

# Pest plant risk assessment



## Kidneyleaf mudplantain

*Heteranthera reniformis*

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Front cover: *Heteranthera reniformis*

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## Summary

*Heteranthera reniformis* is native to shallow (less than 15 cm deep), freshwater wetlands over a broad area of North, Central and South America. It is a submerged or floating, annual or facultatively perennial plant that grows 20–50 cm tall.

Within its native range, *H. reniformis* grows rapidly to form dense mats when competition is low. However, it is a poor competitor with taller sedges and rushes. ‘It will grow well for a few years on the edges of ponds and marshes before it is shaded out’ (NatureServe 2007). Its seeds last for many years and enable the species to reappear when the next disturbance event occurs. As such, it appears to be a quick-growing, opportunistic coloniser of open wetlands.

In late 2007, the first naturalised population of *H. reniformis* in Queensland was officially recorded. Soon after, 21 additional sites were found, all within coastal south-east Queensland, and further searching is likely to reveal more.

*H. reniformis* is a popular ornamental pond plant and is actively promoted on internet sites for its attractive foliage. Like most other invasive plants, ornamental use and trade has no doubt resulted in its escape, naturalisation and dispersal.

This study concludes that *H. reniformis* has the potential to become an abundant and troublesome pest, mainly in highly disturbed, open wetlands where the water is less than 15 cm deep. It is expected to be less of a problem in wetlands where taller vegetation is still intact and provides shade. This conclusion is based on the following evidence:

- *H. reniformis* is climatically well suited to tropical and subtropical areas of Queensland. Because of this, there does not appear to be any climatic limitation to its growth in Queensland.
- Suitable disturbed, open, shallow, freshwater wetland habitats exist in Queensland for this species.
- *H. reniformis* has a broad natural geographic range, a common feature of many invasive pest species.
- In Italy, *H. reniformis* is a weed of flooded rice and can reduce yields by up to 70%. *H. reniformis* also forms dense mats within its native range. Its history as a pest elsewhere is perhaps the most reliable indicator of pest potential.
- *H. reniformis* has successfully naturalised at several sites in south-east Queensland, where it appears to form dense mats, albeit at a localised scale.

## Species identity

*Heteranthera reniformis* Ruiz and Pavon, Fl. Peruv. 1: 43. 1798.

**Family:** Pontederiaceae

**Common names:** Kidneyleaf mudplantain (US), roundleaf mudplantain (US).

## Description

*H. reniformis* is an annual or facultatively perennial plant, 20–50 cm tall, that grows in shallow, freshwater wetlands (Figures 1, 2 and 3). It can grow submerged or floating, with procumbent stems that either creep along the mud or float. The stems are wrapped in thick squamiform sheaths and produce roots at the nodes.



Figure 1. Leaves and flowers of *H. reniformis*.

Flowering stems are 1–9 cm long with distal internodes (0.5–4 cm). Leaves are arranged alternately along the stems. Leaves are sessile, forming basal rosettes. Leaf blades are 5 cm × 3 cm, glabrous, cordate-reniform, obtuse or rounded at the apex and bilobate at the base. The petiolate leaves can be floating or emerged. Stipules are 1–5 cm long; petiole 2–13 cm; blade reniform, 1–4 cm × 1–5 cm, length equal to or less than width, apex obtuse. The inflorescence is a raceme, 2–10-flowered, elongating in one day, usually shorter than spathes, terminal flower sometimes extending beyond spathe apex; spathes 0.8–5.5 cm, glabrous; peduncle 0.5–4.2 cm, glabrous.

Flowers are white to pale blue and open about three hours after sunrise and wilt by early afternoon; salverform, tube 5–10 mm, limbs zygomorphic, lobes narrowly elliptic, 3–6.5 mm, distal central lobe with yellow or green region at base, sometimes with distal brown spot; stamens unequal, lateral stamens 0.9–2.2 mm, filaments linear, pubescent with white multicellular hairs toward apex; central stamen 2.2–4.7 mm, filament sparsely pubescent with multicellular hairs; style pubescent with multicellular hairs.

The fruit is a capsule with 8–14 winged seeds, 0.5–0.9 mm × 0.3–0.5 mm.  $2n = 48$ .

*H. reniformis* is sometimes confused with *H. limosa* Willd.



Figure 2. Growth habit of *H. reniformis*.



Figure 3. Mat-forming habit of *H. reniformis* growing in a shallow concrete drain.

## Competitiveness

*H. reniformis* is reported to be a 'fugitive' species of wetlands (NatureServe 2007). Although it can grow rapidly to form dense mats when competition is low, it is a poor competitor with sedges and rushes. 'It will grow well for a few years on the edges of ponds and marshes before it is shaded out' (NatureServe 2007).

## Phenology

In North America, flowering mainly starts in July, but the plant can flower from late May to September and can continue until frost. In New York, at the northern limit of its range, the plant is vegetative through June and July, flowers in August, and fruits in September. South of the equator in Paraguay, the species is in flower and fruit from August to May. The flowers are ephemeral in nature; all flowers on an inflorescence will open in the morning and close by the afternoon of the same day. Flowers on submerged inflorescences will not open (NatureServe 2007).

## Origin and global distribution

*H. reniformis* is native to North, Central and South America, including south-eastern United States, Mexico, Dominican Republic, Jamaica, Belize, Costa Rica, El Salvador, Honduras, Nicaragua, Panama, Guatemala, Colombia, Puerto Rico, Ecuador, Argentina, Brazil, Peru, Venezuela and Paraguay (*Flora of North America* 2007; USDA Plants database 2007; Missouri Botanical Gardens 2007) (Figure 4).

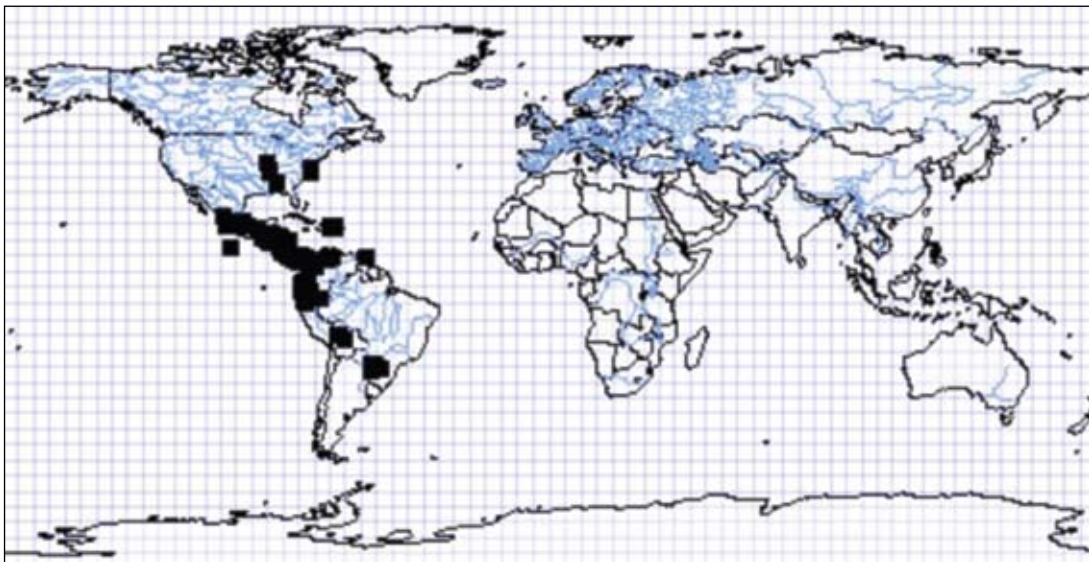


Figure 4. Global distribution of *H. reniformis* (source: Missouri Botanical Gardens w3 database).

Within the United States, the range of *H. reniformis* extends from a sinkhole area in Illinois at its north-western edge; east to New York, Delaware and Connecticut; south along the coast and to Texas where it is known from only one collection; to Mexico and Central America where it is common; and the West Indies (e.g. Puerto Rico, Jamaica), south to Paraguay and Argentina (NatureServe 2007). In the United States, it is most common near the Mississippi River in Louisiana and western Tennessee. In Kansas, Nebraska and Oklahoma, any records for *H. reniformis* are most likely *H. multiflora* (i.e. were misidentified). There are no positively identified *H. reniformis* specimens in these three states, nor does the species exist in Indiana (NatureServe 2007). The native distribution of *H. reniformis* in the United States is provided in Figure 5. It is listed as an endangered plant in Illinois and Ohio (USDA Plants database 2007).



Figure 5. Native distribution of *H. reniformis* in North America (source: *Flora of North America* 2007).

*H. reniformis* has naturalised in Italy, Spain (and Australia). *H. reniformis*, along with *H. limosa*, another American subtropical species, is found in northern Italy on the borders of rice fields (at 70–100 meters elevation). Populations have been found on the Plain of Lombardy in the Pavia area and to the south of Milan. It was observed for the first time in 1968 near Pavia in the village of Marcignago and Vidigulfo. Since then it has been observed in different areas of the Plain of Lombardy and the range appears to be expanding (Pignatti 1982). *H. limosa* has also been noted, with some possible uncertainty in identification, in Carmague, southern France. It seems that only an examination of herbarium specimens could conclude that it is not *H. reniformis* (Lagarde & Gauthier 1991).

## Preferred habitat

*H. reniformis* is adapted to open, sunny sites with nutrient-rich soil and shallow water (less than 15 cm deep) (NatureServe 2007). Because it is a poor competitor with many sedges, rushes and other wetland species, *H. reniformis* is easily crowded out of wetlands. It is, however, able to take advantage of favourable situations quickly, such as recently inundated areas (e.g. following flooding, beaver dams or human activity) and areas where competition has been destroyed or otherwise removed (as in the case of herbicide use). As a result, this species is found in seemingly disjunct and dissimilar areas such as ponds and sinkholes, rice fields, ditches, and powerline corridors (NatureServe 2007). Soil seed-banks are thought to exist for many years; as a result, populations show up unexpectedly when conditions improve. This could explain populations that appear unexpectedly when rice fields are flooded. Within its native range, *H. reniformis* may have historically benefited from the hydrologic changes created by beavers (NatureServe 2007).

Within its native range *H. reniformis* grows in roadside ditches, the edges of freshwater streams/rivers and ponds and in freshwater tidal mudflats from an elevation of 0–2600 m (Flora of North America 2007).

A summary of habitat types by state and country is provided by NatureServe (2007) and is as follows:

- Connecticut: Creek banks and in a freshwater tidal zone growing on mud in mid-tide range.
- Georgia: Fairly disturbed habitats where it can be abundant and show up erratically.
- Iowa: Noted from an historic collection in Red Haw State Park growing in 2–3 inches of water.
- Missouri: Occurs ‘along sloughs, ditches of valleys and swampy depressions and margins of artificial and natural ponds, especially of oxbow lakes in river bottoms.’
- Camden County, New Jersey: Generally occurs in less densely vegetated zones of marshes than *H. multiflora* which occurs with *Typha* spp.; *H. reniformis* occurs with *Nuphar lutea*, *Sagittaria graminea*, *S. subulata*, *Eleocharis parvula* and *Ludwigia palustris* (Snyder 1988).
- New York: *H. reniformis* is often vigorous and common on open mudflats (including both sandy and silty tidal mud substrates) and marshes, particularly in areas with little competition from other plants. Associates include *Sagittaria subulata*, *Scirpus* spp. and *Nuphar* sp. It commonly occurs as an understory to peltate-leaved emergent and sometimes in ‘grassy’ areas. Populations have also been noted to be most dense and robust near manure dumps and boundaries between marshes and cow pastures. It was also noted to be mat-forming in a freshwater intertidal marsh where it is isolated from other plants along the mudflat.

- North Carolina: This plant is found creeping in mud or floating in shallow water. In Ohio, two extant populations occur in the Ohio River, one of which is on a narrow linear strip of mud bar along the Ohio River edge where it is flooded in high water and locally abundant. An adjacent population across the river in West Virginia should perhaps be called the same population. The other population is several miles downstream in a muddy area that is highly disturbed because of trampling and erosion caused by fishing along the riverbanks. In both areas, the water levels remain fairly stable due to dams on the river.
- South Carolina: One occurrence record from a stream in shallow water.
- Virginia: It is noted to occur in swampy and inundated woods.
- West Virginia: Reported habitats include: a creek under willows, a shallow pool in a river gorge, and muddy riverbanks and shorelines with *Ludwigia peploides* and *L. leptocarpa*.
- Cuba: One record (1940) of specimens in a water-filled depression in a cane field road (University of Minnesota Herbarium).
- Ecuador: Collected from marshy ground and a small pond (Horn 1987).
- Guatemala: Generally found in mud, along ponds or lakes, or along streams or ditches at 2000 meters or lower. Plants are usually creeping on mud and rarely floating.
- Honduras: Collections dated 1948 were made from a marsh along the Rio Charrera and a roadside ditch near the Rio Yeguare (University of Minnesota Herbarium).
- Mexico: One collection (1926) from swamps and pools in Jalisco (University of Minnesota Herbarium).
- Jamaica: Locally common in ditches, swamps and sluggish streams.
- Panama: The following habitats are mentioned: swamps in pasture, bogs, and a pool in a savanna.
- Paraguay: Found in 'suelo humedo y aguas poco profundas' (moist soil and shallow waters).

While, *H. reniformis* is listed as 'endangered' at certain locations at the periphery of its native range in the United States, it appears to have increased in abundance elsewhere, perhaps due to disturbance and the creation of suitable habitat. For example, the Ohio Department of Natural Resources (2007) commented that 'it is possible that the damming of the Ohio River has created habitat suitable for this species as well as an avenue for the species to migrate into Ohio. It is likely that this species could become more common in Ohio in the future, especially on mudflats along the shore of the Ohio River'. Similarly, this species appears to have extended its natural range slightly into north-west Florida.

## Reproduction, dispersal and seed longevity

Since the stems of *H. reniformis* produce roots at each node, it is expected that any broken fragments of stems, with one or more nodes intact, could be washed downstream to infest new areas. A single flood-event is likely to disperse stem fragments over a considerable distance.

Each fruit on *H. reniformis* contains 8–14 winged seeds. While this study was unable to find published information on dispersal, it is reasonable to assume that these winged seeds can be dispersed by wind and water.

Seed banks may exist in the soil for many years (NatureServe 2007). Optimum conditions for seed germination may include daily fluctuations in temperature. These fluctuations naturally raise and lower soluble oxygen levels and may act as a trigger for germination (NatureServe 2007).

## History as a weed overseas

*H. reniformis* is a weed of flooded rice in Italy where rice yield reductions of up to 70.5% were recorded in experimental plots (Ferrero 1996).

Weber and Gut (2005) list *H. reniformis* as an agricultural weed (naturalised) that is spreading in Europe.

*H. reniformis* is listed as a weed in Portugal and Spain (*Global compendium of weeds* 2007).

Within its native range, *H. reniformis* can become locally abundant following disturbance events that remove other vegetation. However, it tends to disappear when other taller vegetation regrows.

## Uses

*H. reniformis* is used as an ornamental pond plant in the United States, Australia and elsewhere. One website comments that it is a 'very attractive' and is 'excellent for use in small ponds and water gardens'.

## Related species

There are several other morphologically similar congeners and *H. reniformis* is sometimes confused with *H. limosa* Willd. and *H. multiflora*.

*H. reniformis* can be distinguished by the following characteristics: the internode of the flowering stem is generally longer (0.5–5 cm vs. less than 1 cm in *H. multiflora*); the spike is generally shorter than the spathe; inflorescences have fewer flowers (2–8 vs 3–16); lateral filament hairs are multicellular, and white rather than purple; the perianth is white, rarely blue, and densely glandular pubescent on the outside rather than pale purple or white and scarcely glandular pubescent; and the sessile leaves of seedlings are in a basal rosette rather than on an elongate stem.

The species have differing chromosome numbers: *H. reniformis* ( $2n = 48$ ) and *H. multiflora* ( $2n = 32$ ) (Horn 1985; Rosatti 1987). The ranges of *H. reniformis* and *H. multiflora* overlap in the United States; however, *H. multiflora* is more typical of the central and eastern plain states (Snyder 1988), whereas *H. reniformis* ranges from the eastern plain states to the east coast. In addition, *H. multiflora* is more likely to inhabit deeper water because of its superior ability to produce elongate stems (Horn 1985, Rosatti 1987).

*H. reniformis* is also easily confused with *H. peduncularis*, a species occurring primarily in the Mexican highlands (Snyder 1988). Those in western Missouri are assigned to *H. peduncularis* by Gleason (1952); however, Steyermark (1963) argued that the criteria for this assignment (i.e. with *H. reniformis*, the spathe and leaf next below it are separated by a conspicuous internode and the base of the short spike is included by the spathe, whereas with *H. peduncularis* the spathe and leaf next below it are contiguous and the base of the spike is exerted from the spathe) are only based upon a growth phase and would therefore assign these to *H. reniformis*. In addition, the leaves of *H. peduncularis* are cordate-rotund, the spathe is loosely sheathing at the base and is abruptly caudate-acuminate (Gleason 1952), the inflorescence is more elongate, and the filaments are glabrous or nearly so (Horn 1985).

In *H. rotundifolia*, the leaves are more round and the lobes, on the single flower, are not as acute as in *H. reniformis*, which has 2–8 flowers (Horn 1987).

## Status in Queensland

In December 2007, the first naturalised population of *H. reniformis* in Queensland was officially recorded. Soon after, 21 additional sites have been found, all within coastal south-east Queensland, and further searching is likely to reveal more.

## Pest potential in Queensland

Based on the evidence collected in this study, it seems reasonable to conclude that *H. reniformis* has long-term potential to become an abundant and troublesome pest in Queensland, mainly in highly disturbed, shallow freshwater wetland habitats. It is expected to be less of a problem in wetlands where taller vegetation is still intact and provides shade. This conclusion is based on the following evidence:

- *H. reniformis* is climatically well suited to tropical and subtropical areas of Queensland. As such, there do not appear to be any climatic limitations to its growth in Queensland.
- Suitable shallow, open (full sun), disturbed, freshwater wetland habitats exist in Queensland for this species.
- *H. reniformis* has a broad natural geographic range—a reliable indicator of pest potential.
- In Italy, *H. reniformis* is a weed of flooded rice and can reduce yields by up to 70%. *H. reniformis* also forms dense mats within its native range. History as a pest elsewhere is perhaps the most robust indicator of pest potential.
- *H. reniformis* has successfully naturalised at several sites in south-east Queensland, where it appears to dominate other wetland vegetation, albeit at a localised scale.

However, it is important to note that this species is an opportunistic coloniser of open, shallow wetlands, ditches and creek banks. It is readily outcompeted and replaced by taller vegetation and does not thrive under shade.

## Control

This study was unable to find detailed information on the control of *H. reniformis*. However, experiments to control common *Heteranthera* species within flooded rice in Italy found that cinosulfuron (sulfonylurea) showed the highest effectiveness and selectivity, even when applied in very low amounts (Sparacino et al. 1996).

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