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Do riparian zones improve stream water quality in flat, sandy catchments?

Like many agricultural, flat, sandy catchments across Australia and around the world, Ellen Brook exports large amounts of nutrient to waterways.

Ellen Brook flows only seasonally so it contributes only 7% of the total flow into the Swan River, but delivers 39% of total phosphorus (P) and 28% of total nitrogen (N) annually, which contributes to algal blooms and fish kills. A common way to reduce nutrients leaving the catchment is to restore or protect riparian zones along stream banks, but do these riparian zones improve water quality in streams in these flat, sandy catchments?

What are riparian zones?

Riparian zones are narrow strips of land adjacent to streams, which provide a buffer between the stream and farmland. Nutrients in water passing through the zone can be intercepted and stored in the plants and soil, which helps maintain and improve stream water quality, and provides a suite of environmental benefits. However, much of the research that has described the effectiveness of riparian zones as a nutrient reduction tool are based on studies in places that have soils with a good nutrient-holding capacity, a marked slope towards the stream channel and are adjacent to perennial streams (as shown on the right hand side of Figure 1). With many of these key characteristics missing in the flat and sandy catchments, typical of Western Australian agricultural areas (left hand side of Figure 1), our research investigated whether these riparian zones still functioned effectively to improve stream condition.

Methods and results

This study compared the hydrology and nutrient dynamics of two streams in the Ellen Brook catchment north of Perth, one an intermittent stream in a flat sandy landscape (Bingham Creek) and the other a perennial stream in a nearby landscape with slope and good soils (Lennard Brook). Nutrient stores within groundwater, soil and plants were analysed.

In these flat sandy riparian zones, the dominant flow path is not horizontally, towards the stream, but rather the vertical rise and fall of groundwater in response to rainfall, which limits the interaction of groundwater with the active root zone of riparian soils and reduces their potential for nutrient assimilation (Figure 2). However, this also results in long residence times, allowing denitrification to occur. In comparison, Lennard Brook has the characteristics of good soils, an underlying clay layer and slope, so horizontal surface flow occurred through the root zone increasing the interception of soil particles and phosphorus (Figure 2).

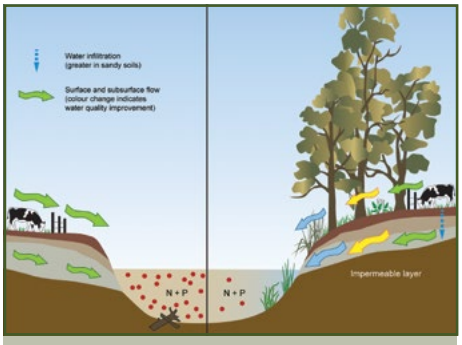

FIGURE 1 A conceptual model highlighting the importance of flow in nutrient removal for vegetated and unvegetated riparian zones

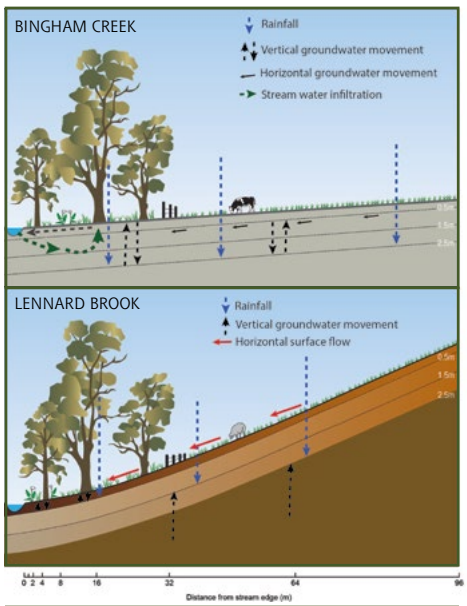

FIGURE 2 A conceptual model of the hydrology of Bingham Creek and Lennard Brook

Riparian vegetation was also found to improve the aquatic animal community in both intermittent and perennial streams. While the vegetation, where present, was similar throughout the catchment, the aquatic fauna (macroinvertebrates) differed between perennial and intermittent streams, with perennial streams having greater diversity (33 families) when compared to intermittent streams (26 families). The presence or absence of riparian vegetation along these streams had a significant effect on what species inhabited the streams, with greater diversity and more shredding aquatic insects like caddisflies in the vegetated streams. In fact the threatened freshwater mussel (*Westralunio carteri*) was only found in perennial vegetated stream reaches. Riparian vegetation increased biodiversity and provided organic matter for food and habitat and limited algal growth in streams through shading.

Conclusions and recommendations

The capacity for vegetated riparian zones to remove nutrients in flat sandy catchments like Ellen Brook is limited due to soil type and hydrology; however, they still provide significant benefits including:

- Improving the nutrient holding capacity of the underlying soils through input of organic matter
- Reducing the flow of groundwater, allowing nutrient transformations like denitrification to occur
- Providing a sink for nitrogen and phosphorus
- Improving and maintaining stream ecosystems as indicated by aquatic macroinvertebrate communities in intermittent and perennial streams

The results from this study indicate that revegetating stream banks is beneficial, however, revegetation alone cannot be used to stem the flow of nutrients and it must be supplemented with other management practices. Overall, riparian vegetation increased the retention of nutrients, improved soils and in-stream biodiversity, warranting the protection and rehabilitation of riparian zones in flat sandy catchments. ■

BOX 1 How does slope and soil characteristics affect nutrient storage in riparian zones?

There are clear differences in the nutrient stores in riparian zones on the flat sandy stream banks and those with slope and good soils. As the riparian and paddock soils at Bingham Creek had a poor nutrient holding capacity, nutrients were primarily stored in the groundwater and not the soil, making nutrients potentially much more mobile. However, as the land is so flat, groundwater movement is incredibly slow and the long residence time favors nutrient transformation processes that reduce nutrients, such as denitrification. In comparison, Lennard Brook has good soils, resulting in nutrients being stored in the soil and not the groundwater (Figure 3), thereby reducing the export of nutrients to streams. The riparian vegetation had a similar community structure at both sites, and contributed comparable amounts of leaf litter to the underlying soils. The addition of this organic matter improved the retention of water and nutrients in soils at both sites and promoted the loss of nitrogen through denitrification, illustrating the value of revegetating stream banks.

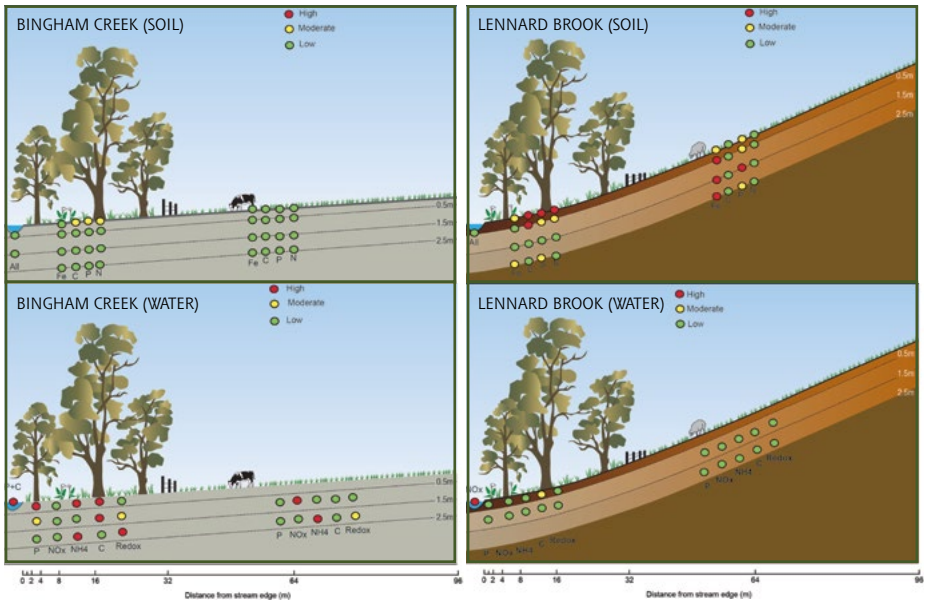

FIGURE 3 A comparison of nutrient stores in the soil and water between Bingham Creek and Lennard Brook

More information

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