

Section 2

Managing willows

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If not controlled properly, willows will readily re-sprout. (Sarah Holland Clift, DPI Victoria)

Managing willows

Now that you understand why willows were introduced, the impacts they cause, how they spread and their perceived benefits, it's time to plan your willow management program.

Willow management is extremely complex and to be successful requires detailed planning, follow up and revegetation.

This section will guide you through all the factors you will need to consider before developing a willow management program and prioritising your activities. As every situation is different, you will also need to weigh up each of these factors before deciding on the best management scenario for your particular circumstances.

Planning a willow management program

As with all major projects, a significant amount of planning is necessary before getting started on a willow management program.

Willow management can be expensive and dangerous and, in many cases, control of all willows is not feasible or desirable. Careful planning is essential to ensure that you clearly achieve what you set out to do in a safe and cost-effective way. Poorly planned projects can waste valuable resources and are rarely successful.

"It may be tempting to control and remove a willow infestation straight away, but without pre-planning, site preparation, follow-up controls and site rehabilitation, the site may revert back to a willow-infested or other degraded condition in a short period of time."

– Sarah Holland Clift, National Willows Program



Any willow management plan should be:

- targeted to achieve both short and long-term objectives
- flexible to changing conditions which may affect the management plans (for example, flood, drought or fire, or the discovery of a seeding willow population that had not previously been recorded)
- based on a good understanding of the life cycle and characteristics of the willows present (see Section 1 Understanding Willows, for assistance)
- based on thorough knowledge of the site conditions, such as climate, water flows, stream morphology, ecology and history
- cost-effective in the medium to long term
- part of an integrated project, with broad environmental, economic and / or social outcomes
- aware of current community perceptions and how the community can best be engaged in the project.

Remember, willows are not necessarily the only problem that needs management, nor should they be the sole objective of your program. Ask yourself what you are trying to achieve by managing the willows and work towards that goal.



The bad, the ugly and the good: Directly following willow removal, the site can look devastating but, in just a few years, it can become a much healthier site, as long as good site preparation, follow-up control and site rehabilitation has been conducted. (The Ovens River, Victoria – Terry McCormack, North East CMA)

Planning generally needs to be carried out at two levels:

Broad-scale planning...

...will help you to determine **where** to undertake willow management works and to develop an investment plan to take to funding bodies.

You will have a greater chance of success if you have a detailed plan and demonstrated support. Planning at this level might be broad enough to cover reaches, sub-catchments, regions or states and should likely also demonstrate links to supporting, over-arching strategies for the region and/or the state you are working in.

Site-specific planning...

...immediately before starting on-ground activities will help you to clarify or determine:

- **what** you plan to achieve
- **why** you want to manage willows
- **who** you should involve
- **when** and **how** you will conduct the works, and
- how you will monitor, **review** and learn from the program.

Broad-scale planning

Where should I prioritise my management efforts?

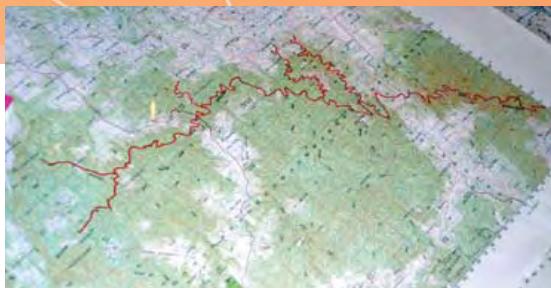
It is important to think about where willows occur in the landscape and in what order these should be managed in order to maximise environmental benefits, make the best use of scarce resources, increase your ability to maintain action in the long term and enable you to integrate willow management into other riparian management initiatives.

As part of your planning, it will be necessary to:

1. Determine where and what type of willows occur in the landscape.
2. Establish realistic objectives.
3. Set priorities for action, based on:
 - the risk of further spread by seed or branches
 - the current impacts and the value of the site
 - density and location of willows and behaviour of the river
 - ease and cost of management
 - landholder commitment and community support, and
 - current and potential resources.
4. Develop a plan for investment.

What you will need to consider as you work through each of these steps is broken down into more detail in the following pages.

Marking the density and location of willows on a map will help you plan your willow management program and prioritise works. (DPI Victoria)



The sex of willows can generally only be determined in spring, when willows are in flower. (Sarah Holland Clift, DPI Victoria)

1. Determining where and what type of willows occur in the landscape

Because you can't manage what you don't know.

In most cases, controlling all willows in an area is not feasible or necessarily desirable.

Mapping and collating site information will allow you to decide which willows to control, when and how to control them. It will also allow you to effectively measure progress over time.

Whether you are working on a local, catchment or regional scale, you will need to undertake a thorough assessment to determine:

- which willows are present in your area
- their density, location and impacts
- their potential for further spread, and
- the value of the area and potential effects if willows are removed.

What information to record?

Wherever possible, you should record where all willows occur in the landscape, including trees in parklands and backyards.

Willows along waterways may be the current cause of most problems but willows away from the waterway may be the cause of significant impacts in the future if they are a source of viable seed or pollen that enables their spread into new areas.

For a detailed assessment form that outlines the key information you should record when mapping willows, refer to the *National Willows Program Resource Kit, Willow Resource Sheet 4: Willow and willow sawfly assessment form and Willow Resource Sheet 5: Willow infestation classes*.

To determine the type of willows and how they spread, refer to *Willow Resource Sheet 2: Willow Identification, an essential skill for effective willow management*.

The above resource sheets are available for download at www.weeds.org.au/WoNS/willows.

If you don't know where and what type of willows occur in your area, how will you know where to manage them?

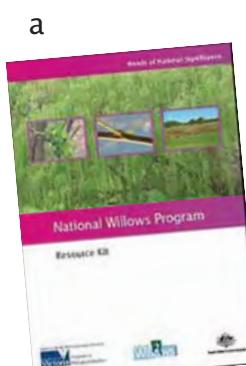
How and when to map willows?

There are several ways to map willows, depending on the scale of work planned, the resources available, your access to the site and the extent of the willow infestation.

On-ground inspection by foot or by boat is generally necessary to collect the information needed to set most effective priorities for management.

Aerial photography, remote sensing and use of local knowledge are quick methods to collect crude, broad-scale mapping data that can later be refined through on-ground inspection.

See 'Methods available for mapping willows' in the following pages for a more detailed explanation, including when to conduct each method, what you will need and the advantages and disadvantages of each.



a



b

a) National Willows Program Resource Kit cover
b) Resource Sheet 2
c) Resource Sheet 4
d) Resource Sheet 5

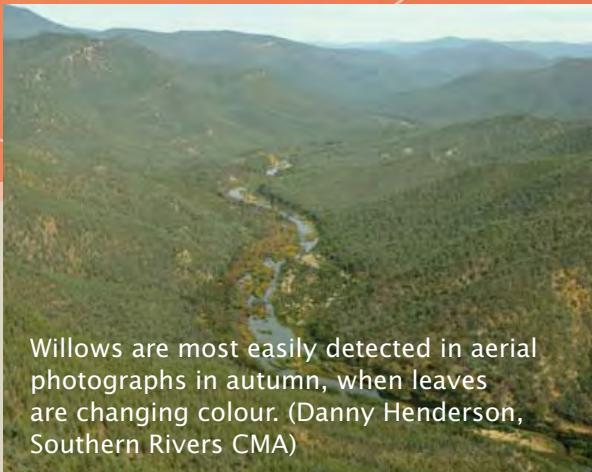
Available at www.weeds.org.au/WoNS/willows



c



d



Willows are most easily detected in aerial photographs in autumn, when leaves are changing colour. (Danny Henderson, Southern Rivers CMA)



Nice day for a paddle: Willow Warriors Inc. mapping willows along the Murrumbidgee River. (Willow Warriors Inc.)

On-ground mapping of willows provides better outcomes for strategic willow management

Fine-scale, on-ground willow mapping is helping to develop more effective willow management strategies in the upper Murrumbidgee River catchment where volunteers have so far mapped the species and size of more than 16,000 willows.

Members of Willow Warriors Inc. have paddled over 150 km of the Murrumbidgee River in inflatable rubber rafts, mapping the location of each willow they pass.

Ready access to the detailed information collected, including the species, size (large, small or seedling), density and location of willows, has been critical in developing effective management strategies, including:

- The early detection and control of young seedlings and local seed sources, such as preventative control plans to eradicate black willow (*Salix nigra*) at an early growth stage.
- Highlighting areas of risk where crack willows (*Salix fragilis*) are likely to become established from existing populations.

Fine-scale, on-ground mapping is needed to determine the type, size, density and location of willows, which are important for planning an effective willow management program. (Willow Warriors Inc.)



- Monitoring willow spread in relation to 'willow-free' zones and containment points.
- Incorporating other data, such as land use and vegetation, into willow control plans to maximise biodiversity benefits.

Broad-scale mapping techniques, such as aerial photography or satellite remote sensing, although quick and effective ways to collect information over a large area, by comparison tend to detect only large willow trees and are unable to distinguish between willow taxa.

Fine-scale mapping provides an optimum level of baseline information to assist willow managers in planning and implementing strategic management.

Note: The Willow Warriors' activities assisted the Upper Murrumbidgee Landcare Inc. and the Upper Murrumbidgee Catchment Coordinating Committee's projects, with funding assistance from the NSW Environmental Trust and the Australian government's Defeating the Weed Menace program.

Methods available for mapping willows

Method and description	When	What you will need	Advantages	Disadvantages
On-ground inspection Surveying on foot, using a hand-held GPS device or topographic map to record the location of willow infestations <i>Best for small, accessible areas</i>	Any time of year, but best in spring, when willows are in flower Identifying if trees are male or female or both is only possible in spring, when flowering occurs, and it is often easier to determine the willow taxa at this time, based on when the flowers and leaves emerge As different taxa flower at different times, more than one visit to the site may be needed	Site assessment forms Willows infestation class table Hand-held GPS unit Topographic maps / aerial photographs Camera Willow identification guide Sample bags and labels (for collecting plant specimens)	Provides detailed information needed for setting effective management priorities Relatively inexpensive	Labour intensive (2 people can survey about 1-6 km per day) Limited by accessibility Requires landowner consent If landowner wants to be with you on site, will need to coordinate access times
Rafting or canoeing Surveying from the river, using a hand-held GPS device or topographic maps to record the location of willow infestations <i>Best for remote areas, easily accessed by water</i>	As above Two to three weeks after a flood can be an opportune time to survey for willows, as they can appear bright green amidst the native seedlings	Site assessment forms Willows infestation class table Hand-held GPS unit Topographic maps / aerial photographs Camera Willow identification guide Sample bags and labels (for collecting plant specimens)	Provides detailed information needed for setting effective management priorities Relatively inexpensive Allows access to otherwise remote areas Does not require landowner consent, once on river Only need to organise access at a couple of points along the river	Labour intensive Requires specialised rafting equipment and training Limited by suitable conditions and accessibility (for example, not suitable when rivers are in flood or are too narrow or dry)

Method and description	When	What you will need	Advantages	Disadvantages
Using local knowledge <p>Local people asked to record on topographic maps where they know willows to occur (an acetate overlay may be used, so that the maps are not permanently marked)</p> <p><i>Useful when needing to quickly gain broad-scale mapping information at low cost</i></p>	Any time of year. In combination with community education and awareness activities.	Topographic maps (minimum of 1:100,000) Acetate sheet to cover map Willow infestation class table 8 markers in the 'willows infestation class' colours	Quick and easy Low cost Draws on local knowledge Engages the community, so can be combined with education and awareness activities	Relies on people's memory Lacks important detail, such as type of willow, method of spread and location in the waterway Often difficult to attain information on minor tributaries
From the air <p>Use of a helicopter or light plane using aerial photography or video</p> <p><i>Useful for gaining broad scale mapping information.</i></p>	In autumn, when the leaves are turning yellow, as this makes them easier to distinguish from evergreen native vegetation.	A helicopter or light plane Aerial photography or video equipment, with attached GPS technology	Large area mapped in short timeframes Can provide a good overview of larger infestations over a large area Not limited by access	Lacks detail (e.g. small infestations may be missed, cannot determine willow type or seed production) Expensive Mainly limited to autumn when willows are changing colour Can be difficult to distinguish willows from other plants
Remote sensing technology <p>ASTER imagery and Spot 5 are currently under investigation as a cost-effective alternative for mapping willows on broad scales</p> <p><i>Useful for gaining broad-scale mapping information</i></p>	Two spectral images taken in summer and winter or summer and autumn will enable willows to be best distinguished from other plants	Remote sensing technology Skilled GIS professional A composite of summer and winter SPOT 5 imagery or summer and autumn ASTER imagery	Large areas mapped in short timeframes Quicker and cheaper than conventional aerial methods Up to 77% accuracy Not limited by access	Winter images limited by undergrowth exposure, shadowing, topography and boundary-mixed pixels Will not pick up isolated trees or seedlings Requires specialised technology and skills

2. Establishing realistic objectives

Why manage willows?

Before deciding where to manage willows, you first need to determine why you want to manage them, as this will form the reference point for your program.

Set realistic objectives that focus on long-term outcomes, rather than on weed control alone.

For example, long-term objectives may include wanting to:

- improve river health by replacing willows and other weeds with native species

- protect and restore native vegetation by eradicating a recent willow infestation
- protect a threatened plant or animal by controlling willows that threaten their habitat
- stop the spread of willows and gradually control existing infestations.

It is often useful to set short, medium and long term objectives that enable you to measure progress over time.

Consult with your local community, land managers and investors to determine what objectives they want to achieve, as they may have different objectives and you may need to find the middle ground.

Timeframe	Example Objectives
Short term (between 1-2 years)	<p>Prevent further spread of a seedling willow infestation by controlling and removing all adult plants capable of producing seed</p> <p>Start site rehabilitation activities, including erosion prevention measures where needed</p>
Medium term (within 5 years)	<p>Control and remove remaining adult plants where needed</p> <p>Control any seedling willows that emerge</p> <p>Continue site rehabilitation activities, including maintaining erosion prevention measures, follow-up monitoring and controls and revegetating with native plants</p>
Long term (over 10 years)	<p>Eradicate all undesirable willows</p> <p>Rehabilitate the site with appropriate native vegetation</p> <p>Demonstrate improvements in water quality and riparian health</p>

Managing willows as part of a broader river health program

Many regional Catchment Management Authorities (CMA) or Natural Resource Management (NRM) bodies address the impacts of willows on river health through their regional river health strategies. This enables them to integrate willow management with the management of a range of other river health issues, such as bed and bank instability, livestock access, threatened assets, feral animals and other environmental weeds.

3. Setting priorities for management

Deciding which infestation has higher priority is not a simple process and will require you to assess a range of interlinking factors. Each situation will need to be judged on its particular mix of circumstances and may require compromises.

Remember, willows are not necessarily the only problem that needs management. It is also important to consider other current or potential problems in your area when setting priorities and allocating resources.

Some key factors to consider when setting priorities:
(note: you may need to add to this list for your particular area)



Each of these factors will have different levels of importance, depending on your specific situation and objectives. How you weight the importance of each, is up to you.

Always review and adapt your priorities over time, as new information becomes available.



Female *S. cinerea* catkins can shed lots of seed in spring. (Terry McCormack, North East CMA)



Bees collecting pollen from male *S. cinerea* catkins. (Sarah Holland Clift, DPI Victoria)

a) Risk of further spread by seed or branches

As with all weeds, it is much more cost effective to prevent future problems than to wait until the problem occurs.

Controlling spread by seed

Very high priority

The need to remove any willows that are producing viable seeds should be a very high priority for management, as these species have the potential to spread long distances into new areas and become a serious problem within a short time period (see Section 1 Understanding Willows, for further information). In some cases, such willows will need to be immediately controlled in areas where they do not currently cause significant impacts, to prevent them from spreading to other, more important, environments.

To determine the potential for spread by seed, you need to know:

- **Is the present mix of willows able to produce viable seed?**

Pollination and seed production is most likely when fertile male and female plants from the same subgenus (tree or shrub willow) flower at the same time and are close enough for pollination to occur. Exactly how far willow pollen can travel is not yet known, but female plants growing 1 km from the nearest male have been observed producing viable seeds. It is therefore recommended that male plants are separated from females by at least 2 km and preferably more if possible.

- Are there potential seed sources outside the area covered by your plan?

In some cases, willow seeds have been known to spread up to 50-100 km from their initial source, so seed may continue to spread in, from other catchments, regions or states.

Early detection of, and rapid response to, seeding willows could save significant cost later on and may make the difference between complete eradication of the weed in the catchment and a long term, expensive control program.

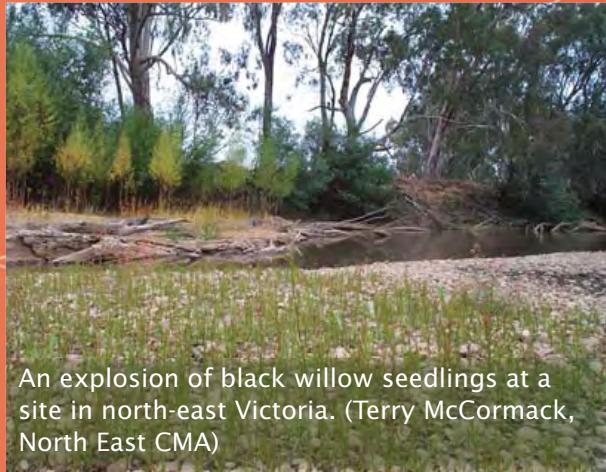
Suggested actions:

- If you find female and male willows from the same subgenus ('tree' or 'shrub') within a few kilometres of each other, remove all female plants immediately (or males, if they are less common).
- If new seedlings are found, remove them immediately, preferably while they are still easy to pull up and before they flower and seed. Seek out and control all parent plants even if they are well away from the river (see inset box 'Selective control of female seeding willows').

Note: In some cases, parent plants may be a long way from the new seedling population, making them difficult to identify. If, however, hundreds to thousands of seedlings germinate in an area in the same season, it is likely that the parent plants are nearby.



The willows on this road cutting in Tasmania are not currently creating significant impacts but, if left unmanaged, they could spread into and threaten some of Tasmania's unique environments. (Sarah Holland Clift, DPI Victoria)



An explosion of black willow seedlings at a site in north-east Victoria. (Terry McCormack, North East CMA)

Selective control of female seeding willows

When resources are limited, rather than controlling all willows in an area, one sex can be targeted (whichever is in lowest abundance) to prevent spread by seed. A thorough survey is critical to this approach.

Thousands of viable seeds may still be produced in a short period if:

- Males are targeted for control, but a few are missed, as they may still pollinate the remaining female trees and enable them to produce viable seed, or
- Females are targeted for control, but a few are missed, as a single, female plant can produce thousands of seed each spring.

'X' marks the spot

Although control activities are possible year round, the sex of a willow can only be determined in spring when flowering occurs. A simple way to maintain a year-round record of the sex of willows, is to survey them in spring and mark all female trees in permanent paint or flagging tape. Female willows are then easily identifiable for selective control at a later date.



'X marks the spot': marking all female willows with an X is a simple way to identify the sex of a willow year round. (DPI Victoria)



To prevent permanent establishment, seeding grey sallow (*S. cinerea*, also known as 'wild pussy willows') are a high priority for eradication in Tasmania. (Sarah Holland Clift, DPI Victoria)

Preventing spread by twigs and branches

High priority

Willows that spread by twigs or branches are mainly of concern along waterways, where the twigs can break off, spread downstream, take root and establish new willow infestations.

To find out whether spread by twigs and branches is likely, you need to know:

- how easily the branches and twigs break off at the base
- the extent and density of the willow infestations, and
- the location of willows along the waterway.

Although managers tend to remove dense willow infestations first, it is actually more effective (and cost effective) to remove sparse populations first, as this is where population growth is most rapid.

Dense infestations can actually act as a 'choke' if the build up of sediment and debris around their roots traps twigs and branches and reduces

their potential to spread further downstream. In contrast, sparse willow populations may not be sufficiently established to limit the spread of willows from upstream, but can act as a source of further spread downstream. There are also likely to be less negative consequences (for example, soil erosion) of removing sparse willows from a stream, compared with dense willows, since they have not yet started to cause significant changes to the stream (see Section 1 Understanding willows, for more information).

Suggested actions:

- If you find plants with brittle branches growing along waterways (for example, crack willow, *Salix fragilis*, and crack willow hybrids, *Salix x rubens*), first control sparse willow populations, then consider management of the dense infestations.
- Prioritise the management of dense infestations based on other key factors discussed in the following pages.

Spread by twigs and branches along a central Victorian stream

Extremely fragile branches make crack willow (*S. fragilis*) the most aggressive willow species to spread by twigs and branches. Aerial photographs clearly document the spread of crack willow along the Birch Creek, a small stream in central Victoria, in a study conducted from 1945 to 1991. This study found that:

- Willows spread downstream at a rate of 90–150 m per year.
- Willows are most likely to take root in shallow sections of a stream or silted backwater environments. In deep, free-flowing sections, where it is more difficult for willows to take hold in the middle of the channel, they tend only to lodge or grow on the banks. By trapping silt and debris, however, willows can eventually change the morphology of the river, creating shallow, braided streams that enable more rapid spread.

- Willow sticks of various sizes floated easily, over 50 m at a time, in reaches that were clear of obstructions under normal flow conditions, but stopped moving where channel obstructions (such as dense willow infestations) occurred.
- Dense clumps of willows act as 'chokes' that trap twigs and branches and thus hinder their ability to spread further downstream.
- The rate of willow spread is strongly related to the number of points of dispersal (i.e. how many willow clumps occur along the stream) and the amount of stream available for colonisation (i.e. the proportion of the stream without much canopy cover).

Management should focus on sparse rather than dense willow populations, as this is where population growth is most rapid.



'Which do I control first?': It's often tempting to control dense infestations (left), but control of sparse willows (right) first will help prevent spread by twigs and branches. (Sarah Holland Clift, DPI Victoria)

b) Current impacts and value of the site

Protect the best

Very high priority

It is much better to protect, preserve and / or rehabilitate high-value sites that are in good to excellent condition, rather than rehabilitate low-value sites in poor condition. High-value sites may include areas with threatened species or vegetation communities or sites otherwise identified as significant at international, state-wide or regional levels.

Sites with native vegetation in good to excellent condition:

- will generally require fewer resources to rehabilitate than sites in poor condition
- have a high chance of recovery, as native seed banks are more likely to exist, and
- are less prone to future willow invasion, due to reduced levels of disturbance and competition with other plants.



Isolated grey willow plant growing on the Baw Baw Plateau in the Baw Baw National Park. The park is listed on the Register of the National Estate and forms part of the Australian Alps national parks system. (Parks Victoria)



*Better value for money will be achieved by protecting, preserving and/or rehabilitating sites that are in good to excellent condition (above) rather than trying to rehabilitate sites in poor condition (below).
(Terry McCormack, North East CMA)*



Suggested actions:

- Identify and protect areas of high conservation significance that may be negatively impacted by willow invasion (for example, where willows may restrict the passage of a threatened fish species or out-compete significant native vegetation).
- Control willows in areas where there is a high likelihood of recovery, such as those in close proximity to native vegetation, or with downstream vegetation in good condition.

If you are unsure, consult your regional Catchment Management Authority or Natural Resource Management board for information on significant sites in your region.

c) Density and location of willows and behaviour of the river

The potential impact of all willows is clear, but removal of willows can also have significant impact. The density and location of the willows and the behaviour of the river at the site are important factors to consider when contemplating management activities.

River behaviour is determined by understanding the geomorphology of the river and what was happening prior to willow invasion. If you are unable to recognise the indicators of flow energy level, equilibrium, aggradation and degradation, consult a specialist.

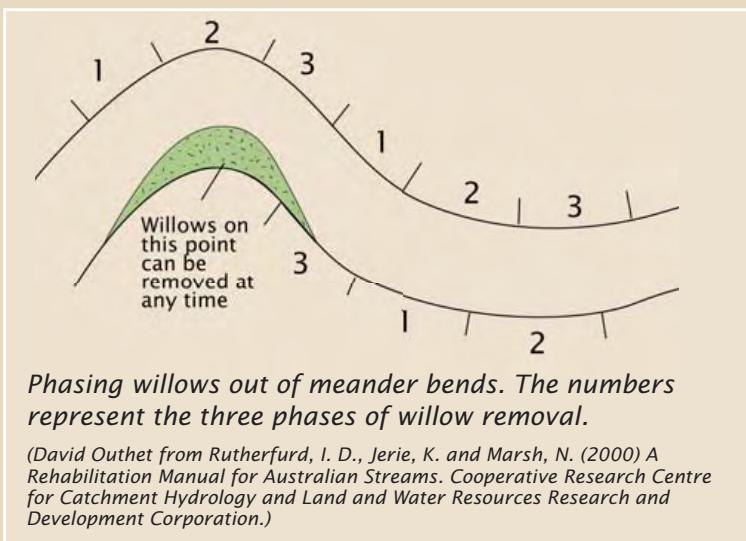
Manage willows first in locations where they have no benefit for erosion control.

Suggested actions:

- **In smaller streams,** willows can hold several metres of headcuts in their roots, extending over a few kilometres of stream. A headcut is an erosion feature that is a vertical or near-vertical drop or change in elevation of a stream channel or gully. There are several examples of major erosion occurring after willow removal as these headcuts migrate upstream. If you plan to remove these willows, you should plan for consequent bed erosion and how you will manage this.
- **In larger streams,** control willows wherever possible, so long as this does not trigger major erosion and willows are quickly replaced with native vegetation.
- **On channel beds and bars, and on bedrock banks,** remove willows if:
 - They are not preventing bed degradation. If they are preventing degradation, install bed control structures before removing willows.
 - There are other trees along the stream to provide shade. If there is not, plant native plants on adjacent land, and wait until they mature before removing the willows.
 - A significant amount of sediment has not accumulated around the willows. If significant amounts of sediment have accumulated, you should not remove more than 1 km at a time, as otherwise large amounts of sediment will be released, which may choke the river channel downstream.
- **On alluvial banks, on equilibrium or aggrading inside bends and straight reaches,** control willows in one operation, leaving at least the stump and roots behind. In locations where flow energies are too high

for native plants to survive, structural erosion controls may be needed.

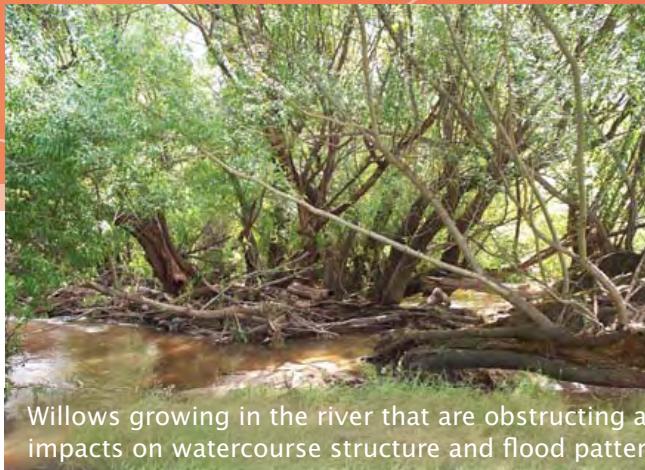
- **On alluvial banks, on outside bends and on straight, degrading reaches,** control willows in strips of three phases along the bank, with an interval of at least 5 years between, to allow the replacement vegetation to become well established and reduce the length of bank exposed to erosion. Where flow energies are too high for native plants to survive, consider the use of long-stem native tube stock or structural erosion control measures.



Phasing willows out of meander bends. The numbers represent the three phases of willow removal.

(David Outhet from Rutherford, I. D., Jerie, K. and Marsh, N. (2000) *A Rehabilitation Manual for Australian Streams*. Cooperative Research Centre for Catchment Hydrology and Land and Water Resources Research and Development Corporation.)

- **Where flow energies are too high for native plants to survive,** consider the use of long-stem native tube stock or structural erosion control measures (see Section 4 Site rehabilitation, for more information).
- **If willows cannot be removed from a site,** lop frequently to prevent them growing into large trees and layering into the stream, ensuring that even the smallest branches are removed from the area.



Willows growing in the river that are obstructing and diverting flows can have major negative impacts on watercourse structure and flood patterns. (Terry McCormack, North East CMA)

Should I always start from the top of the catchment and work down?

There has been a long-held belief that willow management should always start at the top of the catchment and work down, to prevent continued reinvasion by willows spreading from upstream. In fact, a range of important factors need to be considered when deciding where in the catchment you should control willows first.

Starting from the top of the river and working your way down can be very effective if:

- there are occasional or scattered willows that only occur on the banks and are not growing in stream, or
- all willows upstream have been controlled and you are now looking to progress further downstream.

With large, dense infestations and / or where willows encroach into the stream and are impeding flow, it may be better to create a mosaic along the river and then try to join the dots over time.

Creating a mosaic along the river and then joining the dots over time may be more effective than starting at the top and working down, in some instances.

If you start at the top and work down, you can increase the risk of flooding to properties at the willow face, as the water increases in momentum along the recently cleared part of the stream and is then impeded by dense willows constricting the channel downstream. The 'mosaic' method tends to reduce the effects of opening up large sections of waterways, thereby controlling potential increases in water velocity, and creates opportunities to establish native vegetation. This helps to maintain the bank integrity as the river is progressively opened up. Creating a mosaic may also result in vegetation of mixed age

groups growing along the waterway, which aids in the recovery of biodiversity.

The type, extent and location of the willows and the behaviour of the river at the site are important factors to consider when deciding where to manage first.

Rather than working from the top down, willows should be managed according to the type, extent and location of the willows and the behaviour of the river. Risk assessment should be undertaken to address the potential for further willow spread and the potential hydraulic and geomorphological implications of controlling willows. Management activities based on risk assessment may, for example, need to take into account the following:

- Some seeding willows can spread seed up to 50 km in any direction on prevailing wind currents, including upstream and across catchments.
- When a recognised risk of propagation from twigs and branches exists, use of booms or other techniques to catch twigs and branches can help prevent them from spreading further downstream.
- Willows may need to be temporarily retained in some sections of river (for example, where flow energies are high and the bed or banks are in unstable soil types) until other structures are put in place and / or alternative vegetation is established.
- Willow control should only be conducted where site rehabilitation is possible and may depend on the willingness of landholders to become involved, as well as the source and type of funding available.



"Don't bite off more than you can chew or the problem will just grow back". Ensure you adequately allocate resources for follow up control and site rehabilitation. (Danny Henderson, Southern Rivers CMA)

d) Ease and cost of management

Having considered the potential for further spread, the site's current impacts and value, willow location and river behaviour, the next step is deciding how and when you will manage willows.

Willow management can be dangerous and expensive and what resources are available to you will be an important component when deciding which activities to undertake. Long-term outcomes are best achieved through careful assessment of the risks, effective allocation of resources and gradual adaptation of your program, over time, matched with available resources.

Note: There is a tendency for willow managers to focus on the easiest and most visible willows first, before considering management of more difficult plants. Other factors, such as potential for further spread and current impacts and value of the site, should also be considered when setting priorities for management.

Don't bite off more than you can chew – assess the risk, allocate resources effectively and adapt your program gradually over time!

Suggested actions:

- **Identify risks and assets:** Working with willows often involves considerable risk. Before deciding on a management strategy, it is critical to identify and assess all potential and likely risks in the project area and propose measures that might reduce them. What you discover in the process may determine the control and removal methods you eventually choose to employ.

For examples of risks associated with willow management and how to reduce these risks, refer to Appendix 1. For control and removal methods, refer to Section 3.

- **Ensure that resources are available for planning, follow-up control, site rehabilitation and monitoring:** The biggest and most immediate cost of a willow project is the control and removal work. Long-term

success, however, relies on good planning, follow-up control, site rehabilitation and monitoring. Allocating sufficient resources to a long-term willow management and rehabilitation project can be difficult with short funding cycles, but is absolutely essential for success. It is better to bite off small bits at a time and do them well than to conduct large-scale projects quickly.

- **Remember that people are the most important resource:** Assess how many 'people hours' will be required to complete the planned management program and consider what skills, training and experience are needed (including herbicide application, willow removal, willow disposal, monitoring and site rehabilitation).

Some useful tips:

- Using the right personnel for the job will save time and money in the long term. Consider the use of trained professionals, such as contractors, as they are experienced in identifying and minimising risks and skilled in the use of different management techniques.
- Financial assistance is often available for willow management programs. Check with local contacts in your area (such as Natural Resource Management bodies or Catchment Management Authorities) to see if there are any financial incentives.
- Machinery hire rates can be two or three times the cost of manual labour. Plan works carefully so that hired machinery is kept in operation all the time, to avoid having to stop and wait for manual tasks (such as felling trees or raking up debris) to be completed.

e) Landholder commitment and community support

Willows can be an extremely divisive issue within a community and the relationships you build can make or break a willow management program.

Landholder commitment

Willow management is a long-term process that often requires long-term support and commitment from adjacent landholders in order to be successful.

Engaging the community throughout all phases of a willow management program, from planning through to rehabilitation, monitoring and evaluation, is key to gaining long-term commitment from landholders in maintaining sites.

Some helpful ways of gaining landholder commitment:

- **Try to avoid making willow management compulsory** unless absolutely necessary, as landholder support is needed for effective long-term management of the site.
In Tasmania, at least 85% of landholders must be on board before legislation is enforced. If the landholder will not support your project in the short term, this may change over time once they see the outcome of your work on neighbouring properties.
- **Be clear about which landholders you will provide assistance to and why.** It can become a challenge if you start to get too many requests from landholders who want you to work on their properties.
If you are unsure about why you are targeting works in particular locations, then what are you doing there in the first place?

- **Take landholders to a demonstration site.** Show them 'before' and 'immediately after' photos and what it looks like now, to prepare them for what to expect.

Most negative feedback about willow management is received immediately following control, when the visual impact is greatest. Be honest about this and let the landholder know that there will be an initial scar left on the landscape until the site has had time to rehabilitate. Over time, people will easily forget what the site looked like before the willows were removed, and even that the willows were ever there. It is much easier to visually demonstrate the long-term benefits of willow removal than to try to explain it with words.

- **Gain co-investment from the landholder in the management of the site** (for example, in fencing and revegetation of the site).

Along the Bass River in West Gippsland, Victoria, the West Gippsland Catchment Management Authority (CMA) funded the cost of willow removal, site clean up, planting work and fencing material, while the landholders funded the construction of the fence and the tube stock required for planting. Once the works were completed, the landholders became responsible for the site, but the CMA assisted with any necessary follow-up control and monitoring. This long-term commitment from both the CMA and landholders has helped to ensure that the ultimate goal of improving river health is achieved.

- **Provide incentives to improve your chances of getting the best job done**, but be careful not to provide too many incentives as this may result in a lack of ownership by the landholder.

A small incentive, such as providing native tube stock at 10c / tube less than what the landholders can source them at, may help to ensure that good tube stock is being planted.

- **Ensure everyone's responsibilities are clarified** and that everything is agreed and signed off on before the project starts.

Community support

Attempts to remove willows from along waterways are often still met with strong community opposition, but there is also growing opposition to leaving them unchecked. Strong community support will help to ensure that enduring outcomes are achieved. It is important, therefore, to understand community perceptions and to try to gain as much support as possible before starting works in an area.

For common community concerns and suggested responses to these, see 'Understanding your community' in Section 1 Understanding willows.

Some helpful ways of engaging the broader community:

- ☐ Provide resource material that explains the problem with willows and why they need to be managed.

- ☐ Explain management priorities and objectives (i.e. which sites are being targeted and why and what long-term improvements are planned).
- ☐ Give the community an opportunity to provide input through public meetings, workshops or field days.
- ☐ Listen to concerns and try to incorporate their suggestions into management planning.
- ☐ Set up interpretation signs and demonstration sites at frequently visited locations that provide a 'before and after' picture for visitors (see inset box, 'Interpretation signs: Lest we forget').
- ☐ Use the media to raise awareness and engender community support.
- ☐ Door knock and have face-to-face conversations with residents about what you are planning to do and why, and to give them an opportunity to provide comment.

Suggested actions:

- Establish and maintain good relationships and communication with land managers, the community and your investors throughout the entire management program, from site assessment and planning through to monitoring and evaluation.
- Clearly define the roles of all people involved in management so that everyone's responsibilities are known well in advance of management works starting.
- Proactively deal with community concerns by developing a communications strategy that incorporates landholder engagement and broader community education and awareness.
- Develop clear and measurable objectives, carefully set priorities for management and implement a sound, long-term management program.

It can take a long time to gain community support, but that support can be lost very quickly. Doing a good job that demonstrates clear environmental and social benefits is one of the best ways of gaining ongoing community support for your program.



Interpretation signs: Lest we forget

Interpretation signs can effectively communicate the benefits of willow management to the community.

The 'Ribbon of Blue' project involved the removal and rehabilitation of heavy crack willow infestations along the North Esk River in Launceston, Tasmania.

These signs at the 'Ribbon of Blue' interpretation centre are a permanent reminder of the problems willows once created and the benefits of managing them. Over time, without this reminder, it is easy for people to forget or not to be aware of what the site once looked like, before the willows were removed.

The signs were developed by the North Esk and Corra Linn Landcare groups as a key part of the project.



Signs are an invaluable education tool that will continue to promote the benefits of willow management for years to come.

f) Current and potential resources

A final consideration when setting priorities for willow management is the source of current and potential resources. When developing a management plan, it is important to consider where funding will come from, the investors' areas of interest and their likely level of investment. It is also worthwhile to maintain good relationships with your investors and to clearly demonstrate to them the outcomes of your program, to increase your chances of receiving funding in future.

Regularly review and adapt priorities

Setting priorities is an ongoing process that will require review and adaptation over time, as new information becomes available. No matter how well you plan your willow management program, unexpected situations will emerge. For example, urgent preventative work or a quick response should be sparked if:

- a new infestation of seedling willows is discovered, or
- there is an immediate risk of asset damage or loss of access to the river that was previously undetected.

4. Developing a plan for investment

Funding bodies are becoming increasingly wary of investing in programs that are not well planned and that are unable to demonstrate clear benefits for the environment and the community.

When developing a plan for investment you should always consider:

Context, scope and objectives

What is the project area, why has it been selected, what is the basis of this decision and what do we aim to achieve at the site?

Key risks/threats

What factors may hinder or enable success and how will we manage these?

Options for management

What approaches and techniques are available, which are preferred and why?

Information needed

What further information is needed to develop the detail for analysis and design, key assumptions and data?

Implementation strategy

What short-term actions are needed to achieve our long-term objectives? What are the assumptions or gaps that will get us from these actions to the desired long-term outcomes, and how will we know that we are on track to achieving this?

Communications strategy

Who do we need to communicate with, how and when?

Monitoring, review and adaptive management

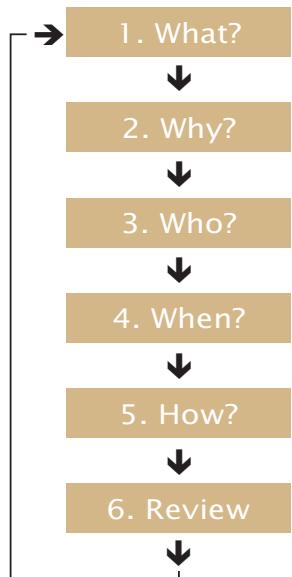
What, when and how will we demonstrate that the project objectives are being achieved?

Site-specific planning

Now that you have selected which sites to manage, the next step is to plan how you will conduct management at your site.

There is no golden rule to management that covers all situations. Planning, therefore, needs to take place on a site-by-site basis just before on-ground activities start.

Although the scale of the works will inevitably influence the complexity of the process, there are at least six basic steps that must be considered for all projects:



These steps are broken down into more detail in the pages that follow, each including the questions you need to answer and the activities you need to consider. Although this might sound complex, in reality many of these elements are basic common sense.

1. WHAT to do?

Before starting willow control works, you need to be clear about exactly what you intend to do. For example:

- What is your vision for the final project?
- What will success look like?
- What is the broader context?
For example, does your regional Catchment Management Authority or Natural Resource Management board have a broad willow management policy or strategic priorities for waterway management?
- What other programs does your project fit into?
- What factors may hinder or enable success?
- What are the indicators you will apply to measure success?
- What is your monitoring strategy to enable you to learn and adapt management over time? (see Section 4 Site rehabilitation, for more information)

Have you considered?



- Land Tenure – Who actually owns or manages the land you propose to work on?
- Cultural heritage requirements?
- Any permits required/legal restraints (for example, works on waterways, fire management, local planning authority)?
- Revegetation and fencing programs?
- Occupational health and safety requirements?

2. WHY manage willows?

This may seem an obvious question, but take time to ask yourself, ‘**Why** am I embarking on a willow management project? How do I justify this project?’ For example:

- Is the project based on **fact** (addressing a known, specific threat to a waterway) or **opinion/emotions** (addressing the broader desire for eradicating weeds and restoring waterways for ‘pure’ environmental purposes)?
These are both legitimate reasons. Each, however, will impact on how you plan, implement and evaluate your project and the final outcome that is achieved, particularly communicating your purpose to stakeholders and generating support.
- Is the project part of a wider strategy for whole-of-waterway management (for example, for fish passage, water quality, fencing for stock exclusion)?

Have you considered?

- What is your capacity for maintaining your site for the next 3 years, 5 years, 10 years and onwards, following initial control works?

‘The purpose of all river management actions is to improve riparian and river health, while safeguarding the environmental, economic and social assets associated with the river environment.’

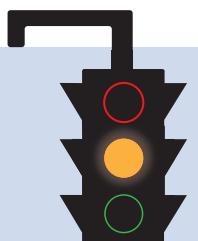
Goulburn Broken Catchment,
Willow Management Strategy, 2005



3. WHO to involve?

Waterways are often the thread that binds together multiple agencies, community and other interest groups. Willow management works are often controversial and it is therefore vital that you are aware of who these stakeholders are and have a plan for engaging/advising them of your project. Note, for example, that:

- Landholders, fishing clubs, local government and other government agencies can all assist in the development of your project, by providing advice, resources and positive promotion.
- A communication strategy is a vital tool for engendering support, promoting your activity and even as a defensive mechanism in the event of negative feedback.



Have you considered?

- Have you developed and initiated your communications strategy?
- Have you got people with the skills to conduct works and maintain the site?
- Do you understand the perspectives of your community, landholders, contractors and investors?

Be aware: willow removal can result in massive change to the landscape, both physically and aesthetically. It is often very messy in the short-term. This can shock people, even those who might support the project. Do not try to hide this fact, as people will be less surprised in their reactions if they understand that this is a normal part of the process.

‘Consistency is crucial – it is important to maintain a set standard when dealing with landholders – everyone should get the same deal and never waiver from that’.

Mal Gibson, West Gippsland CMA

"If you can't be there next year, what are you doing there, now?"

Andrew Ford, Mersey NRM, Tasmania

4. WHEN to conduct the works?

Working on waterways can be highly seasonal. The extended period of a willow management project, from inception to completion, combined with arbitrary administrative guidelines (for example, funding timelines), means that the timing of works needs serious consideration. In particular, consider the following:

- Seasonal constraints (too wet, too dry).

For example, access to the site may be restricted during periods of wet weather and different control methods may be effective in different seasons.

- Advanced ordering of revegetation supplies.

- Funding/budget guidelines.

This often conflicts with revegetation activities, as revegetation is often conducted in the spring following the end of the financial year. You may need to talk to your investors about how you can 'carry forward' funding for this activity. Funding, while important, is just one of the tools you will need to get the job done. Be creative and look for other opportunities that can help you achieve the same result, such as getting a Work for the Dole team or volunteer group involved, or gaining funding through carbon offsetting or Drought Assistance.

- Timing of farming and landholder operations.

- Timing of other neighbouring activities and projects.

It may be cost effective to adjust your timing to match other neighbouring activities.

Have you considered?

- Adjoining land use and tenure may change suddenly. For example, previously cropped land may suddenly be converted to grazing land. This may have a major impact on your project objectives, timing of works or budget (for example, unforeseen fencing costs). Maintain regular dialogue with the adjoining land managers to help manage for these changes.



5. HOW to conduct the works?

By now, you should be very familiar with the site and the various physical, social and financial constraints that apply. All these factors will combine to help you choose the most successful operational technique. Consider the following:

- Contractors?

Many agencies and groups employ contractors to do the willow control works, including tree felling, applying herbicides and removing debris. As there is often little room for error, clear communication and a good relationship with contractors is an important factor in the success of a willow management program. Ensure that contractors fully understand the requirements of the work and have appropriate training and insurance before any quotes are accepted.

Every site is different and may require a variety of control and disposal methods to achieve the most effective results.

See Section 3 Controlling and removing willows and Section 4 Site rehabilitation, for more detail.

Have you considered?



- Bed and bank instability and other potential changes to stream morphology.
- If lopping willows, do not underestimate the size of debris piles and how to dispose of them. This can be time consuming and costly, depending on the location and scale of the site.
- Match the technique to your budget.
- Willow management can be dangerous work, so ensure you have an occupational health and safety plan for each site.

6. Monitoring, evaluation and REVIEW!

Reviewing your project is a fluid process and should be undertaken at regular intervals during the life of the project. It will help to remind you of where you have been, and can help to avoid potential issues in the future. Most importantly, once the works are completed, take a breath and review what you have done, in detail. For example:

- Have the vision or expectations been met?
- What changes did you make during the process?
- What mistakes were made?
- Can you adapt the technique to better suit your specific purpose?
- What maintenance schedules will you now put in place, and how many years will you continue to conduct them?
- Have you considered exactly why you want to control willows and what you aim to achieve in the long term?

See 'Monitoring, evaluation and reporting' in Section 4 Site rehabilitation, for more information.

Additional resources

McNaught, I., Thackway, R., Brown, L. and Parsons, M. (2006) *A field manual for surveying and mapping nationally significant weeds*. Bureau of Rural Sciences, Canberra. (Available free of charge from <http://www.affashop.gov.au>)

Noonan, M.J. and Chafer, C.C. (2007) A method for mapping the distribution of willow at a catchment-scale using bi-seasonal SPOT5 imagery, *Weed Research*, being published.

Noonan, M.J. and Chafer, C.C. (2006) Comparison of ASTER, SPOT5 and aerial photography for mapping the distribution of willow at a catchment-scale, *Proceedings of the 13th Australasian Remote Sensing and Photogrammetry Conference*, Canberra.

Available for download at www.weeds.org.au/WoNS/Willows:

Holland Clift, S., Ede, F.J. and Wadley, S. (2006) *National Willows Program Resource Kit: Resource Sheets 2, 4 and 5*. Department of Primary Industries, Victoria.

- Willow Resource Sheet 2: Willow Identification, an essential skill for effective willow management
- Willow Resource Sheet 4: Willow and willow sawfly assessment form
- Willow Resource Sheet 5: Willow infestation classes