# Client Report

**Prepared for DEEResearch Ltd**

May 2005

## How does a stream recover after deer have been prevented from wallowing. Progress report – year 1

R. W. McDowell

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# 1. Executive Summary

Recent work has highlighted the concern surrounding the wallowing of deer and their potential to impair surface water quality. A study was initiated to see if fencing-off a wallowing area from deer could improve water quality. During the first year of this trial the site has been left unfenced to establish a baseline. This data in conjunction with previous data for another study indicates that water quality guidelines were exceeded for several parameters (E. coli, suspended solids, total P, and ammoniacal-N). However, the high level of contamination should emphasize the beneficial effect of fencing-off once completed.

# 2. Introduction

Recent work has highlighted the potential for deer to harm water quality. One of the main causes of this impact is via wallowing (McDowell & Paton 2004). Recent work by Environment Southland (2000) measured concentrations of suspended solids (SS) and the faecal indicator bacteria Escherichia coli (E. coli) upstream and downstream of a wallowing site. The few spot samples taken indicated that SS was up to 35 times greater downstream than upstream while E. coli was 20 times greater downstream of the wallow.

In order to give a better estimate of the potential range of contaminants draining from wallowing areas and into streams McDowell & Paton (2004) conducted a pilot study from a wallowing area that drained into the Dow stream near the AgResearch - Invermay Deer farm. Data from this study indicated that mean concentrations exceeded current lowland surface water limits for dissolved reactive P (DRP, 0.01 mg/l) and total P (TP, 0.033 mg/l), E. coli (126 E. coli/100ml), nitrate-N (0.444 mg N/l) and ammoniacal-N (0.021 mg N/l). Damage was also occurring to the structure of the stream banks and bed. Such high concentrations of nutrients can promote the growth of unwanted aquatic weeds and algae.

In order to alleviate this problem a study has begun to determine if fencing off the wallow and small stream from deer can improve the water quality coming from the wallow area. This report summarises the first year in which the current situation of unrestricted access exists, before fencing off occurs.

## 3. Materials and methods

The AgResearch Invermay deer farm near Mosgiel covers c. 160 ha split amongst 90 paddocks of rolling to steeper hill country at an altitude of 150 to 300 m. The farm has been running since 1972, while about half has only been farmed with deer since 1991. Mean annual rainfall is 687mm falling on 153 days of the year. The predominant soil type is a Warepa silt loam (mottled fragic Pallic soil) with outcrops of Cargill hill soils (acidic mafic Brown soil) higher up. Currently c. 1200 deer are farmed with a pasture rotation of 21-56 days depending on the time of year.

The wallow (Fig. 1) receives water from a 10 ha catchment and feeds a tributary of the Dow stream, which feeds the Silverstream and ultimately the Taieri River. Flow was measured manually on a daily basis while samples of flow were also taken on a weekly basis for contaminant analysis.

**Fig. 1.** Photograph of the wallow site taken in February 2005.

Flow samples were filtered (< 0.45 μm) immediately and analysed for DRP within 24 h, and total dissolved P (TDP) after persulphate digestion within 48 h. An unfiltered sample was also digested and TP measured within 7 days. Fractions defined as dissolved unreactive (largely organic) P (OP) and particulate P (PP) were determined as TDP less DRP and TP less TDP, respectively. All P analyses were made using the colorimetric method of Watanabe & Olsen (1965). Suspended sediment (SS) was determined by weighing the oven dry (105oC) residue left after filtration through a GF/A glass fibre filter paper. Samples were analysed for NH4+-N and NO3--N concentrations using standard auto-analyser procedures.

*Escherichia coli* was measured as the preferred faecal indicator bacteria for freshwater in New Zealand (MfE 2002). Overland flow samples from fence-line soils were diluted 1:20 w/w with sterile distilled water (otherwise undiluted). For each sample, diluted or not, a volume of 100 ml was enumerated using the Colilert® media and the Quanti-Tray® system (IDEXX Laboratories, Maine, USA).

## 4. Results and discussion

Data for daily flow and weekly total P and E. coli concentrations from the wallow site is given in Figure 1. As is the case with headwaters, flow from the wallow was characterized by short periods of high flow and long periods of low flow. This is due to the inability of headwaters to buffer inputs of overland flow via precipitation; larger streams with more flow coming in as baseflow would not exhibit this pattern. Concentrations of E. coli were generally greatest when stock were either in the paddock containing the wallow or in the paddock immediately upstream of the wallow paddock. However, even when stock was not in either paddock E. coli concentrations well in excess of the recommended limits for lowland water quality were still possible during periods of high flow. This can be attributed to the survival and storage of E. coli in sediments (McDowell & Stevens 2006). For other contaminants such as total P, concentrations were generally best related to flow, but also peaked when stock were allowed access to the wallow paddock.

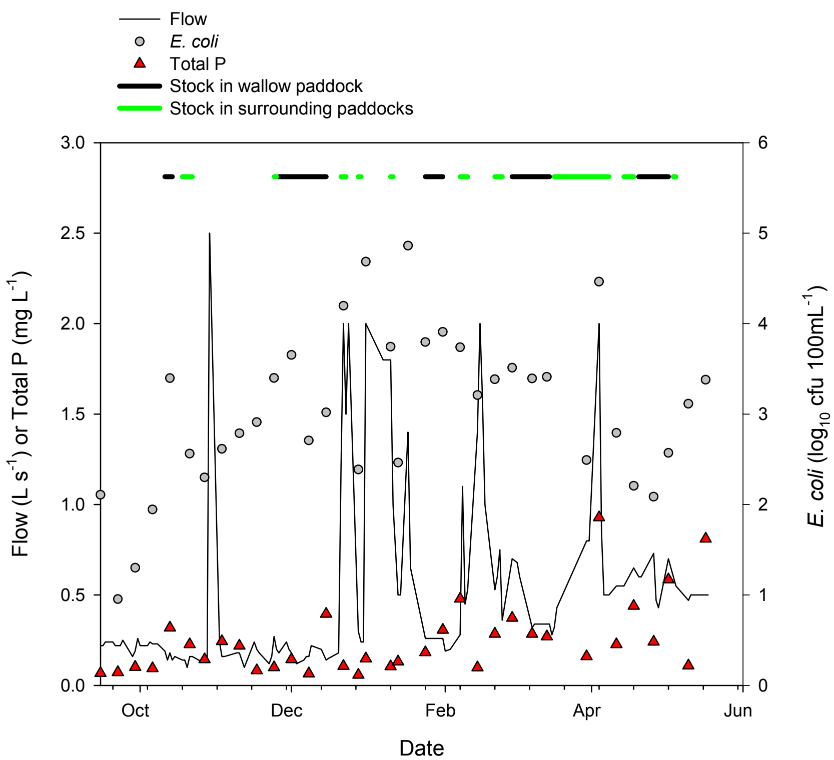


Fig. 1. Daily flow and weekly total P and *E. coli* concentration in flow from the wallow.

In comparison to the current limits for good lowland water quality, all contaminat concentrations baring the median concentrations of DRP and NO3—N, exceeded these guidelines (Table 1). This indicates that the quality of water draining the wallow was in general poor. This is especially the case for E. coli, which is an order of magnitude in excess of the recommended limit. The median concentrations of SS, TP and NH4+-N were approximately 250, 450 and 350% in excess of their respective ANZECC (2000) limits.

Compared to the previous year (2003-04) of monitored data, median concentrations of most contaminants were similar, except for SS, to the current year's median concentration. The reason for the disparity between median SS concentrations between years is unclear, but may have been associated with cultivation for winter forage cropping in upslope paddocks (not the wallow paddock).

**Table 1**. Median concentration of contaminant species in comparison to ANZECC (2000) limits for lowland water quality.

| Contaminant | 2003-04[a] | 2004-05 | ANZECC (2000) limit |
|---|---|---|---|
| Suspended solids (g $L^{-1}$) | 0.300 | 0.141 | 0.040 |
| E. coli ($log_{10}$ cfu 100m$L^{-1}$) | 2.96 | 3.07 | 2.10[b] |
| DRP (mg $L^{-1}$) | 0.007 | 0.006 | 0.010 |
| TP (mg $L^{-1}$) | 0.176 | 0.183 | 0.033 |
| $NH_4^+$-N (mg $L^{-1}$) | 0.080 | 0.095 | 0.021 |
| $NO_3^-$-N (mg $L^{-1}$) | 0.300 | 0.220 | 0.444 |

[a] Taken from McDowell & Paton (2004)

[b] Relates to the recreational water quality guidelines (MfE 1999).

While data indicates that the water quality draining the wallow site was poor this should be put in perspective. Overall, the water quality on deer farms will be greatly affected by the number of wallows contributing to permanent waterways, but if wallowing areas can be managed then their effect can be minimised. By fencing-off access, as is planned next year, the direct source of E. coli and much of the P and NH4+-N via dung will be stopped, leaving only the contribution via overland flow. If fencing alone is not successful then additional measures such as planting to stabilise banks and regulate water flow should be considered.

## 5. Conclusions

Data for the monitoring of a stream draining a wallowing area indicated that overall water quality was poor, especially for E. coli, SS, TP and NH4+-N. However, much of this is likely to be caused by direct deposition of dung into the wallow and may be decreased when the wallow area if fenced-off.

## 6. Acknowledgements

This work was funded by DEEResearch.

# 7. References

ANZECC 2000. Australian and New Zealand Guidelines for fresh and Marine Water Quality. Volumes 1 and 2. Canberra, ACT, Australia. Australian and New Zealand Environment and Conservation Council.

Environment Southland. 2000. State of the environment report – Water. Environment Southland, Invercargill, New Zealand. 48 p.

McDowell RW Paton RJ 2004. Water and soil quality in an Otago deer farm. Proceedings of the New Zealand Grasslands Association 66, 187-194.

McDowell RW Stevens DR 2006. Experiments examining soil and water quality in a New Zealand deer farm. Progress in Environmental Research. In press.

MfE. 1999. Recreational water quality guidelines. Ministry for the Environment, Wellington, 16pp.

Watanabe FS & Olsen SR 1965. Test of an ascorbic acid method for determining phosphorus in water and $NaHCO_3$ extracts from soil. Soil Science Society of America Proceedings 29, 677-678.