Large-flower Primrose-willow (*Ludwigia grandiflora*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, May 2012
Revised, March 2018
Web Version, 2/1/2019

Photo: O. Pichard. Licensed under Creative Commons (CC-BY-SA-3.0). Available: https://commons.wikimedia.org/wiki/File:Ludwigia_grandiflora_saint-mathurin-sur-loire_49_10082007_4.JPG. (March 2018).

1 Native Range and Status in the United States

Native Range

From CABI (2018):

"*L. grandiflora* is native to the Americas, ranging from the Rio La Plata in Argentina north to the south/southeastern USA. In the USA, its range is primarily along the Atlantic coast and through the Gulf Coastal Plain (southeastern New York through Florida, westward to Texas) (McGregor et al., 1996)."

From NatureServe Explorer (2018):

"Global range includes two disjunct areas, one in southern Brazil, Bolivia, northeastern Argentina, Uruguay, and Paraguay (also locally in Guatemala), and the second (with relevance here) in the southeastern United States coastal plains of southern South Carolina, Georgia, northern Florida, and Louisiana, west to central Texas; and once in southwest Missouri (Zardini et al., 1991; Crow and Hellquist, 2000a)."

"There is some uncertainty over the native range of *Ludwigia grandiflora*."

The USDA Natural Resources Conservation Service (2018) website reports all occurrences in the contiguous United States are introductions.

Status in the United States

From NatureServe Explorer (2018):

"This species has expanded rapidly in the past in the United States beyond its original early invasion into the Pacific Northwest and the American southeast. It is now found in more than 20 states with recent expansion continuing, though not as rapidly because a significant portion of its potential range has already been filled. Recent expansions in California have prompted the California Invasive Plant Council to rate *Ludwigia* as a High Impact invasive species due to its ability to rapidly invade unexploited ecosystems (Sonoma County Water Agency, 2005); and it is also listed as a noxious weed in Washington, Florida, North Carolina, and South Carolina. Recent rapid epansion [*sic*] is also documented in Tennessee and Kentucky (Chester and Holt, 1990)."

According to NatureServe (2018), distribution of *Ludwigia grandiflora* within the contiguous United States includes the following states: AL, AR, CA, DC, FL, GA, KY, LA, MO, MS, NC, NJ, NY, OK, OR, PA, SC, TN, TX, VA, WA, and WV.

Means of Introductions in the United States

From CABI (2018):

"In North America, *L. grandiflora* was introduced outside its native range into Tennessee and Kentucky where the first collections were made in 1968 and 1988, respectively. Introduction to California is referred to as 'recent' (Okada et al., 2009)."

Remarks

From NatureServe Explorer (2018):

"Recent expansions in California have prompted the California Invasive Plant Council to rate *Ludwigia* as a High Impact invasive species due to its ability to rapidly invade unexploited ecosystems (Sonoma County Water Agency, 2005); and it is also listed as a noxious weed in Washington, Florida, North Carolina, and South Carolina."

"*Ludwigia grandiflora* was recently (Zardini et al., 1991; 1992) delineated as a distinct species from the *Ludwigia uruguanyensis* species complex, but confusion still exists, even in recent literature, as to whether *Ludwigia grandiflora* and *Ludwigia hexapetala* are distinct species or not. Taxonomically, many synonymies have not been reconciled and in North America, *Ludwigia grandiflora* and *Ludwigia hexapetala* have often been used interchangeably (Crow and Hellquist, 2000a; ITIS, 2005; Kartesz, 1999; Washington State Noxious Weed Control Board, 2006; Wittenberg, 2005), and are likely the same species. Global range of *L. grandiflora* includes two disjunct areas, one in southern Brazil, Bolivia, northeastern Argentina, Uruguay, and Paraguay (also locally in Guatemala), and the second (with relevance here) in the southeastern United States coastal plains of southern South Carolina, Georgia, northern Florida, and Louisiana, west to central Texas; and once in southwest Missouri (Zardini et al., 1991; Crow and Hellquist, 2000a). *Ludwigia hexapetala* was also similarly delineated but has since been synonymized with *Ludwigia grandiflora*. Its global range included southern Brazil, Uruguay, eastern Paraguay, and northern and central Argentina; also central Chile and scattered localities in Bolivia, Peru, Ecuador, Colombia, Costa Rica, and (introduced) widespread in the southeastern United States but scattered introductions elsewhere including California (Zardini et al., 1991) all the southeast and Gulf states (Benson et al., 2001) and north to New England (Benson et al., 2004). USDA (2006) lists the range in the U.S. as the eastern coastal states from New York to Florida (absent from Delaware and Maryland) through the Gulf states to Texas and up the Mississippi River drainage to Missouri; also California to Washington."

From Nehring and Kolthoff (2011):

"An ecological risk assessment, mainly based on knowledge about invasion histories in neighbouring countries, showed that this species is a threat to German biodiversity; thus, it is considered to be invasive and has been assigned to the German Black List."

"The genus *Ludwigia* needs a taxonomic revision."

ITIS (2018) lists *Ludwigia uruguayensis* (Cambess.) H. Hara, *Jussiaea grandiflora* Michx., *Jussiaea michauxiana* Fernald, *Jussiaea uruguayensis* Cambess, *Jussiaea repens* var. *grandiflora* (Michx.) Micheli, *Ludwigia uruguayensis* var. *major* (Hassler) Munz, and *Ludwigia grandiflora* ssp. *grandiflora* (Michx.) Greuter & Burdet as synonyms for *Ludwigia grandiflora* (Michx.) Greuter & Burdet.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2018):

"Kingdom Plantae
Subkingdom Viridiplantae
Infrakingdom Streptophyta
Superdivision Embryophyta
Division Tracheophyta
Subdivision Spermatophytina

Class Magnoliopsida
Superorder Rosanae
Order Myrtales
Family Onagraceae
Genus *Ludwigia*
Species *Ludwigia grandiflora* (Michx.) Greuter & Burdet"

"Taxonomic Status: accepted"

Size, Weight, and Age Range

From CABI (2018):

"During the first growth stage, the plant produces smooth or sparsely pubescent stems that grow horizontally over the soil or water, rooting at nodes and producing white, spongy roots. Leaves are smooth, alternate and have petioles. During the second stage, shoots begin to grow vertically and flower, stems become pubescent and can grow up to 1 m tall (USACE-ERDC, 2009). Leaves tend to be more elongate in the second growth form (IPAMS, 2009), but can vary widely in shape from lanceolate to elliptic and acute at both ends (USACE-ERDC, 2009). Flowers are on solitary stalks that are approximately 2.5 cm long; actinomorphic; sepals 5 (rarely 6), villous or glabrous; petals 5, caducous, obovate, emarginate, bright golden-yellow with a darker spot at the base; stamens in 2 whorls, the epipetalous ones shorter; disc slightly elevated, with a depressed, white-hairy nectary surrounding the base of each epipetalous stamen; style glabrous or hairy in lower two-third. Fruit is a pubescent light-brown capsule, 2.5 cm long containing 40-50 seeds, 1.5 mm long, embedded in a woody endocarp (IPAMS, 2009)."

Environment

From CABI (2018):

"High levels of polymorphism and phenotypic plasticity have been reported for this species in France, which allows the species to grow in a wide range of environments (Ruaux et al., 2009). Its allelopathic properties mean it is an ecosystem engineer, and by making habitats unsuitable for native flora, it increases its competitive potential (Dandelot et al., 2008). It can reproduce vegetatively quite rapidly, but can also repopulate disturbed areas from seed banks. *L. grandiflora* is quite tolerant of fluctuations in water level and flooding."

Climate/Range

CABI (2018) reports *L. grandiflora* is tolerant of tropical wet and dry savanna climate and preferences for warm temperate climates, wet all year and dry summer (i.e., warm average temperature > 10°C, cold average temperature > 0°C). Range is listed as 49°N to 34°S.

Distribution Outside the United States

Native

From CABI (2018):

"*L. grandiflora* is native to the Americas, ranging from the Rio La Plata in Argentina north to the south/southeastern USA [see Section 1]."

From NatureServe Explorer (2018):

"Global range includes two disjunct areas, one in southern Brazil, Bolivia, northeastern Argentina, Uruguay, and Paraguay (also locally in Guatemala), and the second (with relevance here) in the southeastern United States [see Section 1]."

"There is some uncertainty over the native range of *Ludwigia grandiflora*."

Introduced

CABI (2018) lists France, Germany, Netherlands, Spain, and Switzerland as countries where *L. grandiflora* has been introduced.

Means of Introduction Outside the United States

From CABI (2018):

"*L. grandiflora* disperses primarily through the movement of plant parts in water, although sexual reproduction and transportation of the resulting seeds may also be an important means of dispersal (Ruaux et al., 2009). Water currents can generate very high propagule pressure and water-mediated dispersal of stem fragments or floating mats can contribute both to population growth and invasive spread (Okada et al., 2009).

Stems can break off the plant and can be carried by animals to a new location, where they may establish new populations (IPAMS, 2009). No specific studies quantifying the propagule pressure due to biotic vector transmission have been conducted at this time.

Humans may be the primary vector of transmission. *L. grandiflora* has been historically valued as an ornamental; ornamental plantings likely explain its introduction to Europe (Ruaux et al., 2009). Due to its presence in the horticultural trade, it is likely that propagules of this plant are occasionally present as hitchhikers, and included in orders of non-target species. It is possible that this plant may unintentionally be introduced in mixed-species planting orders."

Short Description

From CABI (2018):

"*L. grandiflora* is an emergent, aquatic, herbaceous perennial with two growth forms. During the first growth stage, the plant produces smooth or sparsely pubescent stems that grow horizontally over the soil or water, rooting at nodes and producing white, spongy roots. Leaves are smooth, alternate and have petioles. During the second stage, shoots begin to grow vertically and flower,

stems become pubescent and can grow up to 1 m tall (USACE-ERDC, 2009). Leaves tend to be more elongate in the second growth form (IPAMS, 2009), but can vary widely in shape from lanceolate to elliptic and acute at both ends (USACE-ERDC, 2009). Flowers are on solitary stalks that are approximately 2.5 cm long; actinomorphic; sepals 5 (rarely 6), villous or glabrous; petals 5, caducous, obovate, emarginate, bright golden-yellow with a darker spot at the base; stamens in 2 whorls, the epipetalous ones shorter; disc slightly elevated, with a depressed, white-hairy nectary surrounding the base of each epipetalous stamen; style glabrous or hairy in lower two-third. Fruit is a pubescent light-brown capsule, 2.5 cm long containing 40-50 seeds, 1.5 mm long, embedded in a woody endocarp (IPAMS, 2009)."

Biology

From NatureServe (2018):

"Fragmentation of stems is the main mode of dispersal of *Ludwigia* spp. although reproduction by seeds is known though unusual (Sonoma County Water Agency, 2005). Individuals resprout readily when broken or cut and stems fragment very easily (see management). The role of seeds remains to be studied further (viable seeds were able to germinate in laboratory conditions but no data has yet been obtained in outdoor conditions)."

Human Uses

From CABI (2018):

"The plant has attractive yellow flowers, is tolerant of a broad range of aquatic habitats and is very adaptable. These characteristics make it an interesting specimen for water gardening and means it is amenable to cultivation in a wide variety of situations."

"Water garden enthusiasts may have an aesthetic appreciation of this species. There might be some value in exploring the use of this species in wastewater treatment. Little other information is available regarding this species' productive social use."

"Due to the plant's phenotypic plasticity, it may provide some use in the reclamation of severely impacted ecosystems. However, its tendency toward invasiveness coupled with its allelopathic potential make this plant a poor candidate for restoration projects."

Diseases

None reported.

Threat to Humans

From NatureServe (2018):

"The Sonoma County Water Agency (2005) listed several dozen common and rare avian species that will benefit from *Ludwigia* removal in Laguna, California, because the growth of *Ludwigia* in this area actively promotes mosquito production, including mosquitos carrying the West Nile Virus, discovered in the area in 2004, which can kill native bird fauna."

3 Impacts of Introductions

From NatureServe (2018):

"Large plant biomass results in a reduction in dissolved oxygen, an increase in acidity of the water, the euthrophication of the water body, and an increase in sedimentation (Dutartre, 2004; Wittenberg, 2005). Mats impair water flow and has the potential to dominate shoreline vegetation if introduced to lakes, rivers, ponds, ditches, or streams (Washington State Noxious Weed Control Board, 2006). In Laguna, California, *Ludwigia* may also contribute to flooding in the Laguna system, as plant biomass fills in flood control channels, reducing its capacity for flood-retention and altering the characteristics of the wetland. Perennial *Ludwigia* mats slow the movement of water through the system, trapping trash and debris and likely fine sediments, further reducing flood-storage capacity and degrading the wetland. Over the long term, with no remediation, *Ludwigia* will potentially lead to a decrease in shallow wetland areas overall, but with increased flooding during storm events (Sonoma County Water Agency, 2005)."

"*Ludwigia grandiflora* forms dense stands that eliminate native vegetation by forming monospecific stands that competitively exclude other flora (Wittenberg, 2005). Mats impair water flow and has the potential to dominate shoreline vegetation if introduced to lakes, rivers, ponds, ditches, or streams (Washington State Noxious Weed Control Board, 2006)." *Ludwigia grandiflora* forms dense stands that eliminate native vegetation by forming monospecific stands that competitively exclude other flora. Dense mats can also reduce the habitat of surface water birds (Wittenberg, 2005). In France, it has been found to compete with native plants (Dutartre, 2004). Similarly, evidence suggests *Ludwigia hexapetala* (here considered a synonym) outcompetes native wetland species in the Laguna de Santa Rosa, California.

"*Ludwigia* is also a direct threat to the diversity of native plant and animal communities, growing over surrounding vegetation to produce a thick mat of woody perennial stems and decaying plant matter. This mat inhibits the recovery and recruitment of other plants, and eliminates open-water habitats that are important foraging-grounds for birds and other wildlife. As *Ludwigia* tissue sloughs off or dies back and decomposes, microbial growth reduces dissolved oxygen in the water, impacting fish and invertebrate populations. Eighteen species of fish are found in the Laguna, California, including threatened populations of steelhead that use Laguna channels for seasonal passage to upstream breeding habitats. Current efforts to protect and enhance wetland habitats for migratory birds and waterfowl on the Pacific Flyway are substantially limited by *Ludwigia* growth, especially in the CDFG's Laguna Wildlife Area, site of the proposed *Ludwigia* control project (Sonoma County Water Agency, 2005). The Sonoma County Water Agency (2005) listed several dozen common and rare avian species that will benefit from *Ludwigia* removal in Laguna, California, because the growth of *Ludwigia* in this area actively promotes mosquito production, including mosquitos carrying the West Nile Virus, discovered in the area in 2004, which can kill native bird fauna."

From CABI (2018):

"In California, USA dense stands of *L. grandiflora* reduce floodwater retention (Okada et al., 2009). The plant can also cause hyper-sedimentation and silting (Dandelot et al., 2008). *L.*

grandiflora has naturalized in France and has cost millions of Euros (RAFTS, 2009). *L. grandiflora* is considered by some to cause the most damage of any invasive aquatic macrophyte in water ecosystems across many regions of France. In the northeast of France, it often achieves growth capable of blocking slow-moving waterways, interfering with navigation, impacting irrigation and drainage in lakes, ponds and ditches (Ruaux et al., 2009). The species' physical and chemical alteration of the environment can cause severe damage to local ecosystems and biodiversity."

"*L. grandiflora* can cause very severe environmental impacts. It gives off allelopathic elements that impact water quality throughout the year. Nuisance levels of the plant can lead to impoverished flora by decreasing seedling survival of vulnerable native taxa (Dandelot et al., 2008). *L. grandiflora* can manipulate dissolved oxygen concentrations, causing severe hypoxia or even anoxia during summer months. The plant also causes sulphate and nitrate levels to drop in favour of increased sulphide and phosphate concentrations, thus effecting what Dandelot et al. (2005) refer to as 'a dystrophic crisis' and an intoxicated ecosystem."

"Due to the species' ability to shade out other submersed vegetation, it is generally considered a threat to biodiversity in its introduced range. Its allelopathic activity is detrimental to vulnerable native flora, as the chemical alterations the plant effects on the habitat contribute to decreasing seedling viability. There are threatened species in France that are highly susceptible to these impacts and that are placed at significant risk by *L. grandiflora* (Dandelot et al., 2005). Additionally the plant provides little in terms of suitable habitat or food source (IPAMS, 2009), and where invasive, can have far-reaching effects on multiple trophic levels (Dandelot et al., 2008)."

"This plant can cause substantial nuisance to recreational users by impeding navigation and interfering with hunting, fishing and other recreational activities (IPAMS, 2009) and can decrease the aesthetic value of waterbodies. Dense matting also prevents effective mosquito control (Okada et al., 2009)."

From Haury et al. (2011):

"Terrestrial forms of *Ludwigia* cause an increasing problem for managers as well as farmers, because invaded areas in meadows and pastures cannot be accepted for EU environmental grants. It is only possible to pick up Ludwigia during flooding. At present, no efficient removal method is known for meadows when they are out of flood."

4 Global Distribution

Figure 1. Known global distribution of *Ludwigia grandiflora*. Map by GBIF Secretariat (2018).

5 Distribution Within the United States

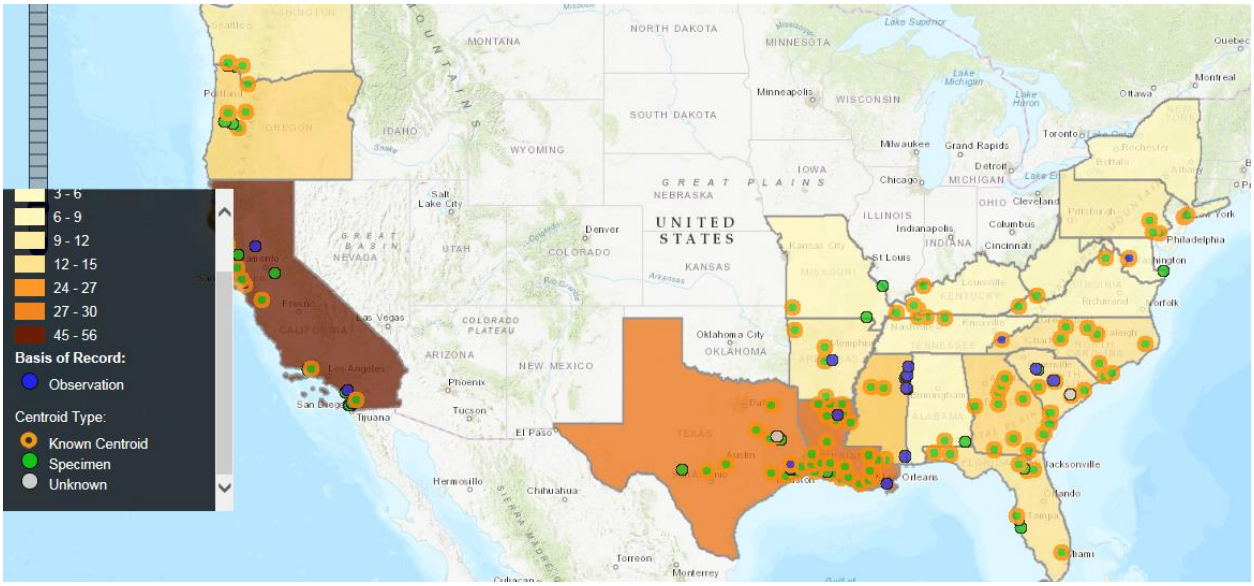

Figure 2. Distribution of *Ludwigia grandiflora* in the United States. Map from USGS BISON (2018).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) for *Ludwigia grandiflora* within the contiguous United States is high overall. The Climate6 proportion for this species is 0.616. The range of proportions classified as high match is ≥0.103. Locally, forty states are considered high match, covering much of the eastern, southeastern, and western United States. Colorado, Nebraska, New Hampshire, and Wyoming are medium match, while only Maine, Minnesota, North and South Dakota are low match.

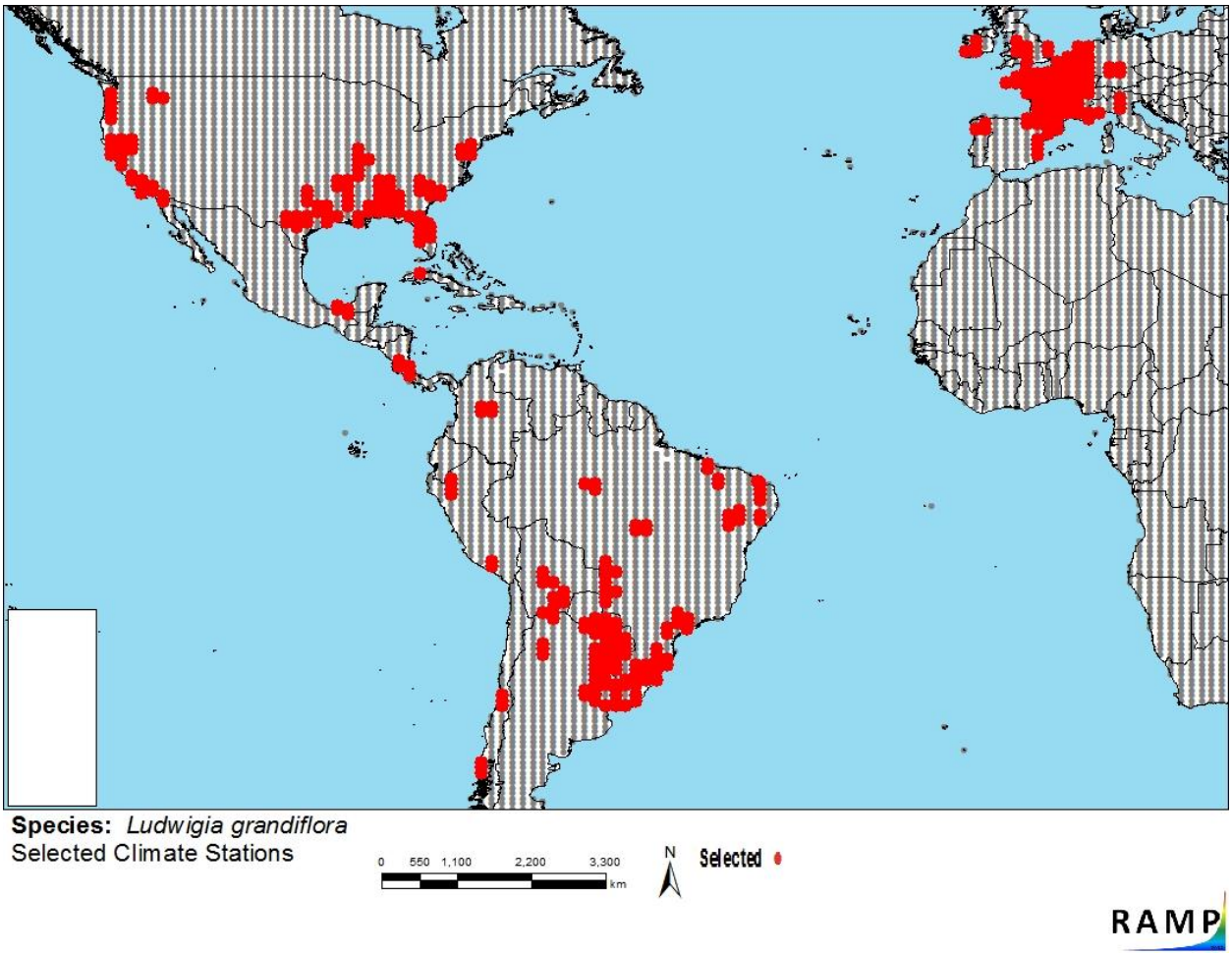

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Ludwigia grandiflora* climate matching. Source locations from GBIF Secretariat (2018).

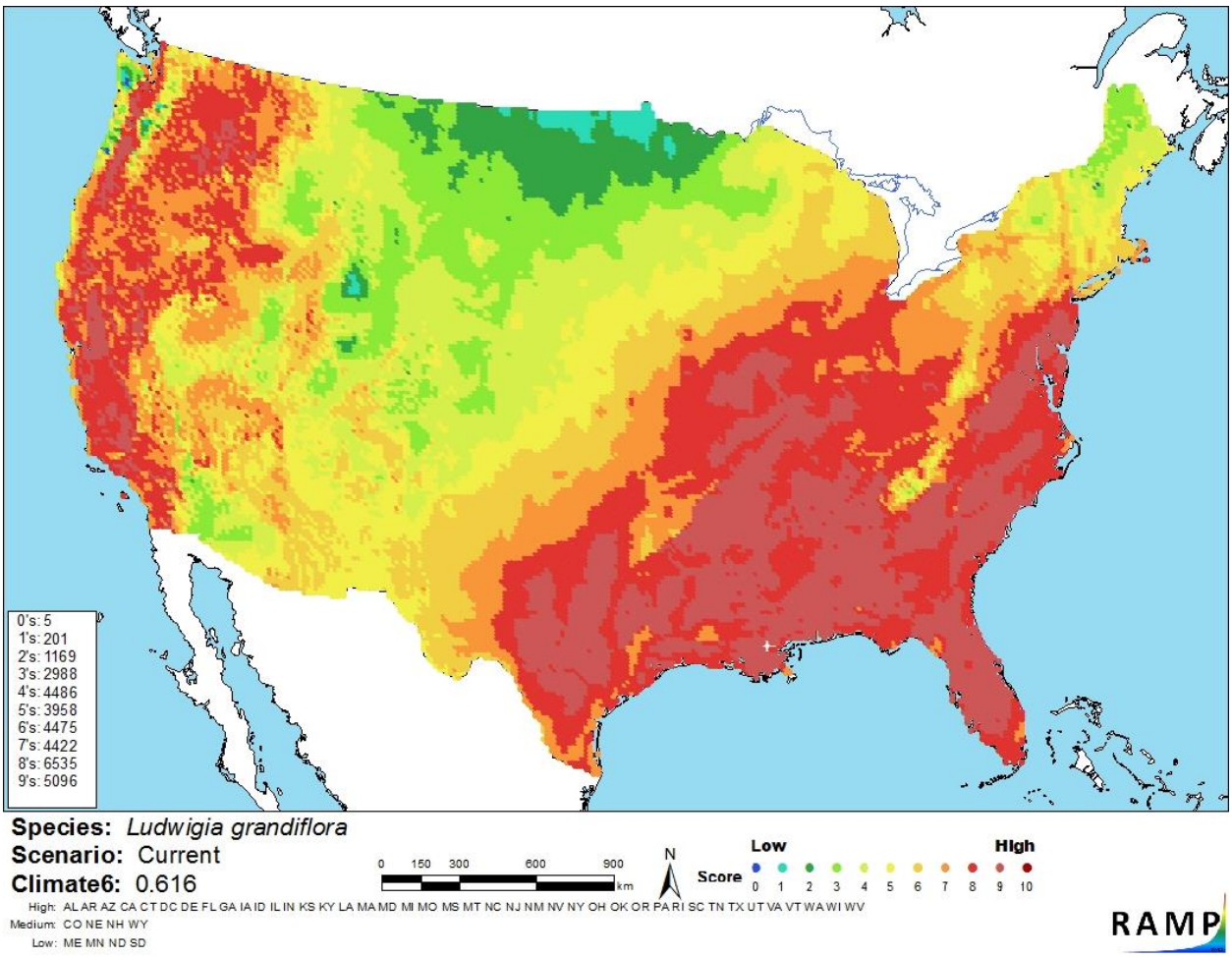

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Ludwigia grandiflora* in the contiguous United States based on source locations reported by GBIF Secretariat (2018). Counts of climate match scores are tabulated on the left. 0=Lowest match, 10=Highest match.

The "High", "Medium", and "Low" climate match categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
$0.000 \leq X \leq 0.005$	Low
$0.005 < X < 0.103$	Medium
≥ 0.103	High

7 Certainty of Assessment

A fair amount of information about *Ludwigia grandiflora* currently exists. Information is readily available regarding the species' biology, ecology, distribution, and impacts of introduction. However, some confusion surrounds the species' native range and taxonomy. Conflicting reports exist over what the species native range actually is and whether parts of the United States should be included. This has led to suggestion that the *Ludwigia* genus needs taxonomic revision. Given the uncertainty surrounding *L. grandiflora*, the overall certainty of assessment is medium.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Ludwigia grandiflora is a plant species with an unclear native range. Review of the species found all accounts include a range of southern Brazil, Bolivia, northeastern Argentina, Uruguay, and Paraguay, and locally in Guatemala. Some accounts also include a second disjunct range that covers the southeastern United States coastal plains (i.e., southern South Carolina, Georgia, northern Florida, and Louisiana) and stretches west to central Texas, while others suggest this range should be considered introduced. The differing native ranges is possibly attributed to some confusion over the taxonomy of the *Ludwigia* genus. It has been suggested the further review of the genus is necessary. Regardless, *L. grandiflora* is now considered invasive in other parts of the contiguous United States, as well as several European countries. Several negative impacts of introduction have been documented in many of these areas. This species can impact water quality, cause increased sedimentation, decrease native biodiversity, impede navigation, and interfere with recreational activities. Within the United States, *L. grandiflora* is listed as a noxious weed in Washington, Florida, North Carolina, and South Carolina. Climate match within the contiguous United States is high and supports the wide distribution *L. grandiflora* has established. With its high climate match and high history of invasiveness, *Ludwigia grandiflora* has an overall risk assessment of high.

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Medium**
- **Overall Risk Assessment Category: High**

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

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10 References Quoted But Not Accessed

Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

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