildfowl is similar on an areal basis to that of Loch Leven, a

large (13.3 km^2) eutrophic shallow Loch for which estimates of bird inputs exist (Bailey-Watts and Kirika, 1999).

P_{STW}: P input from sewage treatment works. This was estimated from the 90 person equivalent caravan site in the catchment exporting 0.44 kg/person/year for 50% of the year. There is some anecdotal evidence of storm overflows into the catchment from a sewage treatment works out with the catchment, but we have no means of quantifying this input at present.

$P_{\mathrm{int}ernal}$: Refers to net release from the Loch sediment. Jeppesen et al. (2005) observed higher Loch [TP] than expected from calculations of Vollenweider and Kerekes (1982) considering only external loads, on shallow eutrophic Lochs, and that during restoration it took 10-15 years for a new equilibrium to be reached, once external inputs had been reduced. We have therefore assumed that a figure for $P_{internal}$ of 5% of default total TP load is reasonable, under conditions where we are aiming at restoration by reducing external inputs. However if default inputs were maintained, this figure may be an overestimate.

The annual mean Loch [TP] is estimated from the Vollenweider equation (Vollenweider and Kerekes, 1982):

$$Loch[TP] = [TP]_{in}\ (1+\sqrt{t_{res}}) \qquad (2)$$

Where t_{res} = residence time in years.

We have used the observed mean $Loch[TP]$ value for the years 2003-2006 (SEPA, personal communication) to estimate the expected value of $[TP]_{in}$.

2. Landscape connectivity estimates

The export model gives a 10 year annual mean estimate of export from 90 riparian (594kg P) and 109 non-riparian fields (361 kg P) to streams. This is considerably higher than the P loading of 605 kg P implied by the average Loch TP. We assume this is due to three factors:

(a) poor connectivity between non-riparian fields and streams ($fconnectivity_i < 1$).

(b) buffering of riparian fields according to the regulatory requirement of 2m buffers

(c) deposition of P export from land in streams and Loch riparian areas ($f\,stream_to_loch < 1$). We have adjusted the value for $fconnectivity$ from the non-riparian land to 0.06 , and for a $f\,stream_to_loch$ to 0.85 so that we achieve agreement between model and observed Loch [TP]. Table 5 (main manuscript) summarises the Loch P mass balance assumed under default conditions (i.e., 2 m buffer strips on all riparian fields).

A full validation of the export model requires comparison of multi-annual P load data for the streams discharging into the Loch, and simulations based on actual crops and crop areas. This is beyond the scope of the current paper, but monitoring of the loading of P has been done for the 238 ha Baldardo sub-catchment (Vinten et al., 2010), giving 123±48 kg/year (n=3 years). The export model using the LandSFACTS simulated crop rotation, simulates 67 ±16 kg P/year (n=10 years). The range was 50-97 kg P/year.

References

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