



NSW DEPARTMENT OF  
PRIMARY INDUSTRIES

**This document is part of a larger publication** and is subject to the disclaimers and copyright of the full version from which it was extracted.

The remaining parts and full version of the publication, as well as updates and copyright and other legal information can be found at:

<http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/profiles/alligator/alligator-weed-control-manual>

# Part 1: The alligator weed profile

## Physical characteristics of alligator weed: (*Alternanthera philoxeroides*)

Alligator weed is a perennial stoloniferous herb that produces masses of creeping and layering and upright stems. It has the ability to grow in aquatic, semi-aquatic and terrestrial habitats in tropical, subtropical and temperate regions (Julien & Stanley 1999).

### Stems

The stems of alligator weed are hollow when mature and can be single or branched to form dense mats. Stems may lie flat along the ground or grow vertically. Vertical stems are dark green and can be up to 80 cm long, or longer (up to 2 m) if supported on other vegetation. Prostrate stems can be light green, yellow or brown to red. When prostrate stems become buried in silt the nodes become thickened. Stems have pairs of leaves at each node.

### Leaves

The spear-shaped leaves are in opposite pairs along the stems and are generally dark green, waxy, glossy and sessile (there is no obvious stalk attaching them to the stem).

Leaf size and shape vary considerably with growth habit and conditions. Leaves range from 2 to 12 cm in length and 0.5 to 4 cm in width, usually with an acute tip.



Vertical stems are dark green. Photo: Biosecurity Queensland DPI&F



Stems are hollow when mature. Photo: Brian Worboys



Brownish red prostrate stems. Photo: NSW DPI



Leaves are generally spear shaped, but size and shape can vary considerably.

Photo: Biosecurity Queensland DPI&F



Glossy, dark green leaves. Photo: Brian Worboys



Stems have pairs of leaves at each node. Photo: CSIRO

<sup>1</sup> Information in this section is from Julien (1995) unless otherwise referenced.



Line drawing by S. Fiske. Used with permission courtesy of CSIRO



*Filamentous roots can occur at each node along a stem.*

Photo: Biosecurity Queensland DPI&F



*Roots will penetrate into the soil and have been found more than 1 m from the surface.* Photo: Graham Prichard



*Root storage tissues allow survival over dry periods.* Photo: Brian Worboys

## Roots

Alligator weed has an extensive underground root system. Filamentous roots can occur at each node along a stem. They are relatively fine and short in water but become thicker, starchy, rhizome-like and longer in soil. Taproots will penetrate into soil to a depth of 50 cm, but roots and stems have been found growing more than 1 m from the surface. Root storage tissues in terrestrial and semi-aquatic environments allow survival over dry periods and form a significant proportion of terrestrial biomass (Tucker, Langland & Corbin 1994).

Alligator weed is often referred to as having underground rhizomes. It is, however, thought that what appear to be underground rhizomes are either thickened roots, or stolons (above-ground creeping stems that root at nodes) that have become buried in silt and sediment over time. The whitish creeping underground stems are either new shoots making their way to the surface or old stems that have been buried over time.



*Whitish stems under flood debris appear to be rhizomes, but are more likely to be stolons (above-ground creeping stems).*

Photo: Elissa van Oosterhout



*Roots become thicker, starchy and rhizome-like in soil.* Photo: CSIRO

## Flowers

Papery white ball-like flowers occur on peduncles (stalks) 1 to 9 cm long. Each ball-like flower is an inflorescence made up of a number of smaller individual flowers. Alligator weed flowers in mid to late summer, peaking in January in aquatic situations and earlier (from November to January) in terrestrial situations. Seed production has not been observed in Australia.



*Papery, white, ball-like flowers on stalks.* Photo: Biosecurity Queensland DPI&F

## Distinguishing features for identification

Alligator weed is generally distinguished from other similar plants by its combination of opposite leaves, hollow stems and papery white ball-shaped flowers on stalks (see *Similar-looking plants*).

▼ *The flower stalks are an important distinguishing feature of alligator weed.* Photo: Bruce Auld

▼ *Each flower is made up of smaller individual flowers.* Photo: Brian Worboys





*Erect summer growth.* Photo: Brian Worboys



*Dense mats of stems, stolons and roots form above and below the soil.* Photo: John Moorhouse

## Growth habits

Alligator weed growth habits differ depending on habitat and conditions. Aquatic and terrestrial plants can be extremely different in size, shape and appearance. In both situations growth is generally erect under mid-summer conditions and prostrate under mid-winter conditions (Sainty *et al.* 1998). An infestation generally consists of a tangled mat of older, prostrate stems supporting younger upright stems bearing pairs of leaves on each node (Julien & Bourne 1988).

### Terrestrial habit

In its terrestrial habit, alligator weed forms herbaceous stands with dense mats of stolons, taproots and filamentous roots beneath the soil. Mats of prostrate stems and filamentous roots can be up to 10 cm thick. Terrestrial growth is highly competitive and able to displace other plants (Julien & Bourne 1988; Julien 1995; Julien & Stanley 1999).

Terrestrial plants are subject to more stresses than aquatic plants, including moisture and temperature stress, inter-specific competition, and nutrient stress. These factors limit growth and affect the appearance of the plants (Sainty *et al.* 1998).

In general, terrestrial plants are smaller-leaved, more compact plants. Leaf area is on average four times smaller than aquatic plant leaf area, and terrestrial plants have fewer flowers (on average 0.8 flowers per stem compared with 1.0 flowers per stem on aquatic plants).

Plant biomass on land is less than in water; however, terrestrial alligator weed has the ability to form very extensive root systems, with the below-ground biomass measured at 10 times that of the above ground biomass. Terrestrial root masses are up to seven times heavier than aquatic root masses (on land the tops to roots ratio is 0.3, whereas in water the ratio is 5.6) (Schooler S, Cook T, Prichard G, Bourne A, Julien M, Effects of selective and broad spectrum herbicides on below-ground biomass of alligator weed, submitted to *Weeds Research*).



*Prostrate winter growth.* Photo: Rebecca Coventry



*Infestations generally consist of a tangled mat of older stems supporting younger upright stems.*

Photo: Biosecurity Queensland DPI&F



*Mats of stems, roots and leaves growing rooted in the bank.* Photo: John Moorhouse



*Stems can be rooted in the substrate in shallow water.*

Photo: Elissa van Oosterhout



*The weed forms herbaceous stands.* Photo: Biosecurity Queensland DPI&F



*Larger leaves and elongated stems of an aquatic plant.* Photos: Terry Inkson

## Aquatic habit

As an aquatic plant, alligator weed grows rooted in soil near the water's edge or rooted in substrates beneath the water. It then produces large mats of stem, root and leaf material that can extend many metres across the water, forming a blanket across the water surface. Mats can exceed 1 m in thickness and can break away and become free-floating (Sainty *et al.* 1998; Julien and Stanley 1999). Mats that dislodge can free-float self-sufficiently in favourable conditions, and can also become lodged again and send roots into the substrate or banks. In favourable conditions, stem fragments that include nodes and buds can break away, become lodged downstream and develop roots and shoots to form a new infestation (Julien 1995).

## Habitat

Alligator weed grows commonly in 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 cool and warm temperate and subtropical climates.

Infestations thrive in areas of high summer rainfall (Sainty *et al.* 1998) but can easily tolerate average moisture availability levels and dry periods. Alligator weed will grow in a range of soils and substrates from sand to heavy clay.

Alligator weed can tolerate saline conditions, surviving in flowing water with salinity levels 30% that of sea water (cited in Sainty *et al.* 1998). It has been found growing above the high tide zone on beaches in Sydney Harbour and Botany Bay; this indicates that it can survive sea-strength salinity for 'days' (Sainty *et al.* 1998:197).

Under aquatic conditions alligator weed competes successfully with most species, with the exception of water hyacinth. In pastures its creeping habit and tendency to form dense mats allows it to compete successfully for light and space. It can become dominant in wetter sections of pastures. Grasses will usually predominate on slightly elevated areas.



*Floating stems extend across the water.*  
Photo: Bob Trounce



*Mats can free-float and take root further downstream.* Photos: Andrew Petroeschovsky, Lalith Gunasekera





*Alligator weed dominating wetter sections of pastures, with grasses predominating in slightly elevated areas.* Photo: Elissa van Oosterhout



*(Top) Alligator weed competes for light and space in pastures.* Photo: NSW DPI



*Banks and edges of waterways provide ideal habitat.* Photo: Rebecca Coventry



*Slower, prostrate growth can continue in dry conditions.* Photo: Biosecurity Queensland DPI&F

## Growth rates

When water and nutrients are not limiting, temperature and day length have most influence on growth. Growth rates differ in terrestrial and aquatic situations.

### Terrestrial growth rates

In terrestrial habitats temperature and moisture availability are the most limiting factors for growth. Terrestrial growth is slower than aquatic growth. Root growth is affected by time and soil moisture, and growth of above-ground plant parts is affected by time, soil moisture and seasonal conditions. In a terrestrial pasture trial at Williamstown, uncontrolled alligator weed biomass increased steadily at a rate of 22% a year over a 9-year period (Julien & Bourne 1988).

*Weights of the above-ground plant parts have been recorded to increase at a rate of 55% a year, and by 400% when soil moisture went from 0% to 100%. Weights of roots increased at a rate of 18% a year, and by 34% when soil moisture went from 0% to 100% (Julien & Bourne 1988:95).*

### Aquatic growth rates

In aquatic situations there is usually less interspecific competition; temperatures are modified and less extreme; nutrient levels are relatively high and there is no water availability stress. Aquatic growth rates therefore always exceed terrestrial growth rates at the same air temperatures (Sainty *et al.* 1998). Aquatic

biomass can double in 41 days during the growing season. Although slow, growth can often continue over winter (Julien 1995).

## Growing season

Alligator weed requires a warm growing season, and in Australia this can be between September and May, but the growing season is commonly referred to as November to May. Growth generally slows or ceases in temperate zone winters. However, if severe frost has killed the above-ground stem and leaf material, perennation can still occur because of the presence of the underground or underwater stems and roots. In subtropical climates growth can occur all year but is slower during the cooler months. After each growing season, above-ground stems lose their leaves and become prostrate, eventually forming a tangled mat that supports new vertical growth each season. New stems occur from axillary and terminal buds on the previous season's growth in spring.

Stem density and production of new nodes peak during early summer; and stem length, weight and leaf area peak in January when temperatures are highest. Growth is faster and biomass greater when day length is longer.

Over the growing season maximum growth rates occur in early and mid-summer; peak densities occur in mid-summer (January or February); and biomass peaks in late summer. At peak production, 69 nodes per square metre per day were produced at an aquatic site and 54 at a terrestrial site (Julien, Bourne & Low 1992).

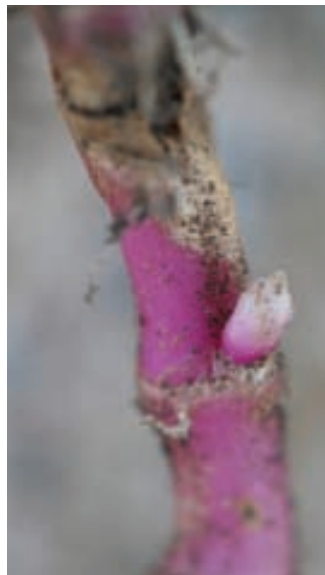
Photosynthesis is highest at the beginning of the growing season (November) and lowest at the end of the growing season (May). Transpiration is similar, being six times higher in November and three times higher in February than in May (Kelley & Hennecke 2006).



*Roots occurring at a stem node on an aquatic plant.*  
Photo: Brian Worboys



*Roots occurring at stem node on a terrestrial plant.* Photo: Brian Worboys



*New shoot from a bud on a buried stolon.* Photo: Brian Worboys



*New stem growing from root material.* Photo: Brian Worboys

## Reproduction

It is generally accepted that alligator weed does not produce viable seeds under field conditions outside its native range (Julien & Stanley 1999). Alligator weed reproduction is entirely vegetative, and records suggest that all alligator weed in Australia is from the same parent material that has spread from the original point of introduction (Julien & Bourne 1998).

New plants (shoots and roots) can occur at any node along a stem (two axillary buds are present at every node); or from underground stems and root material, which are capable of developing roots and shoots.

Buds on stems at the bottom of a weed mat can remain dormant until exposed to light. Regeneration rates from root fragments are probably lower from smaller roots, and the exact size of the smallest root fragment that is able to regenerate is not known.

## Spread

Stem and root fragments have the ability to produce roots and shoots and form new infestations, and therefore the potential for spread is enormous.

Natural spread occurs in aquatic infestations when sections of a mat or small plant fragments break away and float downstream (Julien & Stanley 1999) or are moved during floods. In terrestrial infestations, natural spread is through competition and eventual domination of other vegetation.

Accidental spread occurs commonly through human activities (on earthmoving machinery and watercraft; through the slashing and mowing of infested areas; in mulch, gravel extraction and turf; and even through



*Alligator weed and water hyacinth spread by the recent flooding of the Hunter River.* Photo: Brian Worboys



*New shoots coming from very dry root material.*  
Photo: Brian Worboys

control activities). Cattle and horses have been observed to spread fragments, both in their hooves and when pieces of plant material drop out of their mouths while grazing.

Purposeful spread (which is illegal in all States and territories) has also occurred through propagation as a garden vegetable or for the ornamental/aquarium plant trade.

### Fragments are resilient

Alligator weed fragments are very resistant to desiccation (drying out). It is unlikely that fragments ever dry out enough to render them unviable under field conditions. Fragments are also able to withstand moderate damage (i.e. from earthmoving equipment or trampling by stock) and still form buds, shoots and roots. Even damaged fragments can remain viable for long periods of time, particularly when in contact with soil or mud (Kruger 2005).

## Similar-looking plants

There are 12 other species of *Alternanthera* in Australia, four of which are native (see table). The other non-native *Alternanthera* species in Australia include various weed plants such as Khaki weed (*Alternanthera pungens*), sessile joyweed (*Alternanthera sessilis*) and some ornamental varieties.

The four native Australian species of *Alternanthera* are *Alternanthera angustifolia* (narrow-leaved joyweed); *Alternanthera denticulata* (common or lesser joyweed); *Alternanthera nana* (hairy joyweed); and *Alternanthera nodiflora* (common joyweed). These are easily distinguished from alligator weed because they have sessile flower clusters (i.e. their flowers clusters have no stalks), whereas alligator weed has flower clusters on its stalks. Weed authorities are promoting *Alternanthera denticulata* for culinary use.

A number of other plants are commonly mistaken for alligator weed in the field due to their similar appearance and growth habits (see table). On close inspection each is able to be distinguished from alligator weed.

## Native *Alternanthera* species in Australia

|                         | Alligator weed has:                           | The four native <i>Alternanthera</i> species all have: |
|-------------------------|---|--|
| Similar features        | Opposite leaves                               | Opposite leaves  |
| Distinguishing features | White ball-like flowers on stalks (peduncles) | Sessile flowers – the flowers have no stalks           |

### *Alternanthera denticulata* (lesser joyweed)

- Native to Australia
- Occurs throughout Australia



*Alternanthera denticulata*.  
Photo: Bruce Auld



*Alternanthera denticulata*. Photo: FG and FJ Richardson

### *Alternanthera nana* (hairy joyweed)

- - Native to Australia
- - Not widespread, occurs in southern and inland Australia

*Alternanthera nana.*  
Photo: Bruce Auld



### *Alternanthera nodiflora* (common joyweed)

- - Native to Australia and Europe
- - Occurs throughout Australia but more common on Western Plains of NSW and in inland Australia

*Alternanthera nodiflora.*  
Photo: Richard Medd



### *Alternanthera angustifolia* (narrow-leaved joyweed)

- - Native to Australia
  - - Not widespread, occurs mostly in dry inland Australia
- no image available*

## Plants that look similar to alligator weed

### *Ludwigia peploides subsp. montevidensis* (water primrose)

- Possibly native to South America but sometimes considered native to Australia.
- Occurs in NSW, Vic, SA, Qld



Water primrose. Photo: Jackie Miles, Max Campbell



Photo: Bruce Auld

|                         | Alligator weed has:  | Water primrose has:   |
|-------------------------|--|---|
| Distinguishing features | <ul style="list-style-type: none"> <li>• opposite leaves</li> <li>• white ball-like flowers on stalks (peduncles)</li> <li>• hollow stems</li> </ul> | <ul style="list-style-type: none"> <li>• alternate leaves</li> <li>• single yellow flowers</li> </ul> |

### *Veronica anagallis-aquatica* (blue water speedwell)

- Native to Europe and Asia
- Widespread weed in temperate Australia



Blue water speedwell.  
Photo: RG and FJ Richardson

|                         | Alligator weed has:   | Blue water speedwell has:  |
|-------------------------|---|--|
| Similar features        | <ul style="list-style-type: none"> <li>• opposite leaves</li> <li>• hollow stems</li> </ul>   | <ul style="list-style-type: none"> <li>• opposite leaves</li> <li>• hollow stems</li> </ul>  |
| Distinguishing features | <ul style="list-style-type: none"> <li>• leaves with entire margins</li> <li>• white ball-like flowers on stalks (peduncles)</li> </ul> | <ul style="list-style-type: none"> <li>• leaves with finely toothed margins</li> <li>• leaves that clasp stems</li> <li>• spikes of pale blue flowers</li> </ul> |

## Enydra fluctuans (Enydra, buffalo spinach)

- Native to Australia
- Occurs in NSW and QLD



*Enydra fluctuans*.  
Photo: Graham Prichard

|                         | Alligator weed has:   | Enydra has:   |
|-------------------------|---|---|
| Similar features        | <ul style="list-style-type: none"> <li>• opposite leaves</li> <li>• hollow stems</li> </ul>       | <ul style="list-style-type: none"> <li>• opposite leaves</li> <li>• hollow stems</li> </ul>                     |
| Distinguishing features | <ul style="list-style-type: none"> <li>• white ball-like flowers on stalks (peduncles)</li> </ul> | <ul style="list-style-type: none"> <li>• flower heads in leaf axils</li> <li>• serrated leaf margins</li> </ul> |

## Persicaria sp. (smartweeds, slender knotweeds) e.g. Persicaria decipiens

- Some species native to Australia
- Occur throughout Australia

*Smartweed*. Photo: RG and FJ Richardson



*Smartweed*. Photo: Bruce Auld

|                         | Alligator weed has:  | Persicaria species have:  |
|-------------------------|--|---|
| Distinguishing features | <ul style="list-style-type: none"> <li>• opposite leaves</li> <li>• white ball-like flowers on stalks (peduncles)</li> <li>• hollow stems</li> </ul> | <ul style="list-style-type: none"> <li>• alternate leaves</li> <li>• elongated spikes of flowers in a range of colours (white, pink, purple)</li> </ul> |

**Plants that look similar to alligator weed (CONT'D)**

***Gomphrena celosioides* (Gomphrena weed)**

- Native to South America
  - Occurs in NSW, SA and Qld
- Gomphrena weed.*  
Photo: RG and FJ Richardson



|                         | Alligator weed has:   | Gomphrena weed has:   |
|-------------------------|---|---|
| Similar features        | • opposite leaves   | • opposite leaves   |
| Distinguishing features | • white ball-like flowers on stalks (peduncles)<br>• hollow stems | • an oval-shaped cluster of greenish-white flowers at the end of each branch between the pair of uppermost leaves |

***Hygrophila costata* (Hygrophila)**

- Native to the Americas
  - Occurs in Qld and NSW
- Hygrophila costata.*  
Photos: Sheldon Navie



|                         | Alligator weed has:   | <i>Hygrophila costata</i> has:   |
|-------------------------|---|--|
| Similar features        | • opposite leaves   | • opposite leaves  |
| Distinguishing features | • white ball-like flowers on stalks (peduncles)<br>• hollow stems | • whorls of inconspicuous whitish flowers in the leaf axils (at the stem and leaf junctions) |

## *Gymnocoronis spilanthoides* (Senegal tea plant)

- Native to South America
- Occurs in NSW, Vic, Qld

**National Alert List Species: all findings must be reported to the local weeds authority**

*Senegal tea.*  
Photo: www.biolib.de



|                         | Alligator weed has:  | Senegal tea plant has:  |
|-------------------------|--|---|
| Similar features        | • opposite leaves  | • opposite leaves   |
| Distinguishing features | <ul style="list-style-type: none"> <li>• completely hollow stems</li> <li>• white ball-like flowers on stalks (peduncles)</li> <li>• leaves with smooth margins</li> </ul> | <ul style="list-style-type: none"> <li>• cane like ribbed stems that are hollow between the joints</li> <li>• half sphere-shaped (pom-pom like) white or pale purple flower heads in clusters at the ends of branches</li> <li>• leaves with irregularly toothed margins</li> </ul> |

## *Alternanthera sessilis* (sessile joyweed)

- Native to Asia and Pacific
- Occurs in NSW, Qld and NT
- Used as a food plant
- Noxious weed in USA

*Sessile joyweed.*  
Photos: Lalith Gunasekera



|                         | Alligator weed has:                             | Sessile joyweed has:                                   |
|-------------------------|---|--|
| Similar features        | • opposite leaves                               | • opposite leaves                                      |
| Distinguishing features | • white ball-like flowers on stalks (peduncles) | • sessile flower clusters – the flowers have no stalks |