



Alligator weed

Alternanthera philoxeroides

Steve Csurhes and Anna Markula

Biosecurity Queensland
Department of Employment, Economic Development and Innovation
GPO Box 46, Brisbane 4001

April 2010

Note: information is still being collected for this species.
Technical comments on this publication are welcome.

© The State of Queensland, Department of Employment, Economic Development and Innovation, 2010.

Except as permitted by the *Copyright Act 1968*, no part of the work may in any form or by any electronic, mechanical, photocopying, recording, or any other means be reproduced, stored in a retrieval system or be broadcast or transmitted without the prior written permission of the Department of Employment, Economic Development and Innovation. The information contained herein is subject to change without notice. The copyright owner shall not be liable for technical or other errors or omissions contained herein. The reader/user accepts all risks and responsibility for losses, damages, costs and other consequences resulting directly or indirectly from using this information.

Enquiries about reproduction, including downloading or printing the web version, should be directed to ipcu@dpi.qld.gov.au or telephone +61 7 3225 1398.

Front cover: Leaves of *Alternanthera philoxeroides*
Flower of *Alternanthera philoxeroides*

Photo: Biosecurity Queensland

Contents

Summary	2
Introduction	3
Identity and taxonomy	3
Description	3
Reproduction and dispersal	6
Origin and distribution	7
Status in Australia and Queensland	7
Preferred habitat	9
History as a weed elsewhere	10
Uses	10
Pest potential in Queensland	11
Control	11
References	12

Summary

Alligator weed (*Alternanthera philoxeroides*) is a perennial aquatic and semi-aquatic plant native to tropical and subtropical South America.

Originally introduced into Australia in the 1940s, it has spread over more than 4000 ha, primarily in New South Wales. Under favourable conditions, alligator weed forms pure stands of dense, interwoven stems that smother aquatic and semi-aquatic habitats; block irrigation ditches and infrastructure; replace native vegetation; interfere with crops and pastures in low-lying, poorly drained areas; and impede fishing and boating. More than \$3 million has been spent controlling alligator weed in New South Wales, where it threatens to block irrigation infrastructure in the Murrumbidgee Irrigation Area.

Alligator weed is one of 20 Weeds of National Significance and is a declared pest in every state and territory of Australia. In Queensland, it is a Class 1 declared pest, as defined by the Queensland *Land Protection (Pest and Stock Route Management) Act 2002*.

Alligator weed is an invasive pest in at least 30 countries, scattered across tropical, subtropical and warm temperate areas. In the United States, it blocks parts of the Mississippi River. In China, it ranks among 12 of the country's worst invasive species—in some places it reduces rice production by 45%, wheat by 36%, sweet potato by 63%, lettuce by 47% and corn by 19%. Its dense growth affects hydro-electric power production, impedes fishing, degrades famous scenic sites and contributes to internal parasites and ill health in cattle and milking cows.

Despite being present in Queensland for over 20 years, alligator weed occupies no more than 88 ha and is still in a very early stage of population development, thanks largely to a committed eradication campaign by state and local governments. Climate modelling suggests alligator weed has the potential to become abundant in freshwater aquatic and semi-aquatic habitats across most of coastal and sub-coastal Queensland.

Considering the evidence presented in this assessment, it seems reasonable to conclude alligator weed is a 'high-risk' invasive species that poses a significant threat. As such, early preventative control in Queensland appears to be a wise investment.

Introduction

Identity and taxonomy

Species identity: *Alternanthera philoxeroides* (Mart.) Griseb.

Common names: alligator weed, pig weed

Family: Amaranthaceae

Synonyms: *Bucholzia philoxeroides*, *Telanthera philoxeroides*, *Telanthera philoxeroides* var. *acutifolia*, *Telanthera philoxeroides* var. *obtusifolia*, *Telanthera philoxeroides* var. *phyllantha*, *Telanthera philoxeroides* var. *denticulate*, *Achyranthes philoxeroides* (Groves et al. 1995)

Alternanthera comprises about 80 species worldwide. There are 12 species of *Alternanthera* in Australia, four of which are native—*A. angustifolia* (narrow-leaved joyweed), *A. denticulata* (lesser joyweed), *A. nana* (hairy joyweed) and *A. nodiflora* (common joyweed).

Description

Alligator weed is a perennial, stoloniferous plant. Its morphology varies depending on whether it is growing on the edge of a water body (with its long stems floating out over the water surface) or growing in a low-lying, poorly drained site away from the water's edge. Hence, the literature often refers to two so-called 'forms'—an aquatic form and a terrestrial form. While not true genetic forms, such morphological plasticity enables the species to survive and dominate across a range of aquatic and semi-aquatic habitats. When growing away from open water, the plant produces deep taproots and a total root mass up to seven times heavier than plants growing over open water. This root mass makes the terrestrial form much more difficult to kill with herbicides, compared to the free-floating form. The leaves of terrestrial plants are smaller and have fewer flowers. When floating over water the plant grows more vigorously and has taller, thicker stems with larger internal air spaces and larger, darker leaves. The aquatic form is still rooted in soil near the water's edge or in underwater substrate. A problematic feature of alligator weed is its ability to produce dense mats of interwoven stems extending many metres across a water surface, effectively forming a 'blanket' across the water (Figure 1). Such mats can be more than 1 m thick and sometimes break away to become free-floating and self-sufficient (Groves et al. 1995; van Oosterhout 2007).



Figure 1. A dense infestation of alligator weed in a water body (photo: Andrew Petroeschevsky, New South Wales Government)

Stems are simple or branched and can produce roots at each node (Figure 2).



Figure 2. Roots growing from each node along the stem of *Alternanthera philoxeroides* (photo: Biosecurity Queensland)

Stems are hollow, which is a distinctive diagnostic feature of the species (Figure 3).



Figure 3. Hollow stems of *Alternanthera philoxeroides* (photo: Joe Vitelli, Biosecurity Queensland)

Leaves are dark green, waxy, glabrous, opposite and sessile; linear lanceolate to narrowly obovate; and usually have acute tips, 2–12 cm long and 0.5–4 cm wide (Figure 4).



Figure 4. Leaves of *Alternanthera philoxeroides* (photo: Biosecurity Queensland)

The inflorescence (flower) is a simple terminal spike on an axillary peduncle, 1–9 cm long (Figure 5).



Figure 5. Flower of *Alternanthera philoxeroides* (photo: Biosecurity Queensland)

The spike is subglobose to cylindrical and 12–14 mm in diameter. The perianth is silvery white and the flowers perfect with at least four tepals, each 4–6 mm long. Tepals are glabrous, nearly equal, obscurely four-veined, lanceolate to ovate oblong, acute, firm and serrulate near the apex. Bracts are one-fourth as long as the tepals and are broadly ovate and glabrous. Each flower has five stamens, each with two-locular anthers. Alternating with the stamens are narrower ligulate staminodes that project beyond the anthers and are half as long as the tepals. The filaments are united at the base forming a short tube. The ovary is superior; unilocular with a solitary ovule. The style is elongate and the stigma entire. The ovule is pendulous from a long funicle (Groves et al. 1995).

Two biotypes exist. *Alternanthera philoxeroides* f. *philoxeroides* has small, ovate leaves, short internodes and slender stems. In comparison, *A. philoxeroides* f. *angustifolia* has acute, long leaves and broader stems (Sosa et al. 2003).

Four species of *Alternanthera* native to Australia can be distinguished from alligator weed by their sessile flower clusters (flower clusters do not have stalks).

Non-related, but morphologically similar, species include:

- *Ludwigia peploides* spp. *montevidensis* (water primrose)
- *Persicaria* sp. such as *P. decipiens* (slender knotweed, smartweed)
- *Veronica anagallis-aquatica* (blue water speedwell)
- *Enydra fluctuans* (enydra, buffalo spinach)
- *Gomphrena celosioides* (gomphrena weed)
- *Hygrophila costata* (hygrophila)
- *Gymnocoronis spilanthoides* (Senegal tea plant)
- *Alternanthera sessilis* (sessile joyweed).

For information on distinguishing these species, refer to the *Alligator weed control manual* (van Oosterhout 2007).

Reproduction and dispersal

Alligator weed is polygamous, producing male and female flowers on the same plant. Flowering is from midsummer until March. In its native range, alligator weed produces viable seeds. However, in Australia, seeds are not produced and the plant reproduces entirely from broken sections of stem. Stem fragments can be carried considerable distances by floodwater—downstream and out over floodplains. Once lodged in a suitable substrate, stem fragments can produce new roots and leaves within three weeks. Fragmentation and dispersal can also occur as a result of human activity, such as mulching or movement of earthmoving machinery.

Origin and distribution

Alligator weed is native to the Parana River floodplains of southern Brazil, Paraguay and Argentina, which lie within tropical and subtropical South America.

Naturalised populations exist in California and the south-eastern United States, Puerto Rico, New Zealand, Burma, Thailand, Indonesia, India, China, France, Italy, Papua New Guinea, Singapore, Sri Lanka and Australia (Agriculture and Resource Management Council of Australia and New Zealand 2000; Groves et al. 1995; ISSG 2006; Sainty et al. 1997) (Figure 6).

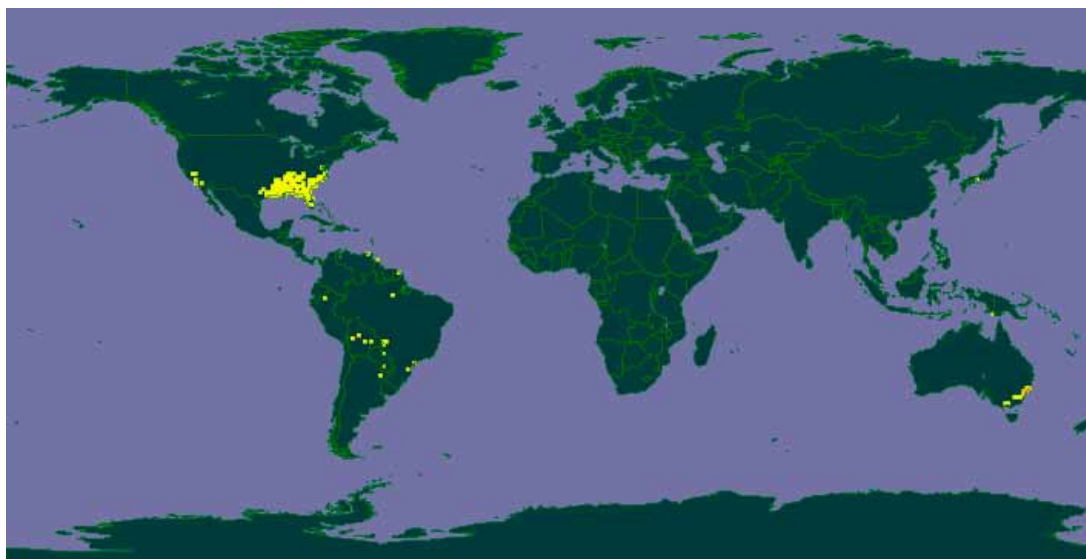


Figure 6. Worldwide distribution of *Alternanthera philoxeroides* (Source: GBIF, undated)

Status in Australia and Queensland

Alligator weed was first discovered in the Newcastle docks area, New South Wales, in 1946. It might have been introduced within a ship's ballast from South America; however, early herbarium records suggest it was more likely to have been introduced via cargo from ships, possibly during World War II. Subsequent spread occurred throughout the Hunter floodplain, central coast and Sydney region in New South Wales and into the Australia Capital Territory.

Currently, at least 4000 ha are infested by alligator weed in Australia (van Oosterhout 2007). The largest infestations exist in the Greater Sydney region and Hunter basins, New South Wales. Smaller infestations are scattered across south-east Queensland, Melbourne, the Northern Rivers area of New South Wales (Richmond River Catchment) and the Murray-Darling Basin (WONS 2008) (Figure 7).

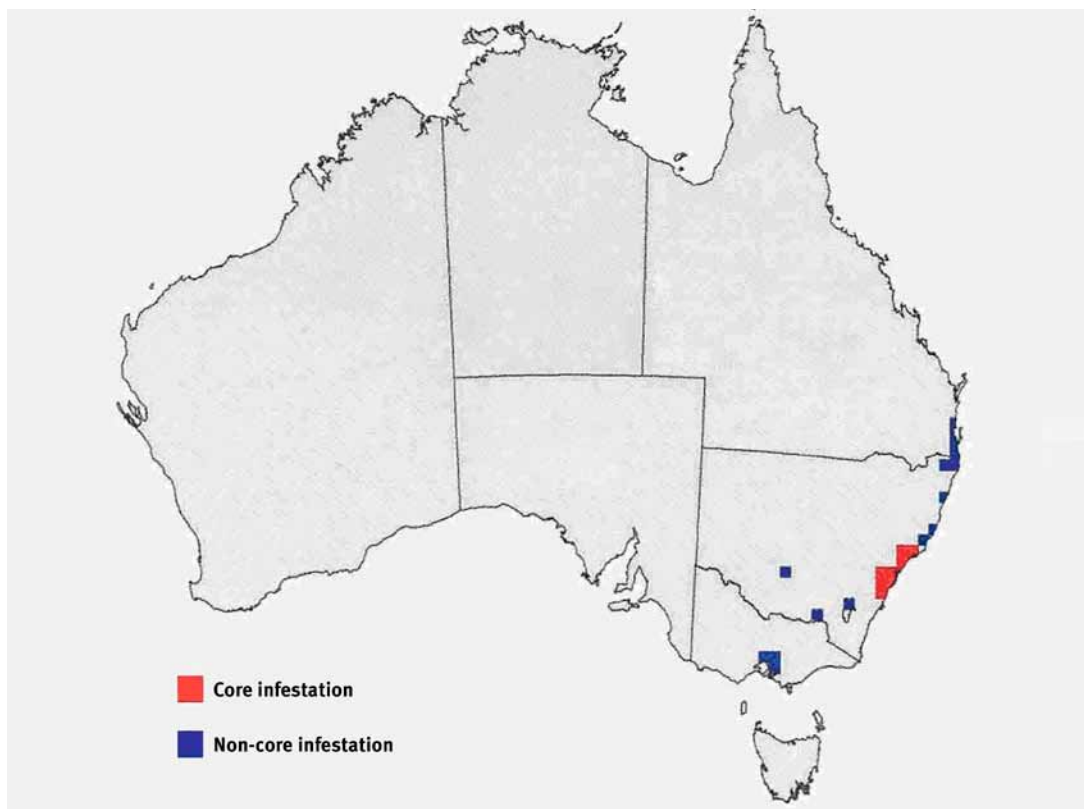


Figure 7. Current distribution of alligator weed in Australia—red indicates extensive ‘core infestations’ and blue indicates less extensive ‘non-core infestations’ (Petroeschevsky 2007)

Under favourable conditions, alligator weed forms pure stands of dense, interwoven stems that smother aquatic and semi-aquatic habitats; block irrigation ditches and dams; replace native vegetation; interfere with crops and pastures in low-lying, poorly drained areas; and interferes with fishing and boating. The plant’s stems float on water and can completely cover water bodies.

The New South Wales state government and local councils spent \$2 844 000 on control of alligator weed over five years (2003 to 2008), with substantial expenditure directed at protecting the Murrumbidgee Irrigation Area. In addition, approximately \$500 000 of Australian Government and Catchment Management Authority funding has been spent. Victoria spends approximately \$40 000 to \$60 000 per annum on control. The Australian Capital Territory spends approximately \$20 000 per annum on control (A Petroeschevsky, National Aquatic Weeds Coordinator, pers. comm. 2008).

Alligator weed was detected for the first time in Queensland in the 1980s in a drain at Indooroopilly (Brisbane). In the 1990s, alligator weed was mistakenly cultivated as an edible vegetable in hundreds of gardens in Queensland (at least 90 sites in Brisbane and the Gold Coast), Victoria (over 700 sites), New South Wales (over 500 sites), South Australia (less than 10 sites), Western Australia and Tasmania. People believed it was a closely related edible species, *A. sessilis*. (Agriculture and Resource Management Council of Australia and New Zealand 2000; Petroeschevsky 2007; Sainty et al. 1997; van Oosterhout 2007). In Queensland, all garden populations of alligator weed have been subject to many years of control and monitoring by local governments and Biosecurity Queensland. Currently, only two sites still have alligator weed (Barry Sullivan, pers. comm. 2009).

Currently, the total area supporting naturalised alligator weed in Queensland is estimated at 88 ha. This area involves four separate locations, all in coastal south-east Queensland (Table 1).

Table 1. Locations where alligator weed exists as naturalised populations in Queensland

Site	Area of infestation (ha)
Stable Swamp Creek, Salisbury	41
Bullock Head Creek, Richlands (along the Caboolture River)	31
Mudgeeraba wetlands, Gold Coast	12
Currumbin District Horse Club, Gold Coast	4

These four sites are currently subject to control work. However, these populations are proving resilient, with repeated regrowth from underground roots and stems following herbicide application at some sites.

Other smaller infestations have been detected at Roma, Port Douglas and Paradise Palms Golf Course, Cairns (Queensland Herbarium records). These populations are believed to have been successfully eradicated. An infestation at Charleville has also been eradicated (Barry Whyte, pers. comm. 2009).

Alligator weed is one of 20 Weeds of National Significance and is a declared pest in every state and territory of Australia. In Queensland, it is a Class 1 declared pest, as defined by the Queensland *Land Protection (Pest and Stock Route Management) Act 2002*.

Preferred habitat

Alligator weed prefers open (full sun), disturbed sites along the banks of freshwater creeks, rivers, dams and lakes, but will also invade poorly drained, low-lying, floodplains. It tends to be absent or persists at low levels in riparian habitat that has retained a dense cover of native trees and shrubs. Some of the most vigorous stands of alligator weed tend to be associated with slow-moving water bodies that have suffered eutrophication, or otherwise high nutrient and sediment loads. It is occasionally found in drier habitats such as gardens, footpaths and building sites, presumably where the subsoil retains adequate moisture.

Alligator weed tolerates several days of inundation but does not survive permanent inundation (Groves et al. 1995; PIER 2007).

Preferred soil types are generally various alluvial soils, from sands to heavy clays, with pH of 4.8–7.7 (ZipcodeZoo 2008; van Oosterhout 2007). While preferring fresh water, alligator weed can tolerate the saline upper tidal reaches of rivers and creeks where salt content is 10% that of sea water in still water and 30% of sea water in flowing water (Groves et al. 1995).

A study in China found that alligator weed preferred more fertile and wetter soils compared to the native joyweed (*A. sessilis*), which preferred less fertile, drier coarse gravels (Pan et al. 2006).

Climatically, alligator weed prefers tropical and subtropical areas but can still grow prolifically in warm temperate climates. Like many aquatic plants, it seems to have a broad climatic tolerance. Shen et al. (2005) reported that optimum shoot emergence and growth occurred at a constant 30 °C, whereas no shoot emergence was observed below a constant 5 °C, suggesting a preference for tropical to subtropical conditions. While alligator weed requires a warm growing season, it can readily survive cold winters, including severe frosts. When subject to extreme winter cold, the leaves may drop but the underground parts of the plant survive and regrow the following spring (Groves et al. 1995).

This study was unable to find any information on this species' tolerance to fire.

History as a weed elsewhere

Alligator weed ranks among the most problematic aquatic weeds in the world, being a pest in at least 30 countries (Geng et al. 2007).

In the United States, alligator weed was introduced in around 1900, most likely as part of ballast water from South America. It now causes major impediments to navigation on the Mississippi River (Agriculture and Resource Management Council of Australia and New Zealand 2000; Everglades CISMA 2008).

Alligator weed is one of the 12 most harmful alien invasive species in China. In some places it reduces rice production by 45%, wheat by 36%, sweet potato by 63%, lettuce by 47% and corn by 19%. It also causes significant losses of cotton, soybean and peanuts, and infests orchards, gardens, tea plantations, mulberry fields and medicinal and herbal crops. Its dense growth affects hydro-electric power production, impedes fishing and has seriously degraded famous scenic sites. It contributes to internal parasite infections and ill health in cattle and milking cows (Agriculture and Resource Management Council of Australia and New Zealand 2000; Pan et al. 2007).

Uses

Alligator weed has been used as an aquarium plant (Georgia Invasive Species Task Force 2005). There has also been research into its potential to remove lead and mercury from polluted water (Prasad 2003; Cho-Ruk et al. 2006). It has been grown in Australian backyards in the mistaken belief it was *A. sessilis*, a popular leafy vegetable in Sri Lanka. To assist with eradication, a native replacement (*A. denticulata*) was found (Gunasekera & Bonila 2001).

Pest potential in Queensland

Despite its presence in Queensland for over 20 years, alligator weed is still in a very early stage of population development and has the potential to become abundant in freshwater aquatic and semi-aquatic habitats across substantial areas of the state.

Climate-modelling software was used to predict the area of Australia at risk from alligator weed (Figure 8).

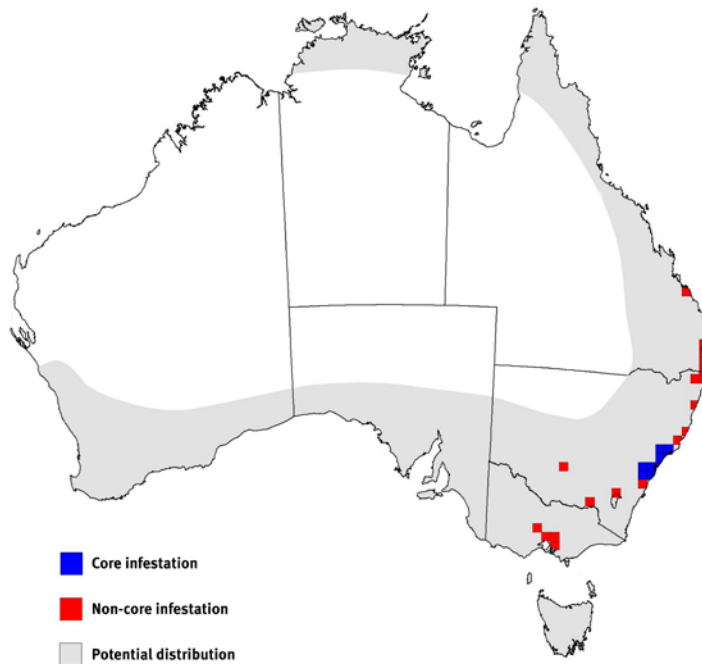


Figure 8. Current and potential distribution of *Alternanthera philoxeroides* in Australia (map: Andrew Petroeschovsky, National Aquatic Weeds Coordinator)

If permitted to fill its entire potential bioclimatic range, the impact of alligator weed in Queensland is predicted to be substantial. Possible impacts include:

- blocking slow-moving water bodies such as creeks, some rivers, dams and lakes
- interfering with irrigation systems (blocking irrigation ditches, pumps and pipes)
- reducing pasture and crop yield on poorly drained floodplains
- dominating disturbed wetland ecosystems
- interfering with recreational activities such as fishing, boating and canoeing
- imposing ongoing control costs.

Considering the multi-million dollar impacts interstate and overseas, early preventative control in Queensland appears to be a wise investment.

Control

This study does not attempt to detail control methods for alligator weed. For detailed information refer to the *Alligator weed control manual* (van Oosterhout 2007).

References

- Agriculture and Resource Management Council of Australia and New Zealand, Australian and New Zealand Environment and Conservation Council and Forestry Ministers (2000) *Weeds of National Significance. Alligator Weed (Alternanthera philoxeroides) Strategic Plan*. National Weeds Strategy Executive Committee, Launceston.
- Bourke, CA & Rayward, D (2003) 'Photosensitisation in dairy cattle grazing alligator weed (*Alternanthera philoxeroides*) infested pastures', *Australian Veterinary Journal*, 81(6): 361–362.
- Cho-Ruk, K, Kurukote, J, Supprung, P & Vetayasuporn, S (2006) 'Perennial Plants in the Phytoremediation of Lead-contaminated Soils', *Biotechnology*, 5(1): 1–4.
- CRC Weed Management (2003) *Weed Management Guide—Alligator Weed (Alternanthera philoxeroides)*. <http://www.weedsrc.org.au/documents/wmg_alligator_weed.pdf>.
- CSIRO (2006) *Biological control of alligator weed*. <<http://www.csiro.au/science/AlligatorWeed.html#3>>.
- DPIF (2007) *Fact Sheet—Alligator Weed*. <http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Alligator-Weed-PP4.pdf>.
- EPPO (2007) *Alternanthera philoxeroides (Amaranthaceae)*. <http://www.eppo.org/QUARANTINE/Alert_List/invasive_plants/Alternanthera_philoxeroides.htm>.
- Everglades Cisma (2008) *Alligatorweed*. <<http://www.evergladescisma.org/species/subinfo.cfm?sub=2779>>.
- GBIF (undated) *Global Biodiversity Information Facility—Alternanthera philoxeroides*. <<http://data.gbif.org/species/13739378>>.
- Geng, YP, Pan, XY, Xu, CY, Zhang, WY, Li, B, Chen, JK, Lu, BR & Song, ZP (2007) 'Phenotypic plasticity rather than locally adapted ecotypes allows the invasive alligator weed to colonize a wide range of habitats', *Biological Invasions*, 9: 245–256.
- Georgia Invasive Species Task Force (2005) *Aquatic Pests Introduced from Aquariums and Water Gardens*. <<http://www.gainvasives.org/pubs/aquatics.pdf>>.
- Groves, RH, Shepherd, RCH & Richardson, RG (1995) *The Biology of Australian Weeds Volume 1*. RG and FJ Richardson, Melbourne.
- Gunasekera, L & Bonila, J (2001) 'Alligator Weed: Tasty Vegetable in Australian Backyards?', *Journal of Aquatic Plant Management*, 39: 17–20.
- ISSG (2006) *Alternanthera philoxeroides*. <<http://www.issg.org/database/species/ecology.asp?si=763&fr=1&sts=&lang=EN>>.
- Liu, C & Yu, D (2009) 'The bud and root sprouting capacity of *Alternanthera philoxeroides* after over-wintering on sediments of a drained canal', *Hydrobiologia*, 623: 251–256.
- Pan, X, Geng, Y, Zhang, W, Li, B & Chen, J (2006) 'The influence of abiotic stress and phenotypic plasticity on the distribution of invasive *Alternanthera philoxeroides* along a riparian zone', *Acta Oecologica*, 30(3): 333–341.

- Pan, XY, Geng, YP, Sosa, A, Zhang, WJ, Li, B & Chen, JK (2007) 'Invasive *Alternanthera philoxeroides*: biology, ecology and management', *Acta Phytotaxonomica Sinica*, 45(6): 884–900.
- Petroeschovsky, A (2007) *Review of Progress Towards the Alligator Weed Strategic Plan 2006-2007*. <http://www.weeds.org.au/WoNS/alligatorweed/docs/Alligator_weed_Strategic_Plan_Review_2006-07.pdf>.
- PIER (2007) *Alternanthera philoxeroides*. <http://www.hear.org/Pier/species/alternanthera_philoxeroides.htm>.
- Prasad, MNV (2003) 'Metal hyperaccumulation in plants—Biodiversity prospecting for phytoremediation technology', *Electronic Journal of Biotechnology*, 6(3). <<http://www.ejbiotechnology.info/content/vol6/issue3/full/6/6.pdf>>.
- Sainty, G, McCorkelle, G & Julien, M (1997) 'Control and spread of Alligator Weed *Alternanthera philoxeroides* (Mart.) Griseb., in Australia: lessons for other regions', *Wetlands Ecology and Management*, 5(3): 195–201.
- Shen, J, Shen, M, Wang, X & Lu, Y (2005) 'Effect of environmental factors on shoot emergence and vegetative growth of alligator weed (*Alternanthera philoxeroides*)', *Weed Science*, 53(4): 471–478.
- Sosa, AJ, Julien, MH & Cordo, HA (2003) 'New research on *Alternanthera philoxeroides* (alligator weed) in its South American native range', in *Proceedings of the XI International Symposium on Biological Control of Weeds*, Canberra, Australia, 27 April – 2 May 2003.
- van Oosterhout, E (2007) *Alligator Weed Control Manual*. NSW Department of Primary Industries.
- Wikipedia (2008a) *Amaranthaceae*. <<http://en.wikipedia.org/wiki/Amaranthaceae>>.
- Wikipedia (2008b) *Alternanthera*. <<http://en.wikipedia.org/wiki/Alternanthera>>.
- Willsher, L, Mifsud, G & Mason, P (2007) *Containment and suppression of a non-core infestation: Currumbin District Horse Club*. In: *Alligator Weed Control Manual*. NSW Department of Primary Industries.
- Wilson, JRU, Yeates, A, Schooler, S & Julien, MH (2007) 'Rapid response to shoot removal by the invasive wetland plant, alligator weed (*Alternanthera philoxeroides*)', *Environmental and Experimental Botany*, 60: 20–25.
- WONS (2008) *Alligator Weed National Priority Framework 2009–2011*. <http://www.weeds.org.au/WoNS/alligatorweed/docs/National_Alligator_Weed_Priorities_2009-2011.pdf>.
- Yeates, A (2004) 'Effect of herbicide, repeated leaf removal, and single event complete above ground biomass removal on the production, nutrient, and stored energy allocation of alligator weed (*Alternanthera philoxeroides*)', *Final Report Submitted to The Cooperative Research Centre for Weed Management*. <http://www.ento.csiro.au/weeds/pdf/alligator_yeates_report.pdf>.
- ZipcodeZoo (2008) *Alternanthera philoxeroides*. <http://zipcodezoo.com/Plants/A/Alternanthera_philoxeroides/>.

