

## **Sagittaria (*Sagittaria graminea* Michx.) – a threatening aquatic weed for the Murray-Darling Basin**

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**Summary** *Sagittaria* is an aquatic plant that is becoming a serious problem in the Murray-Darling Basin (MDB). It spreads rapidly, blocks channels and drains, is tolerant to high doses of herbicides, and greatly reduces the effectiveness of water distribution systems. It has the potential to have a detrimental impact on biodiversity values within the MDB, with a negative impact on native flora and fauna species and on the integrity of natural waterways.

**Keywords** *Sagittaria*, Murray-Darling Basin, infestations, biodiversity.

### INTRODUCTION

*Sagittaria* (*Sagittaria graminea* Michx.) was first reported in the northern Victorian irrigation areas in 1962, but had probably been present for some time before then. The first populations in Victoria occurred in a drain at Katandra West and in the Nine Mile Creek at Wunghnu, part of the Broken Creek system (Aston 1973). Prior to this its first Australian record was in the Ekibin Creek, near Brisbane, in 1959 (Aston 1973).

*Sagittaria* was not initially treated as a major threat, until the early 1980s, when the distribution of the plant increased rapidly. The reasons for this dramatic increase are unclear, although one theory is that the number of propagules produced constantly since the 1960s by smaller populations reached a critical level by the 1980s that allowed the plant to spread beyond established populations. This is in accordance with established principles of aquatic weed infestation (Arthington and Mitchell 1986) that invasion by aquatic species is followed by a period of establishment before dispersal.

*Sagittaria* now infests drains and channels across four of the six of Goulburn-Murray Water's Irrigation Areas in Victoria, the Murray and Murrumbidgee Irrigation Areas in southern New South Wales, and many natural systems in Northern Victoria and Southern New South Wales. These include the Edwards River, Goulburn River, Broken Creek and associated Nine-Mile and Boosey Creeks, the Ovens River, particularly at its confluence with the River Murray and the River Murray itself. By the end of 2005 it was the most

widespread introduced emergent aquatic plant between Echuca and Torrumbarry Weir.

### THE PROBLEM

Annual expenditure on the control of *sagittaria* by Goulburn-Murray Water (G-MW) alone is estimated at \$666,000, depending on seasonal variables that govern the growth of the weed. The weed is managed by G-MW because it blocks channels and drains, causing increased water levels that lead to inefficiencies in water delivery and damage to infrastructure. It may also cause flooding where water flows in drains are retarded during rain and periods of high drain flow (Gunasekera and Krake 2001). It also has a negative impact on native species and on the integrity of natural waterways, such as the waterways of the Barmah-Millewa Forest, where it has been recorded.

### RESEARCH

Research into the plant's biology and control methods has been undertaken by G-MW as the lead agency, in conjunction with CMAs and other Water Authorities. Close to \$1 million has already been spent over the past six years. This approach will help to identify important aspects of *sagittaria*'s germination, growth and spread, as well as assessing the effectiveness of current and potential methods of control. The information gathered will help in developing a more effective control strategy, involving several aspects of physical/environmental, herbicidal and possibly biological control of *sagittaria*.

### METHODOLOGY REVIEW

Integrated Weed Management (IWM) can be defined as the integration of effective, environmentally safe and socially acceptable control tactics that reduce weed interference below the economic injury level (Elmore 1996). In practical terms, this means the development of a management plan that includes aspects of the target species' biology, along with targeted or specific herbicide use and other management techniques, such as minimising the spread of weed propagules. It may also include aspects of biological control, if available.

With a sound knowledge of other possible approaches to a sagittaria management, a good IWM program may be able to be implemented. Currently the principal method of control is through the use of herbicides.

**Spread** Sagittaria spreads rapidly, due to its many methods of reproduction. Not only does sagittaria reproduce by the germination of seeds, it also has several methods of vegetative reproduction available to it. The plant has underground rhizomes (horizontal stems which put out both roots and shoots) which when detached from the plant can establish a new plant. It also produces corms, which remain viable in the soil for many years.

**Herbicides** A number of herbicides are currently used for sagittaria management. Given the restrictions of the environments such as natural carriers and Ramsar Wetlands in which sagittaria grows, options are very regulated and restricted. However, in irrigation channels and drains herbicides are likely to continue having a role in sagittaria management.

**Physical/environmental control** The management of sagittaria infestations by removal of silt excavation has been undertaken. There are disadvantages to channels of this method in terms of cost. There are other methods of mechanical control that may involve the removal of silt: however, stem fragments through mechanical control pose a threat for further spread and therefore this method is undesirable. Cutting of *Typha* spp. is an accepted method of control, particularly when the plant is cut below water level, allowing the plant to 'drown' (Apfelbaum 2001). This process may not be effective against all species, as some species can respond to cutting by actively putting on new growth. Sagittaria has not been tested using this methodology, as it is suspected that the fragments will increase the distribution of the plant. Shading is another method of mechanical control that is gaining popularity. Anecdotal evidence that aquatic weed growth in small, on-farm channels is reduced by the presence of large shade trees, is backed up by the more intense shade provided by the use of plastic sheeting (Carter *et al.* 1994). This sort of control has its disadvantages; however, being prohibitively expensive for large areas, such as G-MW's 7000 km of open channels. It is much more appropriate for submersed vegetation, over which the sheeting can sit. As well as this, re-colonisation is rapid after removal of matting (Eichler *et al.* 1995) and matting can get covered with sediment in a dynamic system, providing a fresh substrate for weeds to colonise.

**Biological control** This method can be defined as 'the use of living organisms to suppress a pest population, making it less abundant and thus less damaging than it would otherwise be' (Crump *et al.* 1999). It can be broadly divided into two categories, classical biological control, where an organism is released into the environment to reproduce and proliferate and, from there, to infect, compete with or consume the target organism, and inundative biological control, where the controlling organism is cultured and applied directly to the pest organism.

Classical biological control is hampered by the large amount of money required to implement it (Chokder 1967) and sometimes variable success rates. An example of the successful implementation of classical biological control is the introduction of the *Cactoblastis* moth into Australia to control prickly pear. However, such unbridled success stories are somewhat rare. As well as examples, like prickly pear, of biological control using an organism that eats or infects the pest species, introduced species may compete with the pest plant for resources (allelopathy), or interfere with the pest species by releasing compounds into the environment that act upon the pest species, a process known as allelopathy (Szczepanski 1977). Literature on allelopathy in aquatic plants is very limited; however, and effects are often mistakenly attributed to this process.

The most successful method of inundative biological control for Alismataceous species has been the mycoherbicide approach, where a mycoherbicide is defined as 'a fungal pathogen which, when applied inundatively, kills plants by causing a disease' (Crump *et al.* 1999). In the Australian rice industry, most work has been done using the fungus, *Rhynchosporium alismatis* (Cother 1999), but other pathogens have been investigated overseas (Chung *et al.* 1998).

## ISSUES

Control based on plant biology and ecology, morphology, seed dormancy and germination, physiology of growth, competitive ability and reproductive biology are all aspects that need to be used for management of sagittaria. Ross Gledhill of G-MW in the Murray Valley region is implementing control based on these principles; however, at present there is insufficient knowledge in most of the above aspects of the plant. Information on seed banks, root reserves, dormancy and longevity of propagules may be used to better predict infestations. Weed seed bank densities and root reserves can be greatly reduced by eliminating seed production for a few years (Buhler *et al.* 1997) or through interference with dormancy or germination

requirements (Bhowmik 1997), or can increase rapidly if plants are allowed to produce seed.

#### CONCLUSION

G-MW has been the lead agency to undertake all research to date on the plant biology, ecology and morphology of sagittaria leading to its control. Control remains problematic because the biology of sagittaria and the performance of control methods are not fully understood. Data collection for the plant's distribution is currently being undertaken by the Department of Primary Industries in Victoria and some Water Authorities and CMA's in the MDB. Further resourcing from outside GMW is required to progress the prevention of spread and control of sagittaria. To effectively implement successful prevention of spread and control we must first 'know the enemy', before we can then experience success in battling this species.

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