Water Lettuce (*Pistia stratiotes*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, February 2023
Revised, April 2023, May 2025
Web Version, 5/13/2025

Organism Type: Flowering Plant
Overall Risk Assessment Category: High

Photo: Forest and Kim Starr. Licensed under: CC BY 3.0. Available: https://www.biolib.cz/en/image/id56873/

1 Native Range and Status in the United States

Native Range

From Thayer et al. (2023):

"The species is pantropical, occurring on all continents except Antarctica (Adebayo et al. 2011). The center of origin for *P. stratiotes* is unknown."

From Howard et al. (2023):

“The origin of *Pistia stratiotes* is not clear (Parsons and Cuthbertson 2001). It is thought to have originated from Africa or South America (Langeland and Burks [1998]).”

From Rojas-Sandoval et al. (2023):

“In South and Central America, Africa and South-East Asia it is considered an endogenous species.”

Status in the United States

From Thayer et al. (2023):

“In North America, both John and William Bartram described *P. stratiotes* as early as 1765 and 1773, respectively, along the St. Johns River in Florida, up to 300 river km upstream of the ocean inlet where any ballast material would likely have been deposited from trans-oceanic ships (Bartram and Harper 1942; Bartram and Harper 1943). Since plants were found so far upstream from known seaports, a rationale for Florida nativity has been suggested (Evans 2013). Late Pleistocene/early Holocene fossil records for this species in Florida lend support for this contention (Stoddard 1989; Evans 2013).”

“Established in southern states (Alabama, Arizona, California, Florida, Louisiana, Mississippi, Texas) where plants may overwinter and also germinate from seed (Dray and Center 1989). Plants north of the Gulf states (Colorado, Connecticut, Delaware, Illinois, Kansas, Maryland, Michigan, Minnesota, Missouri, New York, North Carolina, Ohio, Rhode Island, South Carolina, and Wisconsin) likely do not overwinter, and are either extirpated, eradicated, or survive by seed production; the exception being Idaho where populations have established in a hot spring-fed river (Tom Woolf, ID Dept. of Ag., pers.comm.).”

USGS (2025) reports establishment of *Pistia stratiotes* in California, Florida, Georgia, Hawaii, Idaho, Kansas, Louisiana, Maryland, Michigan, Mississippi, North Carolina, Puerto Rico, South Carolina, Texas, and the U.S. Virgin Islands; and introduction with unknown status in Alabama, Arizona, Arkansas, Colorado, Delaware, Guam, Illinois, Indiana, Iowa, Minnesota, Missouri, New Jersey, New Mexico, New York, Ohio, Pennsylvania, Rhode Island, Virginia, and Wisconsin.

In contrast to USGS (2025), Rojas-Sandoval et al. (2023) and GISD (2017) report *Pistia stratiotes* as introduced and established in Guam.

GISD (2017) reports *Pistia stratiotes* as cryptogenic and established in the Northern Mariana Islands.

USDA, NRCS (2023) reports *Pistia stratiotes* as native in the contiguous United States, Puerto Rico, and U.S. Virgin Islands and as introduced in Hawaii.

From Howard et al. (2023):

"This species is part of the aquarium trade (Parsons and Cuthbertson 2001). According to a study on aquarium and pet stores near Lakes Erie and Ontario, 20% of stores surveyed carried *Pistia stratiotes* (Rixon et al. 2005)."

Regulations

Pistia stratiotes is regulated in Alabama (Alabama Department of Agriculture and Industries 2006), Florida (Florida Department of Agriculture and Consumer Services 2010), North Carolina (North Carolina Department of Environmental Quality 2022), South Carolina (South Carolina Department of Natural Resources 2010), Texas (Texas Parks and Wildlife 2022), and Wisconsin (Wisconsin Department of Natural Resources 2022). Please refer back to state agency regulatory documents for details on the regulations, including restrictions on activities involving this species. While effort was made to find all applicable regulations, this list may not be comprehensive. Notably, it does not include regulations that do not explicitly name this species or its genus or family, for example, when omitted from a list of authorized species with blanket regulation for all unnamed species.

Means of Introductions within the United States

From Thayer et al. (2023):

"The origin of *Pistia stratiotes* is contentious. Some argue the species is native to North America due to fossil evidence (Evans 2013), while others agree it was dispersed by transcontinental bird migrations (Stoddard 1989) or by dry ballast during early European colonization of North America (Stuckey and Les 1984; Schmitz et al. 1993; Dray and Center 2002)."

"*Pistia stratiotes* was sold through aquarium and pond supply dealers, both online and in retail garden centers (Rixon et al. 2005); it is still offered for sale online and in several states (Rebecca Howard, USGS, pers. comm.). New introductions are probably the result of improper disposal of ornamental pond plants or waters, or when ponds adjacent to local water bodies overflow (Adebayo et al. 2011)."

Remarks

This ERSS was previously published in August 2018. Revisions were completed to incorporate new information and conform to updated standards.

There is significant uncertainty about the native range of this species. Effort was made in this assessment to convey this uncertainty, which results in contradictory information in some places.

From Thayer et al. (2023):

"Fossil records for this species can be found around the globe (Stoddard 1989). Ancient Egyptian hieroglyphics depict the plant and Greek botanists Dioscorides and Theophrastus described the plant floating on the Nile River more than 2,000 years ago, indicating African origin (Stoddard 1989). *Pistia stratiotes* in Brazil and Argentina host a large number of co-evolved specialist

insect herbivores suggesting a South American origin (Center et al. 2002). In North America, both John and William Bartram described *P. stratiotes* as early as 1765 and 1773, respectively, along the St. Johns River in Florida, up to 300 river km upstream of the ocean inlet where any ballast material would likely have been deposited from trans-oceanic ships (Bartram and Harper 1942; Bartram and Harper 1943). Since plants were found so far upstream from known seaports, a rationale for Florida nativity has been suggested (Evans 2013). Late Pleistocene/early Holocene fossil records for this species in Florida lend support for this contention (Stoddard 1989; Evans 2013)."

From Rojas-Sandoval et al. (2023):

"While Blake (1954) and others indicate that it was introduced into Australia some 50 years ago (it was first observed during a survey in 1946/47), Gillet et al. (1988) present evidence for it being indigenous in the Northern Territory. Parsons and Cuthbertson (2001) reference a record in the Northern Territory from 1887, where a complement of organisms naturally regulates its population. Since *P. stratiotes* has not been recorded at nuisance levels in this area, it is highly possible that northern Australia is part of the plant's native range."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2023):

Kingdom Plantae
Subkingdom Viridiplantae
Infrakingdom Streptophyta
Superdivision Embryophyta
Division Tracheophyta
Subdivision Spermatophytina
Class Magnoliopsida
Superorder Lilianae
Order Alismatales
Family Araceae
Genus *Pistia*
Species *Pistia stratiotes* L.

According to WFO (2023), *Pistia stratiotes* L. is the current valid name for this species.

Size, Weight, and Age Range

From Thayer et al. (2023):

"**Size:** Rosette generally 6 to 30 cm in diameter (Godfrey and Wooten 1981)"

"In tropical and subtopical climates it is a perennial. In temperate regions the plant behaves as an annual, returning after the winter months from submersed seeds."

Environment

From Rojas-Sandoval et al. (2023):

"Chadwick and Obeid (1966) reported that optimal growth of *Pistia* was obtained in water cultures at a pH of approximately 4. Such a high acidity, however, was never found in heavily infested waterbodies. It was shown by Pieterse et al. (1981) that the plant performs best in water with a pH of 7. *Pistia* showed particularly vigorous growth, although with a relatively small root system, in polluted water in Nigeria (Sharma, 1984)."

From Thayer et al. (2023):

"This species does not tolerate freezing temperatures, although its seeds can survive submerged in water that is 4°C for at least 2 months (Parsons and Cuthbertson 2001). *Pistia stratiotes* has a low saline tolerance; plants cannot survive in waters with more than 2.5 ppt salinity (Sculthorpe 1967; Haller et al. 1974)."

From Howard et al. (2023):

"[…] seeds survived prolonged experimental periods in water at 4 °C and a few weeks in ice at -5 °C; germination occurred between 20 °C and 25 °C (Parsons and Cuthbertson 2001, Pieterse 1981)."

Climate

From Šajna et al. (2007):

"[…] widely distributed in tropical and sub-tropical regions."

From Howard et al. (2023):

"Distribution is limited by sensitivity to cold temperatures; according to Rivers (2002) this species can endure temperatures between 15° C (59 °F) and 35° C (95 °F)."

Distribution Outside the United States

Native

From Thayer et al. (2023):

"The species is pantropical, occurring on all continents except Antarctica (Adebayo et al. 2011). The center of origin for *P. stratiotes* is unknown."

From Howard et al. (2023):

"The origin of *Pistia stratiotes* is not clear (Parsons and Cuthbertson 2001). It is thought to have originated from Africa or South America (Langeland and Burks [1998])."

From Rojas-Sandoval et al. (2023):

“In South and Central America, Africa and South-East Asia it is considered an endogenous species.”

Introduced

From EPPO (2025):

“*P. stratiotes* is widespread throughout Africa, where the plant was first recorded in South Africa in 1865 from KwaZulu-Natal (Hill, 2003). In North Africa, *P. stratiotes* was first recorded on a small multipurpose impoundment near the town of Fez in Morocco in 2012 (Hill, 2013).”

“In Asia, *P. stratiotes* has a wide distribution and is recorded as invasive (CABI, 2016). The plant was recorded in the Philippines as early as 1925, floating in abundance in shallow waters (Merrill, 1925; Waterhouse, 1997).”

“The first reports from Austria and Germany were made in 1980. Repeated introductions failed to establish in Germany up until 2005; however, since 2008, an established population has been permanently present in thermal sections of the River Erft (Hussner, 2014). In Italy, *P. stratiotes* was found first in 1998 (Brundu et al., 2012). In France, *P. stratiotes* was found once in the Landes department in 2003, but is now no longer present (EPPO, 2012). Several casual populations have been recorded in the Mediterranean parts of France since 1998 (SILENE, 2016). *Pistia stratiotes* is now considered as established in at least one location, in a canal along the Rhône, where first observations date back to 2005 (G. Fried, 2016, pers. comm.). […] In September 2016, *P. stratiotes* was recorded along 17 km of the canal, including several portions with 100% cover.”

“In Belgium, the species was first observed in 2000, and was still present in 2015, mainly in East Flanders (Verloove, 2006; update 2015).”

“On the Canary Islands, the species is considered invasive.”

“In the United Kingdom, the species is occasionally recorded: four occurrences are detailed as persisting for more than 5 years in the database of the Botanical Society of Britain and Ireland. *Pistia stratiotes* was first discovered in Somerset in 2004, when a few plants were discovered on the Burnham Levels. The plant was recorded as well established in the Bridgwater and Taunton Canal in 2010 (Somerset Rare Plant Group Newsletter, 2010).”

From Šajna et al. (2007):

“Only 2 years after its first occurrence [in Slovenia] in 2001 *P. stratiotes* managed to cover most of the water body where the thermal springs cause an elevated temperature (>17°C year round). […] Observations in December revealed viable seed production and seed presence in the sediment.”

“Plants have been spotted in water channels in the Netherlands, and there they have represented a regularly recurring problem since 1973, especially in summer (Mennema, 1977; Pieterse et al., 1981; Venema, 2001). Other sites with recent *P. stratiotes* infestation during summer include the French Jalle de Blanquefort near Bordeaux and Cadiz in SW Spain (García Murillo et al., 2005). Records exist also from Central Europe (Pyšek et al., 2002), and surprisingly even in many ponds and rivers in Moscow and its vicinity (Schanzer et al., 2003).”

From Živković (2019):

“The first published record of its [*P. stratiotes*] presence in the wild dates to 1973 in the water canals of the Netherlands (Mennema 1977 in Šajna et al. 2007). In Italy the species was first recorded in 1998, in the Province of Cremona, followed by subsequent records in the Italian regions of Tuscany, Lombardy, Veneto, Emilia Romagna and Campania (see Brundu et al. 2012). Over the years it has been introduced to a number of European countries, e.g. Czech Republic, Spain and Russia (Pyšek et al. 2002; García Murillo et al. 2005; Shapovalov and Saprykin 2016), but without forming self-replacing populations. Meanwhile, overwintering populations of this invasive species have been reported in geothermal waters in Europe: in Germany (river Erft, North-Rhine Westphalia; Hussner and Heiligtag 2013; Hussner 2014) and Slovenia (thermal stream Topla; Šajna et al. 2007).”

“In Serbia, the occurrence of *P. stratiotes* was previously recorded in natural thermal springs, first in 1994 in a thermal spring “Banjica” in the Sićevačka klisura gorge (Ranđelović et al. 1995) and later on in a new site near Knjaževac city, in Rgošte (Rgoška Banja spa; Bogosavljević et al. 2007).”

“[…] these new findings represent the first records of the occurrence of *P. stratiotes* in natural running waters of Serbia and are the first overall records for the region of Northern lowland Serbia (Vojvodina Province).”

From Weeds Australia (2024):

“There is evidence that Water Lettuce is native to the Northern Territory [Australia] and possibly northern Queensland, but introduced in other parts of eastern Australia (Gillett *et al.* 1989; Cowie *et al.* 2000). […] Outside the Northern Territory it occurs as scattered colonies along the east coast north of Sydney, as well as the inland pastoral districts of Darling Downs and Leichhardt in Queensland (Parsons & Cuthbertson 2001). Small colonies have been reported around Perth in Western Australia (Hussey *et al.* 1997; Parsons & Cuthbertson 2001).”

From Champion and Hofstra (2025):

“Nationally eradicated [from New Zealand], previously known from Tauranga and Hokianga, Northland.”

Champion and Hofstra (2025) report that *Pistia stratiotes* was naturalized in 1975 but fruiting was not seen in New Zealand.

From Howard et al. (2023):

"*Pistia stratiotes* had established in Volta Lake, Ghana before the 1960s (Hall and Okali 1974). It has established in the Erft River in Germany in 2008 (Hussner et al. 2014)."

"*Pistia stratiotes* has been reported in: […] Ontario- Found in the Detroit River and Lake St. Clair (Adebayo et al. 2011; MacIsaac et al. 2016) […]"

From Xiong et al. (2023):

"[…] feral populations of water lettuce are established in a diversity of habitats and have a wide distribution throughout South China […] including 21 Provinces, Autonomous Regions or Municipalities (i.e., Fujian, Guangdong, Guangxi, Guizhou, Hainan, Hubei, Hunan, Jiangsu, Jiangxi, Chongqing, Anhui, Henan, Liaoning, Shandong, Sichuan, Tianjin, Yunnan, Zhejiang, Hongkong, Macau and Taiwan […])."

"In the early period after its introduction, water lettuce only occurred in South China and it did not appear to survive or overwinter successfully in North China. However, in recent years it has been increasing [sic] reported in North China because of global warming and the expansion of artificial farming environments (Wang et al. 2012). Water lettuce has well-established feral populations in North China (Henan, Beijing, and Liaoning) and in some high latitude areas (such as Yunnan, Sichuan, and Chongqing) […]"

NOBANIS (2023) reports *P. stratiotes* as locally established in Austria.

Pallewatta et al. (2003) reports *P. stratiotes* as introduced in Bangladesh and Pakistan.

From NIES (2023):

"First introduction [to Japan] was in 1920s in Okinawa and Ogasawara. Infested on mainland since 1990s"

Additionally, Rojas-Sandoval et al. (2023) report *Pistia stratiotes* as introduced and invasive in Botswana, Brunei Darussalam, Cambodia, Cook Islands, Cuba, French Polynesia, Indonesia, Laos, New Caledonia, Palau, Réunion, and Taiwan; as present and invasive in Benin, Côte d'Ivoire, Kenya, Malaysia, Uganda, and Zimbabwe; as introduced in India, Kazakhstan, Portugal, Romania, Saint Lucia, and Ukraine; and as introduced but not established in the Czech Republic.

GISD (2017) reports *P. stratiotes* as alien and established in Bermuda, Burkina Faso, Reunion, Saint Lucia, and Swaziland (i.e., Eswatini); and as cryptogenic and established in Seychelles, Solomon Islands, Thailand, Vanuatu, and Vietnam.

Finally, Rojas-Sandoval et al. (2023) report *Pistia stratiotes* as present but without an indication of native or introduced status in Afghanistan, Angola, Antigua and Barbuda, Argentina, Belize, Bolivia, Burundi, Cameroon, Central African Republic, Chad, Colombia, Comoros, Congo

Democratic Republic, Costa Rica, Dominican Republic, Ecuador, El Salvador, Equatorial Guinea, Ethiopia, French Guiana, Gabon, Gambia, Guadeloupe, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Israel, Jamaica, Lesotho, Liberia, Madagascar, Malawi, Mali, Martinique, Mauritania, Mauritius, Mexico, Montserrat, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, Panama, Paraguay, Peru, Rwanda, Saint Vincent and the Grenadines, Senegal, Sierra Leone, Singapore, Somalia, Sri Lanka, Sudan, Suriname, Tanzania, Togo, Trinidad and Tobago, Uruguay, Venezuela, Vietnam, and Zambia.

Means of Introduction Outside the United States

From Šajna et al. (2007):

"The introduction into Europe most likely occurred as an accidental release from aquaria (Pilipenko, 1993) or from horticulture, since it is cultivated widely as an ornamental plant (Venema, 2001; Schanzer et al., 2003)."

From GISD (2017):

"*P. stratiotes* can spread from broken-off pieces or whole plants being moved on boats or fishing equipment from an infested to a clean body of water (Rivers, 2002). According to Ramey (2001), *P. stratiotes* continues to be sold through aquarium supply dealers and through the internet. Rivers (2002) cites that dumping of aquarium or ornamental pond plants is often the means of spread for *P. stratiotes*."

"*Pistia stratiotes* was deliberately imported [to New Zealand] by the aquarium trade as an ornamental plant. It was also deliberately planted at two known 'wild' locations but these were successfully and completely eradicated by a successful programme begun in 1979."

From Weeds Australia (2024):

"It [*Pistia stratiotes*] is thought to have been introduced to New South Wales [Australia] rivers and dams via eel traps from Queensland (Osmond & Johnson 2006)."

Short Description

From Thayer et al. (2023):

"**Stem/Roots:** *Pistia stratiotes* is a free-floating, herbaceous monocot with a rosette of gray-green leaves, resembling a head of lettuce (thus the common name), occurring as a single plant or connected to others by stolons (Dressler et al. 1987; Langeland and Burks 1998). Roots numerous and feathery."

"**Leaves:** Leaves are ovate to obovate, up to 15 cm in length, without a leaf stalk, spongy near the leaf base, densely pubescent, with deeply furrowed parallel veins and wavy leaf margins (Godfrey and Wooten 1981; Dressler et al. 1987; Langeland and Burks 1998)."

"**Flowers:** Flowers inconspicuous, perfect, clustered in leaf axils with a single female flower and multiple male flowers (Langeland and Burks 1998)."

"**Fruit/Seeds:** Produces abundant seeds with high percentage of seed viability (Dray and Center 1989a, 1989b)."

From Rojas-Sandoval et al. (2023):

"The morphology of *Pistia* varies largely owing to the influence of environmental factors. In a survey of two populations in ponds of distinct hydrochemical characteristics, two biotypes were identified that propagate true. […] The leaves rise into the air, but under conditions less favourable for optimal growth they may lie flat on the water."

Biology

From Thayer et al. (2023):

"*Pistia stratiotes* reproduces rapidly by vegetative fragmentation from offshoots on short, brittle stolons. Seed production is also considered a major method of reproduction and dispersal (Dray and Center 1989a, 1989b). Plants can be solitary rosettes, or may have more than a dozen stolon-connected ramets or daughter plants. Standing crop may be as high as 2 kg/m^2 at the peak of the growing season (Dray and Center 1992). Although vegetative reproduction is thought to be the primary means of propagation, seed crop has been reported to be in excess of 700 $seeds/m^2$ in a stand at a south Florida location, with greater than 80% seed viability (Dray and Center 1989a, 1989b)."

Human Uses

From Thayer et al. (2023):

"*Pistia stratiotes* was sold through aquarium and pond supply dealers, both online and in retail garden centers (Rixon et al. 2005); it is still offered for sale online and in several states (Rebecca Howard, USGS, pers. comm.)."

"*Pistia stratiotes* has the fiber content, carbohydrate, and crude protein levels that are comparable with quality forages (Parsons and Cuthbertson 2001). Research has been conducted to utilize this species for biofuels and water remediation (Mishima et al. 2008; Lu et al. 2010)."

From Rojas-Sandoval et al. (2023):

"The widespread distribution in most countries with a tropical climate may be the result of its ancient use as medicine for humans, as well as its use as fodder for cattle and pigs (Sculthorpe, 1971)."

Diseases

From Burkett-Cadena and Blosser (2017):

"*Aedeomyia squamipennis* (Lynch Arribalzaga) is a tropical mosquito (Diptera: Culicidae) found throughout most of the American Tropics, from eastern Mexico through Argentina, including

several Caribbean islands. Larvae are typically associated with bodies of water with dense growths of aquatic vegetation, particularly *Pistia stratiotes* L., water lettuce. […] *Aedeomyia squamipennis* is considered an important vector of Gamboa virus [which affects birds] and avian malaria, and is also suspected of transmitting *Venezuelan equine encephalitis virus*."

Threat to Humans

From Thayer et al. (2023):

"Dense populations of *P. stratiotes* can clog waterways and make fishing, swimming and boating difficult (Howard and Harley 1998)."

"Larvae and pupae of the mosquito genera *Culex* and *Mansonia*, found in the southeastern U.S., attach themselves to the root system of *P. stratiotes* (Lounibos and Escher 1985; Center et al. 2002). These mosquitoes are important vectors of St. Louis Encephalitis (Lounibos and Escher 1985; Petr 2000)."

From Rojas-Sandoval et al. (2023):

"*P. stratiotes* can seriously interfere with paddy crops (Holm et al., 1977; Waterhouse, 1993). Although no accurate measurement is available of the loss of water needed for agriculture through transpiration from beds of *P. stratiotes*, losses are believed to be considerable (Holm et al., 1977)."

3 Impacts of Introductions

From Šajna et al. (2007):

"In Slovenia, as early as 3 years after the first observation of *P. stratiotes*, native freshwater plants (*Ceratophyllum demersum* L., *Myriophyllum spicatum* L., *Najas marina* L. and *Trapa natans* L.) in this species-rich wetland habitat were on decline, because the whole water surface was covered with a dense mat that remained closed even during the winter (2004). Dissolved oxygen values declined by more than 50% when measured under the *P. stratiotes* cover, reaching only 2.5 mg L^{-1}, a critical value for fish survival (measured by the Fisheries Research Institute, Ljubljana 2003)."

From Thayer et al. (2023):

"Dense populations of *P. stratiotes* can clog waterways and make fishing, swimming and boating difficult (Howard and Harley 1998). Thick colonies of water-lettuce block the air-water interface which reduces the amount of dissolved oxygen in the water making it less suitable habitat for fish species (Attionu 1976, Šajna et al. 2007, Sridhar and Sharma 1986). These dense mats can also block animal access to the water and may crowd or shade out native plants upon which other organisms depend for food or shelter (Sculthorpe 1967)."

"Larvae and pupae of the mosquito genera *Culex* and *Mansonia*, found in the southeastern U.S., attach themselves to the root system of *P. stratiotes* (Lounibos and Escher 1985; Center et al.

2002). These mosquitoes are important vectors of St. Louis Encephalitis (Lounibos and Escher 1985; Petr 2000)."

From Rojas-Sandoval et al. (2023):

"*P. stratiotes* can seriously interfere with paddy crops (Holm et al., 1977; Waterhouse, 1993). Although no accurate measurement is available of the loss of water needed for agriculture through transpiration from beds of *P. stratiotes*, losses are believed to be considerable (Holm et al., 1977)."

"*P. stratiotes* is one of the major aquatic weeds in tropical and sub-tropical regions. It rapidly forms dense mats which may completely cover the surface of the water. Consequently, such dense stands of *Pistia* may have serious negative effects on the multifunctional human use of waterbodies. These harmful effects include impediment of the transport of irrigation and drainage water, interference with hydro-electric schemes from artificial lakes, hindering navigation and fishing and the creation of habitats favourable for the transmittance of water-borne diseases (Mbati and Neuenschwander, 2005)."

"Cai (2006) reports that growth of *P. stratiotes* causes increases in transparency, nitrate, ammonium, total nitrogen, total phosphorus, and total bacteria, as well as a decrease in pH, DO [dissolved oxygen], permanganate index, total plankton and plankton species diversity. The plant also influenced the size structure of planktonic communities, causing a miniaturization of plankton volume. Dray and Center (2002) review additional ecological impacts of *P. stratiotes* and note that they include increased rates of siltation, slowing of water velocities, degradation of fish nesting sites, increased nutrient loading, thermal stratification, increase in alkalinity and fish and macroinvertebrate mortality."

Pistia stratiotes is regulated in Alabama (Alabama Department of Agriculture and Industries 2006), Florida (Florida Department of Agriculture and Consumer Services 2010), North Carolina (North Carolina Department of Environmental Quality 2022), South Carolina (South Carolina Department of Natural Resources 2010), Texas (Texas Parks and Wildlife 2022), and Wisconsin (Wisconsin Department of Natural Resources 2022). See section 1.

4 History of Invasiveness

The History of Invasiveness for *Pistia stratiotes* is classified as High. There are records of nonnative populations of *P. stratiotes* established in Africa, Asia, North America, and Oceania, and there are also many locations in which the status of the plant as native or nonnative is unknown. Established nonnative populations have resulted in several documented impacts, including declines in native plant species, declines in dissolved oxygen, reductions in waterway access, interference with water transport and irrigation, and facilitation of mosquito-borne diseases.

5 Global Distribution

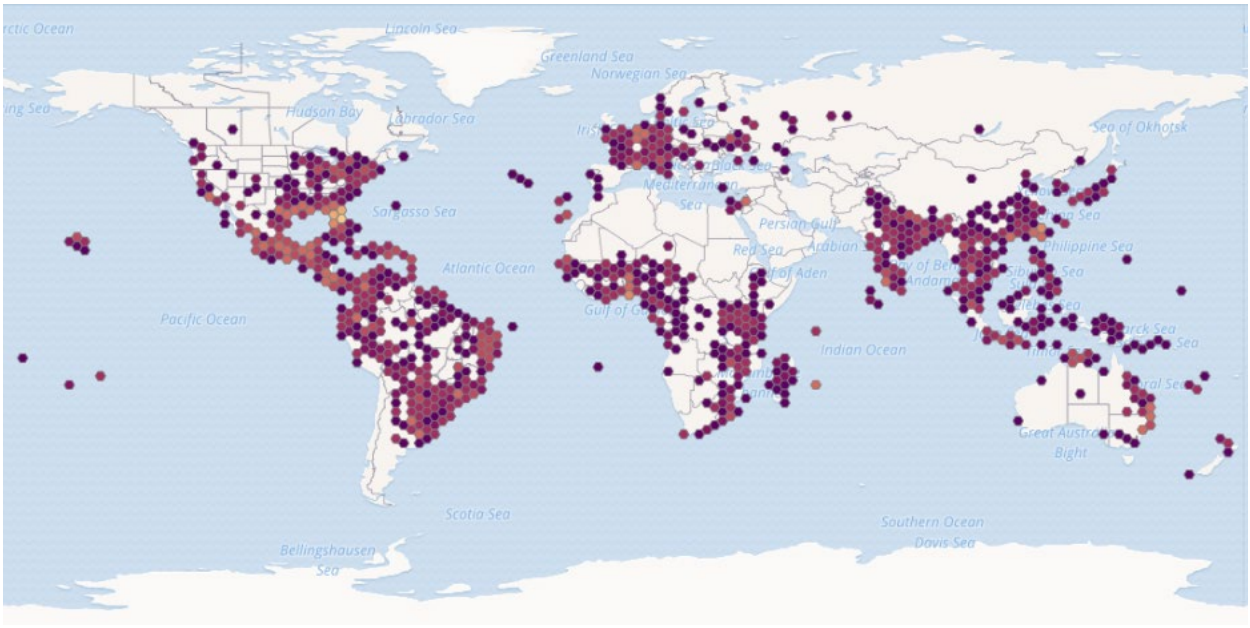

Figure 1. Reported global distribution of *Pistia stratiotes*. Map from GBIF Secretariat (2023). Observations are reported from North America, South America, Africa, Europe, Asia, and Australia.

Following USGS (2025), occurrences in the U.S. States of Alabama, Arizona, Arkansas Colorado, Delaware, Illinois, Indiana, Iowa, Minnesota, Missouri, New Jersey, New Mexico, New York, Ohio, Pennsylvania, Rhode Island, Virginia, and Wisconsin were not used to select source points for climate matching. See figure 2 for more details.

Occurrences in Canada, France (other than along the Rhône), Norway, Sweden, Finland, Ukraine, Poland, Czechia, Hungary, Croatia, Switzerland, Portugal, the United Kingdom (other than in Somerset), Spain, Russia, Bahamas, Tibet, Beijing and Gansu Province of China, and Australia (other than in the Northern Territory, along the east coast north of Sydney, and in Perth) were not used to select source points for climate matching because they are not known to represent established populations of the species.

Occurrences in New Zealand were not used to select source points for climate matching because the species was eradicated and there is also some uncertainty over its establishment status prior to eradication due to the lack of fruiting observed.

Populations present within thermal waters in Idaho (United States), Germany, and Slovenia were not used to select source points for climate matching analysis because the thermal water environment does not reflect the overall climate at those locations.

Points in marine environments do not represent established populations of this freshwater species and may represent coordinate errors; they were not used to select source points for climate matching.

6 Distribution Within the United States

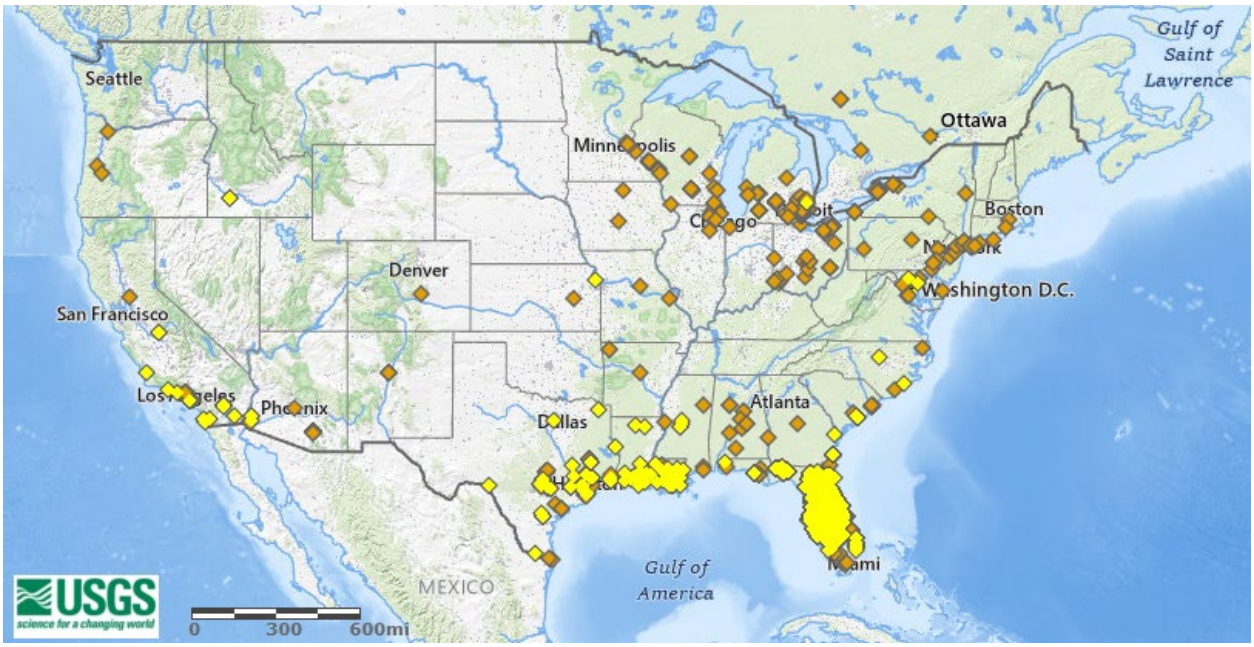

Figure 2. Reported distribution of *Pistia stratiotes* in the contiguous United States. Map from USGS (2025). Observations are reported throughout the eastern United States, Colorado, New Mexico, Arizona, California, and Oregon. Established populations are shown in yellow and other observations (collections, eradications, failed establishment, or unknown status) are shown in orange. Only established populations were used to select source points for climate matching.

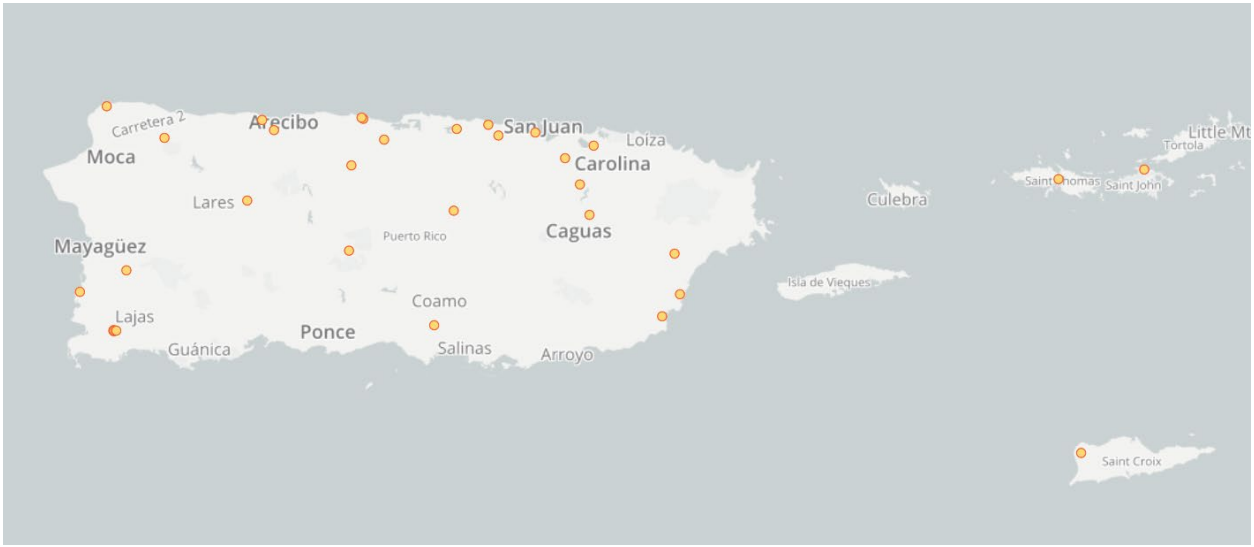

Figure 3. Reported distribution of *Pistia stratiotes* in Puerto Rico and the U.S. Virgin Islands. Map from GBIF-US (2023). Observations are reported throughout Puerto Rico and across the U.S. Virgin Islands.

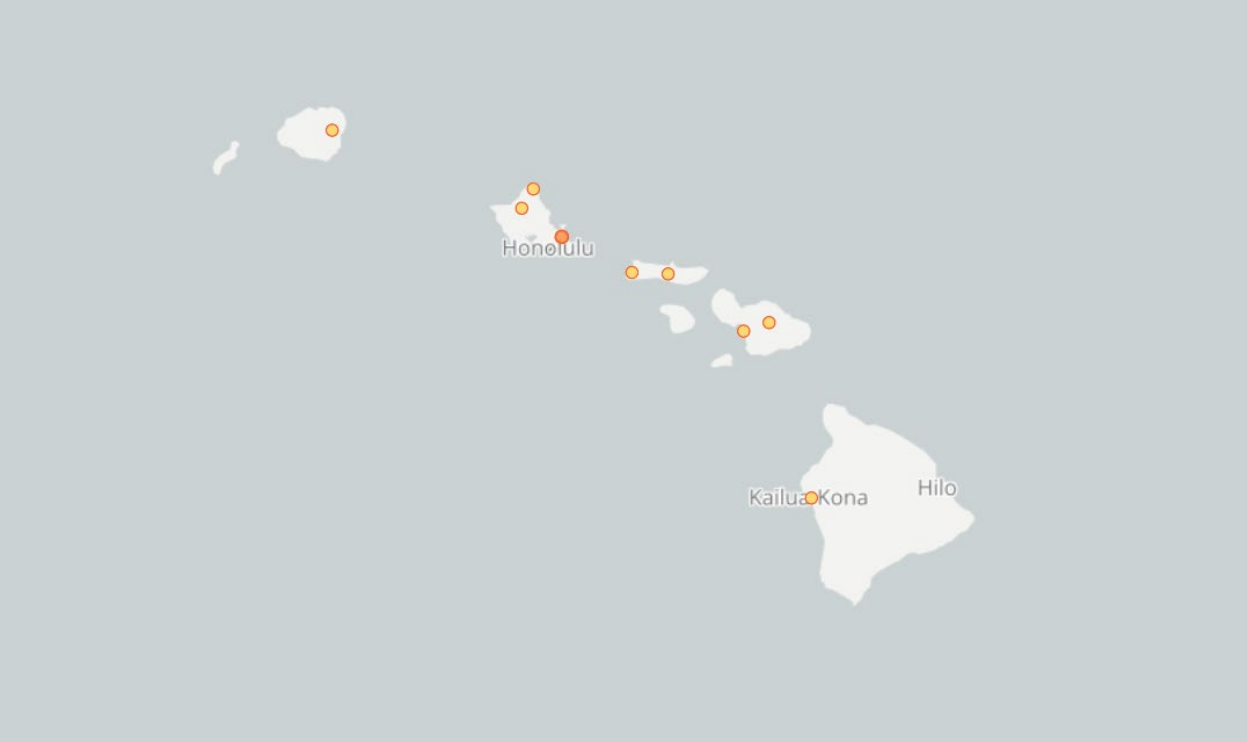

Figure 4. Reported distribution of *Pistia stratiotes* in Hawaii. Map from GBIF-US (2023). Observations are reported throughout Hawaii.

7 Climate Matching

Summary of Climate Matching Analysis

The entire eastern half of the contiguous United States showed a high climate match for *Pistia stratiotes*. Climate match was also high in the Southern Plains and in California into neighboring areas of southern Nevada and western Arizona. The Northern Plains and much of the western contiguous United States had medium climate match, with only small areas of low match in western Washington. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.897, indicating that there is establishment concern for this species. The Climate 6 score is calculated as: (count of target points with scores ≥ 6)/(count of all target points). Establishment concern is warranted for Climate 6 scores greater than or equal to 0.002 based on an analysis of the establishment success of 356 nonnative aquatic species introduced to the United States (USFWS 2024).

Projected climate matches in the contiguous United States under future climate scenarios are available for *Pistia stratiotes* (see Appendix). These projected climate matches are provided as additional context for the reader; future climate scenarios are not factored into the Overall Risk Assessment Category.

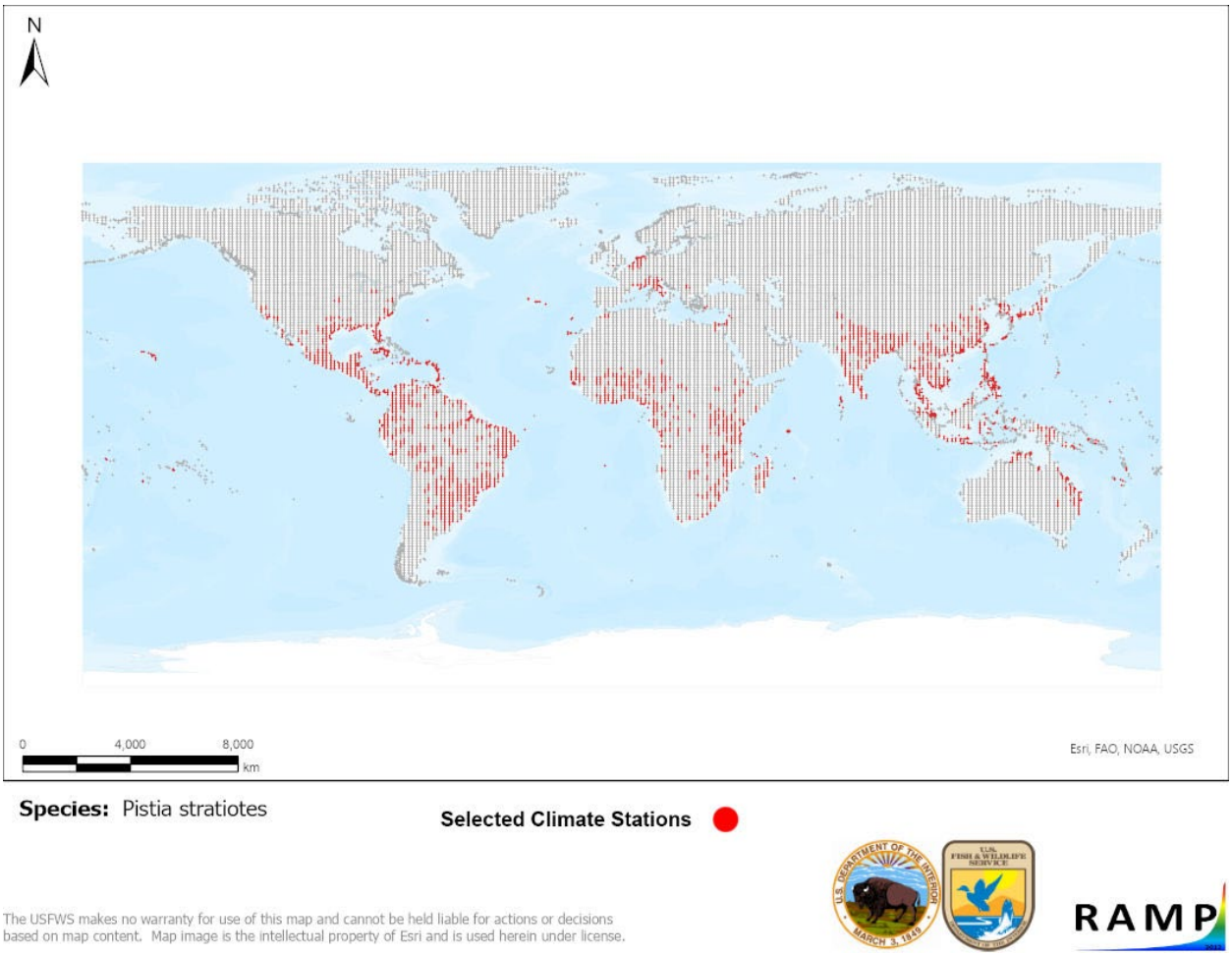

Figure 5. RAMP (Sanders et al. 2023) source map showing global weather stations selected as source locations (red; Canada, United States, Mexico, throughout the Caribbean and Central America, throughout South America except Chile and southern Argentina, throughout sub-Saharan Africa, Morocco, Egypt, Israel, Syria, Lebanon, Turkey, Romania, Serbia, Italy, Switzerland, France, Belgium, Netherlands, Germany, United Kingdom, Canary Islands, Azores, throughout South and Southeast Asia, China, Taiwan, South Korea, Japan, Northern Mariana Islands, Papua New Guinea, Australia, Solomon Islands, Vanuatu, New Caledonia, Micronesia) and non-source locations (gray) for *Pistia stratiotes* climate matching. Source locations from GBIF Secretariat (2023) and USGS (2025). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

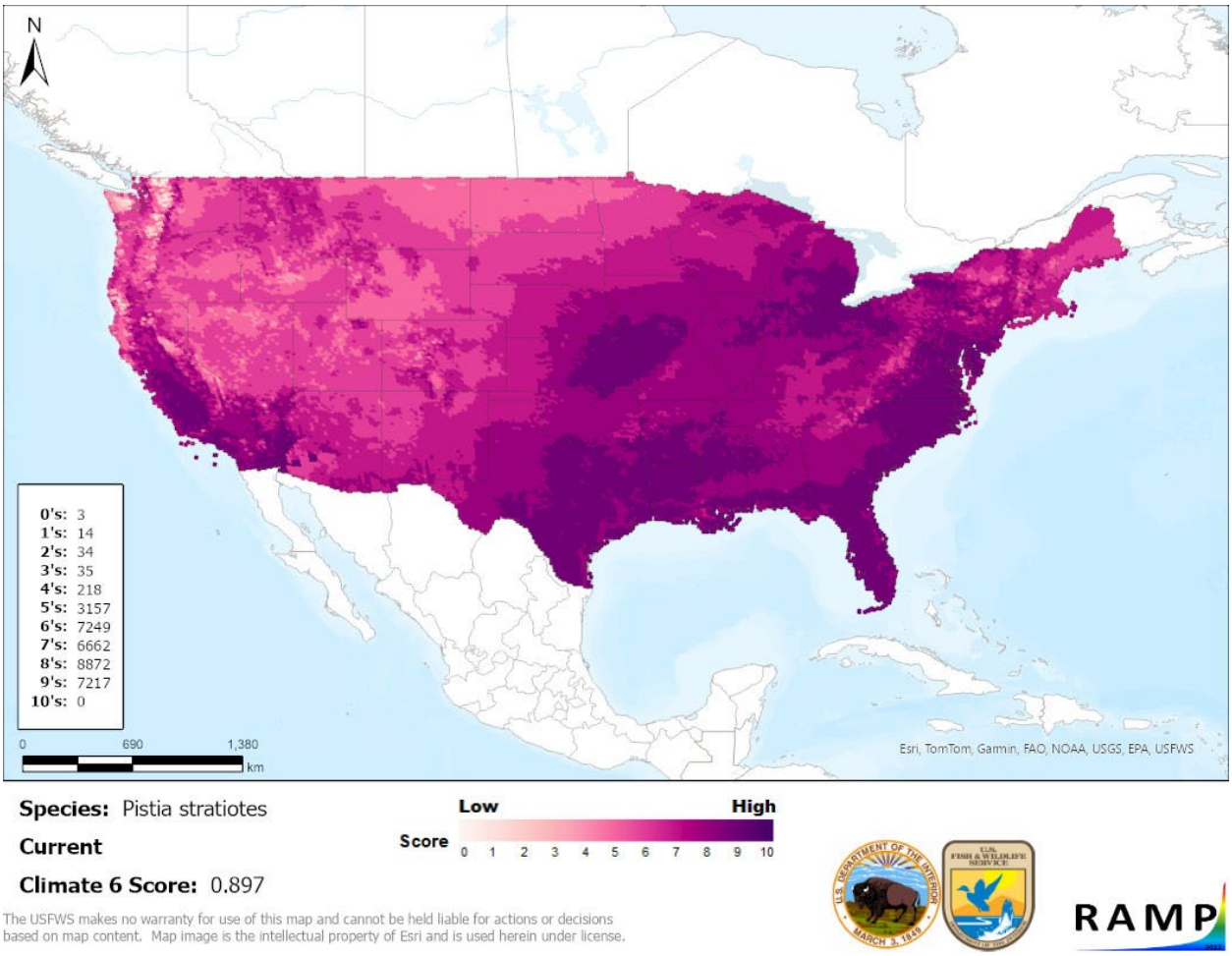

Figure 6. Map of RAMP (Sanders et al. 2023) climate matches for *Pistia stratiotes* in the contiguous United States based on source locations reported by GBIF Secretariat (2023) and USGS (2025). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

There is abundant information regarding the biology, ecology, and distribution of *Pistia stratiotes*. The extent of the species native range is debated among the scientific community, but because the distribution is well described and there are locations where introduced status and negative impacts of introduction are clear, this cryptogenicity does not reduce assessment certainty. Some introductions, particularly in Europe, have been limited to thermally-regulated waters and were therefore omitted from the climate matching analysis, but again, the uncertainty imposed by these occurrences does not affect the climate matching analysis to a degree that the level of establishment concern becomes questionable. Therefore, the Certainty of Assessment for *Pistia stratiotes* is classified as High.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Pistia stratiotes, Water Lettuce, is a free-floating, fast growing, aquatic plant that is widely distributed in tropical and subtropical environments throughout the world, although the location of its native range is under debate. It is also found in temperate regions, reproducing via seed or persisting year-round in thermal waters. It is a widely popular aquarium and pond plant; escape or improper disposal of plants from ornamental trade are likely responsible for many recent introductions, although contamination of boats and fishing equipment may contribute to secondary spread. Possession, transport, or trade of *P. stratiotes* is prohibited or restricted in the following U.S. States: Alabama, California, Connecticut, Florida, North Carolina, South Carolina, Texas, and Wisconsin. Introductions of *P. stratiotes* have led to the decline of native species, decreased dissolved oxygen levels, and habitat loss. Floating mats of *P. stratiotes* have been known to clog waterways and impede fishing, swimming, and water navigation. This species has caused the loss of water for paddy crops, irrigation, and drainage, and provides favorable habitat for the transmission of water-borne diseases. The History of Invasiveness for *Pistia stratiotes* is classified as High due to its record of nonnative establishment and consistency of negative impacts. The climate matching analysis for the contiguous United States indicates establishment concern for this species; nearly the entire contiguous United States had a medium or high climate match. The Certainty of Assessment for this ERSS is classified as High due to the strength of evidence for the History of Invasiveness and Establishment Concern, despite cryptogenicity and introductions in thermal waters. The Overall Risk Assessment Category for *Pistia stratiotes* in the contiguous United States is High.

Assessment Elements

- **History of Invasiveness (see section 4): High**
- **Establishment Concern (see section 7): High**
- **Certainty of Assessment (see section 8): Medium**
- **Remarks, Important additional information: None**
- **Overall Risk Assessment Category: High**

10 Literature Cited

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in section 11.

Alabama Department of Agriculture and Industries. 2006. Noxious weed rules. Alabama Administrative Code 80-10-14.

Burkett-Cadena ND, Blosser EM. 2017. *Aedeomyia squamipennis* (Diptera: Culicidae) in Florida, USA, a new state and country record. Journal of Medical Entomology 54:788–792.

Champion P, Hofstra D. 2025. *Pistia stratiotes*. New Zealand Plant Conservation Network. Available: https://www.nzpcn.org.nz/flora/species/pistia-stratiotes/ (May 2025).

[EPPO] European and Mediterranean Plant Protection Organization. 2025. *Pistia stratiotes*. EPPO datasheets on pests recommended for regulation. Available: https://gd.eppo.int/taxon/PIIST/datasheet (May 2025).

Florida Department of Agriculture and Consumer Services. 2010. Prohibited aquatic plants. Florida Administrative Code section 5B-64.011.

GBIF Secretariat. 2023. GBIF backbone taxonomy: *Pistia stratiotes* L. Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/2870583 (May 2025).

GBIF-US. 2023. Species occurrences: *Pistia stratiotes*. Available: https://doi.org/10.15468/dl.wn9w5y (February 2023).

[GISD] Global Invasive Species Database. 2017. Species profile: *Pistia stratiotes*. Gland, Switzerland: Invasive Species Specialist Group. Available: http://www.iucngisd.org/gisd/speciesname/Pistia+stratiotes (February 2023).

Howard V, Baker E, Li J, Alsip P. 2023. *Pistia stratiotes* L. Gainesville, Florida: U.S. Geological Survey, Nonindigenous Aquatic Species Database, and Ann Arbor, Michigan: NOAA Great Lakes Aquatic Nonindigenous Species Information System. Available: https://nas.er.usgs.gov/queries/greatlakes/FactSheet.aspx?Species_ID=1099 (February 2023).

[ITIS] Integrated Taxonomic Information System. 2023. *Pistia stratiotes* L. Reston, Virginia: Integrated Taxonomic Information System. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=42542#null (February 2023).

[NIES] National Institute for Environmental Studies. 2023. *Pistia stratiotes*. Invasive species of Japan. Tsukuba, Japan: National Research and Development Agency, National Institute for Environmental Studies. Available: https://www.nies.go.jp/biodiversity/invasive/DB/detail/80790e.html (February 2023).

NOBANIS. 2023. *Pistia stratiotes*. European Network on Invasive Alien Species. Available: https://www.nobanis.org/species-info/?taxaId=2198 (February 2023).

North Carolina Department of Environmental Quality. 2022. Noxious aquatic weed list. 15A North Carolina Administrative Code 02G .0602.

Pallewatta N, Reaser JK, Gutierrez AT, editors. 2003. Invasive alien species in South-Southeast Asia: national reports and directory of resources. Cape Town, South Africa: Global Invasive Species Programme.

Rojas-Sandoval J, Acevedo-Rodríguez P, Mikulyuk A. 2023. *Pistia stratiotes* (water lettuce). In CABI Compendium. Wallingford, United Kingdom: CAB International. Available: https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.41496 (February 2023).

Šajna N, Haler M, Škornik S, Kaligarič M. 2007. Survival and expansion of *Pistia stratiotes L*. in a thermal stream in Slovenia. Aquatic Botany 87:75–79.

Sanders S, Castiglione C, Hoff M. 2023. Risk Assessment Mapping Program: RAMP. Version 5.0. U.S. Fish and Wildlife Service.

South Carolina Department of Natural Resources. 2010. Illegal aquatic plants. Columbia: South Carolina Department of Natural Resources, Aquatic Nuisance Species Program. Available: https://www.dnr.sc.gov/water/envaff/aquatic/illegal1.html (October 2022).

Texas Parks and Wildlife. 2022. Invasive, prohibited and exotic species. Austin: Texas Parks and Wildlife. Available: https://tpwd.texas.gov/huntwild/wild/species/exotic/prohibited_aquatic.phtml (October 2022).

Thayer DD, Pfingsten IA, Howard V, Li J. 2023. *Pistia stratiotes* L. Nonindigenous Aquatic Species Database. Gainesville, Florida: U.S. Geological Survey. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1099 (February 2023).

USDA, NRCS. 2023. *Pistia stratiotes*. The PLANTS database. Greensboro, North Carolina: National Plant Data Team. Available: https://adminplants.sc.egov.usda.gov/java/profile?symbol=PIST2 (February 2023).

[USFWS] U.S. Fish and Wildlife Service. 2024. Standard operating procedure: how to prepare an "Ecological Risk Screening Summary." Version 3. Available: https://www.fws.gov/media/standard-operating-procedures-how-prepare-ecological-risk-screening-summary-2024 (May 2025).

[USGS] U.S. Geological Survey. 2025. Water lettuce (*Pistia stratiotes*). Nonindigenous Aquatic Species Database. Gainesville, Florida: U.S. Geological Survey. Available: https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=1099# (May 2025).

Weeds Australia. 2024. Water lettuce, nile cabbage, water lily. Available: https://weeds.org.au/profiles/water-lettuce-nile/ (May 2025).

Wisconsin Department of Natural Resources. 2022. Invasive species identification, classification and control. Wisconsin Administrative Code NR 40.

[WFO] World Flora Online. 2023. World Flora Online – a project of the World Flora Online Consortium. Available: http://www.worldfloraonline.org (February 2023).

Xiong W, Zhang Y, Xie D, Liu J, Liu Y, Yu Y, Huang Y, Liu S, Wang H, Xiao K, Bowler PA, Feng Y. 2023. Water lettuce (*Pistia stratiotes* L.) (Araceae) in China: distribution, introduction pathway, and impacts. BioInvasions Records 12:1089–1097.

Živković MM, Anđelković AA, Cvijanović DL, Novković MZ, Vukov DM, Šipoš ŠŠ, Ilić MM, Pankov NP, Miljanović BM, Marisavljević DP, Pavlović DM, Radulović SB. 2019. The beginnings of *Pistia stratiotes* L. invasion in the lower Danube delta: the first record for the Province of Vojvodina (Serbia). BioInvasions Records 8:218–229.

11 Literature Cited in Quoted Material

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.

Adebayo AA, Briski E, Kalaci O, Hernandez M, Ghabooli S, Beric B, Chan FT, Zhan A, Fifield E, Leadley T, MacIsaac HJ. 2011. Water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*) in the Great Lakes: playing with fire? Aquatic Invasions 6:91–96.

Attionu RH. 1976. Some effects of waters lettuce (*Pistia stratiotes*, L.) on its habitat. Hydrobiologia 50(3):245–254.

Bartram J, Harper F. 1942. Diary of a journey through the Carolinas, Georgia, and Florida from July 1, 1765, to April 10, 1766. Volume 33 part 1. Philadelphia: Transactions of the American Philosophical Society.

Bartram W, Harper F. 1943. Travels in Georgia, and Florida, 1773–74. A report to Dr. John Fothergill. Volume 33 part 2. Philadelphia: Transactions of the American Philosophical Society.

Blake ST. 1954. Botanical contributions of the northern Australian regional survey. II. Studies on miscellaneous northern Australian plants. Australian Journal of Botany 1:99–140.

Bogosavljević S, Zlatković B, Ranđelković V. 2007. Flora klisure Svrljiškog Timoka. Pages 41–54 in Proceedings of the 9th symposium on flora of southeastern Serbia and neighbouring regions. Niš, Serbia.

Brundu G, Stinca A, Angius L, Bonanomi G, Celesti-Grapow L, D'Auria G, Griffo R, Migliozzi A, Motti R, Spigno P. 2012. *P. stratiotes* L. and *Eichhornia crassipes* (Mart.) Solms.: emerging invasive alien hydrophytes in Campania and Sardinia (Italy). EPPO Bulletin/Bulletin OEPP 42:568–579.

CABI. 2016. *Pistia stratiotes* (water lettuce). Invasive Species Compendium. Available: http://www.cabi.org/isc/datasheet/41496 (July 2016).

Cai L. 2006. Impact of floating vegetation in Shuikou impoundment, Minjiang River, Fujian Province. Hupo-Kexue 18(3):250–254.

Center TD, Dray FA Jr., Jubinsky GP, Grodowitz MJ. 2002. Insects and other arthropods that feed on aquatic and wetland plants. USDA/ARS Technical Bulletin.

Chadwick MJ, Obeid M. 1966. A comparative study of the growth of *Eichhornia crassipes* Solms. and *Pistia stratiotes L*. in water-culture. Journal of Ecology 54:563–575.

Cowie ID, Short PS, Osterkamp Madsen M. 2000. Floodplain flora. A flora of the coastal floodplains of the Northern Territory, Australia. Flora of Australia Supplementary Series 10.

Dray FA Jr, Center TD. 1989a. Seed production by *Pistia stratiotes* L. (water lettuce) in the United States. Aquatic Botany 33(1-2):155–160.

Dray FA Jr, Center TD. 1989b. Waterlettuce seeds in the U.S. Aquatics 11(4):18–21.

Dray FA Jr, Center TD. 1992. Biological control of *Pistia stratiotes* L. (waterlettuce) using *Neohydronomus affinis* Hustache (Coleoptera: Curculionidae). Vicksburg, Mississippi: U.S. Army Engineer Waterways Experiment Station. Technical Report A-92-1.

Dray FA Jr, Center TD. 2002. Waterlettuce. Pages 65–78 in Van Driesche R, Blossey B, Hoddle M, Lyon S, Reardon R, editors. Biological control of invasive plants in the eastern United States. Morgantown, West Virginia: USDA Forest Service. Publication FHTET-2002-04.

Dressler RL, Hall DW, Perkins KD, Williams NH. 1987. Identification manual for wetland plant species of Florida. 1st edition. Gainesville: Florida State Museum and UF/IFAS, Vascular Plant Herbarium.

EPPO. 2012. *P. stratiotes* (Araceae) Water lettuce. Available: https://www.eppo.int/INVASIVE_PLANTS/iap_list/Pistia_stratiotes.htm (April 2016).

Evans JM. 2013. *Pistia stratiotes* L. in the Florida Peninsula: biogeographic evidence and conservation implications of native tenure for an 'invasive' aquatic plant. Conservation and Society 11:233–246.

Fisheries Research Institute, Ljubljana. 2003. [Source material did not give full citation for this reference.]

García Murillo P, Dana Sanchez ED, Rodrigez Hiraldo C. 2005. *Pistia stratiotes* L. (Araceae) una planta acuatica en las proximidades del parquet nacional de doñana (SW Espana). Acta Botanica Malacitana 30:235–236.

Gillet et al. 1988. [Source material did not give full citation for this reference.]

Gillett JG, Dunlop CR, Miller IL. 1989. Occurrence, origin, weed status and control of Water Lettuce (*Pistia stratiotes* L.) in the Northern Territory. Plant Protection Quarterly 3(4):144–148.

Godfrey RK, Wooten JW. 1981. Aquatic and wetland plants of the southeastern United States, dicotyledons. Athens: University of Georgia.

Hall JB, Okali DUU. 1974. Phenology and productivity of *Pistia stratiotes* L. on the Volta Lake, Ghana. Journal of Applied Ecology 11:709–725.

Haller WT, Sutton DL, Barlowe WC. 1974. Effects of salinity on growth of several aquatic macrophytes. Ecology 55(4):891–894.

Hill MP. 2013. Report on trip to Morocco for the biological control of *P. stratiotes* at Fez. [Source material did not give full citation for this reference.]

Holm LG, Plucknett DL, Pancho JV, Herberger JP. 1977. The world's worst weeds. Distribution and biology. Honolulu: University Press of Hawaii.

Howard GW, Harley KLS. 1998. How do floating aquatic weeds affect wetland conservation and development? How can these effects be minimized? Wetland Ecology and Management 5:215–225.

Hussey BMJ, Keighery GJ, Cousens RD, Dodd J, Lloyd SG. 1997. Western weeds. A guide to the weeds of Western Australia. Victoria Park, Australia: The Plant Protection Society of Western Australia.

Hussner A. 2014. Long-term macrophyte mapping documents a continuously shift from native to non-native aquatic plant dominance in the thermally abnormal River Erft (North Rhine-Westphalia, Germany). Limnologica 48:39–45.

Hussner A, Heidbuechel P, Heiligtag S. 2014. Vegetative overwintering and viable seed production explain the establishment of invasive *Pistia stratiotes* in the thermally abnormal Erft River (North Rhine-Westphalia, Germany). Aquatic Botany 119:28–32.

Hussner A, Heiligtag S. 2013. *Pistia stratiotes* L. (Araceae), die Muschelblume, im Gebiet der unteren Erft/Nordrhein-Westfalen: Ausbreitungstendenz und Problempotenzial. Veröffentlichungen des Bochumer Botanischen Vereins 5:1–6.

Langeland KA, Burks KC, editors. 1998. Identification and biology of non-native plants found in Florida's natural areas. 1st edition. Gainesville: University of Florida, Institute of Food and Agricultural Sciences.

Lounibos LP, Escher RL. 1985. Mosquitoes associated with water lettuce (*Pistia stratiotes*) in southeastern Florida. The Florida Entomologist 68:169–178.

Lu Q, He ZL, Graetz DA, Stoffela PJ, Yang X. 2010. Phytoremediation to remove nutrients and improve eutrophic stormwaters using water lettuce (*Pistia stratiotes* L.). Environmental Science and Pollution Research International 17:84–96.

MacIsaac HJ, Eyraud AP, Beric B, Ghabooli S. 2016. Can tropical macrophytes establish in the Laurentian Great Lakes? Hydrobiologia 767:165–174.

Mbati G, Neuenschwander P. 2005. Biological control of three floating water weeds, *Eichhornia crassipes*, *Pistia stratiotes*, and *Salvinia molesta* in the Republic of Congo. BioControl 50(4):635–645.

Mennema J. 1977. Is waterlettuce (*Pistia stratiotes L.*) becoming a new aquatic weed in the Netherlands? Natura, Netherlands 74:187–190.

Merrill ED. 1925. An enumeration of Philippine flowering plants. Volume 1. Manila: Bureau of Printing.

Mishima D, Kuniki M, Sei K, Soda S, Ike M, Fujita M. 2008. Ethanol production from candidate energy crops: water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes* L.). Bioresource Technology 99:2495–2500.

Osmond R, Johnson S. 2006. Water lettuce. Primefact 251. Orange, Australia: New South Wales Department of Primary Industries.

Parsons WT, Cuthbertson EG. 2001. Noxious weeds of Australia. Collingwood, Australia: CSIRO Publishing.

Petr T. 2000. Interactions between fish and aquatic macrophytes in inland waters. A review. Rome: FAO. FAO Fisheries Technical Paper 396.

Pieterse. 1981. [Source material did not give full citation for this reference.]

Pieterse AH, Lange LD, Verhagen L. 1981. A study on certain aspects of seed germination and growth of *Pistia stratiotes* L. Acta Botanica Neerlandica 30:47–57.

Pilipenko VN. 1993. The tropical species *Pistia stratiotes* (Araceae) in the delta of Volga River. Botanicheskii Zhurnal 78:119–120.

Pyšek P, Sádlo J, Mandák B. 2002. Catalogue of alien plants of the Czech Republic. Preslia 74:97–186.

Ramey V. 2001. *Pistia stratiotes*. University of Florida. Available: http://aquat1.ifas.ufl.edu/seagrant/pisstr2.html (July 2003).

Ranđelović V, Zlatković B, Jović D. 1995. Tropska biljna vrsta *Pistia stratiotes* L. (Araceae) u flori Srbije. Pages 33–34 in II Simpozijum o flori Srbije. IV Simpozijum o flori jugoistočne Srbije. Zbornik rezimea. Vranje, Serbia.

Rivers L. 2002. Water lettuce (*Pistia stratiotes*). University of Florida and Sea Grant. Available: http://www.iisgcp.org/EXOTICSP/waterlettuce.htm (July 2003).

Rixon CAM, Duggan IC, Bergeron NMN, Ricciardi A, MacIsaac HJ. 2005. Invasion risks posed by the aquarium trade and live fish markets on the Laurentian Great Lakes. Biodiversity and Conservation 14:1365–1381.

Schanzer IA, Shvetsov AN, Ivanov MN. 2003. *Eichhornia crassipes* and *Pistia stratiotes* are spreading in ponds and rivers of Moscow and Moscow region. Byulleten Moskovskogo Obshchestva Ispytatelei Prirody Otdel Biologicheskii 108:85–88.

Schmitz DC, Schardt JD, Leslie AJ, Dray FA Jr., Osborne JA, Nelson BV. 1993. The ecological impact and management history of three invasive alien aquatic plant species in Florida. Pages 173–174 in B. McKnight, editor. Biological pollution: the control and impact of invasive exotic species. Indianapolis: Indiana Academy of Science.

Sculthorpe CD. 1967. The biology of aquatic vascular plants. London: Edward Arnold.

Sculthorpe CD. 1971. The biology of aquatic vascular plants. London: Edward Arnold Publishers.

Shapovalov MI, Saprykin MA. 2016. Alien species *Pistia stratiotes* L. (Araceae) in water bodies of urbanized territories of Southern Russia. Russian Journal of Biological Invasions 7:195–199.

Sharma BM. 1984. Ecophysiological studies on water lettuce in a polluted lake. Journal of Aquatic Plant Management 22:17–21.

[SILENE] Systeme d'Information et de Localisation des Especes Natives et Envahissantes, Conservatoire botanique national méditerranéen de Porquerolles. 2016. Available: http://flore.silene.eu/ (October 2016). [Source material did not give full citation for this reference.]

Somerset Rare Plant Group Newsletter. 2010. Issue 11. Available: http://www.somersetrareplantsgroup.org.uk/wp-content/uploads/2014/11/2010-Newsletter-11.pdf (October 2016). [Source material did not give full citation for this reference.]

Sridhar and Sharma. 1986. [Source material did not give full citation for this reference.]

Stoddard AA III. 1989. The phytogeography and paleofloitics of *Pistia stratiotes* L. Aquatics 11(3):21–24.

Stuckey RL, Les DH. 1984. *Pistia stratiotes* (water lettuce) recorded from Florida in Bartrams' travels, 1765–74. Aquaphyte 4(2):6.

Venema P. 2001. Fast spread of water lettuce (*Pistia stratiotes L.*) around Meppe. Gorteria 27:133–135.

Verloove F. 2006. Catalogue of neophytes in Belgium (1800-2005). Scripta Botanica Belgica volume 39. Meise: National Botanic Garden of Belgium.

Wang Z, Zhu P, Zheng J, Sheng J, Chen L. 2012. Effects of herbicide residues in paddy field water on growth of the aquatic plant *Pistia stratiotes*. Journal of Weed Science 30(2):15–19.

Waterhouse DF. 1993. The major arthropod pests and weeds of agriculture in Southeast Asia. Canberra: Australian Centre for International Agricultural Research. Monograph 21.

Waterhouse DF. 1997. The major invertebrate pests and weeds of agriculture and plantation forestry in the Southern and Western Pacific. Canberra: The Australian Centre for International Agricultural Research.

Appendix

Summary of Future Climate Matching Analysis

Future climate projections represent two Shared Socioeconomic Pathways (SSP) developed by the Intergovernmental Panel on Climate Change (IPCC 2021): SSP5, in which emissions triple by the end of the century; and SSP3, in which emissions double by the end of the century. Future climate matches were based on source locations reported by GBIF Secretariat (2023) and USGS (2025).

Under the future climate scenarios (figure A1), on average, high climate match for *Pistia stratiotes* was projected to occur in the Appalachian Range, California, Great Lakes, Gulf Coast, Mid-Atlantic, Northeast, Southeast, Southern Atlantic Coast, Southern Florida, Southern Plains, and Southwest regions of the contiguous United States. Medium climate match was projected for other regions of the contiguous United States, with few to no areas of low climate match. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.845 (model: MPI-ESM1-2-HR, SSP5, 2085) to a high of 0.970 (model: GFDL-ESM4, SSP5, 2085). All future scenario Climate 6 scores were above the Establishment Concern threshold, indicating that Yes, there is establishment concern for this species under future scenarios. The Climate 6 score for the current climate match (0.897, figure 6) falls within the range of scores for future projections. The time step and climate scenario with the most change relative to current conditions was SSP3, 2085. Under one or more time step and climate scenarios, areas within the Colorado Plateau, Northern Pacific Coast, Northern Plains, and Southwest saw a moderate increase in the climate match relative to current conditions. These increases in climate match were most pronounced at the 2055 time step for the Southwest region and at the 2085 time step for the other regions named. No large increases were observed over substantial areas regardless of time step and climate scenarios. Under one or more time step and climate scenarios, areas within the Appalachian Range, California, Great Lakes, Gulf Coast, Mid-Atlantic, Southeast, Southern Atlantic Coast, Southern Florida, Southern Plains, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions. These decreases in climate match were most pronounced at the 2085 time step. No large decreases were observed regardless of time step and climate scenarios. However, additional very small areas of large or moderate change may be visible on the maps (figure A3).

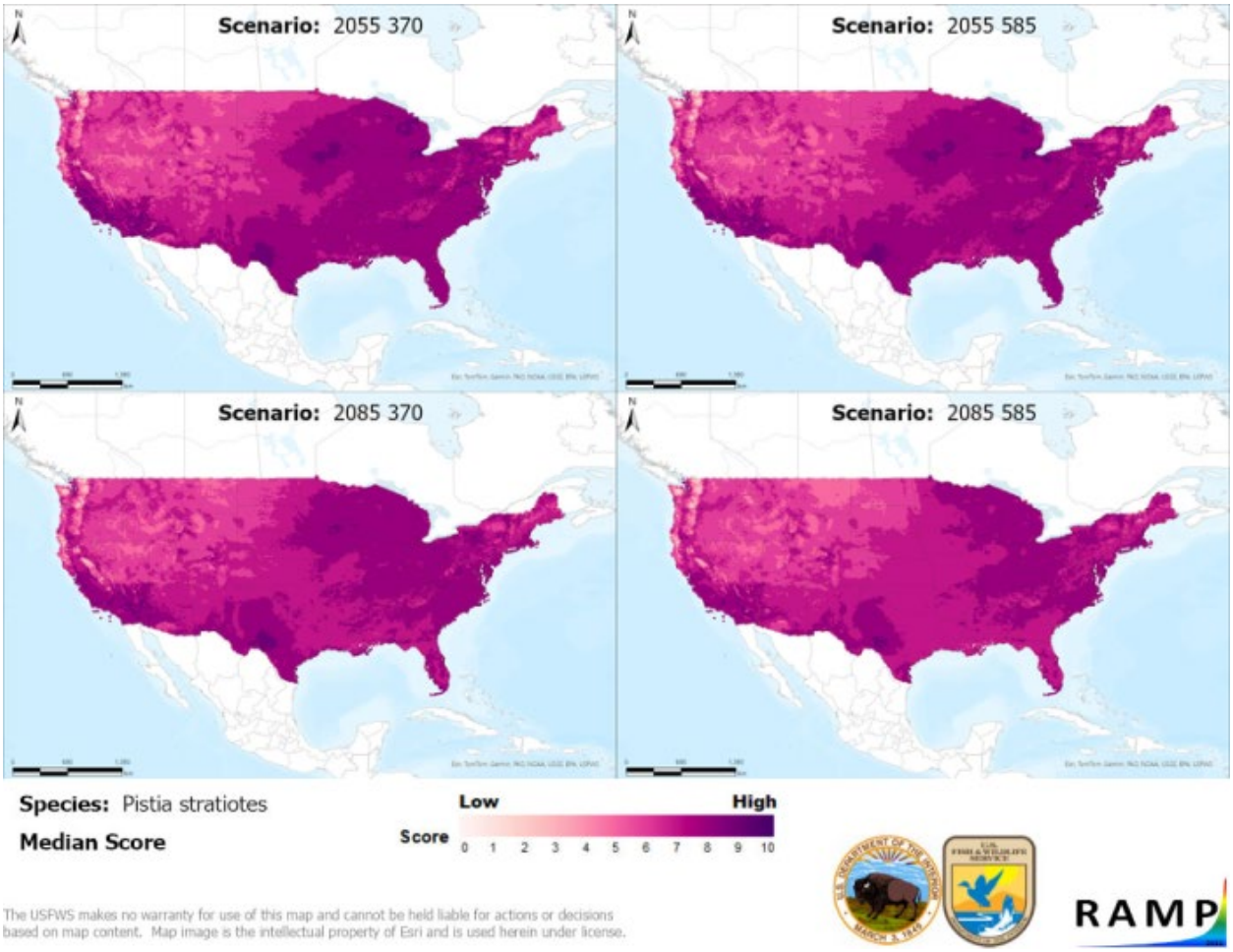

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Pistia stratiotes* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023) and USGS (2025). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

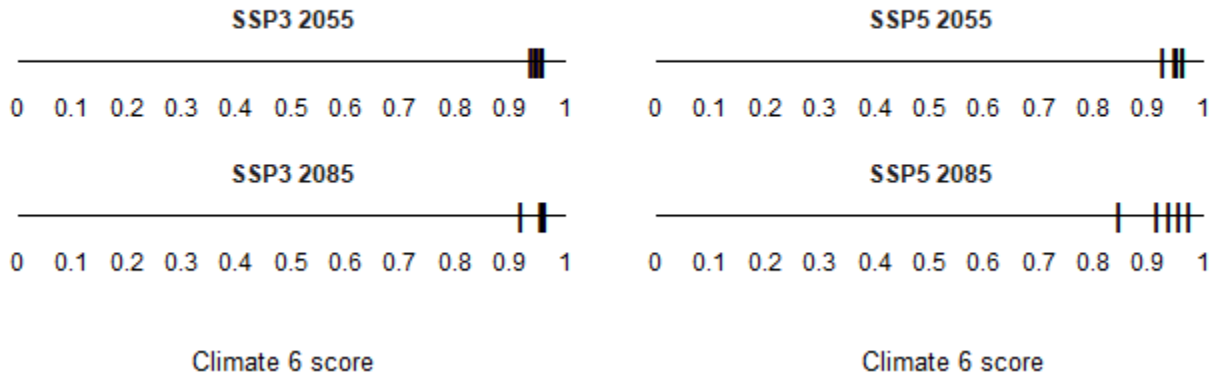

Figure A2. Comparison of projected future Climate 6 scores for *Pistia stratiotes* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0.

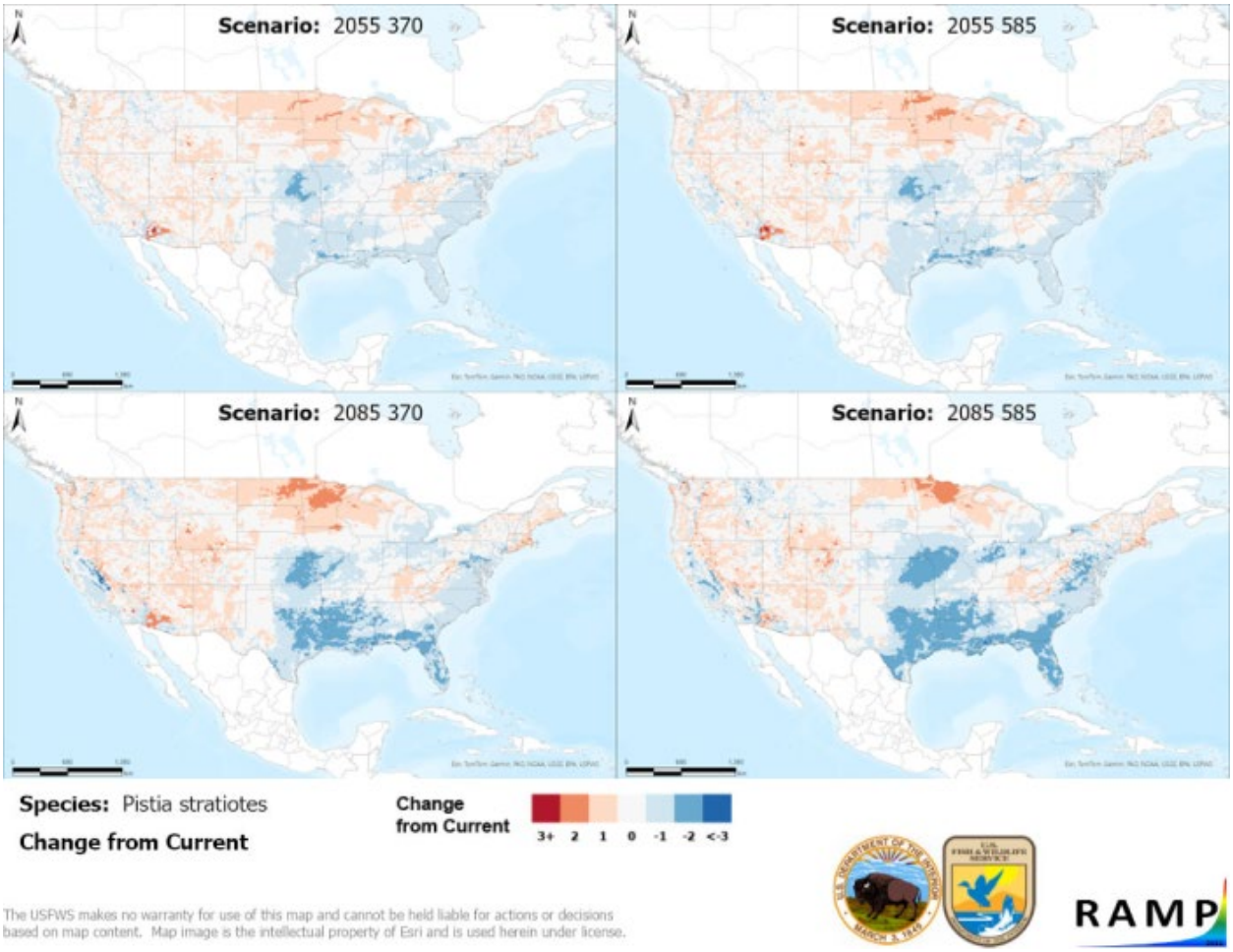

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 6) and the median target point score for future climate scenarios (figure A1) for *Pistia stratiotes* based on source locations reported by GBIF Secretariat (2023) and USGS (2025). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. Shades of blue indicate a lower target point score under future scenarios than under current conditions. Shades of red indicate a higher target point score under future scenarios than under current conditions. Darker shades indicate greater change.

Literature Cited

GBIF Secretariat. 2023. GBIF backbone taxonomy: *Pistia stratiotes* L. Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/2870583 (May 2025).

[IPCC] Intergovernmental Panel on Climate Change. 2021. Climate change 2021: the physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Karger DN, Conrad O, Böhner J, Kawohl T, Kreft H, Soria-Auza RW, Zimmermann NE, Linder HP, Kessler M. 2018. Data from: Climatologies at high resolution for the earth's land surface areas. EnviDat. Available: https://doi.org/10.16904/envidat.228.v2.1.

Karger DN, Conrad O, Böhner J, Kawohl T, Kreft H, Soria-Auza RW, Zimmermann NE, Linder P, Kessler M. 2017. Climatologies at high resolution for the Earth land surface areas. Scientific Data 4:170122.

Sanders S, Castiglione C, Hoff M. 2023. Risk Assessment Mapping Program: RAMP. Version 5.0. U.S. Fish and Wildlife Service.

[USGS] U.S. Geological Survey. 2025. Water lettuce (*Pistia stratiotes*). Nonindigenous Aquatic Species Database. Gainesville, Florida: U.S. Geological Survey. Available: https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=1099# (May 2025).