Riparian buffer strips: Case study of a catchment in Victoria, Australia

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Highlights

- Riparian buffer strips can reduce the concentrations of *E. coli* in waterways, regardless of dry or wet weather and land use.
- The bigger the size of riparian buffer strips, the better the reduction of *E. coli* in waterways.

Introduction

Catchments in general contain diverse sources of waterway pollution, which can be associated different land uses such as residential and agricultural activities. Specifically, faecal pollution of waterways is a problem because it increases the cost of water treatment and poses public health issues. For instance, waste effluents from residential areas (leaking septic tanks) and wild animals (both native and invasive) can introduce faecal pollution. Agricultural manure produced by stocking operations and applied to fields (in cropping areas) can also be washed into streams (Petersen *et al.*, 2018). To mitigate faecal pollution, riparian buffer strips are commonly used. However, previous studies on effectiveness of riparian buffer strips were mostly conducted under controlled settings (e.g., small plots and simulated rainfall).

Therefore, this research was aimed at understanding effectiveness of riparian buffer strips under natural field conditions. In particular, the following questions will be addressed: 1) How do riparian buffer strips affect the concentration of *E. coli* in streams, and does this effect vary over dry and wet weather period?; 2) What is the relationship between size of riparian buffer strips and concentrations of *E. coli*?

Methodology

Catchment information

A catchment in Eastern Victoria was used as a case study. The catchment contains residential land use, forested areas and agricultural activities. In total, there are 3 main tributaries and 7 small sub-catchments within the catchment, with 4 of the small sub-catchments containing riparian buffer strips.

Data collection

Three water quality monitoring campaigns have been conducted to sample from 3 main tributaries and 7 small sub-catchments within the catchment. During each campaign, 125 mL was sampled at intervals of 15 minutes (therefore one 1 L bottle at every two hours), using variants of SIGMA 900 autosamplers. Autosamplers were pre-programmed for sampling to start at 8 am prior to the day of collection for 72 hours, which leads to a total minimum of 36 bottles for each campaign. Concentrations of *E. coli* were measured using Colilert reagents and Quantitray 2000 MPN trays (IDEXX), with either 5 or 10 MPN/100 mL as the limit of detection depending on the dilution factor.

Data analysis

Prior to the analysis, baseflow separation was used to separate dry and wet weather periods. Then, boxplots of all *E. coli* concentrations from the sites were constructed according to buffered sites, unbuffered sites, and main tributaries. Subsequently, Kruskal-Wallis tests with α=0.05 (Kruskal and Wallis, 1952) were used to compare if the differences in the distributions are statistically significant under overall conditions, and also when samples were separated into dry and wet weather regime. The relationship between size of riparian buffer strips and *E. coli* concentrations was also explored through identifying values of Spearman rank-order ρ correlation (Spearman, 2010).

Results and discussion

Based on Figure 1, it was found that in general, catchments with riparian buffer strips have a statistically significant lower median *E. coli* concentration as compared to unbuffered catchments ($p<0.05$; K-W test). The result was found to be the same for both dry and wet weather events, and agreed with previous studies which proved that riparian buffer strips are capable of removing microbes from runoff effectively (Cardoso *et al.*, 2012; Wilcock *et al.*, 2013; Xue *et al.*, 2018).

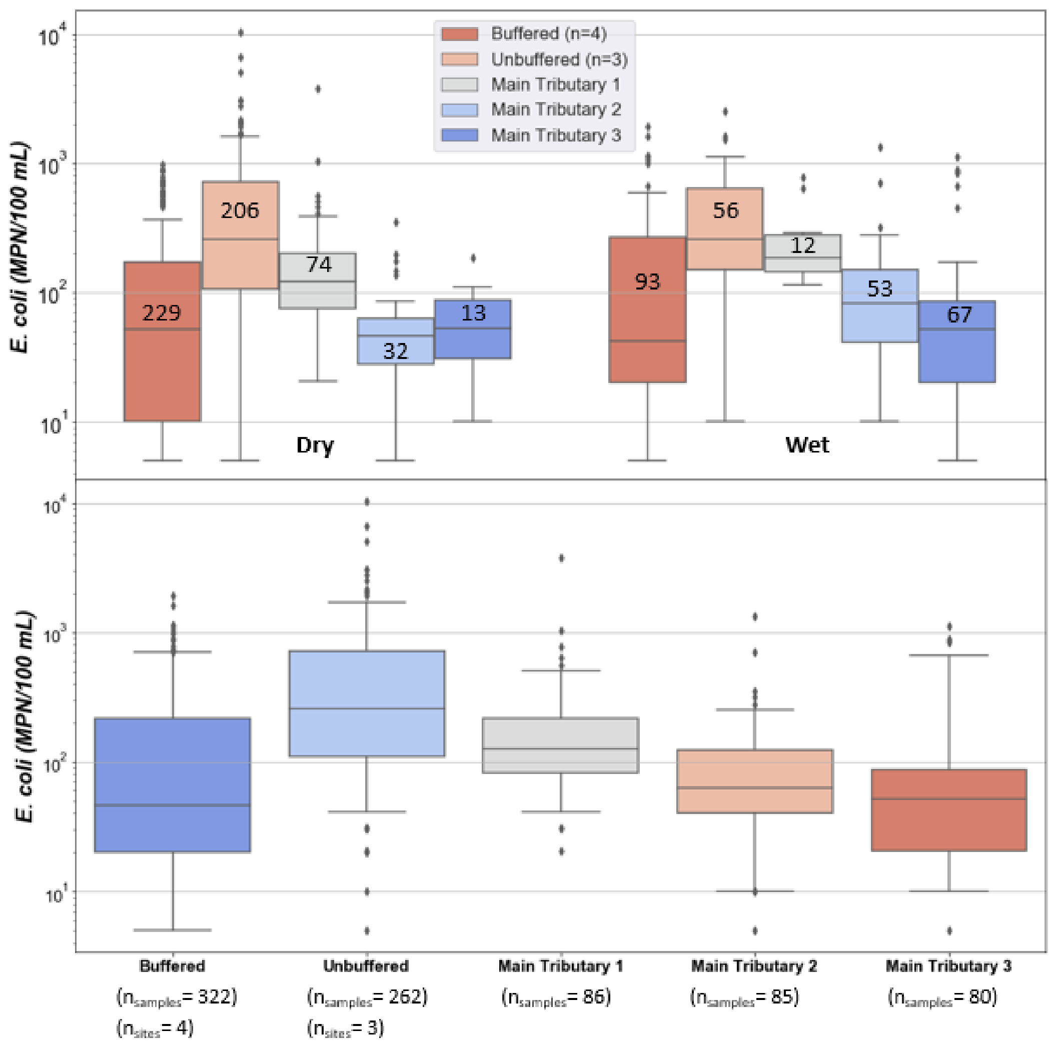

Figure 1. (top) *E. coli* concentrations for buffered, unbuffered, and main tributary sites under dry and wet weather. Numbers in boxplots represent number of samples; (bottom) *E. coli* concentrations for buffered, unbuffered, and main tributaries sites. $n_{samples}$ = number of samples, n_{sites} = number of sites.

When the catchment sites were sorted in ascending order of riparian buffer size (Figure 2), the data showed that the bigger the size of riparian buffer size, the lower the concentration of *E. coli*. This relationship was found to be statistically significant ($p<0.05$; Spearman's Rank-Order Correlation). Hence, this shows that the presence of BMPs within catchment is essential in reducing levels of faecal pollution.

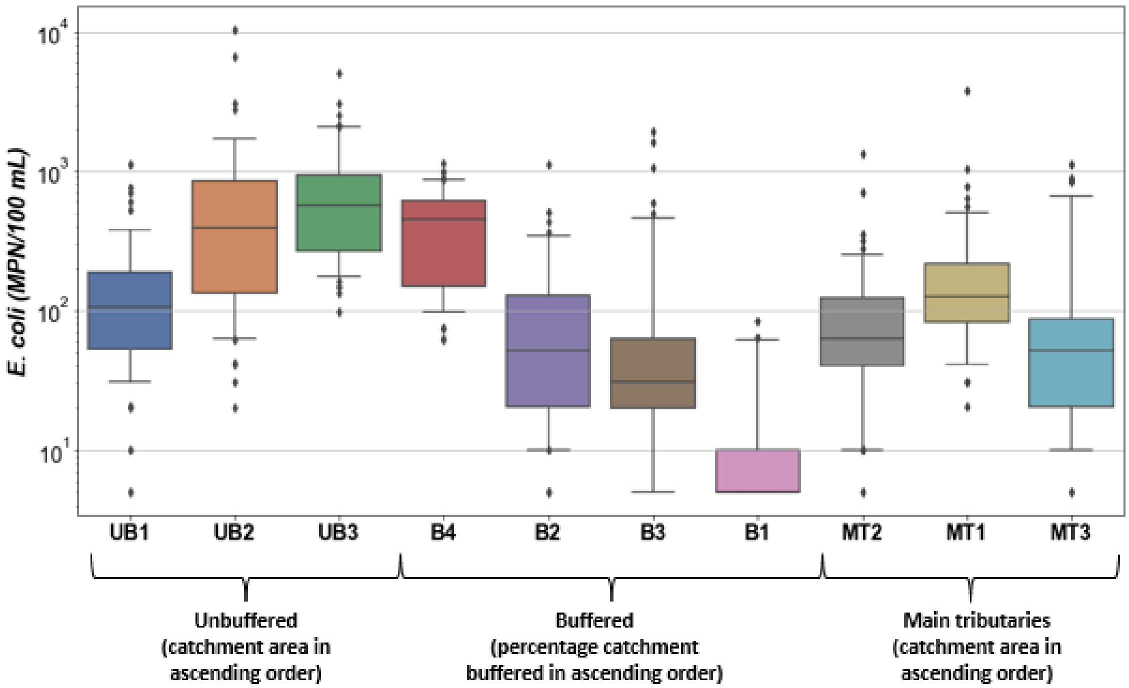

Figure 2. Percentage catchment buffered vs *E. coli* concentration. Sites arranged in terms of unbuffered sites (with increasing catchment area), buffered sites (with increasing percentage catchment buffered), and main tributaries sites (with increasing catchment area)

Conclusions and future work

From this research, the following findings have been obtained: i) faecal pollution in waterways can be mitigated through the use of riparian buffer strips in dry and wet weather conditions, regardless of land use condition; ii) adequate levels of design and implementation of riparian buffer strips are essential in minimising the levels of faecal pollution in waterways. For future work, the effect of riparian buffer strips in faecal pollution source tracking can be investigated.

References

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