Indian Swampweed (*Hygrophila polysperma*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, January 2015
Revised, March 2018
Web version, 8/16/2018

Photo: Pinpin/Wikimedia. Licensed under Creative Commons BY-SA 1.0 Generic. Available: https://commons.wikimedia.org/wiki/File:Hygrophila_polysperma2.JPG.

1 Native Range and Status in the United States

Native Range

From Swearingen and Bargeron (2016):

"It is native to temperate and tropical Asia, which includes China and India."

From Thayer et al. (2018):

"Native Range: India, Malaysia, Bangladesh, Bhutan, Nepal, Cambodia, Laos, Myanmar, Thailand, and Vietnam (Angerstein and Lemke 1994, Nault and Mikulyuk 2009)."

From CABI (2018):

"It is also present in southern China, and is very rare in the lowlands of Taiwan (Flora of Taiwan, 1998)."

Status in the United States

From CABI (2018):

"*H. polysperma* was […] first collected in 1965 as an escape from cultivation along a roadside north of Tampa, Florida (Les and Wunderlin, 1981), though it wasn't correctly identified until 1977. In 1979, reports of populations came from Able Canal, which drained the Caloosahatchee River in western Florida, as well as from Miramar and City of Margate Canals, which are part of the Everglades drainage in eastern Florida (USGS-NAS, 2003). During the 1980s, populations were found at 29 additional sites, including the Loxahatchee River in 1986, and Withlacoochee River in 1989. By 1989, the range of *H. polysperma* extended northward through central Florida to the Santa Fe River, and also disjunctively spread westward to Tallahassee in the Florida Panhandle (USGS-NAS, 2003). In 1999, *H. polysperma* was known from at least 22 rivers/streams, 13 lakes, 2 ditches, and 7 canal systems in Florida, distributed over 20 counties and 17 water drainages in the state. *H. polysperma* is replacing the extremely aggressive non-native *Hydrilla verticillata* in some southeast Florida canals, due to the tolerance of *H. polysperm*a towards herbicides and grass carp that are usually used to control hydrilla in these locations (Duke et al., 2000).

In Texas, specimens were first collected in the San Marcos River in 1969, and additional locations in the San Marcos drainage, including Sessoms Creek, were recorded in the 1970s (USGS-NAS, 2003). The herbarium specimens were incorrectly identified as *Hygrophila lacustris* (Schlecht. and Cham.) Nees or *Ludwigia repens* Forst., and weren't correctly identified as *Hygrophila polysperma* until 25 years later (Angerstein and Lemke, 1994). In 1994, *H. polysperma* was recorded in spring fed portions of the Comal River system, and in 1998 was recorded at San Felipe Springs in western Texas (USGS-NAS, 2003).

H. polysperma was reported as being introduced in the Richmond, Virginia area during the 1950s, and "quickly established itself" for 15-20 years, until extremely cold winter temperatures occurred during the 1970s. The current status of this population is unknown (Sutton, 1995)."

From Swearingen and Bargeron (2016):

"It is listed as a noxious weed in the United States. *Hygrophila polysperma* has only been reported in Alabama, Florida, Kentucky, South Carolina, Texas and Virginia."

According to USDA, NRCS (2018), *Hygrophila polysperma* is listed as a noxious weed in the United States, a Class A noxious weed in Alabama, North Carolina, and Vermont, a quarantine species in California and Oregon, a Prohibited aquatic plant, Class 2 in Florida, a Prohibited species in Massachusetts, and an invasive aquatic plant and plant pest in South Carolina.

From Thayer et al. (2018):

"Alabama - Mobile municipal Park (Langan) of West Mobile in Mobile-Tensaw drainage (University of Alabama Biodiversity and Systematics 2007)
Florida - Kissimmee, Suwannee (Spencer and Bowes 1985), Ochlockonee (University of Florida Herbarium 2016), Peace (Hansen 1999), Southern Florida, Tampa Bay (Les and Wunderlin 1981), and St. Johns (Robert Kipker, FL DEP, pers. comm.) drainages
Kentucky - Jennings Creek in Barren drainage (Center for Invasive Species and Ecosystem Health 2015)
Mississippi - Aberdeen Pool of the Tennessee-Tombigbee Waterway in Upper Tombigbee drainage (Mississippi Museum of Natural Science 2016)
South Carolina - Goose Creek Reservoir in Cooper drainage (Hook and Nelson 2011)
Texas - Elm-Sycamore (David Lemke, Texas State Univ., pers. comm.), Middle Guadalupe, and San Marcos (Angerstein and Lemke 1994) drainages
Virginia - Richmond area lakes in James drainage (Schmitz and Nall 1984)"

"Surveys conducted by Rixon et al. (2005) found that *H. polysperma* was available for purchase in 25% of the pet and aquarium stores surveyed near Lakes Erie and Ontario. Maki and Galatowitsch (2004) had evidence that *H. polysperma* is available for purchase from vendors across the U.S. with delivery service to Minnesota. In addition, it is sometimes sold under the incorrect name of *Alternanthera sessilis*."

"Established in Alabama, Florida, Kentucky, Mississippi, South Carolina, and Texas. Extirpated in Virginia due to freezing temperatures in the 1970s (Nault and Mikulyuk 2009)."

From Jacono et al. (2018):

"*Hygrophila polysperma* has been documented near the Catskills region, New York (Harman 2011)."

"*Hygrophila polysperma* is listed as a Federal Noxious Weed and is prohibited in Illinois and Minnesota (Great Lakes Panel on Aquatic [Nuisance] Species 2012), […]."

Means of Introductions in the United States

From Thayer et al. (2018):

"*Hygrophila polysperma* was first introduced into Florida via the aquarium industry in the 1950s (Cuda and Sutton 2000). It was cultivated in Ohio at the end of WWII by an aquarium dealer (Reams 1953), but there is no indication that this species is still cultivated there."

Remarks
No additional remarks.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing
From ITIS (2018):

"Taxonomic Status:
Current Standing: accepted"

"Kingdom Plantae
Subkingdom Viridiplantae
Infrakingdom Streptophyta
Superdivision Embryophyta
Division Tracheophyta
Subdivision Spermatophytina
Class Magnoliopsida
Superorder Asteranae
Order Lamiales
Family Acanthaceae
Genus *Hygrophila*
Species *Hygrophila polysperma* (Roxb.) T. Anderson"

From CABI (2018):

"*Hygrophila polysperma* was first named *Justicia polysperma* Roxb. in 1820, was revised to *Hemidelphis polysperma* (Roxb.) Nees. in 1832, and further revised to its current accepted scientific name, *Hygrophila polysperma* T. Anderson in 1867."

Size, Weight, and Age Range
From Thayer et al. (2018):

"Size: Stems 6 feet or longer (Ramey 2001)."

Environment
From CABI (2018):

"The optimum temperature for *H. polysperma* is 22-28°C (71-82°F), with a minimum temperature of 4°C (39°F), and maximum temperature of 30°C (86°F) (Kasselmann 1995; Ramey 2001). *H. polysperma* is most commonly found in waters with pH between 5-7 (Spencer and Bowes 1985; Doyle et al. 2003), […]. *H. polysperma* prefers a light intensity of 110 micro-einsteins/m2/h (Cobb and Haller 1981)."

From Thayer et al. (2018):

"[…] *Hygrophila polysperma* can inhabit habitats with a variety of environmental conditions. It favors warmer waters of 18-30°C but can tolerate water temperatures as low as 4°C (Kasselmann 1995, Ramey 2001, Rixon et al. 2005, US EPA 2008). It grows in waters with pH of 6.5-7.8 (Spencer and Bowes 1985, Doyle et al. 2003) and water hardness of 30-140 ppm (Nault and Mikulyuk 2009). This species has low light saturation and compensation points, so it is capable of photosynthesizing in low light levels (Doyle et al. 2003). […]"

Climate/Range

From CABI (2018):

"H. polysperma is native to Tropical Asia, […]. In India, *H. polysperma* is found in wet areas to an altitude of 1600m (Weeds in Florida 2006). […]"

Distribution Outside the United States

Native

From Swearingen and Bargeron (2016):

"It is native to temperate and tropical Asia, which includes China and India."

From Thayer et al. (2018):

"Native Range: India, Malaysia, Bangladesh, Bhutan, Nepal, Cambodia, Laos, Myanmar, Thailand, and Vietnam (Angerstein and Lemke 1994, Nault and Mikulyuk 2009)."

From CABI (2018):

"It is also present in southern China, and is very rare in the lowlands of Taiwan (Flora of Taiwan, 1998)."

Introduced

CABI (2018) lists *Hygrophila polysperma* as introduced in Mexico, introduced and invasive in Germany, present with few occurrences in Hungary and Poland, and present in Pakistan.

From CABI (2018):

"*H. polysperma* has recently been reported in Europe for the first time, where plants were found in North Rhine-Westphalia, Germany (Hussner et al., 2007)."

From Hussner (2014):

"Macrophyte mappings of a 37 km stretch of the thermally abnormal Erft River in 2003, 2005, 2007, 2011 and 2013 documented the presence of nine alien ([…], *Hygrophila polysperma*, […]) in addition to 15 native species."

From Jacono et al. (2018):

"It occurs in Australia (Romanowski 2011), Kasterer Muhlenerft in Germany (Hussner et al. 2007), and Tamaulipas in Mexico (Mora-Olivo et al. 2008)."

NOBANIS (2018) lists *Hygrophila polysperma* as established and rare in Austria. Poland is also listed as a location on the *H. polysperma* page but all statuses are listed as not known.

Means of Introduction Outside the United States

From CABI (2018):

"*H. polysperma* is a very popular aquarium and water garden plant, and the ability to order this plant over the internet and through mail order gives it the ability to travel to all parts of the world (Kay and Hoyle, 2001; Ramey, 2001). It has escaped confinement and has been intentionally or accidentally introduced on several occasions outside of its native range."

"*H. polysperma* can be transported with wildlife and carried to new locations (DCR, 2003)."

"*H. polysperma* can be spread accidentally to new locations by the movement of boats, trailers, nets, sea planes, and other recreational equipment between water bodies (DCR, 2003). It is also possible for *H. polysperma* to be a 'hitchhiker' plant with other species ordered through water garden catalogues."

Short Description

From CABI (2018):

"*H. polysperma* is an herbaceous rhizomatous perennial aquatic plant with squarish stems that are ascending or creeping. The stems are mostly submerged, and are usually rooted in the substrate, though can also root freely at floating nodes. The submerged stem is very brittle, and can grow over 6 feet long. The submerged leaves are opposite along the stem, and are sessile with the bases joined at the nodes by ciliated flanges of tissue. The leaves are elliptic to oblong, light green, sparsely hairy, and usually broader towards the tip. Leaves are up to 8 cm long and up to 2 cm wide (UFL-IFAS, 2005), and the leaves on the submersed stem tend to be considerably larger, wider, and lighter in color than those on immersed stem. The small bluish white flower is nearly hidden by leaves in the uppermost leaf axils, and is 2-lipped, with the upper lip being 2-lobed and the lower lip 3-lobed. The fruit is a narrow hairy capsule up to 9mm long, containing 20-30 seeds, each seed being approximately 0.4-0.62 mm long, 0.3-0.5 mm wide, and 0.002-0.06 mm thick. The seeds are compressed, obovate to elliptic to round, with the entire margin narrowly winged. The seed coating is minutely pebbled, glistening, orange-yellow to brown-yellow, and translucent where the seed is particularly thin (FNW Disseminules, 2007)."

"*H. polysperma* may be confused with other small, opposite-leaved plants that are sometimes found submersed. *Ludwigia repens* has a 4-petaled yellow flower, blunt leaf tips, often has a purple pigment in the submersed leaves, and lacks flanges at the nodes (DCR, 2003). *Hygrophila costata* is entirely emersed or terrestrial, larger and taller, with flowers along the entire stem.

Hygrophila lacustris (Schlecht. & Cham.) Nees is larger and more erect in habitat, with larger flowers in axillary clusters along the upper stems (UFL-IFAS, 2005). *H. polysperma* is also similar to *Alternanthera philoxeroides* (Mart.) Griseb., though the large white papery flowers distinguish the species from the subtle blue flowers of *H. polysperma* (Ramey, 2001). *Diodia* spp. has flat-bristled flanges (UFL-IFAS, 2005)."

Biology

From CABI (2018):

"In one case, *H. polysperma* grew from 0.1 acre to over 10 acres in one year (Vandiver, 1980). *H. polysperma* has been shown to be less susceptible to herbicides and grass carp grazing than the extremely invasive *Hydrilla verticillata,* and in parts of Florida *H. polysperma* has replaced *Hydrilla* as the major aquatic nuisance weed (FNW Disseminules, 2007)."

"Rarely, a terrestrial growth form can grow in moist soil (Ramey, 2001). The leaves of *H. polysperma* are uniquely adapted to draw carbon dioxide directly from either the water or the atmosphere (Bowes, 1987), allowing the plant to inhabit a wide range of amphibious conditions."

From Swearingen and Bargeron (2016):

"*Hygrophila polysperma* may be annual or perennial depending on location."

From Thayer et al. (2018):

"*Hygrophila polysperma* is a wetland plant that can occur as a submerged or an emersed plant. It inhabits lakes, streams, marshy areas, ditches, and rice-fields (de Thabrew 2014). This species can grow in water at depths up to 3 m and on stream banks as an emersed plant (Nault and Mikulyuk 2009). […] *Hygrophila polysperma* exhibits low seasonality and can maintain shoot biomass year round (Spencer and Bowes 1985). Growth rate is dependent on water temperature and daylight (Nault and Mikulyuk 2009), and can increase dramatically in the presence of nutrient inputs (Sutton and Dingler 2000). This species can draw CO2 from both the water and atmosphere (Doyle et al. 2003)."

"In North America, *H. polysperma* has a specific life cycle, starting with a rooted stage in hydro-soil in dense stands of shoots, some with large leaves reaching up to the canopy, and some emergent ones with smaller leaves. Shoots on moist banks are very small, and resemble the submerged form after banks are flooded. Shoots begin elongating in March as the water temperature rises, then they reach the surface in late spring. In summer, they break off into mats and float away, and take root as soon as they come into contact with soil. The whole shoot of the plant breaks off near the root crown in August and forms very dense floating mats, which can sink piece by piece, or all at once to form a new colony; new shoots regrow from the roots, and they grow slowly in winter (Hall et al. 2003)."

Human Uses

From CABI (2018):

"The seeds of *H. polysperma* are said to be used as a medication in India (Ramey 2001). *Hygrophila* has also been utilized in studies of apical dominance and in grafting experiments (Spencer and Bowes 1985)."

From Thayer et al. (2018):

"In India, *H. polysperma* seeds are used as a medicine (Spencer and Bowes 1985)."

From GISD (2018):

"*H. polysperma* appeared in the aquarium trade in 1945 known as 'oriental ludwigia' (FLEPPC, 2003)."

Diseases

Mukherjee et al. (2012) list the following nematodes as parasties of *Hygrophila polysperma*: *Meloidogyne graminicola* Golden & Birchfield, *Helicotylenchus* sp. Steiner, *Meloidogyne incognita* Chitwood, *Rotylenchulus reniformis* Linford & Oliveira, *Hirschmanniella oryzae* Luc & Goodey, *Criconemoides* sp. Taylor, *Tylenchorhynchus mashhoodi* Siddiqi & Basir, *Hoplolaimus indicus* Sher, *Paratrichodorus* sp. Siddiqi, *Trichodorus* sp. Cobb, *Tylenchorhynchus* sp. Cobb, *Hemicycliophora* sp. de Man, *Mesocriconema* sp. Andrassy, *Meloidogyne* sp. Goeldi, *Hemicriconemoides* sp. Chitwood & Birchfield, *Pratylenchus* sp. Filipjev, and *Hoplolaimus* sp. Daday.

Threat to Humans

From Cuda and Sutton (2000):

"In the absence of published reports to the contrary, hygrophila is apparently not poisonous to humans or livestock. However, dense stands of hygrophila may contribute indirectly to human and animal health problems."

From CABI (2018):

"Surface mats may also provide habitat for mosquitoes to breed, which could potentially transmit diseases that could have public health implications (Cuda and Sutton, 2000)."

3 Impacts of Introductions

From Schmitz and Nall (1984):

"In Coral Springs [Florida], over 100 acres of drainage canals are heavily infested with *H. polysperma* causing problems with their pump intake screens (Fig. 2 [in source material])."

From Cuda and Sutton (2000):

"The submersed growth habit of hygrophila [*Hygrophila polyaperma*] causes problems in canals and drainage ditches in south Florida by forming dense mats that impede water flow, clog irrigation pumps, and displace native vegetation. Hygrophila also creates problems as an emergent plant in shoreline areas."

"Hygrophila forms dense stands that occupy the entire water column and easily fragments, clogging irrigation and flood-control systems (Schmitz and Nall 1984, Sutton 1995) and interfering with navigation (Woolfe 1995). This aquatic weed is also capable of competitively displacing native submersed plants in shallow water (Spencer and Bowes 1985) and river ecosystems (Angerstein and Lemke 1994). […] Krombholz (1996) reported that hygrophila is even a threat to rice fields."

From Thayer et al. (2018):

"When *H. polysperma* was grown with *Ludwigia repens*, *L. repens* exhibited slower growth rates compared to when grown alone, suggesting that *H. polysperma* has superior competitive abilities (Doyle et al. 2003). *Hygrophila polysperma* has spread into areas formerly dominated by *Hydrilla verticillata* (Cuda and Sutton 2000)."

"*Hygrophila polysperma* can create anoxic conditions once decomposition occurs (Owens et al. 2001, Robinson 2003). The dense mats of *H. polysperma* can trap sediments and reduce water flows (Robinson 2003). This species is problematic, as it clogs irrigation and flood control canals and interferes with water control pumping stations, and with waterway navigation and recreation (Cuda and Sutton 2000; Robinson 2003).

Hygrophila polysperma may increase water clarity when abundant (Osceola County 2012)."

From Jacono et al. (2018):

"It is costly to control *H. polysperma* infestations; in 2006, Florida spent $14,000 to control *H. polysperma* covering 206 acres (FL DEP 2007)."

From CABI (2018):

"In addition, the loss of recreational and aesthetic value associated with *H. polysperma* can also cause a decline in waterfront property values, as well as possible declines in tourism related revenue for the community (DCR, 2003).

Herbicides typically used in controlling *H. polysperma* are estimated at costing between US$988 to US$1482 per hectare (US $400 to US $600 per acre), and total costs are even higher when labour and equipment are included (Cuda and Sutton, 2000). In an extreme case involving the use of fluridone in flowing water, control was achieved for a period of 20 months at a cost of US $34,580 per hectare (Sutton, 1996)."

"Increased sediment levels are observed with increasing *H. polysperma* abundance (DCR, 2003). Dense mats of *H. polysperma* also have the ability to change water hydrology and quality, negatively affecting the ecosystem in which it occurs. Due to the relatively low seasonality of *H. polysperma*, it is able to maintain shoot biomass and occupy its niche throughout the entire year (ISSG, 2005)."

"*H. polysperma* reduces biodiversity by competing with and displacing native vegetation, and is capable of changing the fauna and flora of an ecosystem. *H. polysperma* can form dense monocultures which exclude all native plants and do not provide habitat or food for wildlife. […] *H. polysperma* is also able to rapidly change resource acquisition in response to changing environmental conditions, allowing it to outcompete many other species (Spencer and Bowes, 1985). Decomposing mats of *H. polysperma* also have the ability to cause fish kills by creating low oxygen levels in the water (DCR, 2003)."

"*H. polysperma* can form dense mats that impede recreational activities such as boating, fishing, swimming, water skiing, canoeing, and kayaking. In addition, unsightly mats of vegetation decrease aesthetic values. These declines in recreational and aesthetic values can decrease tourism, which can be a major source of livelihood within the community. Surface mats may also provide habitat for mosquitoes to breed, which could potentially transmit diseases that could have public health implications (Cuda and Sutton, 2000)."

4 Global Distribution

Figure 1. Known global distribution of *Hygrophila polysperma*. Map from GBIF Secretariat (2018).

The location in Sweden was not used as a source point for the climate match. The record is the result of a specimen in a botanical garden and is not representative of a wild population (GBIF Secretariat 2018).

The location in Germany was not used as a source point for the climate match. According to Hussner (2014) "The studied River Erft is a thermally abnormal river with largely normal

temperatures during summer and abnormal high winter water temperature." RAMP (Sanders et al. 2014) does not contain the capability to handle non-standard conditions and the river conditions would not be reflected in the climate conditions built into RAMP.

5 Distribution Within the United States

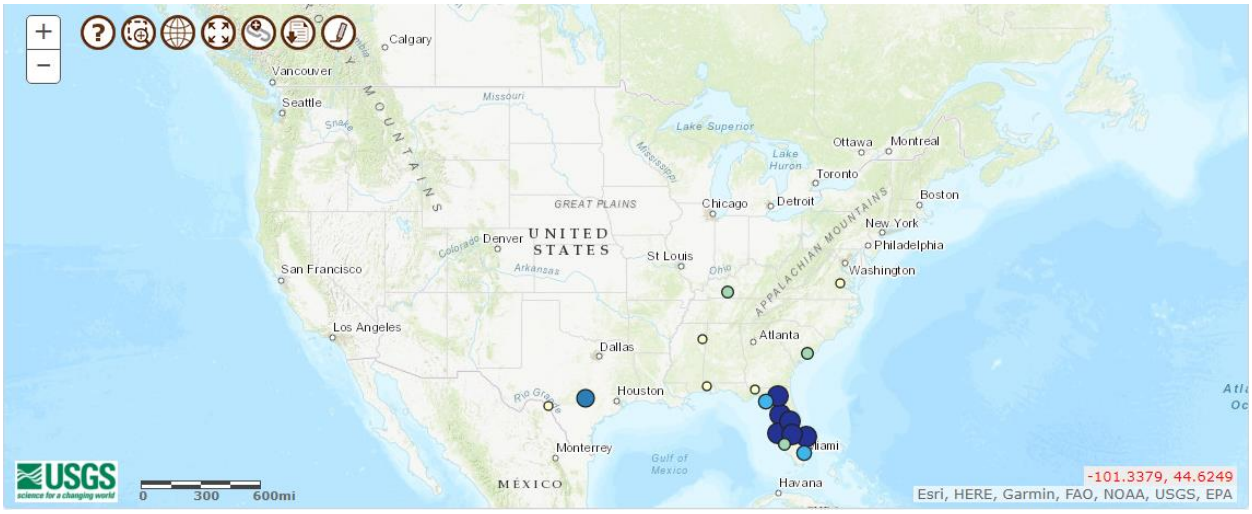

Figure 2. Known distribution of *Hygrophila polysperma* in the United States. Map from Thayer et al. (2018).

According to Nault and Mikulyuk (2009), as referenced in Thayer et al. (2018), the locations in Virginia were extirpated due to colder winter temperatures. Those locations were not used as source points for the climate match.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Hygrophila polysperma* was high in the southeast, particularly along the southern Atlantic and Gulf coasts. It was also high for much of central Texas. The climate match was low for the Northeast and most of the west; everywhere else had a moderate climate match. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous United States was 0.210, high. The following states had individually high climate scores: Alabama, Arizona, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas.

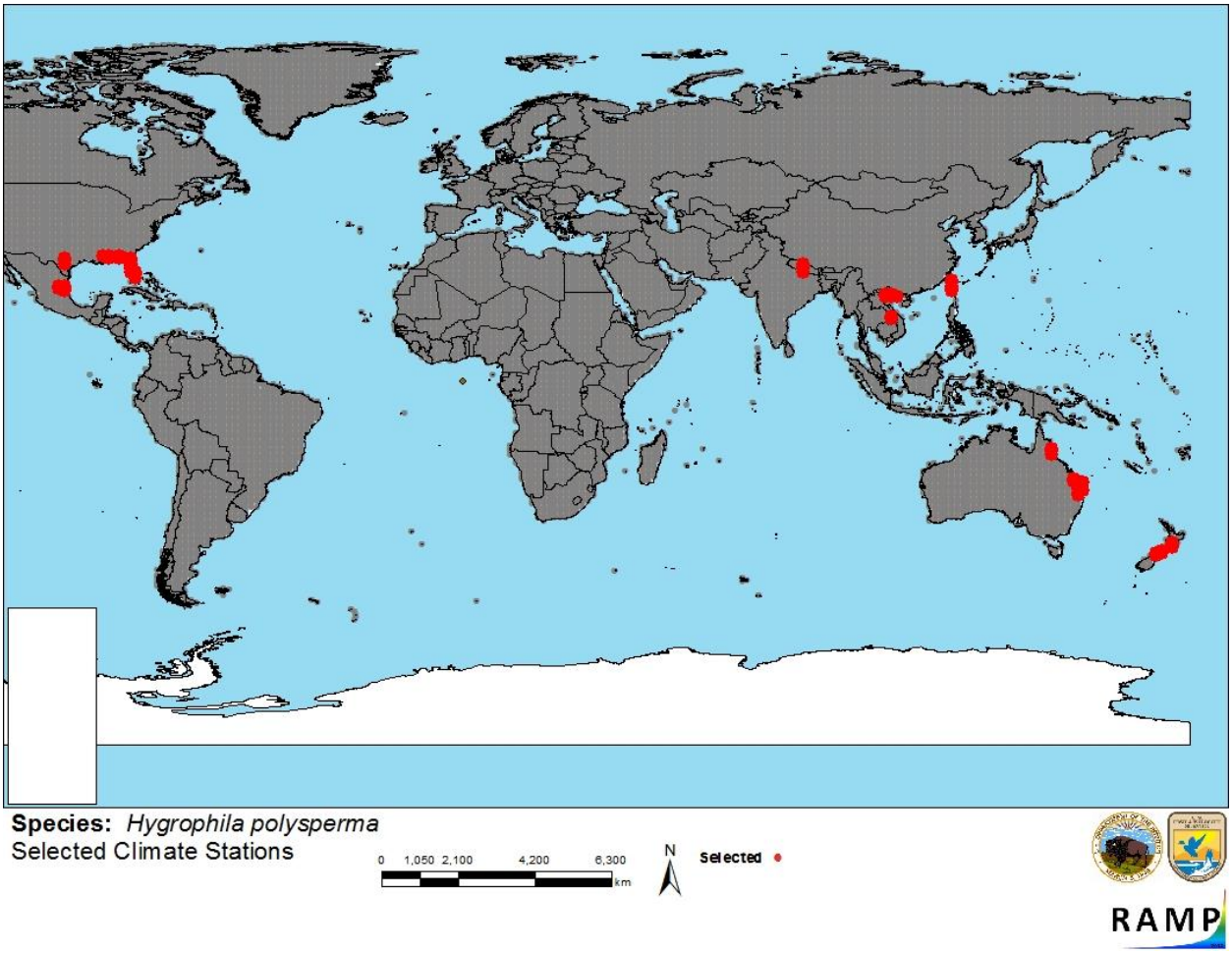

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Hygrophila polysperma* climate matching. Source locations from Hussner (2014), GBIF Secretariat (2018), and Thayer et al. (2018).

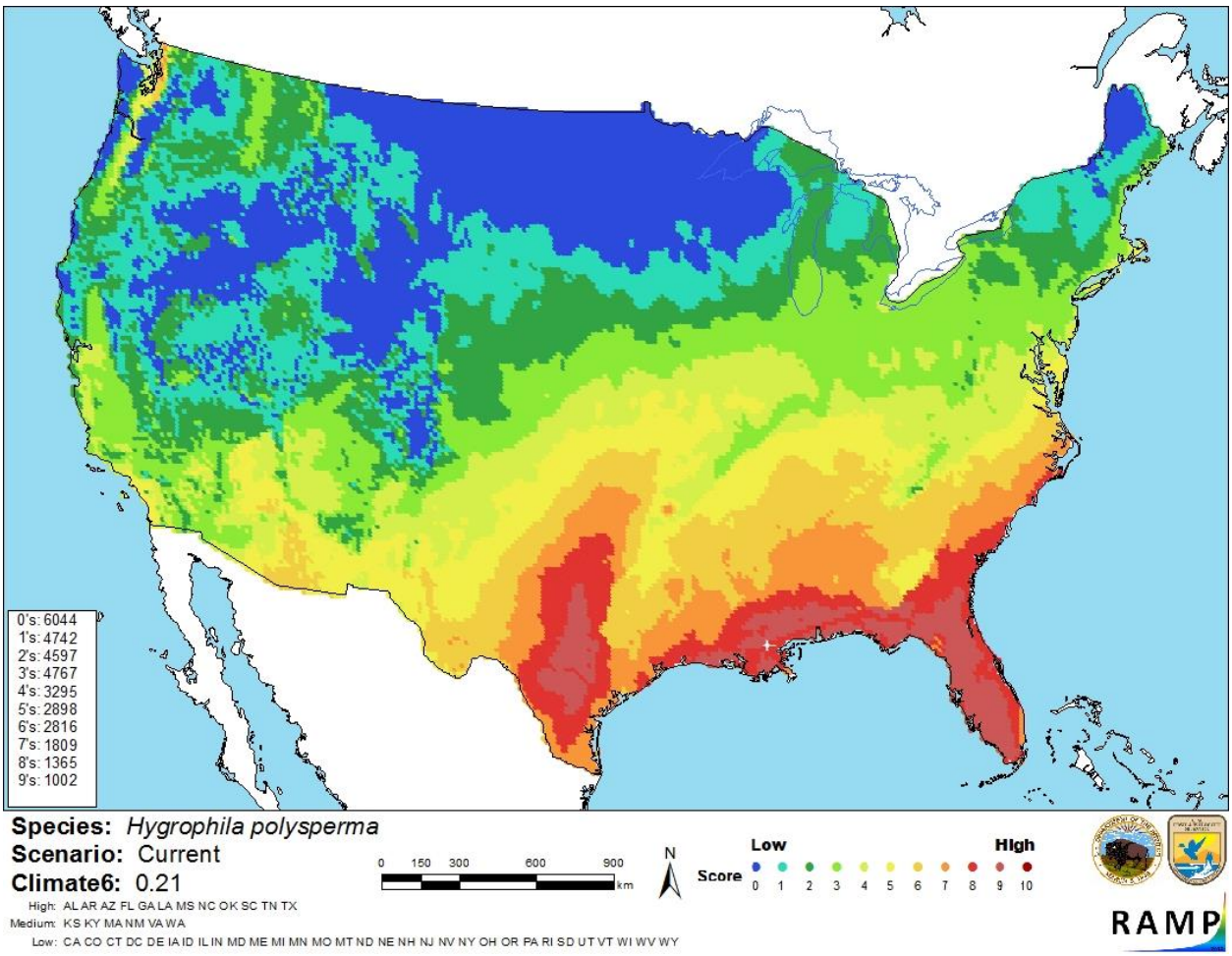

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Hygrophila polysperma* in the contiguous United States based on source locations reported by Hussner (2014), GBIF Secretariat (2018), and Thayer et al. (2018). 0 = Lowest match, 10 = Highest match. Counts of climate match scores are tabulated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

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

Certainty of this assessment is medium. Information on the biology, invasion history and impacts of this species is available, including some peer-reviewed literature. Most information on impacts comes from gray literature or the original work is cited by a peer-review paper reviewed by this author but the original work could not be accessed.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Hygrophila polysperma is native to Southeast Asia. The species has spread for use as an aquarium plant. This plant is well established in Florida and parts of Texas. *H. polysperma* is declared a noxious weed in the United States. The history of invasiveness for *H. polysperma* is high. The plant has negative impacts on water control infrastructure, property value, and native plant communities. Climate matching indicated the contiguous United States has a high climate match with already established *H. polysperma* populations in some states. The climate match indicates that there may be areas with suitable climate outside of currently established populations. The certainty of assessment is medium. The overall risk assessment category is high.

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Medium**
- **Remarks/Important additional information:** *Hygrophila polysperma* can be misidentified as *Hygrophila lacustris* which is native to the United States There is the possibility that *H. polysperma* has a greater distribution within the United States than is currently documented.
- **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.

Angerstein, M. B., and D. E. Lemke. 1994. First records of the aquatic weed *Hygrophila polysperma* (Acanthaceae) from Texas. SIDA 16:365–371.

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