Dotted Duckweed (*Spirodela punctata*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, March 2011
Revised, May 2019
Web Version, 9/17/2021

Organism Type: Plant
Overall Risk Assessment Category: Uncertain

Photo: U.S. Geological Survey. Public domain. Available: https://www.texasinvasives.org/plant_database/detail.php?symbol=LAPU12. (May 9, 2019).

1 Native Range and Status in the United States

Native Range

From Jacono (2019):

"Australia and Southeast Asia. Crawford and Landolt (1993) used enzyme electrophoresis to measure genetic diversity among *Spirodela* species. In *Spirodela* (*Landoltia*) *punctata* the highest diversity was found in biotypes from Australia and southeastern Asia. This supports the

presumption of origin and species development in those regions, where early collection records also were made (Landolt 1986)."

From Gupta (2011):

"In Indochina, it is found in central and southern Thailand and in Viet Nam."

GISD (2017) lists *Spirodela punctata* as native in Australia, Indonesia, Malaysia, Philippines, and Thailand.

Status in the United States

From Jacono (2019):

"*Landoltia* (*Spirodela*) *punctata* is sometimes reported as native to North America (BONAP 1999; USDA, NRCS 1999). However no evidence has been presented that refutes the extensive taxonomic and distribution studies conducted on this species (Landolt 1986). In reviewing more than 10,000 Lemnaceae specimens from North America, none of *Landoltia punctata* were found to predate the 1930 collection from Kansas City, Missouri (Saeger 1934), indicating the species as introduced to North America (Landolt 1986; E. Landolt, pers. comm. 1999)."

"Noted by many as expanding in range in North America; populations are overlooked because of its superficial resemblance to native duckweeds."

According to Jacono (2019), nonindigenous occurrences of *Spirodela punctata* have been reported in the following States, with range of years and hydrologic units in parentheses:

- Alabama (1976–2018; Alabama-Coosa, Cahaba, Choctawhatchee, Choctawhatchee-Escambia, Coosa-Tallapoosa, Locust, Lower Tallapoosa, Lower Tombigbee, Middle Alabama, Middle Chattahoochee-Walter F George Reservoir, Middle Tennessee-Elk, Mobile Bay-Tombigbee, Mulberry, Upper Alabama, Upper Black Warrior, Wheeler Lake)
- Arizona (1986–1988; Lower Gila-Agua Fria, Upper Verde)
- Arkansas (1974–2011, Bayou Bartholomew, Little Missouri, Lower Arkansas-Maumelle, Lower Mississippi Region, Lower White, Upper Ouachita)
- California (1991–2018; Big Chico Creek-Sacrament River, Big-Navarro-Garcia, Central Coastal, Coyote, Honcut Headwaters-Lower Feather, Lower Pit, Lower Sacramento, Middle San Joaquin-Lower Chowchilla, Monterey Bay, Northern California Coastal, Sacramento, San Francisco Coastal South, San Luis Rey-Escondido, San Pablo Bay, Scott, Southern Mojave, Thomes Creek-Sacramento River, Upper Cache, Upper Putah, Upper San Joaguin, Upper Stanislaus)
- Delaware (1991; Brandywine-Christina)
- Florida (1955–2016; Apalachee Bay-St. Marks, Big Cypress Swamp, Blackwater, Caloosahatchee, Choctawhatchee Bay, Choctawhatchee-Escambia, Crystal-Pithlachascotee, Florida Southeast Coast, Hillsborough, Kissimmee, Lower Chattahoochee, Lower Ochlockonee, Lower St. Johns, Manatee, Myakka, New, Ochlockonee, Oklawaha, Peace, Santa Fe, Sarasota Bay, Southern Florida, St. Johns, St. Marys, St. Marys-Satilla, Tampa Bay, Upper Suwannee, Withlacoochee)

- Georgia (1965–1995; Alapaha, Apalachicola Basin, Ichawaynochaway, Lower Chattahoochee, Middle Flint, Ogeechee Coastal, Suwannee, Upper Ocmulgee, Upper Oconee)
- Hawaii (1975–1999; Hawaii, Oahu)
- Illinois (1960–1997; Cache, Lower Illinois-Senachwine Lake, Upper Mississippi-Meramec, Wabash)
- Kentucky (1983–1997; Bayou De Chien-Mayfield, Blue-Sinking, Lower Mississippi-Memphis)
- Louisiana (1961–2000; Atchafalaya, Atchafalaya-Vermilion, Bayou Cocodrie, Bayou Macon, Bayou Pierre, Bayou Sara-Thompson, Bayou Teche, Boeuf, Bogue Chitto, Calcasieu-Mermentau, Castor, Central Louisiana Coastal, East Central Louisiana Coastal, Lake Maurepas, Little, Louisiana coastal, Lower Grand, Lower Maurepas, Lower Mississippi, Lower Mississippi Region, Lower Ouachita, Lower Red, Lower Red-Lake Iatt, Lower Red-Ouachita, Lower Yazoo, Mermentau, Pearl, Red-Saline, Saline Bayou, Tangipahoa, Tensas, Toledo Bend Reservoir, West Central Louisiana Coastal)
- Maryland (1970–1999; Gunpowder-Patapsco, Mid Atlantic Region)
- Massachusetts (1986; Charles)
- Michigan (2017; Clinton)
- Mississippi (1974–2009; Bayou Pierre, Big Sunflower, Deer-Steele, Lower Pearl, Middle Pearl-Strong)
- Missouri (1930–1999; Lower Missouri-Crooked, Peruque-Piasa, Sac, St. Francis, Upper Mississippi-Cape Girardeau, Upper Mississippi-Meramec, Upper St. Francis)
- North Carolina (1981–2010; Albemarle, Chowan-Roanoke, Lower Pee Dee, Lower Roanoke, Middle Roanoke, New River, Northeast Cape Fear, Pamlico Sound, Upper Catawba, Upper Neuse)
- Oklahoma (1985; Groesbeck-Sandy, Red-Little, Upper Beaver)
- Oregon (1986; Pacific Northwest)
- Pennsylvania (1956–1986; Lower Susquehanna-Penns, Middle Allegheny-Tionesta, Tioga)
- Puerto Rico (1981–2005; Cibuco-Guajataca, Eastern Puerto Rico)
- South Carolina (1981–2018; Broad-St Helena, Edisto River, Edisto-Santee, Edisto-South Carolina Coastal, Lake Marion, Lower Savannah, Lumber, Saluda, Santee, Stevens, Upper Savannah)
- Tennessee (1986; Lower Mississippi-Hatchie)
- Texas (1981–2008; Aransas, Caddo Lake, East Galveston Bay, Elm Fork Trinity, Lake Fork, Lower Neches, Lower Sabine, Middle Sabine, Navasota, Sabine Lake, Texas-Gulf Region, Toledo Bend Reservoir, Upper Neches, West Galveston Bay)
- Virginia (1966–1997; Albemarle-Chowan, Blackwater, Lower Chesapeake, Lower James, Lower Potomac, Potomac, Western Lower Delaware)

From GISD (2017):

"*L. punctata* has been classified as a Species to Watch on the Oklahoma state noxious weed list. "Species to Watch" are not currently listed as noxious aquatic plants. However, they are aquatic plants whose impact on the Oklahoma environment is presently unknown, and therefore, may be

considered for inclusion on the noxious aquatic plant list as additional information becomes available to, and as deemed necessary by, the Department of Wildlife Conservation."

No records of *Spirodela punctata* in trade in the United States were found.

From Texas Parks and Wildlife (2020):

"The organisms listed here are legally classified as exotic, harmful, or potentially harmful. No person may possess or place them into water of this state except as authorized by the department. Permits are required for any individual to possess, sell, import, export, transport or propagate listed species for zoological or research purposes; for aquaculture (allowed only for Blue, Nile, or Mozambique tilapia, Triploid Grass Carp, or Pacific White Shrimp); or for aquatic weed control (for example, Triploid Grass Carp in private ponds).
[…]
Dotted Duckweed, Family Araceae
Landoltia punctata [*Spirodela punctata*]"

Means of Introductions in the United States

From Jacono (2019):

"In the 1800's, many of the known localities of *Landoltia punctata* outside of Australia and southeastern Asia were localized near harbors, suggesting very early dispersal among continents by humans (Landolt 1986).

Landoltia punctata is commonly used in aquaria and may be distributed when transporting fish or plants (Landolt 1986) so that even in the aquarium, the introduction one of the world's smallest flowering plants is often by accident (Stodola 1967). The Missouri pond first found with *L. punctata* also contained goldfish, suggesting the the [sic] plant might have been introduced from commercial supply sources for domestic aquaria (Daubs 1962). Its irregularity in distribution in the United States suggests multiple introduction sites. Water garden suppliers are an additional likely source.

Once escaped in a new region, *Landoltia punctata* can be transported short distances (several kilometers) by water birds, and less importantly by mammals like beavers, raccoons and wild hogs (Landolt 1986). However, duckweed fronds quickly desiccate once removed from the water, much more so than other small, floating plants, such as *Salvinia*. Wet feathers or rain may extend the distance of dispersal by birds, but generally fronds will dry out within 0.5 to 2.5 hr (Landolt 1986)."

Remarks

The accepted name for this species is *Spirodela punctata*. However, many databases still refer to the species by the synonym *Landoltia punctata.* Information searches were conducted using both names.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to WFO (2021), *Spirodela punctata* (G.Mey.) C.H.Thomps. is the accepted name for this species.

From GBIF (2019):

"Kingdom Plantae
Phylum Tracheophyta
Class Liliopsida
Order Alismatales
Family Araceae
Genus *Spirodela* Schleid.
Species *Spirodela punctata* (G.Mey.) C.H. Thomps."

Size, Weight, and Age Range

From Swearingen and Bargeron (2016):

"Mature fronds of *Landoltia punctata* appear 1.5 to 2 times longer than wide, with widths measuring from 0.04-0.12 in. (1-3 mm)."

Environment

From Swearingen and Bargeron (2016):

"It grows very quickly in water high in nutrients, for example from run off of fertilized fields. […] desiccates quickly after removal from the water."

From Jacono (2019):

"The inability of *Landoltia punctata* to form turions accounts for its absence in the northern and Midwestern United States. Its fronds are sensitive to severe frosts and plants are reportedly limited by absolute minimum temperatures <- 20 C (- 4 F) (Landolt 1981)."

"Under long-day photoperiods *Landoltia punctata* may sometimes form resting fronds. These are small, delicate single fronds with only one framentary [*sic*] root. High in starch, they function comparably to turions in that they are more capable than normal fronds in surviving unfavorable conditions such as storms and light frost. However, they do not sink to the bottom and thereby do not provide overwintering protection in zones with severe winters (Landolt 1986)."

"However, the seeds tolerate drought. In Australia, *L. punctata* survives by seed in ponds that seasonally dry out (Landolt 1986)."

Climate

From Gupta (2011):

"This is a widespread species that grows in tropical and subtropical regions."

Distribution Outside the United States

Native

From Jacono (2019):

"Australia and Southeast Asia. Crawford and Landolt (1993) used enzyme electrophoresis to measure genetic diversity among *Spirodela* species. In *Spirodela* (*Landoltia*) *punctata* the highest diversity was found in biotypes from Australia and southeastern Asia. This supports the presumption of origin and species development in those regions, where early collection records also were made (Landolt 1986)."

From Gupta (2011):

"In Indochina, it is found in central and southern Thailand and in Viet Nam."

GISD (2017) lists *Spirodela punctata* as native in Australia, Indonesia, Malaysia, Philippines, and Thailand.

Introduced

NOBANIS (2019) lists *Spirodela punctata* as introduced but not established in Sweden.

Pagad et al. (2018) list *Spirodela punctata* as alien in Chile and Sweden, and alien as well as native in Australia.

From Xu et al. (2015):

"The rare presence of *L. punctata* could be due to its recent introduction to Hainan Island [China]."

From Choi et al. (2017):

"In conclusion, the dotted duckweeds have spread and settled in most of the water systems on Jeju Island [South Korea], […]"

De Almeida (2018) reports that *Spirodela punctata* has been introduced and naturalized in Portugal.

From Lansdown (2008):

"Another species *Landoltia* (formerly *Spirodela*) *punctata* (G. Mey) Les & D. J. Crawford has been recorded as a contaminant in garden centres (Rumsey 2006), but not yet in the wild."

From Otto and Verloove (2016):

"In La Palma (and probably in the other Canarian Islands as well) *Landoltia punctata* is an overlooked species or it may have been misidentified (as *Lemna gibba* L. or *L. minor* L.)."

From Gérard and Triest (2014):

"*Landoltia punctata* […] has invaded several European countries [Landolt 1986]. The species is not present in Belgium but has been reported in The Netherlands [van Valkenburg and Pot 2008]."

Klaassen and Kwembeya (2013) list *Spirodela punctata* as present and non-indigenous in Namibia.

From Landolt (1999):

"Between Sao Paulo and Rio de Janeiro [Brazil] *Spirodela punctata* is widespread (probably introduced)."

Elser (1988) refers to *Spirodela punctata* as an alien plant in New Zealand.

Cryptogenic

GISD (2017) lists *Spirodela punctata* as native to the countries listed below; however, this contradicts all other sources on the native range of the species. Any populations in these countries are most likely the result of a non-native introduction but information confirming that assumption could not be found. *S. punctata* is present in Argentina, Colombia, Egypt, Fiji, Guyana, India, Israel, Japan, Madagascar, Maldives, Mauritius, New Caledonia, South Africa, Spain, Taiwan, Vanuatu, Venezuela, and Zimbabwe. Bog et al. (2015) report the presence of *S. punctata* without comment on native or non-native status in Ecuador and Switzerland in addition to countries already mentioned.

Means of Introduction Outside the United States

From Swearingen and Bargeron (2016):

"It probably has been introduced multiple times, possibly through the aquarium and water garden trade."

Short Description

From Jacono (2019):

"Tiny free-floating aquatic plants comprised of individual fronds that produce fine roots. Mature fronds appear 1.5 to 2 times longer than wide, with widths measuring from 1-3 (or 5) mm. Fronds are narrowly egg-shaped to slightly kidney-shaped and intensely green in color. A waxy layer of cuticle makes plants sparkle in the sunlight. Fronds are not leaves; they may be a

reduced form of stem and shoot. The roots number from 2-4 and can range up to 7. All of the roots penetrate the prophyllum (a scale surrounding the base of the frond that covers the point of attachment of the roots)."

"Propagation is mainly through vegetative budding of daughter fronds from two pouches at base of the frond. Daughter fronds often remain attached to mother frond by a short stipe so that plants often appear as a cluster of several fronds."

From GSID (2017):

"The name *punctata* comes from the sunken glands on the undersurface of the fronds. […]; they also have a reddish-purple tint on the underside of the fronds due to anthocyanin production."

Biology

From Swearingen and Bargeron (2016):

"*Landoltia punctata* spreads mainly through vegetative budding from two pouches at base of the frond. […] This species may sometimes reproduce sexually, producing seed."

From GISD (2017):

"*Landoltia punctata* was treated with Diquat for 20-30 years to control dotted duckweed and was the first aquatic plants ever to develope resistance to bipyridium herbicides. (Koschnick et al. 2006)."

Human Uses

From Swearingen and Bargeron (2016):

"It is sometimes used to clean waste water. It probably has been introduced multiple times, possibly through the aquarium and water garden trade."

From Jacono (2019):

"*Landoltia punctata* is commonly used in aquaria […]"

From Amin et al. (2017):

"Duckweed (*Landoltia punctata*) can be utilized to produce ethanol, butanol, and biogas, which are promising alternative energy sources […]"

Diseases

No information on diseases associated with *Spirodela punctata* was found.

Threat to Humans

No information on threats to humans from *Spirodela punctata* was found.

3 Impacts of Introductions

From Esler (1988):

"*Azolla pinnata* and purple-backed duckweed (*Spirodela punctata*) contribute little obstruction or aesthetic detraction, but impair wildlife habitats."

From Jacono (2019):

"Not known, although regarded as a pioneer species in that it is distributed easily, colonizes quickly and has a high rate of vegetative propagation (Landolt 1986)."

"*Landoltia punctata*, often occurs in extensive, almost pure stands while *Spirodela polyrrhiza* usually occurs in mixed populations, with other duckweed species (Godfrey and Wooten 1979; Davenport and Haynes 1981; Wohler et al 1965)."

From Swearingen and Bargeron (2016):

"*Landoltia punctata* invades quiet waters such as ponds, ditches, swamps and backwaters. […] *Landoltia punctata* is often seen in large, almost pure populations while native duckweeds usually occur together with other duckweed species."

From Choi et al. (2017):

"Although the dense growth of dotted duckweed adversely affects growth and development of some aquatic plants due to the shadow effect, it is due to the dominance of floating plants on the water surface [it] should not be regarded as the risk of the dotted duckweed. In conclusion, the dotted duckweeds have spread and settled in most of the water systems on Jeju Island [South Korea], their impact on inhabiting biota and the aquatic environment was minor."

Spirodela punctata is a regulated species in Texas.

4 History of Invasiveness

Spirodela punctata as native in Australia, Indonesia, Malaysia, Philippines, and Thailand. The plant is found in many States, particularly the west and southeastern coasts, and is often confused with native duckweeds. *S. punctata* has been classified as a Species to Watch on the Oklahoma state noxious weed list. The species has also invaded Europe, Africa, Australia, and South America. In the 1800's, many of the known localities of *Spirodela punctata* outside of Australia and southeastern Asia were localized near harbors, suggesting very early dispersal among continents by humans. *Spirodela punctata* is commonly used in aquaria and may be distributed when transporting fish or plants so that even in the aquarium, the introduction one of the world's smallest flowering plants is often by accident. There is some suggestion that they may be impacts from these introductions, however, the statements were not supported with scientifically defensible information. One peer-reviewed paper suggested in the abstract that impacts may be

minor, but the body of the paper was in Korean and methods could not be evaluated. Therefore, the history of invasiveness is classified as Data Deficient.

5 Global Distribution

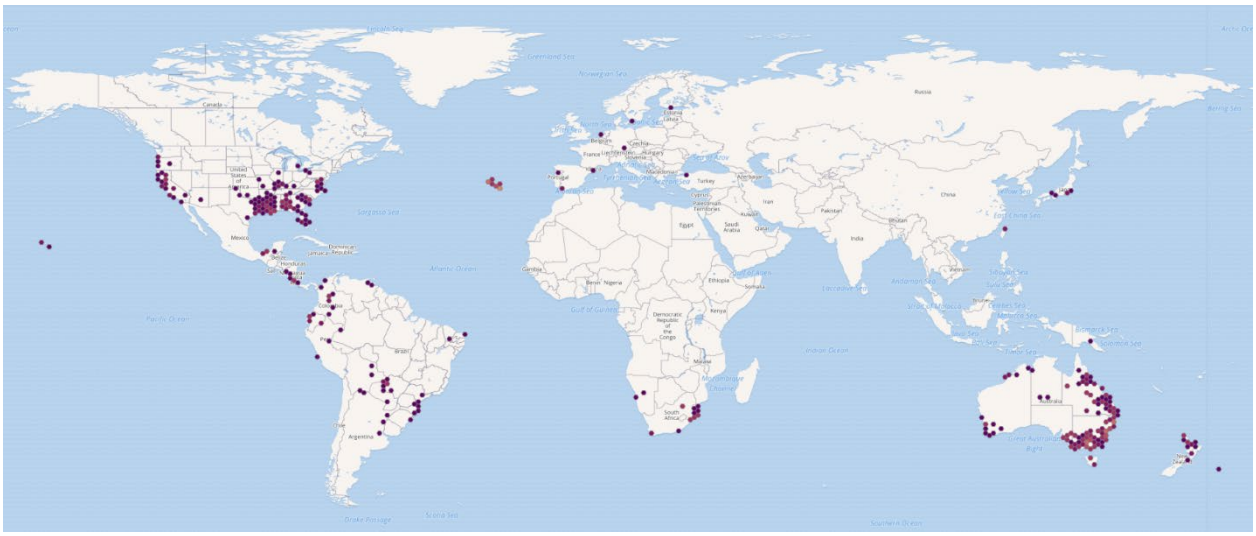

Figure 1. Known global distribution of *Spirodela punctata*. Map from GBIF Secretariat (2019). The location in Sweden was not used to selected source points for the climate match. *Spirodela punctata* is not established in Sweden (NOBANIS 2019). Locations in countries where no confirmation of presence could be found from a source other than GBIF Secretariat (2019) were not used to select source locations for the climate match.

Additional known locations reported in the literature were also used to select source points for the climate match. Xu et al. (2015) report *Spirodela punctata* collected from Baoting in the southern end of Hainan Island, China. Choi et al. (2017) report the establishment of *S. punctata* on Jeju Island, South Korea. Xue et al. (2012) report observations of *S. punctata* in western China and Vietnam. Otto and Verloove (2016) report *S. punctata* as present in the Canary Islands.

6 Distribution Within the United States

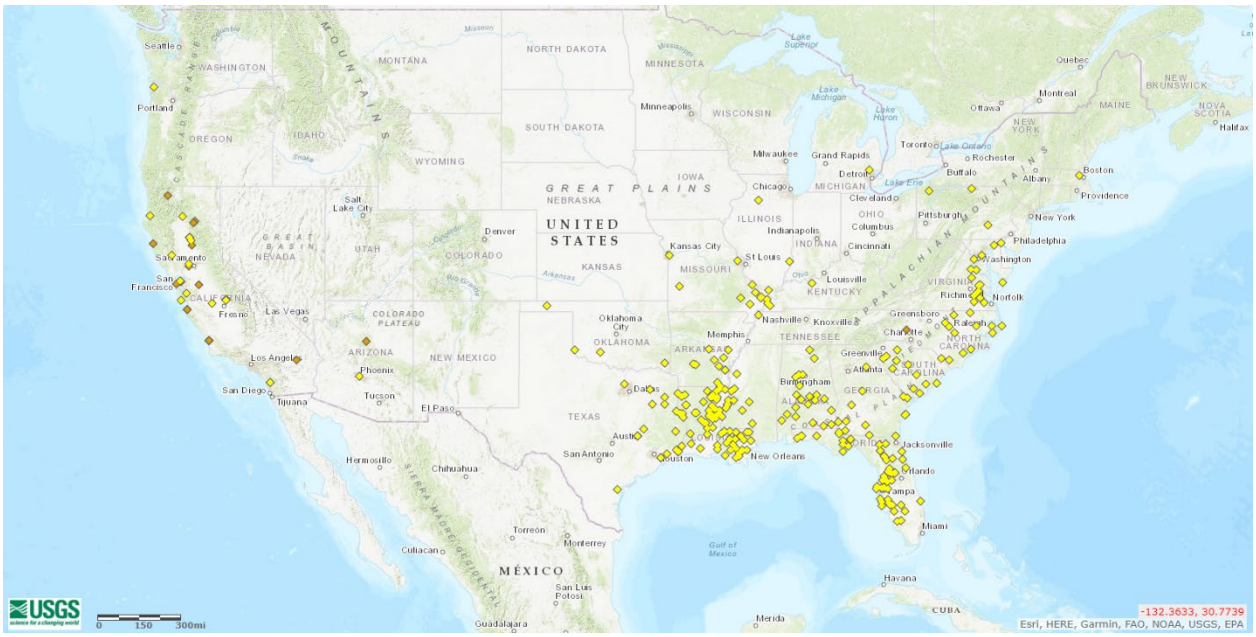

Figure 2. Known distribution of *Spirodela punctata* in the contiguous United States. Map from Jacono (2019). Only established populations (yellow diamonds) were used to selected soruce points in the climate match. Orange diamonds indicate observation records that do not represent an established population.

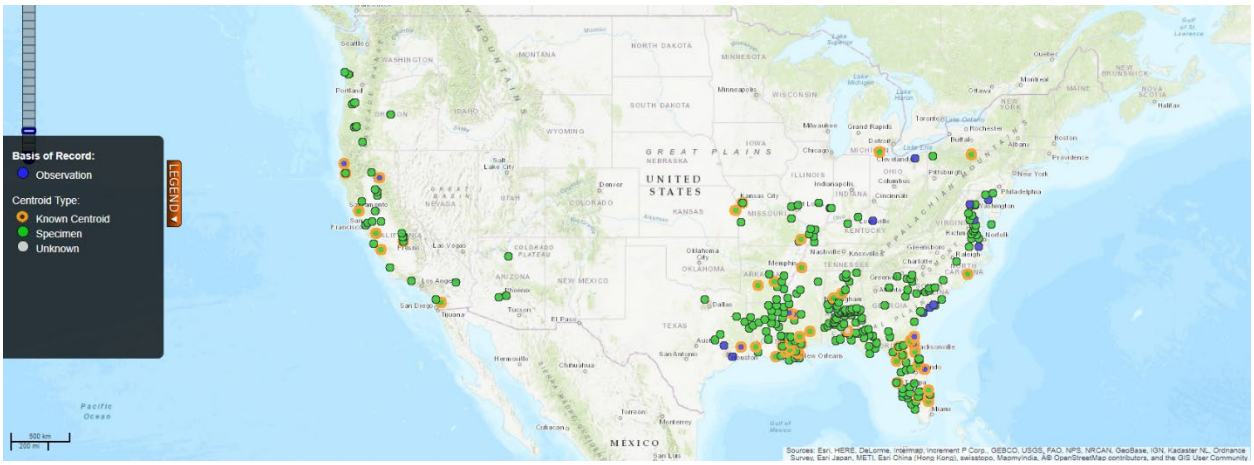

Figure 3. Additional known distribution of Spirodela punctata in the contiguous United States. Map from BISON (2019).

Figure 4. Known distribution of *Spirodela punctata* in Hawaii. Map modified from Jacono (2019). All locations represent established populations and were used to select source points for the climate match.

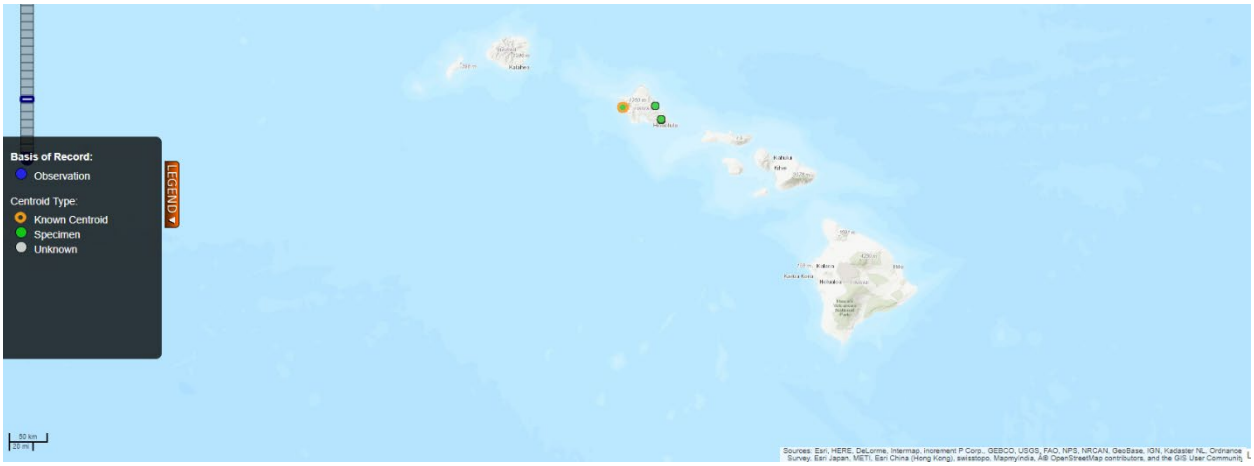

Figure 5. Additional known distribution of *Spirodela punctata* in Hawaii. Map from BISON (2019).

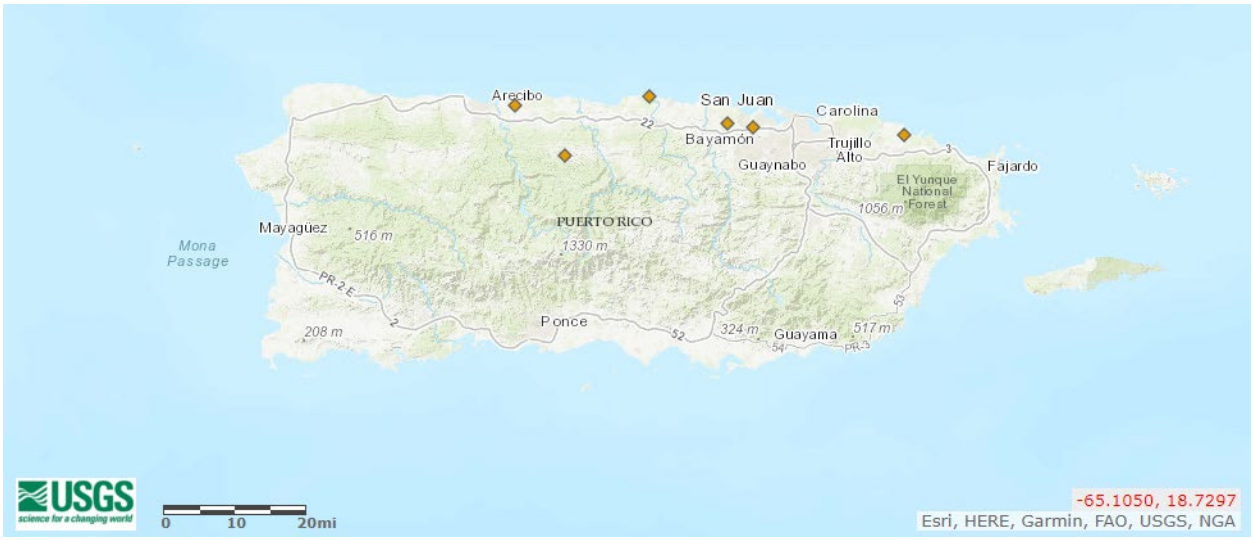

Figure 6. Known distribution of *Spirodela punctata* in Puerto Rico. Map from Jacono (2019). None of the locations represent established populations and were not used to select source points for the climate match.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Spirodela punctata* to the contiguous United States was mostly high. There were areas of medium match in the upper Midwest and much of the Great Plains. Areas of low match were found in the far northern Midwest, in small patches throughout the Great Plains, and scattered in the Pacific Northwest with a larger area of low match on the Olympic Peninsula. Everywhere else had a high match. The overall Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.802, high. (Scores of 0.103 and greater are classified as high.) All States had high individual climate scores except for Montana and Wyoming which had medium scores, and North Dakota which had a low score.

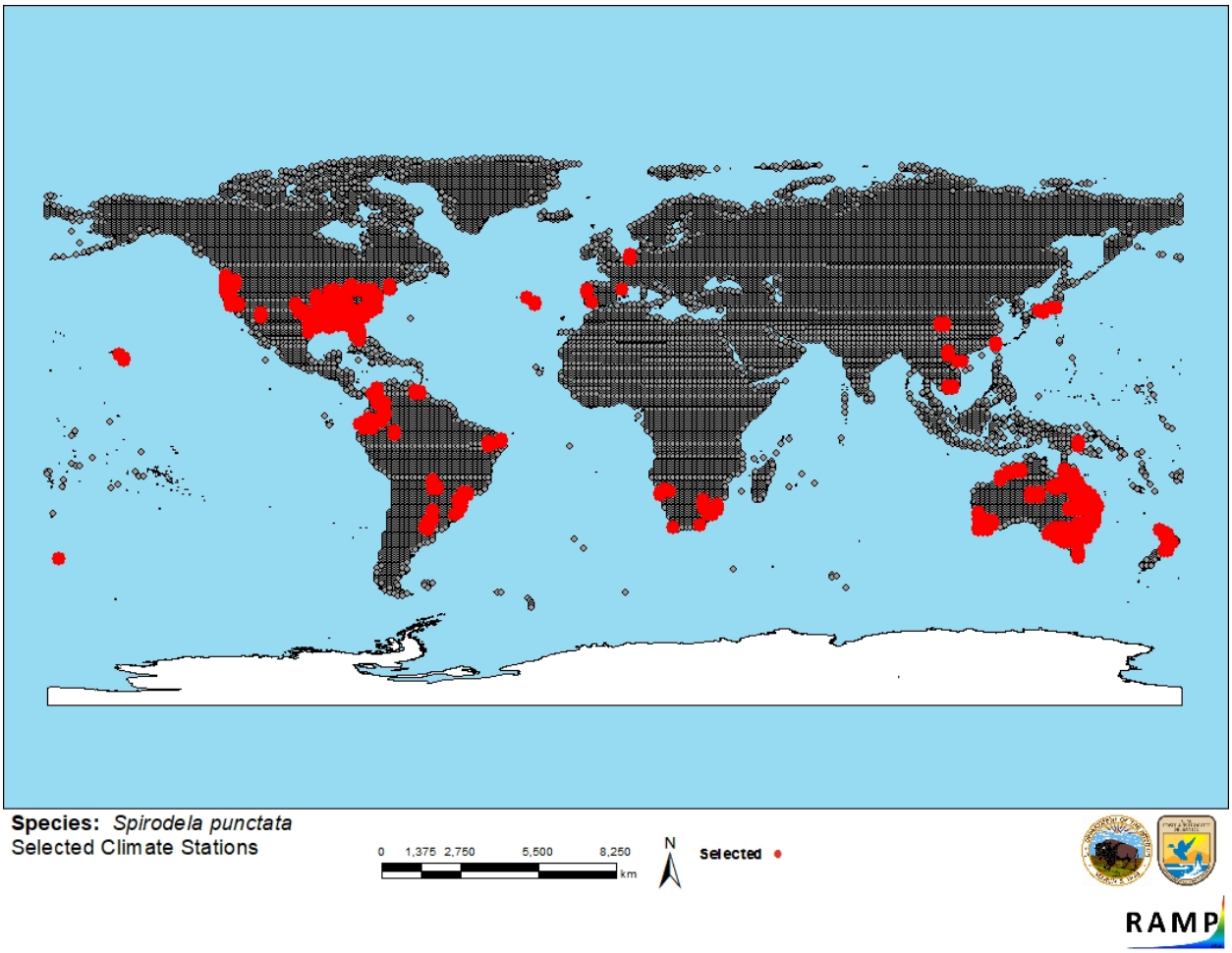

Figure 7. RAMP (Sanders et al. 2018) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Spirodela punctata* climate matching. Source locations from Xue et al. (2012), Xu et al. (2015), Otto and Verloove (2016), Choi et al. (2017), BISON (2019), GBIF Secretariat (2019), and Jacono (2019). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

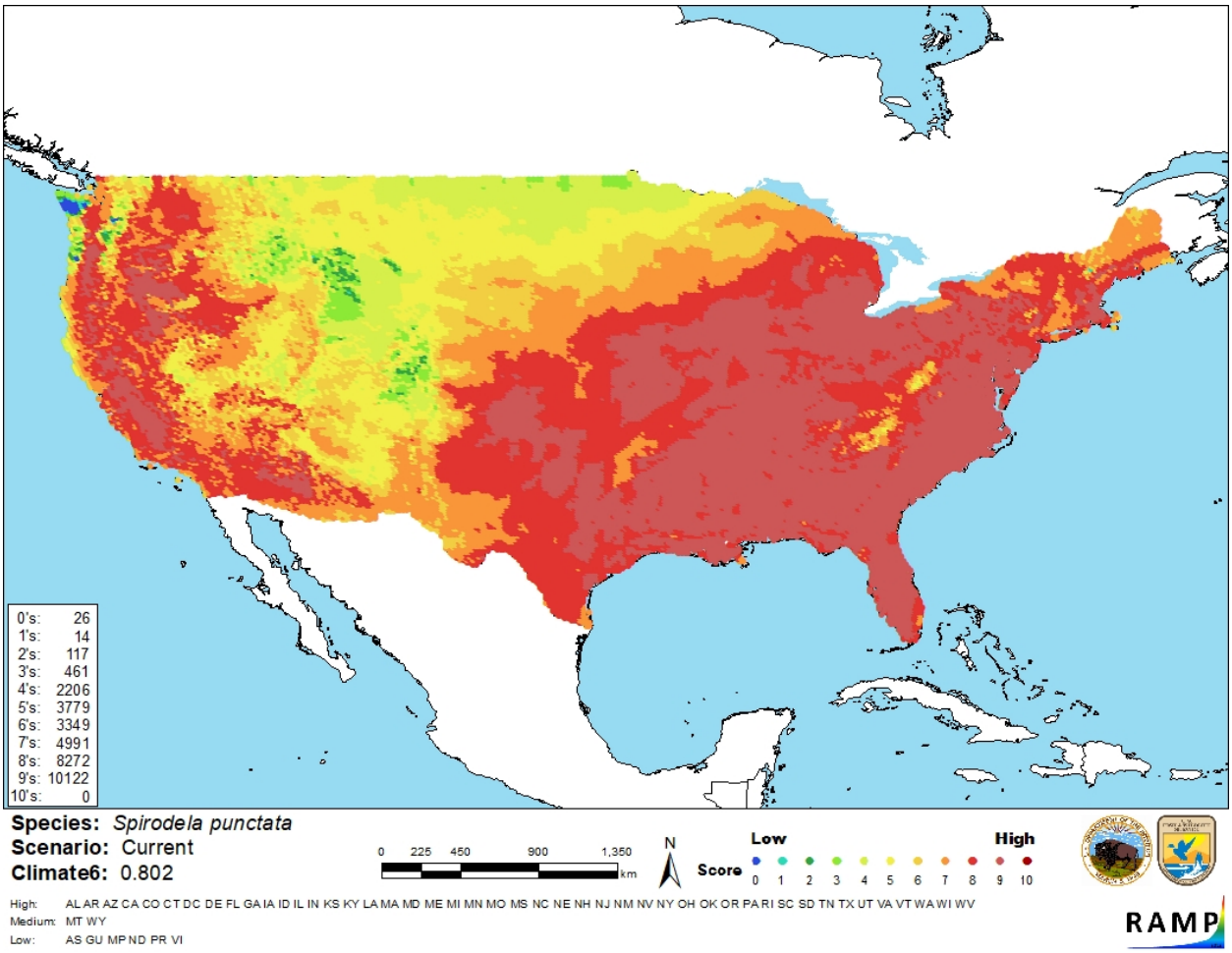

Figure 8. Map of RAMP (Sanders et al. 2018) climate matches for *Spirodela punctata* in the contiguous United States based on source locations reported by Xue et al. (2012), Xu et al. (2015), Otto and Verloove (2016), Choi et al. (2017), BISON (2019), GBIF Secretariat (2019), and Jacono (2019). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

The High, Medium, and Low Climate match Categories are based on the following table:

Climate 6: (Count of target points with climate scores 6-10)/ (Count of all target points)	Overall Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

8 Certainty of Assessment

The certainty of assessment for *Spirodela punctata* is low. There is some information available about the biology and ecology of the species. The distribution of the species is sparsely documented without a consensus on the native range of the species. Some records of introduction

and establishment were found but there is minimal information regarding actual impacts of introduction.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Dotted duckweed (*Spirodela punctata*) is a small flowering, floating aquatic plant. It is native to Australia and Southeast Asia. *S. punctata* can be found in the aquarium and water garden trade, is used to treat wastewater, and is being investigated as a source of biofuel. The history of invasiveness is classified as Data Deficient. There are many records of introductions and establishment along with cryptogenic occurrence records for many countries. *S. punctata* is established in over half of the States in the United States. *S. punctata* is a regulated species in Texas. A few general statements of negative impact after introduction were found. One peer-reviewed paper with an English abstract was found that suggested impacts from *S. punctata* may be minimal. The overall climate match is High. Most areas of the contiguous United States had high climate matches except for the Great Plains, upper Midwest, and some patches in the northwest. The certainty of assessment is Low due to a lack of scientifically defensible impact information. Information is available but there is some contradiction in describing the geographic range of the species. The overall risk assessment is Uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): Data Deficient**
- **Overall Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Low**
- **Remarks/Important additional information:** No additional remarks.
- **Overall Risk Assessment Category: Uncertain**

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.

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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.

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