

IMPACT OF WILLOWS ON AQUATIC
INVERTEBRATE COMMUNITIES

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Impact of willows on aquatic invertebrate communities



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in fulfilment of the requirements for the degree of
Doctor of Philosophy

School of Earth and Environmental Sciences



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DECLARATION

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Wahizatul A. Azmi

Dated: June 2011

ABSTRACT

I dedicate this thesis to my beloved husband, Md. Yuzeiry Md. Yasin and my sons, Erfan Kheiry and Ezlan Kheiry.

The impact of willows and their removal on aquatic invertebrate communities are poorly understood. In the present study, we investigated the impact of willows on aquatic invertebrate communities in a shallow, lowland, tropical stream. We hypothesized that aquatic invertebrate diversity and abundance would be reduced in streams with willows present and after they have been removed. We also investigated whether willow habitat could provide a useful food source by comparing feeding performance, growth rates and survivorship of five detrital aquatic invertebrates. Also, we investigated the potential habitat value provided by willow roots to aquatic invertebrates and whether shade (willow canopy) can influence the invertebrate assemblage.

Our findings suggest that the presence of willows was closely associated with a reduction in stream diversity. However, the abundance of invertebrates was significantly higher in sites with willows due to the high abundance of the introduced hybrid willow (*Salix nigra* × *Salix caprea*). The establishment of this weed willow should be discouraged as it may be in a future competition with native invertebrates. Our invertebrate diversity and abundance were highest where willows were removed and the site was revegetated. The relation between diversity and change in composition of aquatic invertebrates may be due to loss of habitat change in willow canopy, or may depend on the physical effects of willow removal. This suggests that the significant differences among sites when riparian vegetation is changed from the original vegetation to willow or when willows are removed are not limited to the impact of shade on the growth of invertebrates but may also be related to changes in stream temperature, food availability and water quality.

Feeding performance experiments with mayfly and caddisfly larvae were carried out to assess the impact of willow canopy on a range of food for aquatic invertebrates (*Chironomus tentans*, *Chironomus tentans*, *Chironomus tentans*, *Chironomus tentans*, *Chironomus tentans*, *Chironomus tentans*, and *Chironomus tentans*). We found that willow roots improved significantly higher and more diverse aquatic invertebrate assemblages than in revegetated streams or streambeds with removal of willows. Our findings revealed that willow canopy provides a useful habitat and a source of invertebrates

ABSTRACT

Exotic willows (*Salix* spp.) have invaded the riparian zones of many Australian streams, but the impact of willows and their removal on aquatic invertebrate communities are poorly understood. In the Mount Lofty Ranges, South Australia, willows have aggressively invaded riparian zones of many freshwater streams, often affect stream morphology and erosion, leading to water quality problems and suppress growth of native vegetation. We hypothesized that aquatic invertebrate diversity and abundance would be reduced in streams with willows present and after they have been removed. We also investigated whether willow leaves could provide a useful food source by comparing feeding preference, growth rates and survivorship of five dominant aquatic invertebrates. Also, we investigated the potential habitat value created by willow roots for aquatic invertebrates and whether shade (willow canopies) can influence the invertebrate assemblages.

Our findings suggest that the presence of willows was clearly associated with a reduction in taxon diversity. However, the abundance of invertebrates was significantly higher in sites with willows due to the high abundance of the introduced hydrobiid snail (*Potamopyrgus antipodarum*). The establishment of this snail under willows should be considered a serious threat as it may be in resource competition with native invertebrates. Lower invertebrate diversity and taxa numbers were observed where willows were removed and the site not revegetated. This reduction in diversity and change in composition of aquatic invertebrate communities may be due to loss of habitat, changes in water quality, or may depend on the prior history of willow invasion. Taxa responsible for the significant differences among sites when riparian vegetation is changed from the original vegetation to willows, or when willows are removed, were also identified. We found that changes in the pattern of invertebrate assemblages seemed to be influenced by differences in season, habitat quality, food availability and water quality.

Feeding preference experiments where eucalypt and willow leaves were compared revealed that willow leaves are a source of food for some native invertebrates [e.g., *Dinotoperla evansi* (Plecoptera: Gripopterygidae), *Tasmanocoenis tillyardi* (Ephemeroptera: Caenidae) and *Lingora aurata* (Trichoptera: Conoesucidae)], and may influence their growth rates and survivorships. In habitat preference experiments, we found willow roots supported significantly higher and more diverse aquatic invertebrate assemblages than an artificial substrate of aluminium wire mesh of different sizes. These findings revealed that willow roots provide a better habitat and a variety of microhabitats

for invertebrate colonisation. However, the introduced hydrobiid snails were strongly associated with willow root habitats compared with other invertebrates. In experiments of the effect of shade, we found that increased light as a result of willow removal and revegetation resulted in lower invertebrate abundance, although there were higher taxa numbers and diversity. This increase in sites lacking a riparian canopy (i.e., open canopy), may be due to an increase in the availability of quality food through reduced shading, which in turn increases the long term invertebrate community diversity, productivity and abundance.

Careful management of restoration programs to remove willows and to revegetate the sites is highly recommended, particularly in small streams such as those in this study. Many aspects need to be considered before willows are removed and revegetation programs carried out. These include: the impact of willows including their canopies and root masses, and that of the revegetation to replace willows. Aquatic invertebrates are potential bioindicators in the ecological success of willow control and revegetation programs, and should be considered as an important component during monitoring of such programs.