# MANAGING WILLOW (*SALIX*) ALONG THE UPPER KING RIVER IN NORTH-EAST VICTORIA

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**Summary** This paper details a willow (*Salix* sp.) management program undertaken on the Upper King River of north-east Victoria. The program incorporated a range of techniques to remove willow and manipulate the riparian vegetation to achieve specific stream and floodplain management objectives. The program seeks to create an environment suitable for the establishment of a desirable suite of vegetation to replace willow currently dominating the stream and riparian zone.

## INTRODUCTION

Streams and riparian zones are managed to provide for the often conflicting demands of hydraulic conveyance, erosion control, flora and fauna conservation, and recreation and aesthetic values (White *et al*. 1994). Riparian vegetation management requires a high level of sophistication to meet the diverse and often conflicting demands faced by stream managers. No one plant species can adequately satisfy all functions of riparian vegetation. Willow has been used for stream erosion control and stabilization throughout Victoria. Willow is fast growing and provides an extensive root system for erosion control. However willow alone fails to fulfil the diverse requirements of riparian vegetation. Further, uncontrolled willow growth can have a detrimental impact on stream conditions

North Eastern Waterways (NEW), a waterway authority established under the Water Act 1989 and responsible for stream management through the Upper King River has undertaken a willow management program on the Upper King River over a period of years. The works site being the subject of this paper is located approximately 5 km downstream of Lake William Hovell. The location of the King River is shown in Figure 1. The work site starts from the point where the floodplain opens out and the land has been cleared for agricultural purposes. The site extends downstream from this point for 8 km, (16 km of bank), to Hamilton's Bridge near Cheshunt. The floodplain is at an elevation of approximately 300 m (AHD), the catchment has an area of approximately 450 km$^2$.

The program of willow control seeks to retain bank stability, maintain the hydraulic capacity of the river channel and enhance the environmental values of the stream and riparian zone.

## BACKGROUND

The indigenous vegetation of the Upper King River stream banks and floodplain grew as an open forest dominated by *Eucalyptus viminalis* (manna gum) with understorey trees including *Acacia dealbata* (silver wattle), *Acacia melanoxylon* (blackwood) and numerous shrubs and ground flora species. Common waterplants include *Carex gaudichaudiana* (fen sedge) and *Cyperus lucidus* (leafy flat sedge).

Willows have been planted on the Upper King River in north-eastern Victoria for over 40 years. The King River Improvement Trust, a predecessor organization to NEW, was established in 1950 to undertake programs of erosion control through the King River. The Trust introduced willows to the King River as an affordable stream bank stabilization technique where few practical alternatives existed. Willows are now established and a major component of the riparian flora of the Upper King River.

The Upper King River floodplain is prone to scour. The floodplain is relatively steep with typical grades of 0.005 to 0.01 m m$^{-1}$. Major scour of the floodplain has occurred during flood events. The scour has been found to be associated with concentrated outflows from the King River known as breakaways, discharging floodwater over cultivated land. In 1993 Ian Drummond and Associates Pty Ltd. (1993) recommended the implementation of a management strategy to reduce the risk and consequences of breakaways from the Upper King River. Breakaways on the Upper King River have a catastrophic

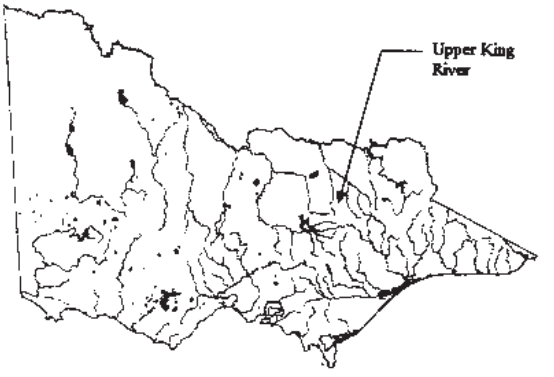


**Figure 1.** King River, north-east Victoria, Australia.

impact on the operations and livelihood of landholders and on stream quality with large quantities of soil lost and extensive infrastructure damaged. A program of riparian vegetation management including selective clearing of willow was proposed as a component of the strategy increasing the river channel capacity and reducing the predisposition for breakaways to occur.

A program of riparian vegetation management commenced in the Upper King River in 1993 as a component of this strategy. The program was undertaken to manage the transition from a river frontage dominated by willows to a frontage dominated by a diverse mix of indigenous vegetation. The program aimed to replace willows growing on the gravel bars and islands with low-growing, pliable, herbaceous species (waterplants). The program concentrated on the mechanical removal of major willow infestations from the stream channel. Riparian Australia was contracted in 1995 to identify and research herbicide control methods and field assess and treat willows in one operation. The field works were completed in eighteen days during February and March 1995.

## WILLOWS

Willows used in bank stabilization along the Upper King River for the past 40 years have grown into substantial trees. Willows have spread from these trees and colonized the banks, the numerous gravel bars and islands of the shallow, rocky river. Spread has been vegetative by floating twigs and branches and by seed.

**Crack (basket) willow (*Salix fragilis*)** The dominant willow of the Upper King River is *Salix fragilis* (crack willow) known locally as the basket willow. It is a large vigorous tree, which is usually exclusively male in sex. The timber is brittle and twigs and branches break easily. Twigs and branches in contact with water quickly develop roots.

**Grey (pussy) willow (*Salix cinerea*)** The other main willow of the Upper King River is the grey sallow (*Salix cinerea*) more commonly known as the pussy willow. It is a rounded shrub or small tree, often multi-stemmed growing to 10 m in height. *S. cinerea* is a relatively minor component of the total willow population of the Upper King River.

Seed from the parent trees of *S. cinerea* are dispersed by wind and water. The seedlings occur both as localized stands, in large numbers, and as dispersed individuals. Conditions on the gravel bars of the Upper King River appear to have been well suited to seedling establishment. On the landward side of one gravel bar, a swampy backwater, a monoculture of *S. cinerea* seedlings numbering in their hundreds had established. At the time of the control program the closely spaced, single trunked seedlings had grown to approximately 10 m in height and had produced flowers and seeds.

Many individual seedlings of *S. cinerea* are also scattered in large numbers among the sedges and tussocks growing on the gravel bars and stream edge. Young seedlings, below about 10 cm high are difficult to detect and may be confused with the seedlings of indigenous or weed species.

Until recently *S. cinerea* seedlings were not known to be present on the Upper King River. Broader recognition of the significance of seed production in willow propagation is a relatively recent phenomenon, even though several River Management Boards have been active in willow control (Thexton 1994, Riparian Australia 1995). Willow seedlings produced by a number of different species may be found on most river systems in Victoria.

## THE HERBICIDE CONTROL PROGRAM

The 1995 willow control program was undertaken through the application of herbicide. Glyphosate (Roundup®) was used for the control program. The herbicide application rates recommended by Monsanto Australia were used for the program.

The herbicide program incorporated the following approaches. The equipment used for the herbicide program is detailed in Table 1.

**Stem injection** Selected trees growing on the banks were wholly or partially treated (selected limbs or trunks) by the wounding of the cambium (phloem) and injection into the wound of a measured dose of neat herbicide (2 mL). Techniques included frilling of small stems, axe incision on larger limbs and trunk, and stump cut with chainsaw on multiple small stems. In trees with multiple stems only the stems injected with Glyphosate were killed.

**Spray** The leaves of twigs and branches growing on gravel bars were sprayed using a low volume pressure equipment.

**Timing of application** The program was undertaken in February and March 1995 prior to the autumn leaf fall. Autumn is commonly recommended as the optimum time of application. Prior to the autumn leaf drop, deciduous trees recover some of the nutrients and carbohydrates present in the leaves. The application period was timed to coincide with this period. This time will vary according to local climatic conditions. The altitude of the Upper King River results in a relatively short growing season and the early onset of leaf fall. Mass leaf yellowing

occurs within five to ten days of herbicide application. At any time other than late summer and early autumn when the tree is in leaf this yellowing may be a cause for some concern among the general public. In the 18 days of field work no rain fell. February and March are relatively dry months in north-east Victoria. Rainfall may well reduce the effectiveness of the application. Axe cuts face upwards forming a dish to hold the herbicide to be absorbed. Rain water is often channelled down the trunk and may wash the herbicide from the wound.

**Safety** All personnel wore safety glasses, gloves, rubber boots, overalls and a hat.

## SITE CONDITIONS

The banks of the Upper King River vary from steep, blackberry covered, rock slopes dropping into deep water, with multi-stemmed willows every three metres to flat banks with few blackberries (*Rubus fruiticosus* spp. agg.) and large single stemmed trees in open conditions.

The amount of work was directly related to the site conditions and the density and type of willows to be treated. A two man crew treated between 500 m and 2 km of stream bank per day. Wasps were an unpredictable impediment. Blackberry was the second most dominant plant species present along the subject reach of river. The blackberry canes severely hampered access to the watercourse and willow.

The injection and spray applications were carried out in separate sweeps of the 16 km of stream bank. Working along the river it was not practical to carry both injecting and spraying equipment at the same time.

## RESULTS

A formal assessment of the willow control work has not been undertaken. However observation made separately by the authors in November 1995 has confirmed that most of the willow trees injected and the stems cut and painted have failed to sprout leaves. The few leaves observed to have sprouted on some trees are restricted to the trunk and are discoloured and distorted. Gravel bars were submerged at the time of inspection. A systematic evaluation of the treatment is planned.

Observations suggest that the phased removal of willows over a period of years starting with mechanical removal from the centre of the stream has allowed recolinization by a diversity of indigenous water plants. The follow-up herbicide-based program which has selectively removed willows and over-hanging branches from the waters edge may extend this recolinization by further removing the dense shade of the willows allowing waterplants to germinate and thrive.

## DISCUSSION

Riparian vegetation is acknowledged as being the main means of achieving long-term bank stabilization. More than ever, the right plants in the right places are required, no single species can fulfil all the functions required of riparian vegetation. In general, a suite of species indigenous to the site can often best satisfy these functions

The vegetative spread of *S. fragilis* along the Upper King River has followed the pattern documented by H. G. Strom. “The very vitality and adaptability which makes the willow so useful for river improvement work may cause it to be a serious nuisance if it gets out of control; pieces of green willow which are allowed to be washed downstream may take root in unexpected places, and if allowed to grow may be hard to get rid of later. Uncontrolled willow growth has ruined many streams in Victoria” (Strom 1962).

It is also probable that the uncontrolled clearing of willow growth may well ruin many Victorian streams. Streams may be once again opened up to erosion, many thousands of dollars may be expended and depending on the methods used debris may be introduced to the channel to be washed downstream during floods. The need to reduce the willow domination represents an opportunity to develop other species of vegetation along the waterway to serve a range of purposes not fulfilled by willow. These plants may, with appropriate erosion management maintain bank stability and may also bring benefits for recreation, conservation and landscape values.

Economical development of a variety of alternative vegetation in locations and at a scale required can only be achieved through natural regeneration. Natural regeneration occurs where a seed source is present and the

**Table 1.** Herbicide application equipment.

| Method (Supplier) | Equipment | Advantages |
|---|---|---|
| Stem Injection (Savco Pty Ltd. 134 Briggs Road, Raceview, Queensland 4305) | Kit consisting of one purpose built half axe**,** Phillips injector and 5 L backpack and sharpening stone. | Versatile, durable, useable on any size tree. Light and easy to carry in the rough river bank terrain, no fuel, no breakdowns. |
| Spray | 15 L knapsack, 5 L hand held sprayer | Smaller sprayer especially useful on slippery gravel bars. |

conditions are created which allow for field germination and growth. The method, timing and sequence in which the willow control program has been undertaken has been observed on the Upper King River to positively influence the natural regeneration of desirable species. The program recognises light as a limiting factor for vegetation growth in the stream environment. The program uses availability of light to manipulate where and when plants grow.

A phased program to progressively remove willows from the centre of the stream, allowing light first into islands and gravel bars where waterplants can grow and build up numbers and followed several years later by control of limbs and trees over hanging the stream which allows waterplants to germinate and spread along the waterline provides for both stream stability and a range of other stream related values. The program when viewed from this perspective is more about providing the conditions for the growth and build-up of desirable species than killing willows.

The cost of failing to regularly monitor and control willows was described by Strom. "A willow a few inches high growing in a river bed may be pulled out with one hand; left for a few years, it may develop into a large clump of strongly rooted trees growing in an island of silt and debris costing hundreds of pounds to remove" (Strom 1962).

Once the vegetatively reproducing *S. fragilis* and the seed producing *S. cinerea* are brought under control a more frequent, less intensive, programmed approach aimed at targeting willows closer to the 'few inches high' stage may prove to be an economical addition to the Upper King River management regime.

There is a case for extending vegetation management to the control of blackberries growing on the margin of the Upper King River, to reduce the competitive effect on the germination and growth of the indigenous dryland species. Spraying would be most economical, effective and practical from the water. Spraying of the blackberries before the willow herbicide control program may be the most practical approach for both willow and blackberry control. The dense blackberry canes severely obstructed access along the river and reduced the rate of herbicide application. A large difference in efficiency and operator comfort occurred on frontages where effective blackberry control had been executed by the adjacent landholder.

With the degree of change to the river environment that has occurred since settlement, re-establishment of an indigenous vegetation corridor will require a considered, ongoing program of management. It will not be achieved in a single year, nor by boom and bust spending. Such a program calls for consistent and continual input. For the range of indigenous species to thrive in the vegetation in the managed river environment, the vegetation must be supported by a complete approach to management.

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