Alligator weed

Alternanthera philoxeroides

The white flowers grow on short stalks and are present from spring till summer. (Photo: Bruce Auld NSW DPI)

- This plant is a water weed
- This plant must not be sold anywhere in NSW

Profile

How does this weed affect you?

Alligator weed is a potentially devastating weed that grows in water and on land, affecting both waterways and floodplain areas.

Alligator weed has extremely vigorous growth and great tolerance of normal control measures, which makes it a major threat to wetlands, rivers and irrigation systems.

Alligator weed is considered one of the world's worst weeds because it impacts on both aquatic and terrestrial environments. Overseas experience indicates that its potential impacts in Australia could be devastating.

Environmental impacts

Alligator weed disrupts the aquatic environment by blanketing the surface and impeding the penetration of light. Such blanketing can also impede gaseous exchange (sometimes leading to anaerobic conditions) which adversely affects aquatic flora and fauna. It also competes with and displaces native flora along river and creek banks and in wetlands.

Impacts on primary production

Alligator weed has eliminated small crops and turf farming from parts of the Lower Hunter. The potential costs to irrigation farming in the Murrumbidgee Irrigation Area from the Barren Box Swamp infestation have been estimated to be $250 million a year if alligator weed remained uncontrolled.

In the Sydney Basin, alligator weed is currently threatening the turf industry valued at over $50 million annually. The vegetable industry valued at $150 million annually is also under threat in the Hawkesbury–Nepean catchment. The extraction industry in the Hawkesbury–Nepean is also under threat. This industry supplies most of Sydney's sand, gravel and soil resources. If contaminated, the movement of these resources would be severely restricted. Sugar cane and soy bean industries are also threatened in the Richmond catchment.

Alligator weed contaminates grazing pastures and competes successfully for light and space, becoming dominant in wetter sections of pastures. Dense infestations also restrict stock access to drinking water.

In New Zealand and Australia, alligator weed is thought to cause photosensitisation in light-pigmented cattle, resulting in cancerous lesions.

Impacts on water resources and infrastructure

Alligator weed restricts access to and use of water, blocking and damaging pumps and other infrastructure. Mats of alligator weed can impede stream flow and lodge against structures promoting sedimentation which contributes to flooding and structural damage. It is currently threatening Warragamba Dam, Sydney's major water supply and storage system.

Social impacts

Tourism and recreation are affected when alligator weed limits recreational activities, reduces aesthetic values, and increases mosquito populations. Dense mats reduce the visual impact of waterways and affect the presence of other native flora and fauna. They also limit water vessel movement and access to waterways, and create a hazard for swimming and other water sports.

During 2008/2009, alligator weed cost state and local government authorities in NSW $800,000 to control. When considering other associated costs of education and awareness programs as well as planning, coordination and inspection, the total expenses would be approximately $1,300,000.

Overseas

Alligator weed is a problem in 30 countries. It is a serious weed in eight of these and a major weed in the others. In the USA floating alligator weed caused major impediments to navigation on the Mississippi River. In North Carolina aquatic infestations increased from 152 ha in 1963 to 1000 ha in 1999 along with a conservative estimate of 4000 ha of infested cropping land. It is a major weed of transplanted rice wherever it is grown in the world. In China crop production is reduced between 20 to 63%. It impacts on hydro electric power production, fishing and has seriously degraded famous scenic spots.

What does it look like?

Alligator weed is a summer growing perennial herb. It has small white papery flower heads 8–10 mm in diameter, generally appearing from November to March. The flowers grow at the end of short stalks which rise from the leaf axils.

Alligator weed has leaves occurring in opposite pairs along the stems. The leaves are shiny, spear-shaped, sessile (no stalk), entire and about 2–7 cm long and 1–2 cm wide.
The plant forms dense mats of interwoven creeping and layering stems. Over water, stems grow to 60 cm high and up to 10 m long and have large, hollow internodes. Mats may extend 15 metres over the water surface and become so robust they can support the weight of a person. On land, stems are shorter and internodes are smaller and less hollow.

Alligator weed has an extensive underground root system. Roots are relatively fine and short in water but become thicker, starchy and rhizome-like in soil, able to penetrate to depths of over 50 cm. Roots and stems

have been found growing more than 1 m below the surface. Root storage tissues allow for survival over long dry periods.

Key identification features

Alligator weed is generally distinguished from other plants by its combination of the following three features:

- small white papery flowers on short stalks
- leaves in opposite pairs
- hollow stems.

Where is it found?

Alligator weed is a native of South America, in northern Argentina and adjacent countries. It is a major problem in south-eastern United States, China, New Zealand, Burma, Thailand, Indonesia and India. Alligator weed has not reached its potential distribution in Australia or within NSW, but has the ability to devastate the environment and agriculture if left unchecked.

Alligator weed was possibly introduced into Australia in the Newcastle area via cargo from ships during the Second World War. Since its introduction alligator weed has spread to nearby seasonally flooded agricultural and grazing lands of Fullerton Cove, Williamtown and the Raymond Terrace area, and has steadily expanded to infest many creeks, lowlands and drainage channels in the lower Hunter region. It was recorded in a dam at Woomargama near Albury in 1967, and after its first recording in the Sydney basin at Duck Creek in 1969 it spread within the Parramatta catchment and throughout the Georges River catchment. In 1981 it was recorded at Camden and new infestations were then reported throughout the 1990s, with alligator weed found higher in the Hunter catchment in the Williams and Paterson Rivers in 1993; in Barren Box Swamp near Griffith in 1994; and in Byron Creek, a tributary of the Richmond River on the far north coast in 1998.

In 1995 alligator weed was observed in a backyard vegetable garden in Brisbane, grown as a substitute for the herb and vegetable Mukunawanna (*Alternanthera sessilis*), favoured by Sri Lankans. Investigations during the following years found it growing in many NSW backyards. More than 500 infestations have been found in the Sydney metropolitan area, and numerous infestations have been reported in many regional areas across NSW.

There is now an estimated total area of 3,950 ha of known alligator weed in NSW, with 2,500 ha of terrestrial infestations and 500 ha of aquatic infestations occurring in the Lower Hunter region. The current distribution is small when compared to the potential range of the weed.

How does it spread?

Alligator weed does not produce viable seed in Australia. Reproduction is entirely vegetative with new plants able to occur at any stem or root node. Stems break up naturally or with disturbance, creating many fragments capable of forming new plants.

A warm growing season is preferred and generally occurs between November and May, with maximum growth and reproduction from stem nodes in mid-summer. Growth generally slows or ceases during cooler months.

Alligator weed spreads naturally in water when stem or root fragments float downstream. The most significant spread between catchments in NSW has been through the commercial and recreational activities of people. Examples of these activities include:

- excavation machinery used to clean channels
- boats and trailers transported between waterbodies
- deliberate planting for ornamental use
- movement of sand dredged from infested catchments.

In terrestrial situations stem and root fragments can be spread in the movement of soil. This has occurred as a result of:

- movement of turf or hay from infested farms
- movement of fill or landscape supplies from infested areas
- accidental spread on machinery
- fragments caught in horses' hooves.

What type of environment does it grow in?

Alligator weed will grow in ponded and flowing waterways, on the banks of waterways, on floodplains and poorly drained land, and less commonly in drier situations above flood level. To date in Australia all

infestations have occurred in temperate and subtropical climates, thriving in areas with high summer rainfall. Alligator weed will grow in a range of soils and substrates from sand to heavy clay, and can easily tolerate dry periods. Infestations have been found growing in saline conditions (flowing water with 30% of the salinity of seawater), and on beaches above the high tide zone. Frost and ice kill exposed stems and leaves, but protected stems can survive these conditions and support the next season's growth.

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More information

- Alligator weed control manual (https://www.dpi.nsw.gov.au/biosecurity/weeds/weed-control/management-guides/alligator-weed-control-manual)
- Alligator weed: Early detection guide for farmers (PDF Brochure) (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/212996/Alligator-weed-an-early-detection-guide-for-farmers-.pdf)
- PlantNET NSW FloraOnline, Alternanthera philoxeroides. Royal Botanical Gardens and Domain Trust. (https://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Alternanthera~philoxeroides)
- Weed futures: Determining current and future weed threats in Australia, Alternanthera philoxeroides. Macquarie University. (http://www.weedfutures.net/species.php?id=2006)
- General Biosecurity Direction to the entirety of Barren Box Storage and Wetland and its riparian areas. (https://gazette.nsw.gov.au/gazette/2021/12/2021-644.pdf)
- Alligator weed model by Rachel Klyve (www.rachelklyve.com) (https://sketchfab.com/models/8ee2bb11bfea417ab60a12cb9e10ecd1/embed)

Control

Alligator weed is difficult to control. Any infestations should be reported immediately to your local council weed officer. Do not try to control alligator weed without their expert assistance. Control effort that is poorly performed or not followed up can actually help spread the weed and worsen the problem.

The Alligator Weed Control Manual (see *More Information*) provides a comprehensive overview of the various chemical, physical and biological control options. Management options for alligator weed depend on the site and location of the infestation, its age and extent and the resources available. Any new infestation should be assessed to determine if immediate eradication is a feasible management objective (small numbers of scattered plants; infestations up to 5 m x 5 m). If not, management should aim for suppression leading to eradication over a period of approximately 6 years (infestations with roots more than 1 m deep; areas of infestation over 10 m x 10 m), or ongoing suppression (in extensive, long established infestations).

Control methods and their application will vary depending on the management aim. While containment and prevention of spread will be necessary in all infestations, controls should be closely aligned with management aims. Table 1 provides a guide for selecting appropriate control methods for the situation.

Table 1. Guide for selecting control methods.

Management aim	Control strategy

Management aim	Control strategy
Immediate eradication	Physical control (deep manual digging) with some initial chemical control (herbicide treatment) to kill above-ground plant growth.
Suppression leading to eradication	Chemical control (annual treatment program, see below) with herbicides over a 6 year period; possibly with initial physical control (shallow mechanical removal to remove above-ground biomass); followed by physical control (deep manual digging) once infestation is small enough to eradicate.
Ongoing suppression	Chemical control (annual treatment program); or biological control (only in aquatic situations in cool climate areas).

Physical control

Physical controls are vital for the eradication of small and isolated infestations and are particularly useful in removing new infestations if they can be located early enough.

For alligator weed, physical control involves either deep manual digging or shallow mechanical excavation. Deep manual digging can be done in terrestrial and shallow aquatic situations and requires an infested area to be hand dug in order to find and remove all the roots associated with each individual stem arising from the ground. While time-consuming, local weed authorities have shown this technique to be successful for eradication of small or new infestations.

Shallow mechanical removal can be used to remove large amounts of above-ground plant material and small amounts of below-ground root material. Excavations should only be made to a depth of 20 cm due to the sheer volume of contaminated soil to be disposed of. An excavated site is then inspected regularly for signs of regrowth, which are then either treated with herbicide or removed by deep manual digging, depending on the management aim. Shallow mechanical removal is generally not appropriate in aquatic situations and the risks of spreading fragments are high.

Disposal

With any physical removal method there are issues of disposing of the removed plant material. Removed material must be treated and disposed of securely.

Do not dispose of alligator weed in green waste or composting facilities.

Plant material can be dried and incinerated, boiled or microwaved. Large volumes of contaminated soil are difficult to process, and if possible need to be spread on an impenetrable surface and dried prior to burial (preferably sealed in containers) at a secure disposal site that can be monitored for any signs of regrowth.

Machinery hygiene

Accidental spread on machinery can introduce the plant to new areas with disastrous consequences. Any machinery working in an infested area should be thoroughly cleaned before it is moved to a new site. Cleaning should include removal of all mud and vegetation, followed by complete and thorough inspection of the machine.

Once alligator weed is established on land it cannot be controlled by cultivation or slashing. Any cultivation or slashing of infested land will only spread the infestation further.

Biological control

The flea beetle (*Agasicles hygrophila*) was first introduced to Australia in 1976. It provides good control in aquatic environments in the Sydney region, successfully reducing the area of floating mats in the Georges River and in parts of the Hawkesbury Nepean system. However, this insect is limited to warm temperate and subtropical areas and the predicted range for alligator weed in Australia far exceeds the predicted range for the flea beetle.

One criticism of the flea beetle is the tendency for alligator weed to fragment when under attack, causing downstream spread. Plant fragments should be contained if downstream spread is an issue in areas where the flea beetles are active.

A moth (*Arcola malloi)* contributes to control in aquatic habitats and is established but, like the flea beetle, has no impact on terrestrial alligator weed.

The role of these agents is therefore limited to ongoing suppression of extensive aquatic infestations. Biological control is not appropriate for eradication strategies. Further biological control programs are being

explored.

Chemical control

Due to its ability to tolerate most herbicides, many herbicides have been trialled over the years for alligator weed control. It is now clear that there are important roles for specific herbicides in suppressing and depleting alligator weed and in assisting with eradication.

It is currently agreed that a program based on three treatments of herbicide products containing metsulfuron-methyl per growing season is the most effective for suppression of both aquatic and terrestrial alligator weed. For application rates and concentrations in aquatic and terrestrial situations please refer to the current range of permits and label registrations for the use of herbicide products containing metsulfuron-methyl 600 g/kg on alligator weed in NSW.

Metsulfuron-methyl Annual Treatment Program

1. Apply the first foliar treatment in November (early in the growing season – could be earlier in subtropical areas).
2. Apply the second foliar treatment in February.
3. Apply the third foliar treatment at the end of the growing season in May.

Carry out this annual treatment program for a number of years (6 on average) and then consider the possibility of eradication by physical removal of any remaining underground plant parts.

Note: Make the second and third treatments only if there has been sufficient regrowth (at least 5 or 6 sets of leaves on stems, 10 cm of stem length, or 30 cm crown width in prostrate growth). In dry conditions the plant may be suppressed and depleted to the point where only 2 applications are possible over the growing season. This can also occur after 2 consecutive years of treatment, as the depleted plants take longer to reach the required level of regrowth. Always maintain at least 2 sprays per growing season.

Herbicide options

WARNING - ALWAYS READ THE LABEL
Users of agricultural or veterinary chemical products must always read the label and any permit, before using the product, and strictly comply with the directions on the label and the conditions of any permit. Users are not absolved from compliance with the directions on the label or the conditions of the permit by reason of any statement made or not made in this information. To view permits or product labels go to the Australian Pesticides and Veterinary Medicines Authority website www.apvma.gov.au

See Using herbicides (http://www.dpi.nsw.gov.au/biosecurity/weeds/weed-control) for more information.

PERMIT 84772 Expires 31/07/2029
Imazapyr 250 g/L (Various products)
Rate: 500 mL in 100 L of water to a maximum of 3L/ha plus Hasten or Uptake Spraying oil at 0.5 L/ha.
Comments: For terrestrial situations only including riparian zones. Do not apply more than once per annum. Use of this permit is limited to Council employees and Government Officers or contractors under their direction. See permit for further critical use comments.
Withholding period: Not required when used as directed.
Herbicide group: 2 (previously group B), Inhibition of acetolactate and/or acetohydroxyacid synthase (ALS, AHAS inhibitors)
Resistance risk: High

PERMIT 14733 Expires 30/06/2029
Dichlobenil 40 g/kg (Casoron 4G Herbicide)
Rate: 43–63 g per square metre
Comments: Granular application for home gardens in residential areas. Treat dormant plants. Use the higher rate for heavier weed infestations. See permit for further critical use comments.
Withholding period: Do not graze livestock on treated areas.
Herbicide group: 29 (previously group O), Inhibition of cellulose biosynthesis
Resistance risk: Moderate

PERMIT 14733 Expires 30/06/2029
Glyphosate 360 g/L (Various products)
Rate: 10 mL in 1 L of water
Comments: Spot spray actively growing plants. For control in home gardens in residential areas. Use coarse droplets and low pressure and avoid run-off. See permit for further critical comments.
Withholding period: Nil.

Herbicide group: 9 (previously group M), Inhibition of 5-enolpyruvyl shikimate-3 phosphate synthase (EPSP inhibition)
Resistance risk: Moderate

PERMIT 14733 Expires 30/06/2029
Metsulfuron-methyl 600 g/kg (Various products)
Rate: 1 g in 10 L of water
Comments: Spot spray actively growing plants. For control in home gardens in residential areas. Use coarse droplets and low pressure and avoid run-off. See permit for further critical comments.
Withholding period: Nil (recommended not to graze for 7 days before treatment and for 7 days after treatment to allow adequate chemical uptake in target weeds).
Herbicide group: 2 (previously group B), Inhibition of acetolactate and/or acetohydroxyacid synthase (ALS, AHAS inhibitors)
Resistance risk: High

PERMIT 14734 Expires 30/06/2027
Metsulfuron-methyl 600 g/kg (Various products)
Rate: 10 g per 100 L water (to a maximum rate of 600 L/ha of weed surface)
Comments: Aquatic and terrestrial areas across NSW. Only apply as a spot spray using a hand directed spray. Do not apply more than 3 applications per growing season. See permit for further critical comments.
Withholding period: Nil (recommended not to graze for 7 days before treatment and for 7 days after treatment to allow adequate chemical uptake in target weeds).
Herbicide group: 2 (previously group B), Inhibition of acetolactate and/or acetohydroxyacid synthase (ALS, AHAS inhibitors)
Resistance risk: High

PERMIT 14200 Expires 30/04/2028
Metsulfuron-methyl 600 g/kg (Various products)
Rate: 10 g in 100 L of water
Comments: Hand gun application within the local government areas of Port Stephens Council, Maitland City Council and Hawkesbury River County Council. See permit for critical use comments.
Withholding period: Nil (recommended not to graze for 7 days before treatment and for 7 days after treatment to allow adequate chemical uptake in target weeds).
Herbicide group: 2 (previously group B), Inhibition of acetolactate and/or acetohydroxyacid synthase (ALS, AHAS inhibitors)
Resistance risk: High

Flumioxazin 15 grams /tablet (Clipper® herbicide)
Rate: 1 tablet for every 37.5 cubic metres of water to achieve 400 parts per billion.
Comments: For use on dense or established weed populations in enclosed water bodies, deeper than 0.5 m and larger than 37.5 cubic metres, or margins of larger, still water bodies. Throw tablets directly into the water to achieve uniform distribution of the herbicide. See label for further instructions and restrictions.
Withholding period: 14 days before using treated water to irrigate food crops. See label for withholding periods for other uses of treated water.
Herbicide group: 14 (previously group G), Inhibition of protoporphyrinogen oxidase (PPO inhibitors)
Resistance risk: Moderate

Flumioxazin 15 grams /tablet (Clipper® herbicide)
Rate: Inject solution into water body. 1 tablet per 37.5 cubic metres. Each tablet dissolved in at least 20 L of water + 0.5-1.0% adjuvant/surfactant
Comments: For use on dense or established weeds in water bodies less than 0.5 m deep or with a volume less than 37.5 cubic metres. Dissolve tablets in water (at least 20 L per tablet) mix thoroughly and then inject the solution directly into the water body.
Withholding period: 14 days before using treated water to irrigate food crops. See label for withholding periods for other uses of treated water.
Herbicide group: 14 (previously group G), Inhibition of protoporphyrinogen oxidase (PPO inhibitors)
Resistance risk: Moderate

Flumioxazin 15 grams /tablet (Clipper® herbicide)
Rate: Spray 12 - 15 L of solution per 100 m2. Solution = 1 tablet per 100 L water + 0.5-1.0% adjuvant/surfactant.
Comments: Spray on low density, establishing or re-establishing weeds in enclosed water bodies, deeper than 0.5 m and larger than 37.5 cubic metres, or margins of larger still water bodies. See label for restrictions.

Withholding period: 14 days before using treated water to irrigate food crops. See label for withholding periods for other uses of treated water.
Herbicide group: 14 (previously group G), Inhibition of protoporphyrinogen oxidase (PPO inhibitors)
Resistance risk: Moderate

Glyphosate 360 g/L (Only products registered for aquatic use)
Rate: 150 mL per 15 L of water
Comments: Spot spray from a knapsack. Apply to actively growing plants from summer through winter. Floating form only.
Withholding period: Nil.
Herbicide group: 9 (previously group M), Inhibition of 5-enolpyruvyl shikimate-3 phosphate synthase (EPSP inhibition)
Resistance risk: Moderate

Metsulfuron-methyl 300 g/kg + Aminopyralid 375 g/kg (Various products)
Rate: 20 g per 100 L of water plus an adjuvant (e.g. BS1000) at 100 mL/100 L
Comments: Spot spray application, for terrestrial situations only. Follow-up applications over at least two seasons are essential for complete control.
Withholding period: Pastures - Grazing for meat production or cutting for animal feed: Do not graze for 56 days after application. See label for further details
Herbicide group: 2 (previously group B), Inhibition of acetolactate and/or acetohydroxyacid synthase (ALS, AHAS inhibitors) + 4 (previously group I), Disruptors of plant cell growth (Auxin mimics)
Resistance risk: High/Moderate

Biosecurity duty

The content provided here is for information purposes only and is taken from the *Biosecurity Act 2015* and its subordinate legislation, and the Regional Strategic Weed Management Plans (published by each Local Land Services region in NSW). It describes the state and regional priorities for weeds in New South Wales, Australia.

Area	Duty
All of NSW	**General Biosecurity Duty** *All pest plants are regulated with a **general biosecurity duty** to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.*
All of NSW	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
All of NSW The Alligator Weed Biosecurity Zone is established for all land within the state except land in the following regions: Greater Sydney; Hunter (but only in the local government areas of City of Lake Macquarie, City of Maitland, City of Newcastle or Port Stephens).	**Biosecurity Zone** *Within the Biosecurity Zone this weed must be eradicated where practicable, or as much of the weed destroyed as practicable, and any remaining weed suppressed. The local control authority must be notified of any new infestations of this weed within the Biosecurity Zone*
Greater Sydney	**Regional Recommended Measure** *Land managers should mitigate the risk of the plant being introduced to their land. Land managers should mitigate spread of the plant from their land. A person should not buy, sell, move, carry or release the plant into the environment.*
Hunter An Alligator Weed Biosecurity Zone is established for all land within the Hunter Local Land Services region except land in the following local government areas: Lake Macquarie Local Government Area,	**Regional Recommended Measure** *Entire Hunter Local Land Services region: A person must not, import into the State or sell. Within the biosecurity zone: If the weed is part of a new infestation of the weed on the land, notify the local*

Area	Duty
Maitland Local Government Area, Newcastle Local Government Area, Port Stephens Local Government Area.	*control authority for the land as soon as practicable. Eradicate the weed or, if that is not practicable, destroy as much of the weed as is practicable and suppress the spread of any remaining weed. Outside the biosecurity zone: Land managers should mitigate spread of the plant from their land. Land managers should reduce the impact of the plant on assets of high economic, environmental and/or social value.*
Riverina	**Regional Recommended Measure** *Notify local control authority if found. Your local biosecurity weeds officer can help to identify, advise on control, and how to remove this weed.* **Griffith City Council has issued a General Biosecurity Direction to the entirety of Barren Box Storage and Wetland and its riparian areas. A link to the direction is above under More Information.**

A dense stand of flowering alligator weed. (Photo: Bob Trounce NSW DPI)

Alligator weed will grow in water and on land. (Photo: Rebecca Coventry)

Erect summer growth on land. (Photo: Elissa van Oosterhout)

Alligator weed growing in dry conditions. (Photo: Courtesy Biosecurity Queensland)

Alligator weed has hollow stems and opposite leaves. (Photo: Andrew Petroeschevsky)

Alligator weed has clusters of small flowers. (Photo: Kylie van der Kolk)

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