

Risk Assessment of Aquatic and Semi-aquatic Plants That Have Been Recommended for the Ohio Invasive Plants List



2018

A sub-committee of the Ohio Aquatic Invasive Species Committee, made up of Eugene Braig, Earl Chilton, John Navarro, Anthony Sasson, and Jennifer Windus meet several time to discuss additional species the should be added to Ohio's prohibited plant list. Although many other species were considered by late summer emerged around species that could be the most problematic, and the easiest to get listed.

By September 13 the list was sent to the Ohio Department of Agriculture.

Species sent to ODA for consideration.

September 13, 2018

1. Pinnate mosquitofern, *Azolla pinnata*
2. Anchored water hyacinth, *Eichhornia azurea*
3. Indian swampweed, *Hygrophila polysperma*
4. Yellow flag iris, *Iris pseudacorus*
5. African oxygen weed, *Lagarosiphon major*
6. Asian marshweed, *Limnophila sessiliflora*
7. European water-clover, *Marsilea quadrifolia*
8. Arrowleaf false pickerelweed, *Monochoria hastata*
9. Heartshape false pickerelweed, *Monochoria vaginalis*

Species sent to ODA for consideration.

September 13, 2018

10. Brittle waternymph, *Najas minor*
11. Duck lettuce, *Ottelia alismoides*
12. Water lettuce, *Pistia stratiotes*
13. Arrowhead, *Sagittaria sagittifolia*
14. Crack willow, *Salix fragilis*
15. Common salvinia, *Salvinia minima*
16. Giant salvinia, *Salvinia molesta*
17. Simple bur-reed, *Sparganium erectum*
18. Water soldier, *Stratiotes aloides*

Domestication & Cultivation

Question Number	Question	Answer	Score
1.01	Is the species highly domesticated?	No	0
1.02	Has the species become naturalized where grown?		
1.03	Does the species have weedy races?		

Climate and Distribution

2.01	Species suited to target region?	Yes	2	Percentage of Climatch score 6-10 to overall scores = 0.14. <i>Azolla pinnata</i> is locally distributed in its native range of Africa and Madagascar, India, Southeast Asia, China and Japan, Malaysia and the Philippines, the New Guinea mainland and Australia. theazollafoundation.org
2.02	Quality of climate match?	Good	2	Mean maximum temperature (°C) 14-35; Mean minimum temperature of coldest (°C) 12-29. cabi.org
2.03	Broad climate suitability?	Yes	1	Growth occurs all year round in tropical and sub-tropical areas
2.04	Native or naturalized in areas with similar climate?	No	0	The native ranges of the three subspecies is given as tropical Africa, southern Africa and Madagascar for subsp. <i>africana</i> ; tropical Asia, China and Japan for subsp. <i>asiatica</i> ; and Australia and New Caledonia for subsp. <i>pinnata</i> . cabi.org
2.05	Does the species have a history of repeated introductions outside its native range?	Yes	0	

Climatch

(A computerized climate match program)

Source Region

Target Region

Select Stations

Map Navigation

Select Stations

Deselect Stations

Data Set

World Stations

Run Match

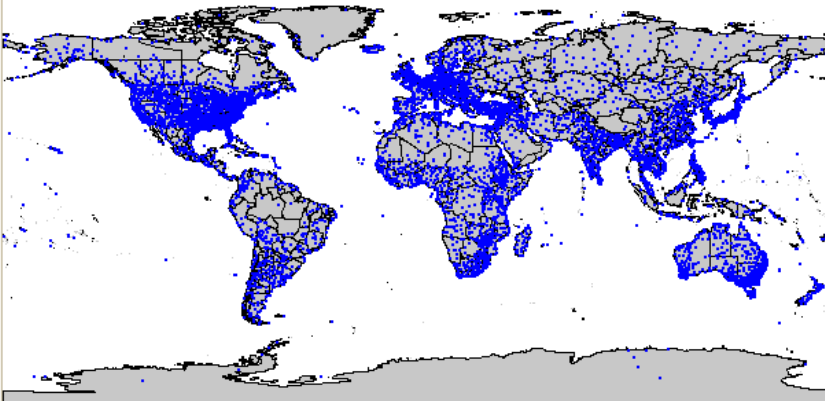
Station Selection: Rectangle

> Drag a rectangle to select a group of points

> Left click to select a single point

> Right click to deselect a single point

Source Map



Climatch v0.8

Invasive Animals CRC

Bureau of Rural Sciences 2008

Selected Stations

Source: 0

Target: 2785

i

Use the ZOOM and PAN buttons to focus on the area of the map that you are interested in.

The RECTANGLE and POLYGON tools allow you to select (and deselect) stations to be used in a match.

Source Region

Target Region

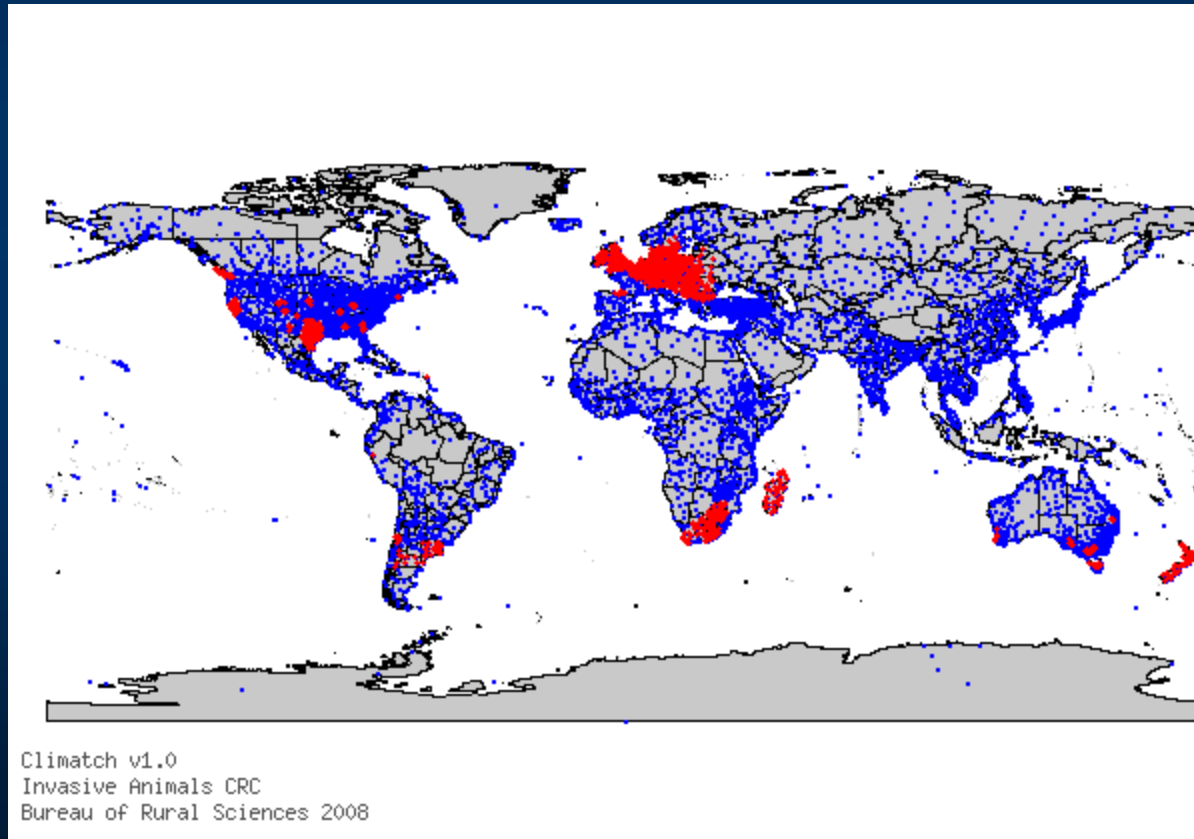
You can select stations to define both a SOURCE and a TARGET region. The default target region is Australia.

Once you have defined source and target regions, click on the RUN MATCH button to compare the regions.

You can change the match settings if you wish.

Climatch

(A computerized climate match program)



Climatch

Match Settings:

Species:

unspecified

Algorithm:

☒ Euclidean ☐ Closest Standard Score

Variables:

- ☒ Annual Mean Temperature
- ☒ Temp - coldest month
- ☒ Temp - warmest month
- ☒ Annual temperature range
- ☒ Temp - coldest quarter
- ☒ Temp - warmest quarter
- ☒ Temp - wettest quarter
- ☒ Temp - driest quarter

- ☒ Mean annual rainfall
- ☒ Rainfall - wettest month
- ☒ Rainfall - driest month
- ☒ Coefficient of variation - rain
- ☒ Rainfall - wettest quarter
- ☒ Rainfall - driest quarter
- ☒ Rainfall - coolest quarter
- ☒ Rainfall - warmest quarter

OK

Cancel

Climatch

Source Region
Target Region

Results

Species: unspecified

Score	Colour	Count
0	Blue	89
1	Cyan	580
2	Green	940
3	Light Green	422
4	Yellow-Green	315
5	Yellow	302
6	Orange-Yellow	107
7	Orange	21
8	Red-Orange	9
9	Red	0
10	Brown	0

[Save scores as .csv](#)



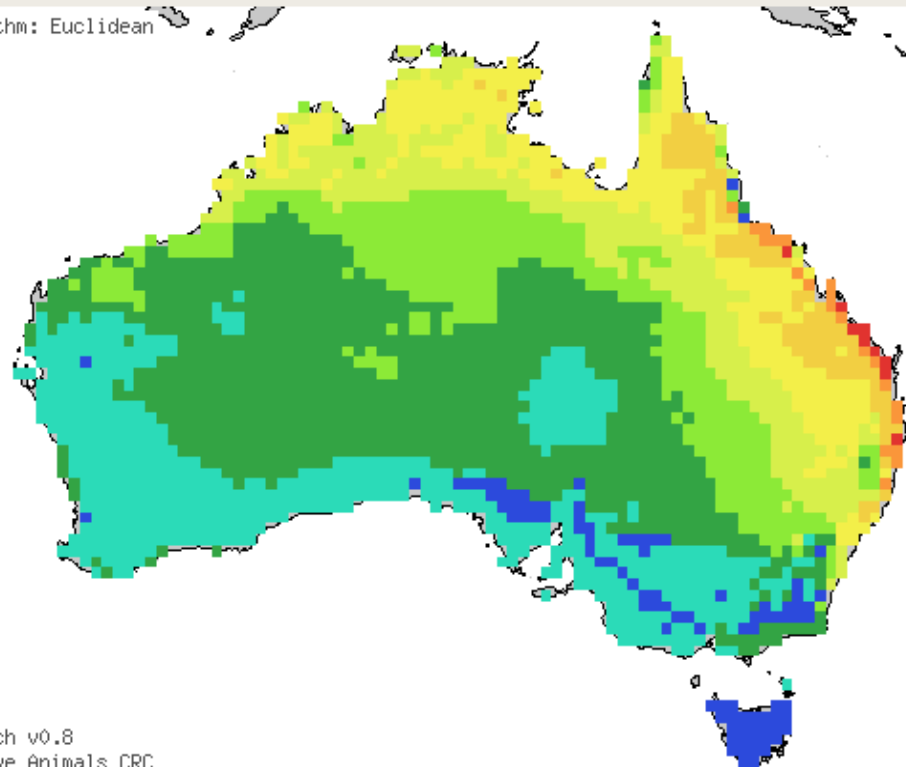
CLEAR
MATCH

Clear Match

Clear the current match results and return to station-select mode.

Target Map

Algorithm: Euclidean



- 8
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10



[Go to tutorial](#)

This map shows the strength of the climate match in the Target region. High scores indicate very similar climate.

You can save this map as an image or in a plain-text format, using the buttons at the bottom of the screen



The CLEAR MATCH button will return you to station selection mode where you can add and remove stations from the match.



CLEAR
MATCH

Climatch v0.8
Invasive Animals CRC
Bureau of Rural Sciences 2008



Selected Stations

Source:

85

Target:

2785

Approximate area: 100,695 sq.km

Climatch



Mike Hoff (right), the Midwest Region's Aquatic Invasives Species Program Coordinator

Climatch

Climate 6 Scores

with Hoff's Risk Categories, and Proportion of actually established populations (in 10 Countries, N=255 populations) that would have been rejected

Proportion of CLIMATE Scores 6-10 to total Climate Scores	Hoff's Risk Category
0.0-0.005 (95% of established species rejected)	L
0.005>X≤0.103 (80% of established species rejected)	M
>0.103	H

Weed History

3.01	Naturalized beyond native range?	Yes	2	Absolute minimum temperature (°C) 4 cabi.org
3.02	Garden/amenity/disturbance weed?	Yes	2	Azolla pinnata can spread very quickly forming dense vegetative masses on areas of still water. cabi.org
3.03	Recreational weed?	No	0	Nowhere in the continental U.S. is there much impact on recreation
3.04	Environmental weed?	No	0	Nowhere in the continental U.S. is there much impact on environmental processes
3.05	Congeneric weed?	Yes	2	Azolla spp. A. caroliniana is a weed in Europe

Undesirable Traits

4.01	Produces spines, thorns or burrs?	No	0	During the summer months, numerous spherical structures called sporocarps form on the undersides of the branches. en.wikipedia.org
4.02	Allelopathic?	Yes	1	Allelopathic Effects Produces deoxyanthocyanins which act as feeding deterrents to mollusks dnr.wi.gov
4.03	Parasitic?	No	0	
4.04	Unpalatable to fish and wildlife?	No	-1	In its native range, provides a food source and habitat for waterfowl, fish, shrimp, insects, worms, snails and crustaceans dnr.wi.gov
4.05	Toxic to animals?	No	0	Grass carp eat it
4.06	Host for pests and pathogens?	No	0	macroinvertebrate density (zooplankton) and phytoplankton decreases significantly dnr.wi.gov
4.07	Causes allergies or toxic to humans?	No	0	Azolla is not harmful to stock that drink the water or consume the plant. Nor does azolla have a harmful effect on domestic house and garden water. agriculture.vic.gov.au
4.08	Creates flood or fire hazard?	No	0	Under optimum conditions, azolla's growth spreads across the dam surface until it covers the surface of the water in a dense cover. Dnr.wi.gov
4.09	Is shade tolerant?	No	0	Minimised sunlight on the dam by planting native vegetation on the north and west sides of the dam will negatively affect the plant. agriculture.vic.gov.au
4.1	Grows in infertile soil or oligotrophic water?	No	0	In addition to its traditional cultivation as a bio-fertilizer for wetland paddy (due to its ability to fix nitrogen) agriculture.vic.gov.au
4.11	Climbing or smothering growth habit?	No	0	Dense surface growth decreases dissolved oxygen concentration and light penetration, block pump inlets and filters, and Impede flow where plants bank up at structures. cabi.org
4.12	Forms dense thickets or mats?	Yes	1	Can form dense mats, interfering with boating, fishing and swimming. Dense surface growth is unsightly and inhibits recreation, clogs irrigation pumps and impedes water flow cabi.org

Plant type

5.01	Aquatic?	Yes	1	Azolla is a native aquatic plant found in still or slow-moving water bodies. agriculture.vic.gov.au
5.02	Grass?	No	0	It is an aquatic plant, its frond floating upon the surface of the water. plants.ifas.ufl.edu
5.03	Nitrogen fixer?	Yes	1	The leaves contain the cyanobacterium, which is a symbiont that fixes nitrogen from the atmosphere cabi.org
5.04	Geophyte?	No	0	A water plant and exists in water surfaces. plants.ifas.ufl.edu

Reproduction

6.01	Evidence of substantial reproductive failure in native habitat?	No	0	<i>A. Pinnata</i> can spread very quickly forming dense vegetative masses. plants.ifas.ufl.edu
6.02	Produces viable propagules?	Yes	1	Leaves fleshy and green with chlorophyll and have a cavity specialized for harboring the cyanobacterium, <i>Anabaena azollae</i> , famous for its symbiotic relationship in providing nitrogen to its ferny host theazollafoundation.org
6.03	Hybridizes naturally?	No	-1	Hybridization with other species is lacking. agriculture.vic.gov.au
6.04	Self-compatible or apomictic?	No	-1	Can reproduce asexually dnr.wi.gov
6.05	Requires special pollinators?	No	-1	Produces sporocarps dnr.wi.gov dnr.wi.gov
6.06	Reproduction by vegetative fragmentation?	Yes	1	The most important sort of reproduction is vegetative fragmentation. plants.ifas.ufl.edu
6.07	Minimum generative time		1	Can be viable for more than a year

Dispersal Mechanisms

7.01	Propagules are likely to be dispersed unintentionally?	Yes	1	'Hitchhiker' with aquaria plants; wind, water, humans; transport of cattle dnr.wi.gov
7.02	Propagules dispersed intentionally by people?	Yes	1	Aquarium trade; agricultural fertilizer; nutrient and heavy metal effluent treatment dnr.wi.gov
7.03	Propagules likely to disperse as a produce contaminant?	Yes	1	To some areas it was likely introduced by someone emptying their aquarium into a natural waterbody plants.ifas.ufl.edu
7.04	Adapted to wind dispersal?	No	-1	Viable only in water
7.05	Adapted to water dispersal?	Yes	1	Vegetative fragments and spores can spread easily downstream, and be carried with floodwaters to colonize new areas. cabi.org
7.06	Adapted to bird dispersal?	unknown	0	
7.07	Adapted to dispersal by animals?	Yes	1	It is thought to have been spread in New Guinea with cattle between drinking ponds (Croft, 1986).
7.08	Propagules survive through gut passage?	No	-1	ex. response 7.07

Persistence Attributes

8.01	Prolific (>2,000) propagules/m2)?	Yes	1	Divide vegetatively, with doubling possible every 3 days, leading to very rapid growth rates and colonization of new lakes and ponds. theazollafoundation.org
8.02	Persistent propagule bank formation?	No	-1	Very persistent. Under ideal conditions can double in area every 4-5 days. keys.lucidcentral.org
8.03	Well controlled by herbicides?	Yes	-1	Some chemicals are available to help control azolla
8.04	Tolerates or benefits from disturbance?	No	-1	Lack of sunlight is intolerable; the droung of a lake/pond would cause death in a few hours. theazollafoundation.org
8.05	Effective natural enemies present?	Yes	1	<i>Elophila africalis</i> (moth), <i>Paulinia acuminata</i> (grasshopper). <i>Rhizoctonia solan</i> ; <i>Sclerotium rolfsii</i> dnr.wi.org
	Total score:		12	

Typically, a score above 6 indicates that a plant is a high risk and should be rejected (not allowed in the area of concern), a score of less than 1 indicates a low-risk species, and a score between 1 and 6 indicates that further evaluation is necessary to determine risk.

***Azolla pinnata* (Pinnate mosquitofern)**

WRA Score = 12

Worldwide Distribution

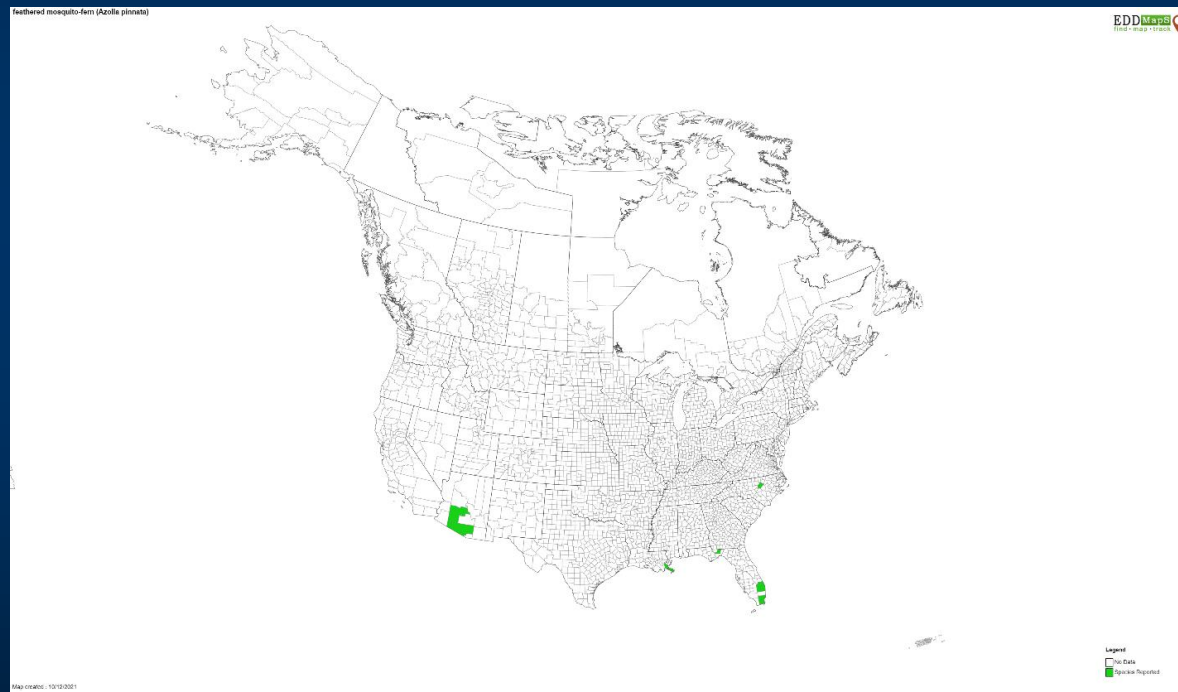


Worldwide distribution of *Azolla pinnata*. Data from
Plantsoftheworldonline.org (Accessed October 2021)

Azolla pinnata (Pinnate mosquitofern)

WRA Score = 12

North American Distribution



North American distribution of *Azolla pinnata*. Data from eddmaps.org (Accessed October 2021).

Eichhornia azurea (Rooted water hyacinth, anchored water hyacinth)

WRA Score = 23

Worldwide Distribution

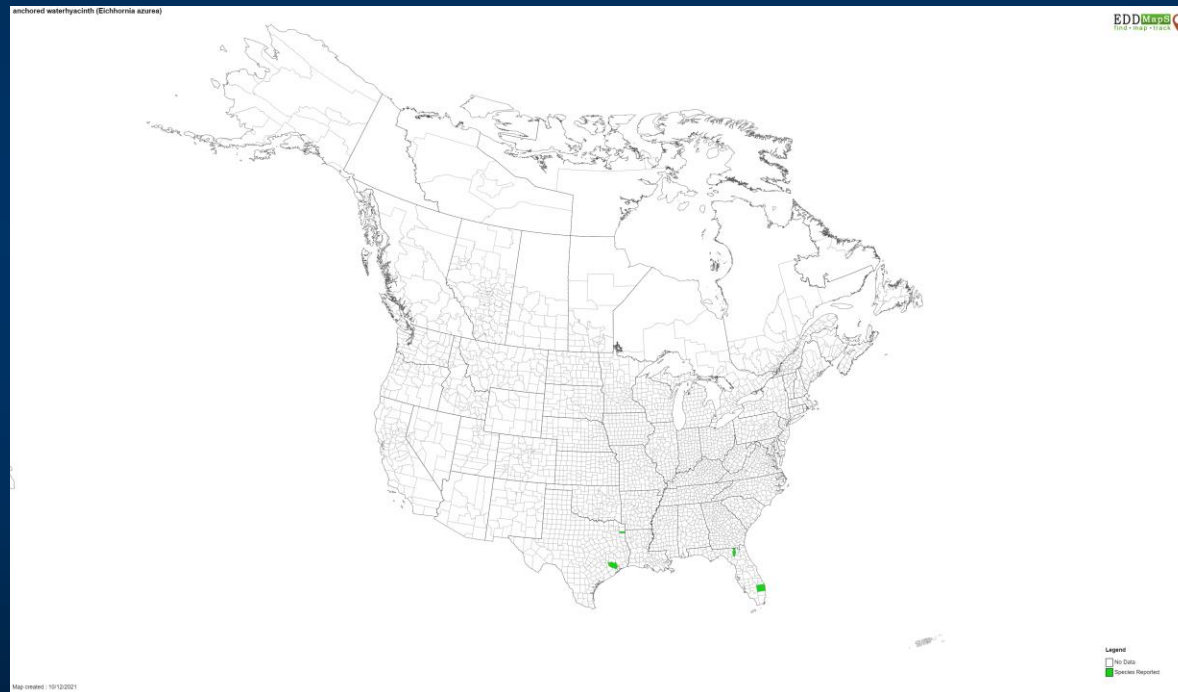


Worldwide distribution of *Eichhornia azurea*. Data from Plantsoftheworldonline.org (Accessed October 2021)

Eichhornia azurea (Rooted water hyacinth, anchored water hyacinth)

WRA Score = 23

North American Distribution

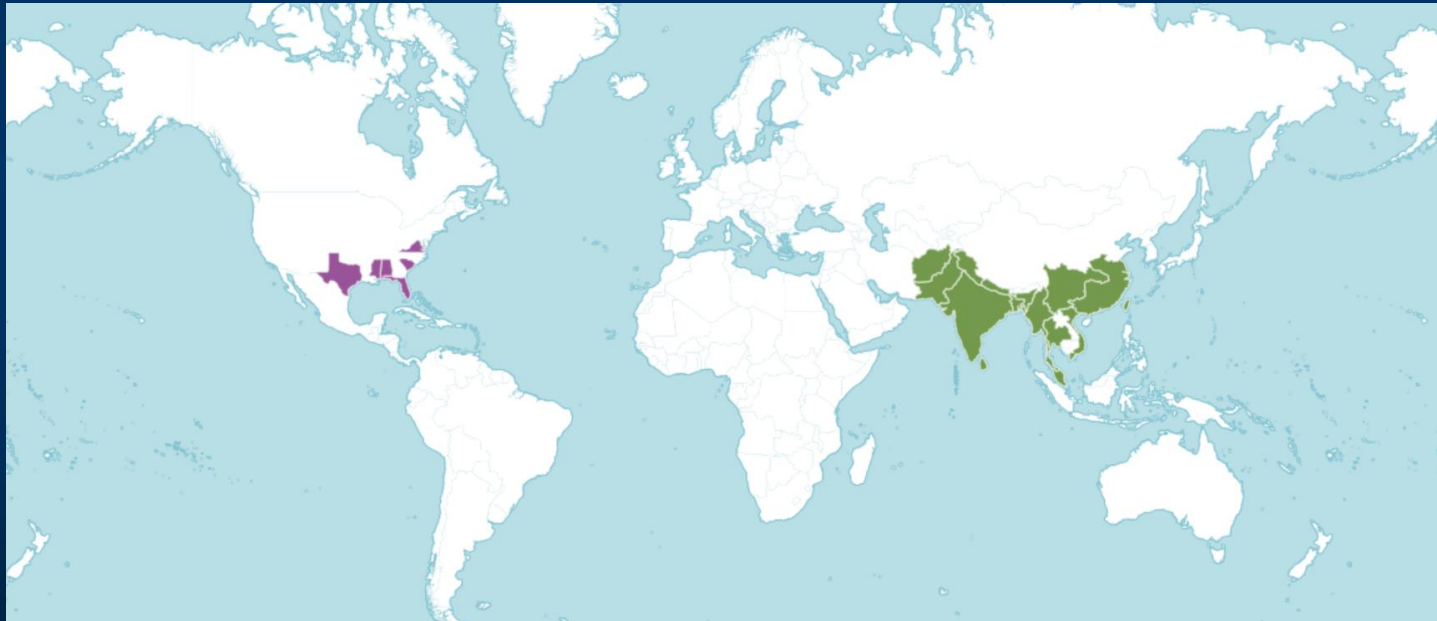


North American distribution of *Eichhornia azuea*. Data from eddmmaps.org (Accessed October 2021).

Hygrophila Polysperma (Indian Swamp Weed)

WRA Score = 21

Worldwide Distribution

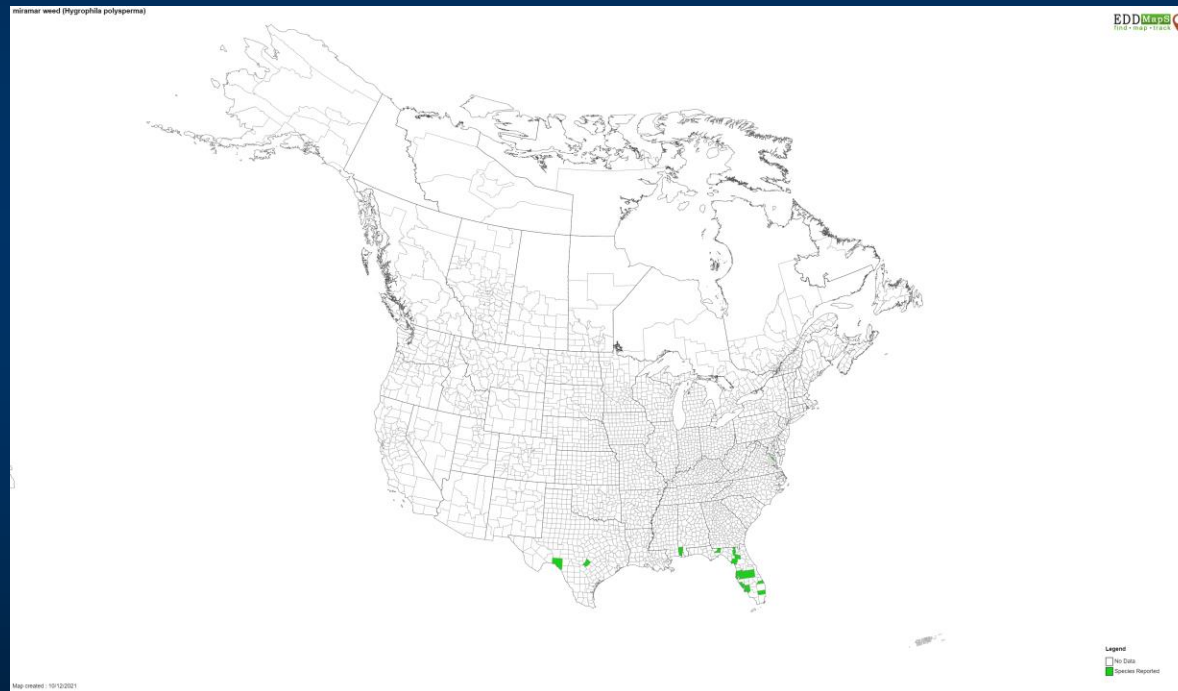


Worldwide distribution of *Hygrophila polysperma*. Data from Plantsoftheworldonline.org (Accessed February 2021)

Hygrophila Polysperma (Indian Swamp Weed)

WRA Score = 21

North American Distribution



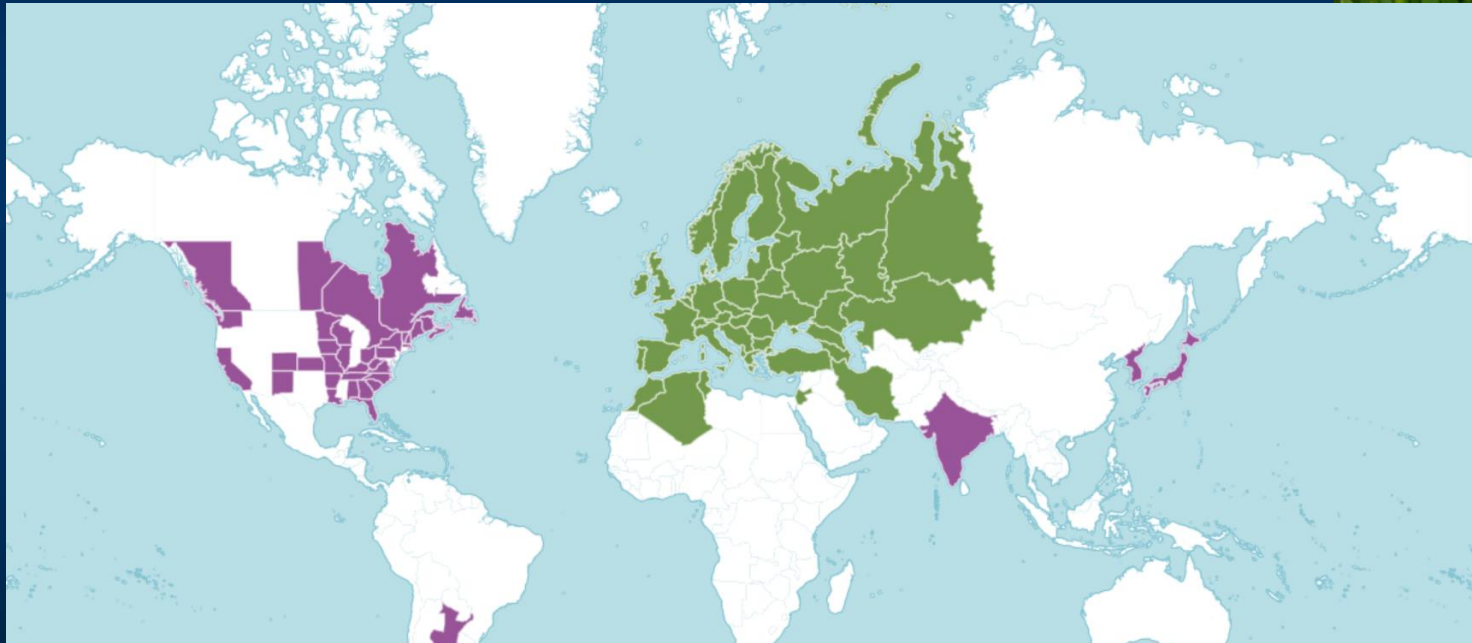
North American distribution of *Hygrophila polysperma*. Data from eddmaps.org (Accessed October 2021).

Iris pseudacorus (Yellow Iris)

WRA Score = 28



Worldwide Distribution

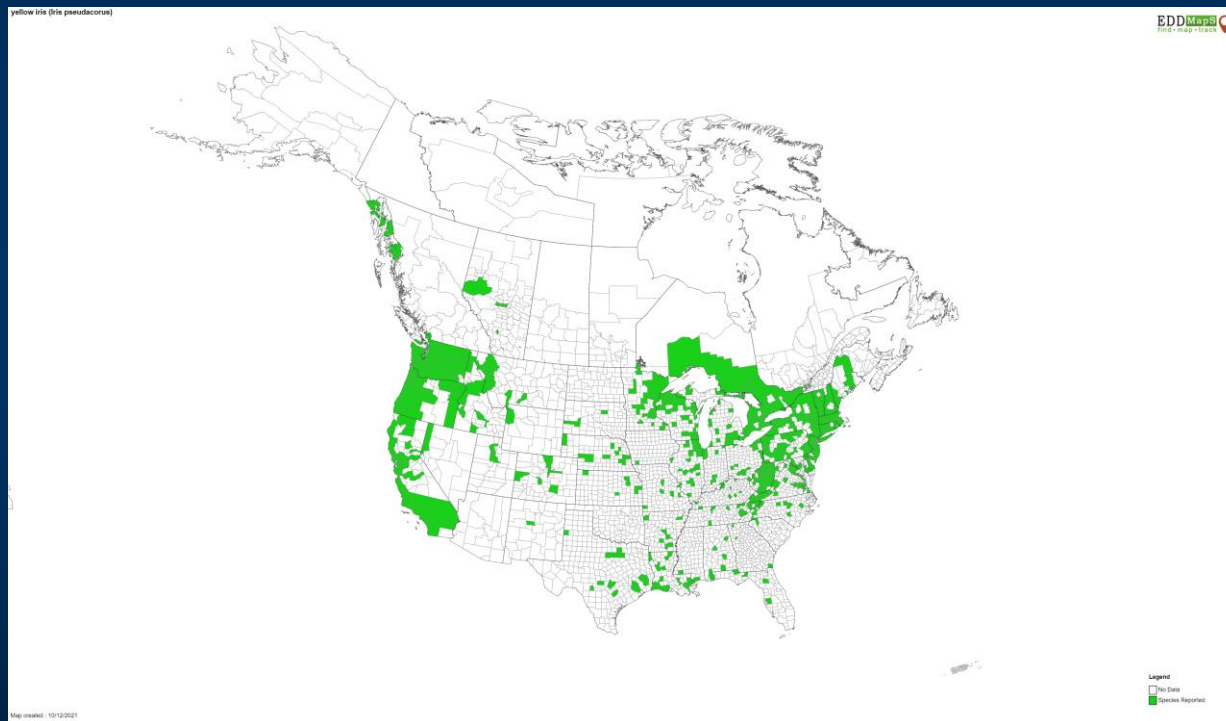


Worldwide distribution of *Iris pseudacorus*. Data from Plantsoftheworldonline.org (Accessed February 2021)

Iris pseudacorus (Yellow Iris)

WRA Score = 28

North American Distribution

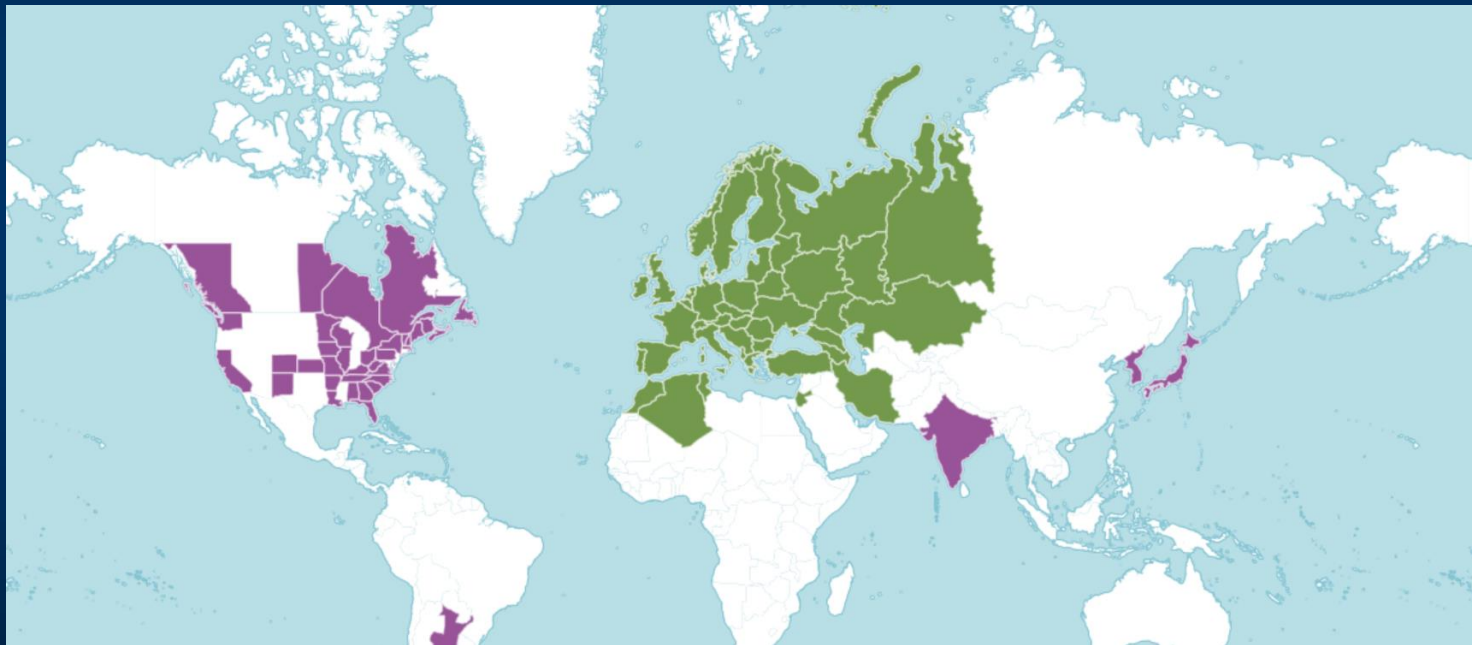


North American distribution of *Iris pseudocorus*. Data from eddmmaps.org (Accessed October 2021).

Lagarosiphon major (African Oxygen Weed)

WRA Score = 8

Worldwide Distribution



Worldwide distribution of *Iris pseudocorus*. Data from
Plantsoftheworldonline.org (Accessed March 2021)

***Lagarosiphon major* (African Oxygen
Weed)**

WRA Score = 8

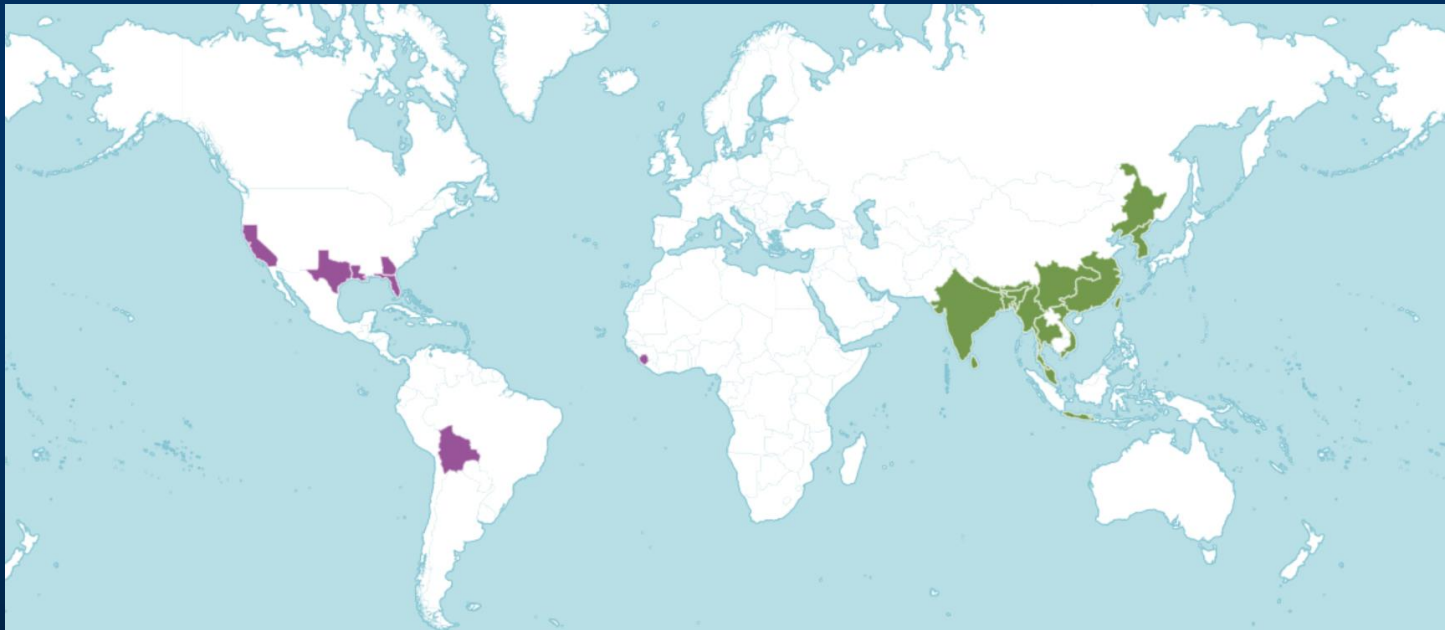
Not found in North American

Limnophila sessiliflora (Asian marshweed)

WRA Score = 14



Worldwide Distribution

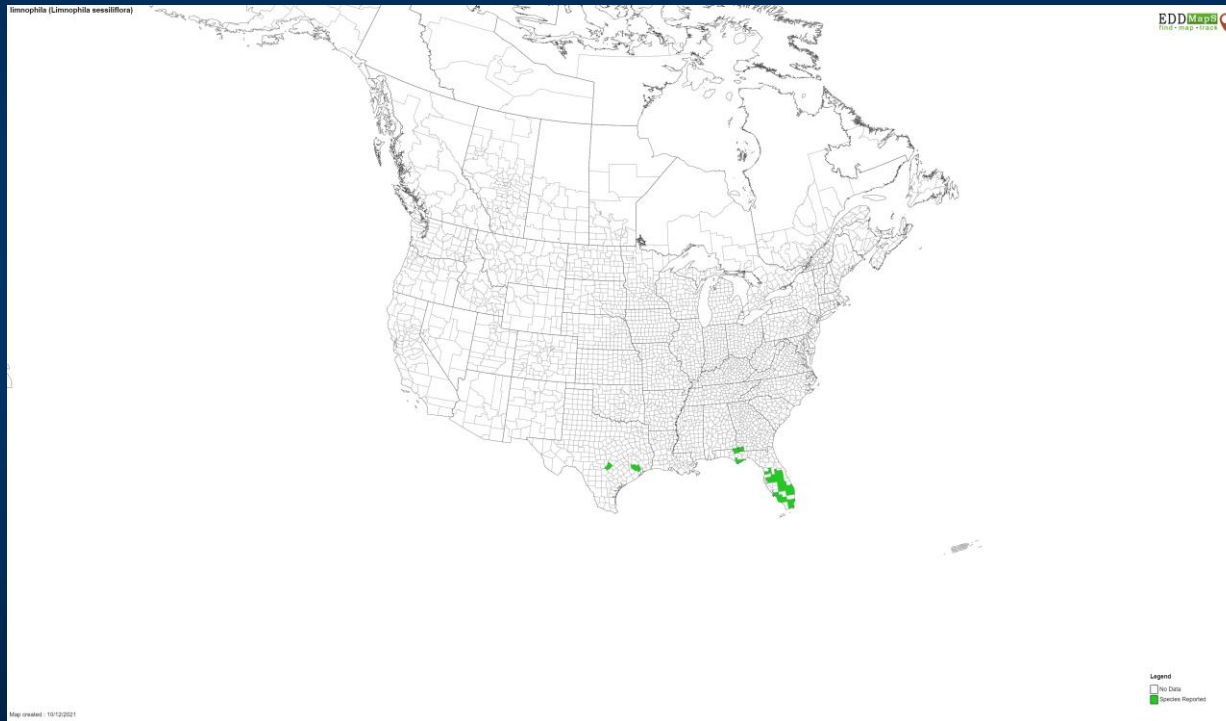


Worldwide distribution of *Limnophila sessiliflora*. Data from
Plantsoftheworldonline.org (Accessed October 2020)

Limnophila sessiliflora (Asian marshweed)

WRA Score = 14

North American Distribution



North American distribution of *Limnophila sessiliflora*. Data from eddmaps.org (Accessed October 2021).

***Marsilea quadrifolia* (European waterclover, Water shamrock, Pepperwort, Four-leaf clover)**

WRA = 20



Worldwide Distribution

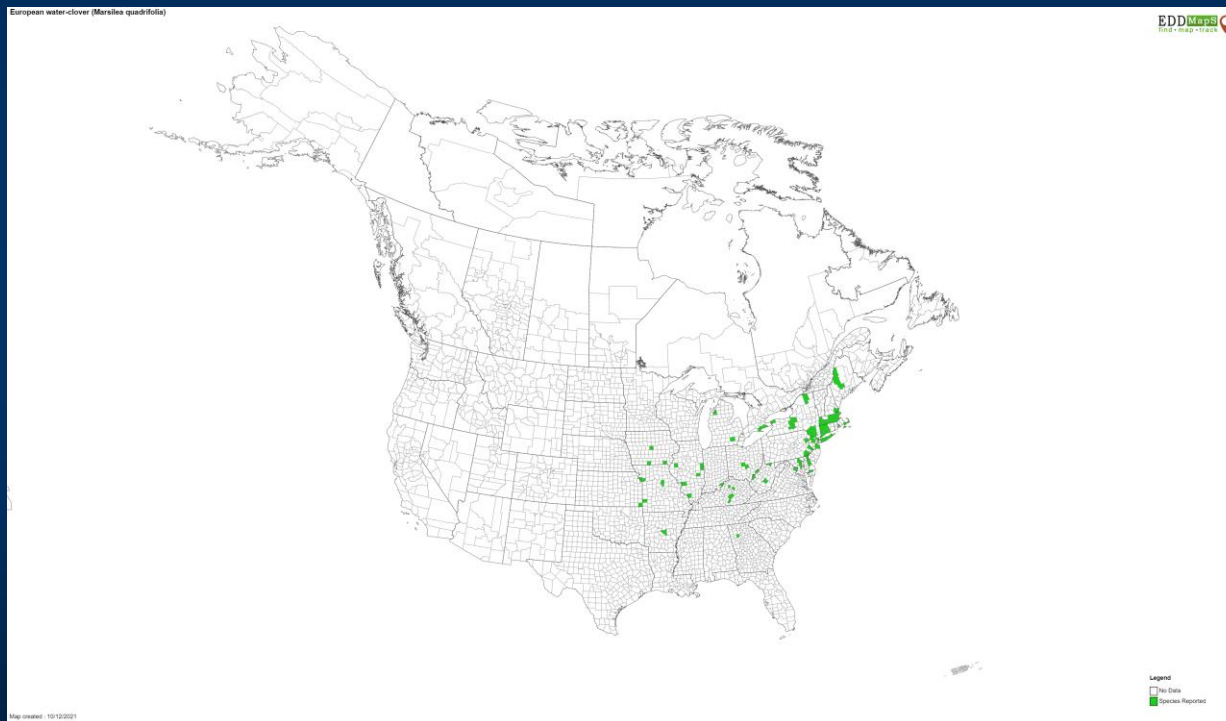


Worldwide distribution of *Marsilea quadrifolia*. Data from Plantsoftheworldonline.org (Accessed October 2021)

Marsilea quadrifolia (European waterclover, Water shamrock, Pepperwort, Four-leaf clover)

WRA = 20

North American Distribution



North American distribution of *Marsilea quadrifolia*. Data from eddmaps.org (Accessed October 2021).

***Monochoria hastata* (monochoria, arrow-leaf monochoria, hastate-leaf pondweed)**

WRA = 14

Worldwide Distribution



Worldwide distribution of *Monochoria hastata*. Data from
Plantsoftheworldonline.org (Accessed November 2021)

***Monochoria hastata* (monochoria, arrow-leaf
monochoria, hastate-leaf pondweed)**

WRA = 14

Not yet found in North American

***Monochoria vaginalis* (pickerel weed, heart-shaped false pickerel weed)**

WRA = 15

Worldwide Distribution

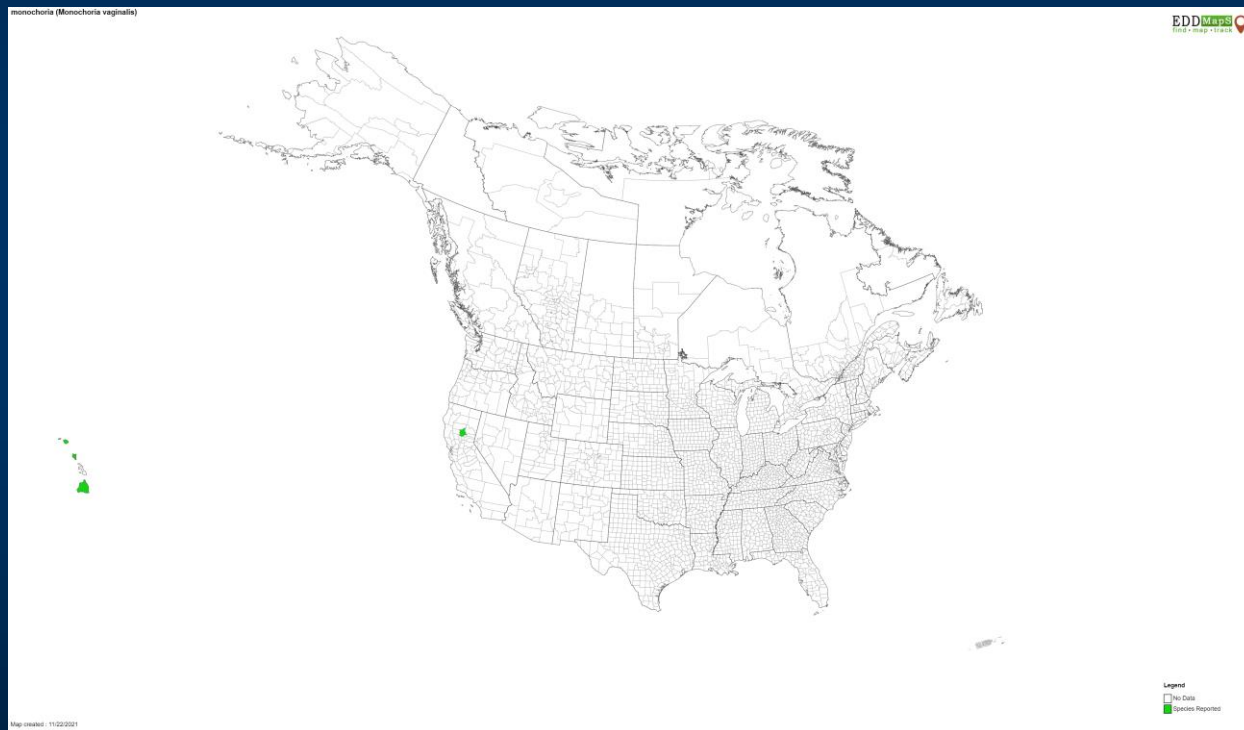


Worldwide distribution of *Monochoria vaginalis*. Data from Plantsoftheworldonline.org (Accessed November 2021)

Monochoria vaginalis (pickerel weed, heart-shaped false pickerel weed)

WRA = 15

North American Distribution

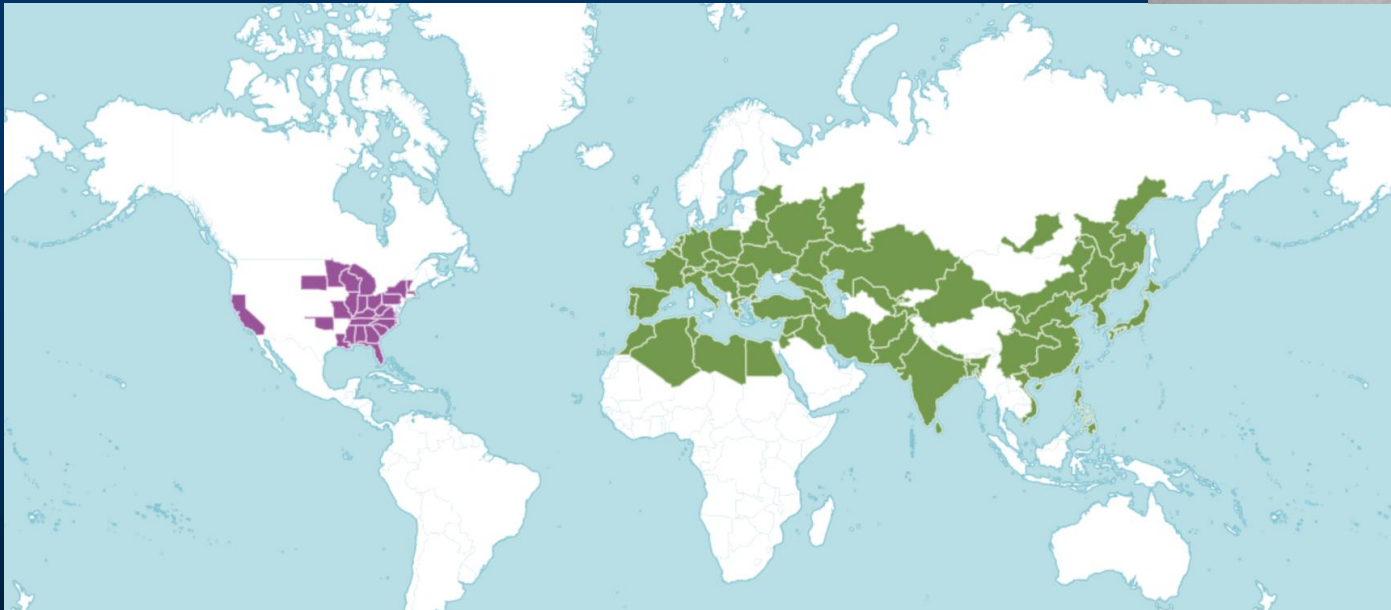


North American distribution of *Monochoria vaginalis*. Data from eddmaps.org (Accessed November 2021).

Najas minor (Brittle waternymph, minor naiad, brittle water-nymph; brittle naiad, brittle-leaf naiad, European naiad, slender naiad, bushy naiad, *lesser naiad*)

WRA = 26

Worldwide Distribution

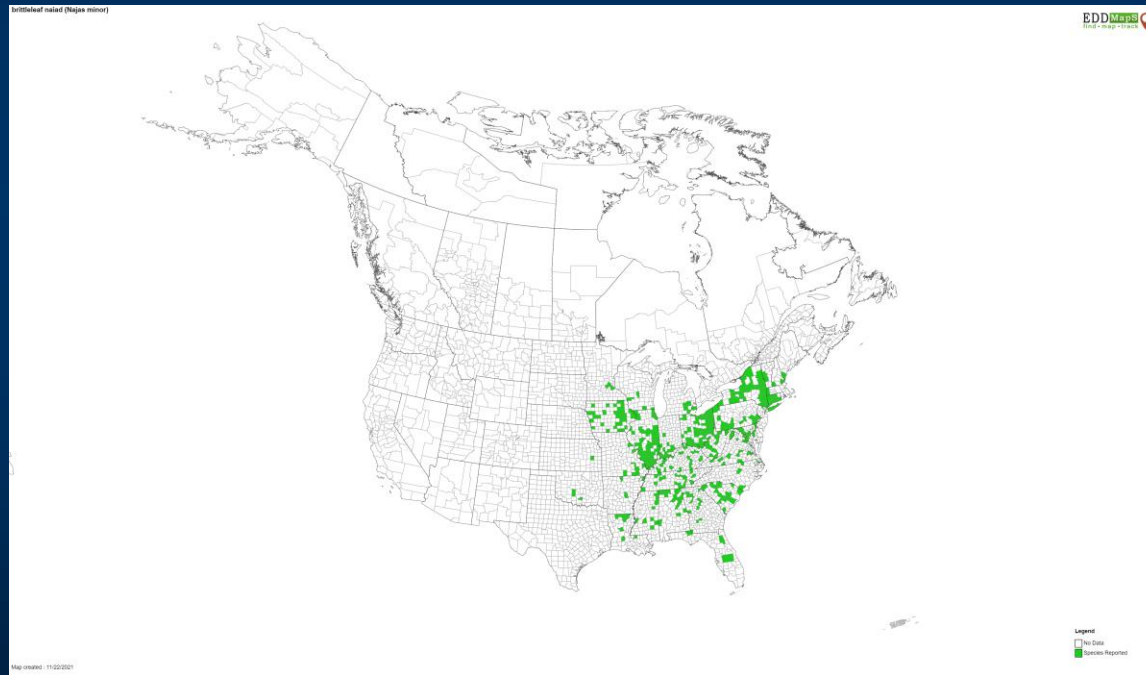


Worldwide distribution of *Najas minor*. Data from
Plantsoftheworldonline.org (Accessed November 2021)

***Najas minor* (Brittle waternymph, minor naiad, brittle water-nymph; brittle naiad, brittle-leaf naiad, European naiad, slender naiad, bushy naiad, *lesser naiad*)**

WRA = 26

North American Distribution

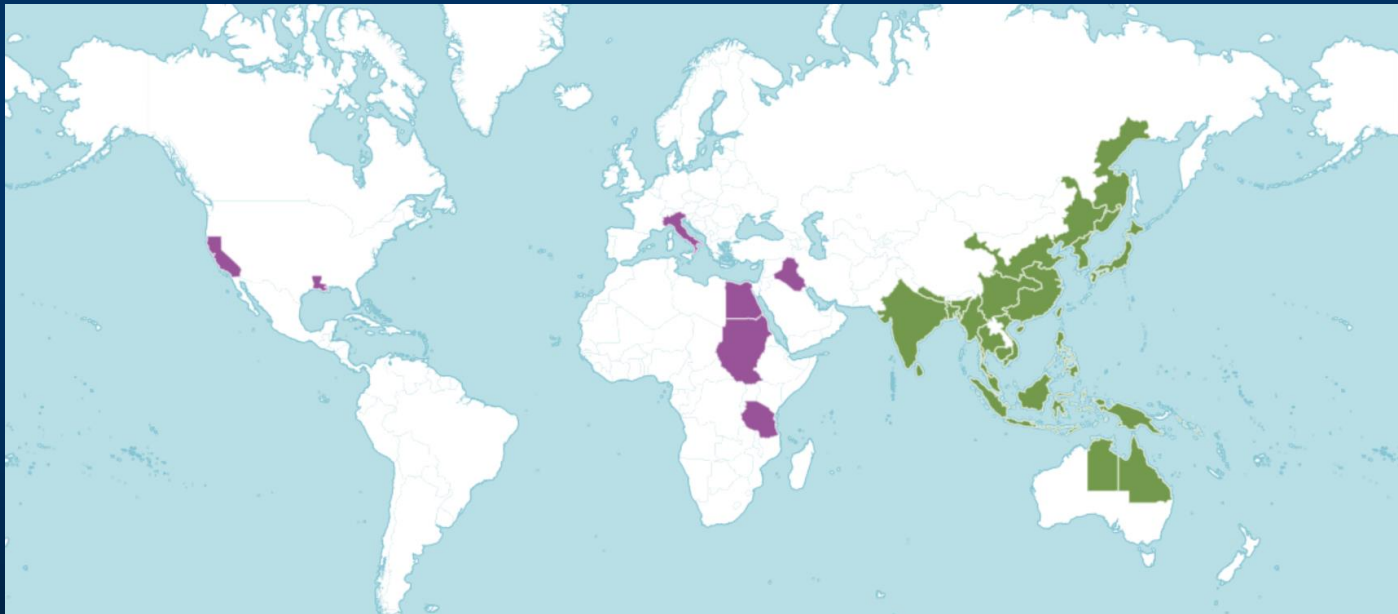


North American distribution of *Najas minor*. Data from eddmaps.org (Accessed November 2021).

Ottelia alismoides (Duck lettuce)

WRA = 8

Worldwide Distribution

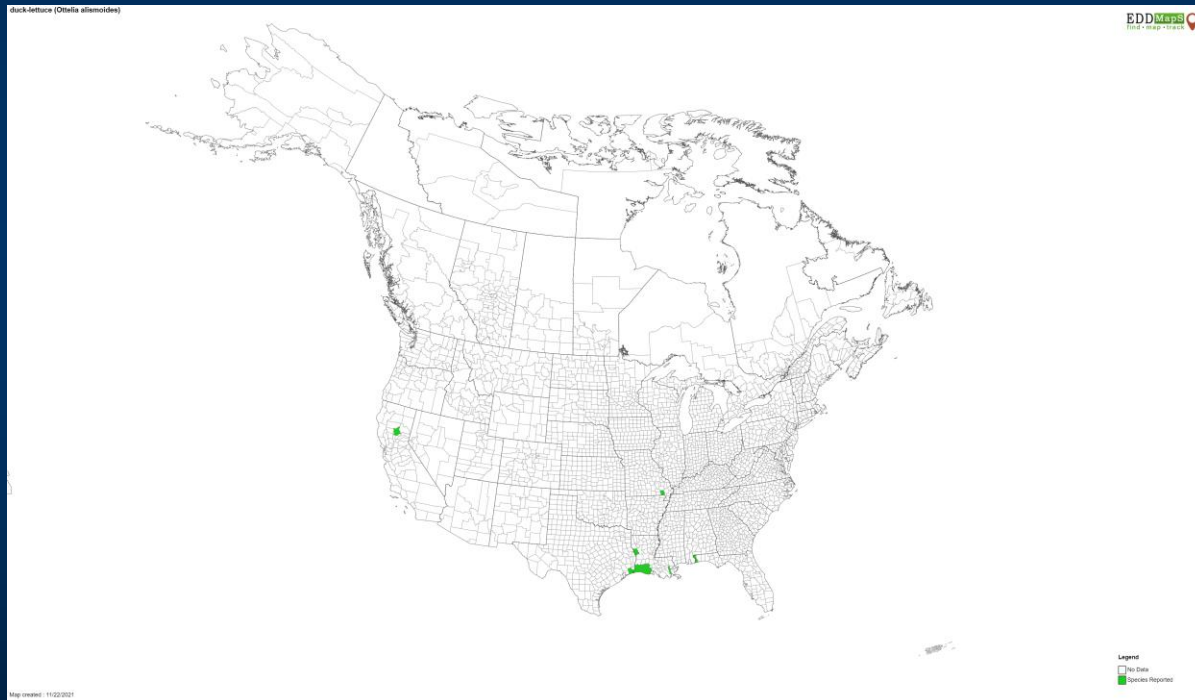


Worldwide distribution of *Ottelia alismoides*. Data from Plantsoftheworldonline.org (Accessed November 2021)

Ottelia alismoides (Duck lettuce)

WRA = 8

North American Distribution

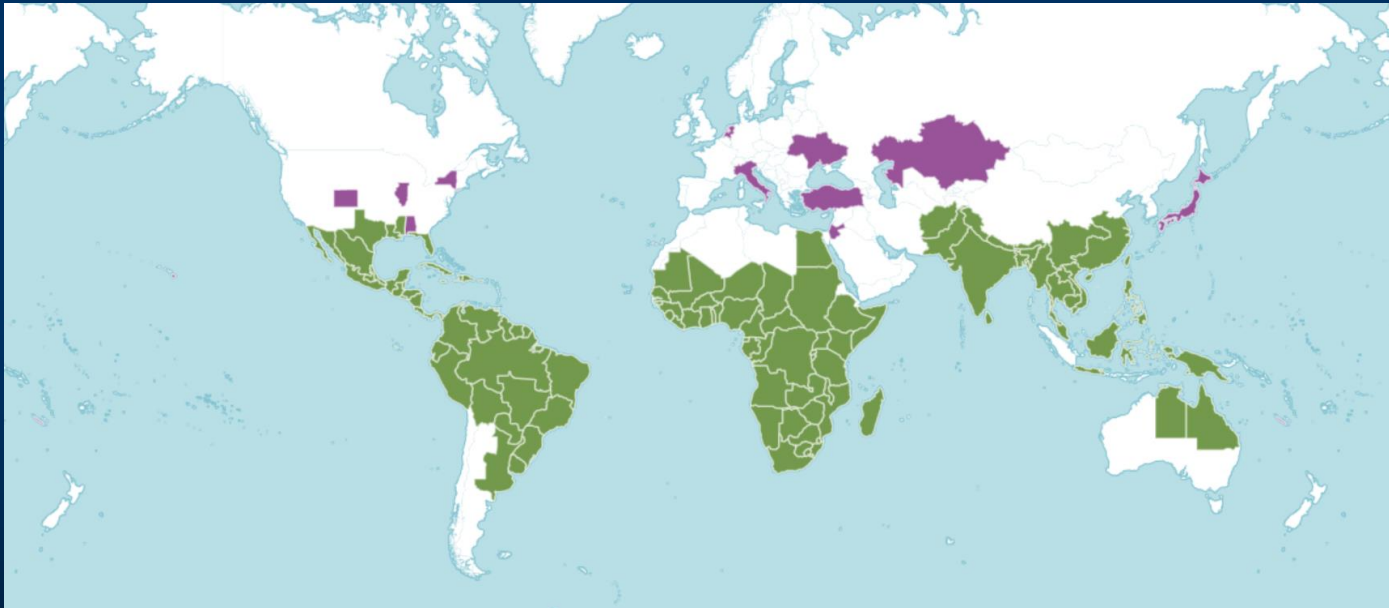


North American distribution of *Ottelia alismoides*. Data from eddmaps.org (Accessed November 2021).

Pistia stratiotes (Water lettuce)

WRA = 25

Worldwide Distribution

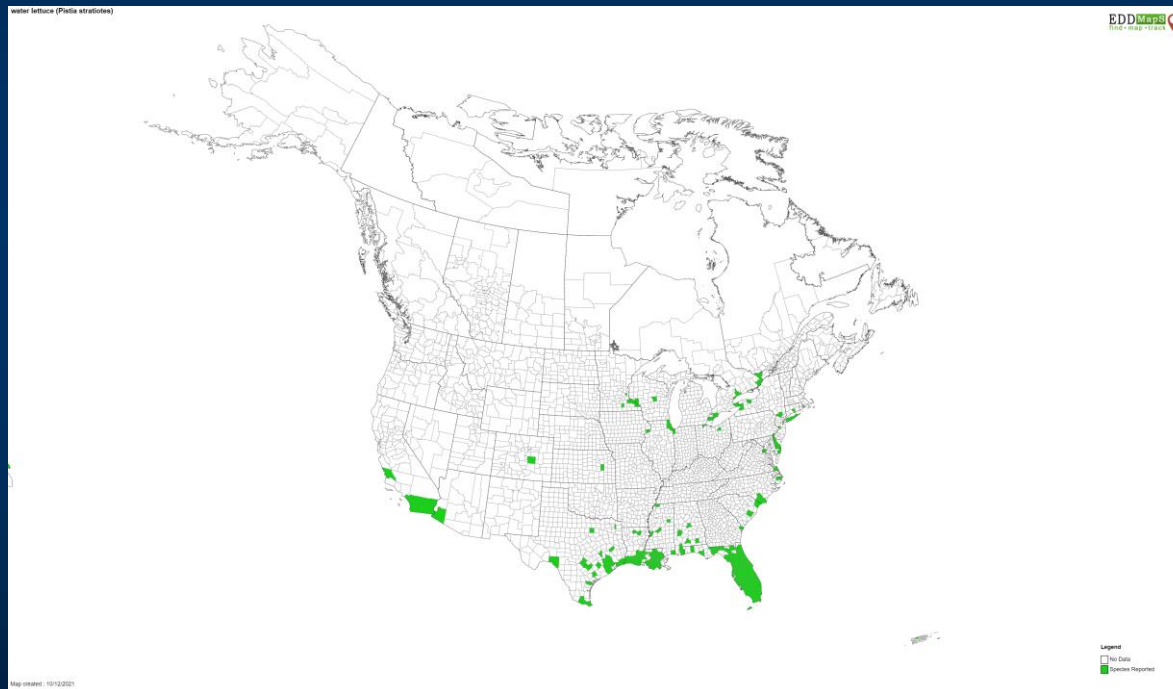


Worldwide distribution of *Pistia stratiotes*. Data from Plantsoftheworldonline.org (Accessed February 2021)

Pistia stratiotes (Water lettuce)

WRA = 25

North American Distribution



North American distribution of *Pistia stratiotes*. Data from eddmaps.org (Accessed October 2021).

Sagittaria sagittifolia (Arrowhead)

WRA = 36

Worldwide Distribution

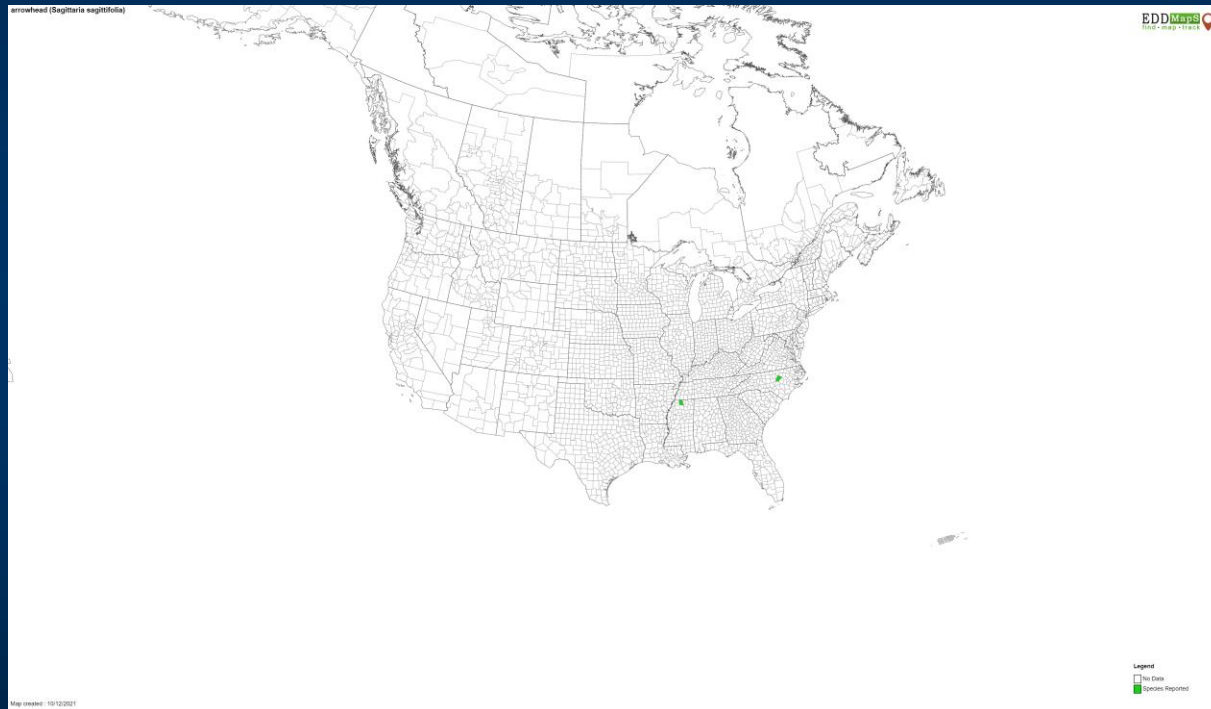


Worldwide distribution of *Sagittaria sagittifolia*. Red indicates the plant has been extirpated. Orange indicates the identification was doubtful. Data from [Plantsoftheworldonline.org](https://www.plantsoftheworldonline.org) (Accessed August 2021)

Sagittaria sagittifolia (Arrowhead)

WRA = 36

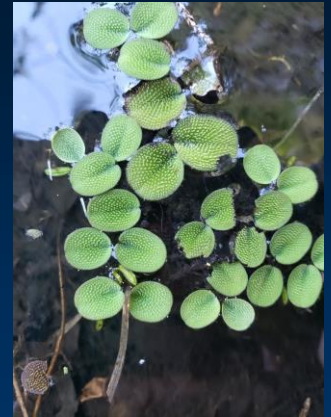
North American Distribution



North American distribution of *Pistia stratiotes*. Data from eddmmaps.org (Accessed October 2021). One source indicates it was present in Ohio as early as 1881

Salvinia minima (water spangles, common salvinia)

WRA = 19



Worldwide Distribution

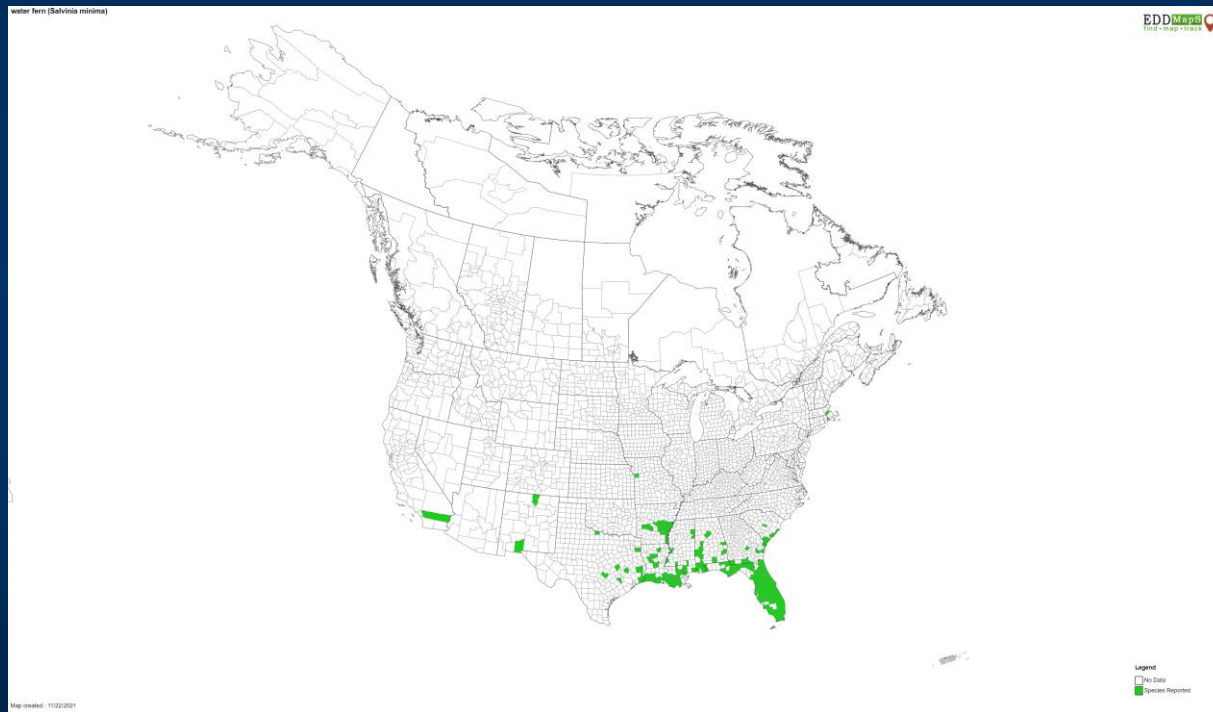


Worldwide distribution of *Salvinia minima*. Data from
Plantsoftheworldonline.org (Accessed August 2021)

Salvinia minima (water spangles, common salvinia)

WRA = 19

North American Distribution

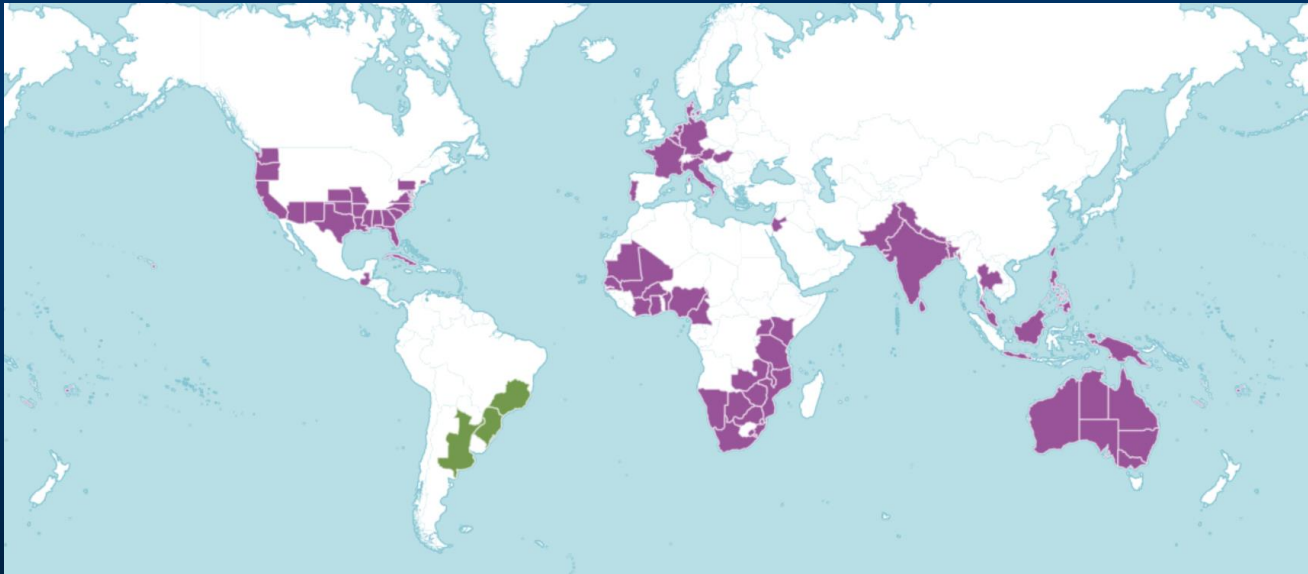


North American distribution of *Salvinia minima*. Data from eddmmaps.org (Accessed October 2021). One source indicates it was present in Ohio as early as 1881

***Salvinia molesta* (giant salvinia, aquatic watermoss, kariba weed, African pyle, Koi kandy, Australian azolla, waterfern, water spangles, giant azolla)**

WRA = 20

Worldwide Distribution

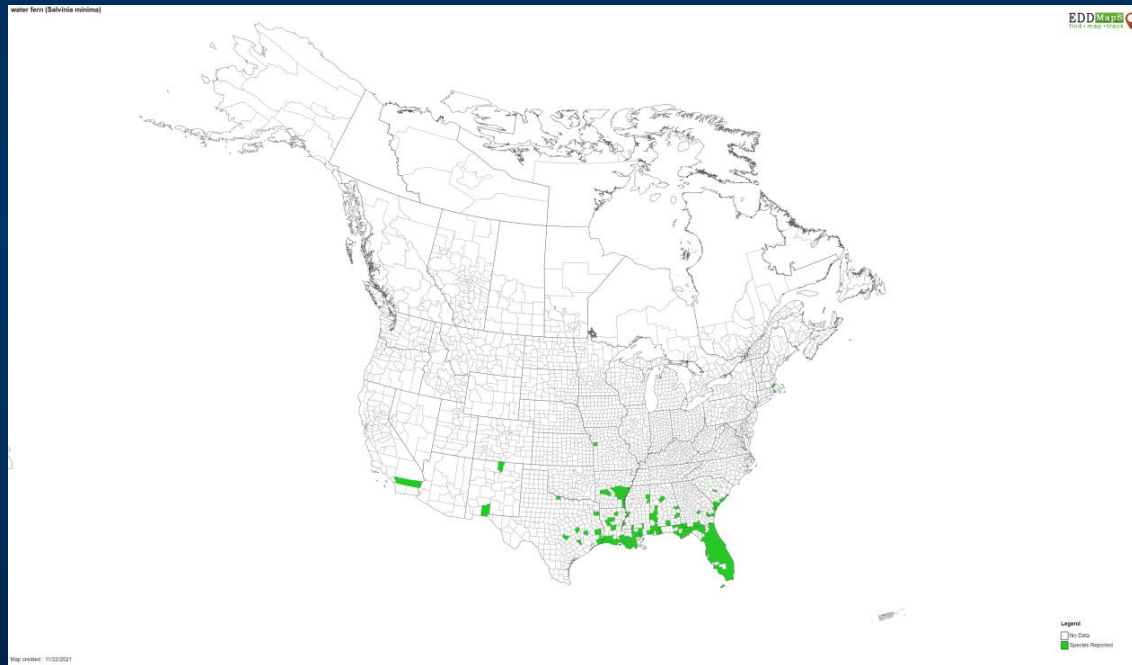


Worldwide distribution of *Salvinia molesta*. Data from Plantsoftheworldonline.org (Accessed October 2021)

Salvinia molesta (giant salvinia, aquatic watermoss, kariba weed, African pyle, Koi kandy, Australian azolla, waterfern, water spangles, giant azolla)

WRA = 20

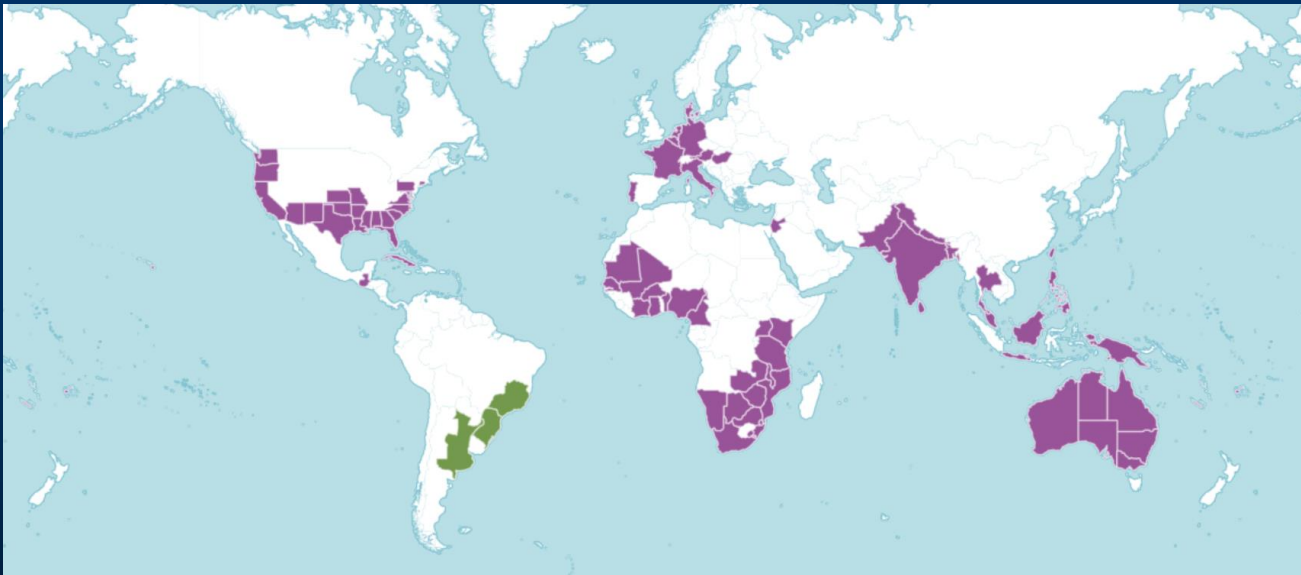
North American Distribution



North American distribution of *Salvinia molesta*. Data from eddmmaps.org (Accessed October 2021). One source indicates it was present in Ohio as early as 1881

***Salix fragilis* (Crack willow) WRA = 13**

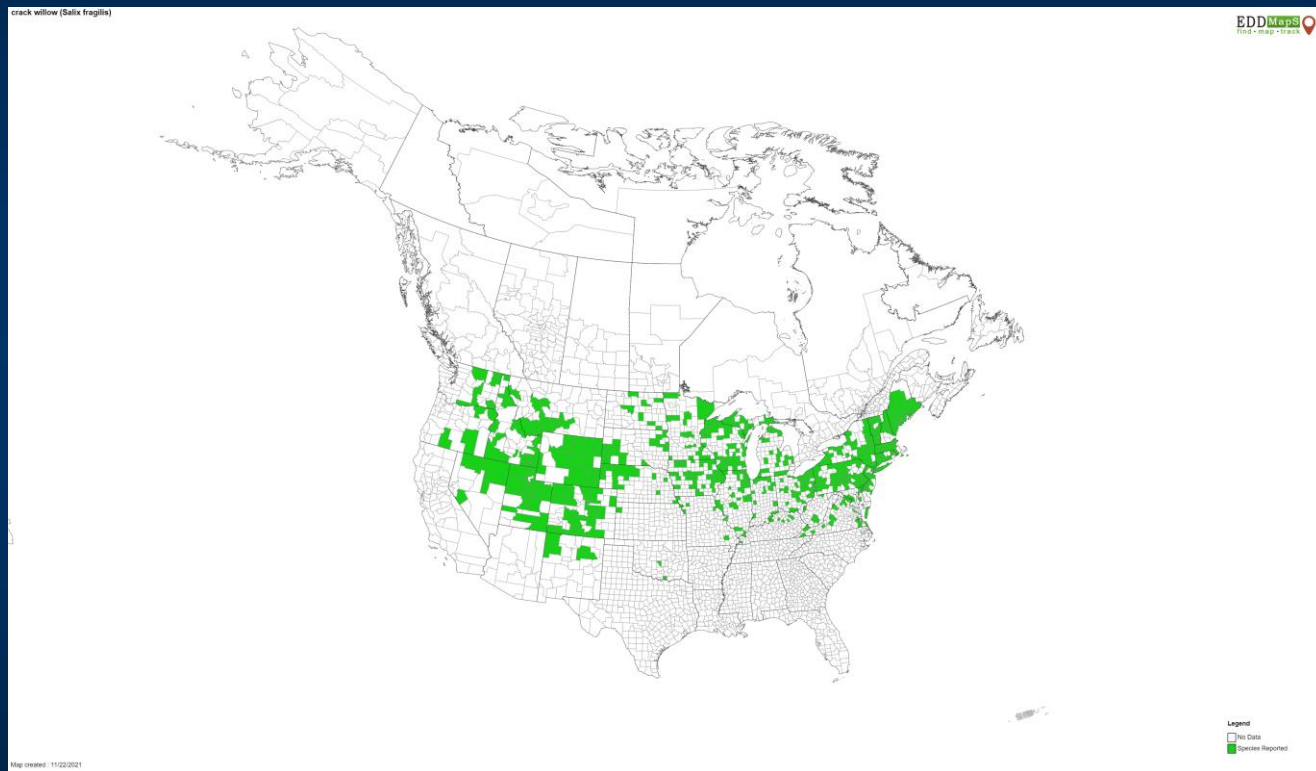
Worldwide Distribution



Worldwide distribution of *Salix fragilis*. Data from [Plantsoftheworldonline.org](http://plantsoftheworldonline.org) (Accessed October 2021)

***Salix fragilis* (Crack willow) WRA = 13**

North American Distribution



North American distribution of *Salix fragilis*. Data from eddmaps.org (Accessed November 2021).

***Sparganium erectum* (Exotic bur-reed, Simplestem bur-reed, branched bur-reed)**

WR = 14

Worldwide Distribution

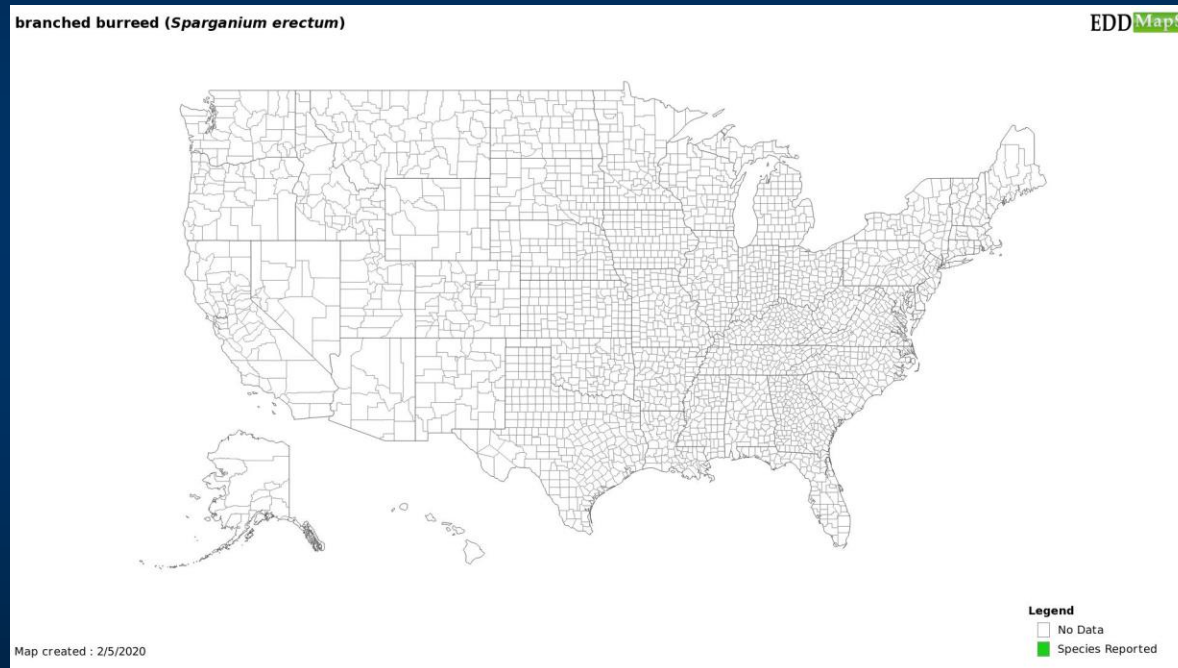


Worldwide distribution of *Sparganium erectum*. Data from [Plantsoftheworldonline.org](https://www.plantsoftheworldonline.org) (Accessed November 2021)

Sparganium erectum (Exotic bur-reed, Simplestem bur-reed, branched bur-reed)

WR = 14

North American Distribution



North American distribution of *Spargnium erectum*. Data from eddmaps.org (Accessed November 2021).

***Stratiotes aloides* (Water soldiers, Water pineapple, Saw tooth, Water aloe)**

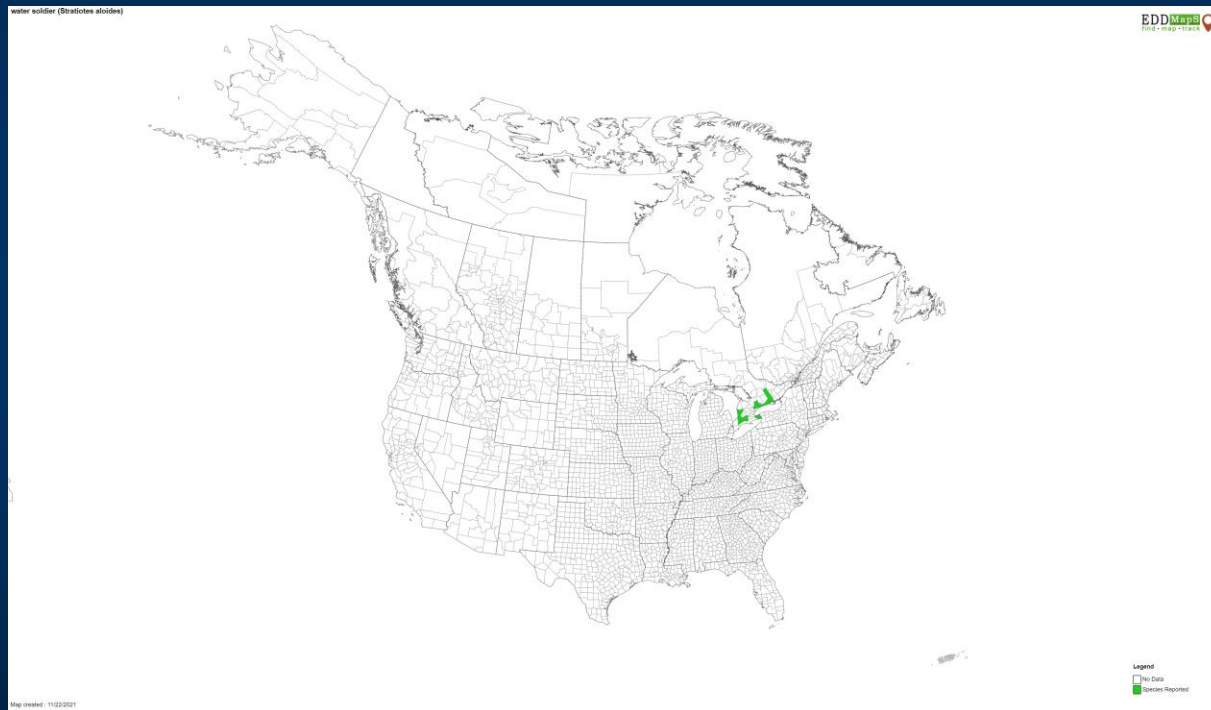
Worldwide Distribution



Worldwide distribution of *Stratiotes aloides*. Red indicates extirpation. Purple indicates introduced. Data from Plantsoftheworldonline.org (Accessed November 2021)

Stratiotes aloides (Water soldiers, Water pineapple, Saw tooth, Water aloe)

North American Distribution



North American distribution of *Sparganium erectum*. Data from eddmaps.org (Accessed October 2021).

Places to start

EDDMapS

Plants of the World Online

USDA PLANTS Database

USGS NAS – Non-indigenous Aquatic Species website

Invasive Species Compendium

Integrated Taxonomic Information System

Global Invasive Species Database

National Geographic Koppen Climate Classification System

Invasive Species in the Great Lakes (EPA)

Great Lakes Aquatic Nonindigenous Species Information System