Yellow Floatingheart (*Nymphoides peltata*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, February 2015
Revised, April 2018
Web Version, 8/16/2019

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1 Native Range and Status in the United States

Native Range

GISD (2017) lists *Nymphoides peltata* as native in Albania, Austria, Azerbaijan, Belarus, Belgium, Bulgaria, China, Czech Republic, Estonia, Europe, France, Georgia, Germany, Greece, Hungary, India, Iran, Italy, Japan, Democratic People's Republic of Korea, Republic of Korea, Latvia, Lithuania, Republic of Moldova, Mongolia, Netherlands, Poland, Portugal, Romania, Russian Federation, Slovakia, Spain, Turkey, Ukraine and the United Kingdom.

From Lansdown (2014):

"N. peltata is native to Europe and northern Asia, from the Baltic States south to the Iberian Peninsula and east through the Middle East, the Caucasus, Jammu and Kashmir in India, Siberia and Mongolia to the Russian Far East, China, Japan and Korean Peninsula."

From Cai (1995):

"Essentially throughout China except Hainan, Qinghai, and Xizang [Japan, Korea, Mongolia, Russia; C and SW Asia, Europe]"

In addition to the ranges listed above, Lansdown (2014) lists *Nymphoides peltata* as native to Bosnia and Herzgovina, Canada (Ontario, Quebec), Croatia, Montenegro, Serbia, and Slovenia.

Status in the United States

Pfingsten et al. (2018a) lists *Nymphoides peltata* as present and nonindigenous in Arizona, Arkansas, California, Connecticut, District of Columbia, Florida, Idaho, Illinois, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, Washington, and Wisconsin.

From CABI (2017):

"*N. peltata* was first recorded in the United States in 1882 in Winchester, Massachusetts. There is also a report of *N. peltata* in New York City's Central Park in 1886. Multiple records from Washington D.C. during the 1890s reported *N. peltata* in several United States Fish Commission ponds as being 'naturalized and spreading into adjacent ponds'. Other first recordings include Missouri in 1893, Louisiana in 1899, and Pennsylvania in 1905. The earliest record of *N. peltata* in the Hudson River was in 1929 from New York, and its origin was speculated as being an escape from a water garden or pool (Stuckey 1973). The first records of *N. peltata* in the Midwestern United States were in Ohio in 1930, Indiana in 1945, and Illinois in 1948. In the Southwest, it was recorded in Oklahoma in 1935, and it was believed to be introduced by either being planted along with other water plants and fish being transferred into the lake, or possibly the seeds were transported in by waterfowl (Stuckey 1973). *N. peltata* was also recorded in the Western U.S in 1930 in Long Lake in Washington (Ornduff 1963). Records also exist for: Arizona, Arkansas, California, Connecticut, Kentucky, Maryland, Mississippi, New Hampshire, New Jersey, Rhode Island, Tennessee, Texas, and Vermont (USDA-NRCS 2005). Within the last five years, *N. peltata* has also been recorded in Virginia, Maine, Oregon, and Nebraska (USGS-NAS 2007)."

In addition to the states listed above, Lansdown (2014) lists *Nymphoides peltata* as introduced in Delaware.

From Darbyshire and Francis (2008):

"It is currently available through the aquatic nursery trade […] the United States."

From Pfingsten et al. (2018b):

"*Nymphoides peltata* is prohibited in Illinois, Michigan, and Wisconsin (GLPANS 2008). The New York Invasive Species Council ranks this species as posing a high ecological risk, and recommends that it be prohibited within the state (New York Invasive Species Council 2010)."

Means of Introductions in the United States

From Pfingsten et al (2018a):

"Commonly cultivated as an ornamental species for ponds, *N. peltata* has been both accidentally and intentionally released into lakes and rivers with some nuisance populations becoming established (Benson et al. 2004). Secondary infestations may result as seed and fragments of plant segments disperse downstream or within a lake (Cook 1990; MISIN 2013)."

From EDDMaps (2018):

"*N. peltata* is still commonly sold as a plant for water gardens and can be carelessly disposed of into local waterbodies. […] It is often found in water gardens, which are the source of many of its introductions."

Remarks

From Darbyshire and Francis (2008):

"The Eurasian *Nymphoides peltata* is readily distinguished from the two native North American species, *N. cordata* and *N. aquatica*, by its yellow flowers with the petals irregularly fringed throughout, the absence of clusters of tuberous roots on the stem, and the longer and thicker stolons bearing more than one erect stem."

From GISD (2017):

"Another problem is that "Hitchiker" plants, such as the invasive *Hydrilla verticillata* (hydrilla), can be introduced to an area with *N. peltata* when mail-ordered."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2018):

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

Class Magnoliopsida
Superorder Asteranae
Order Asterales
Family Menyanthaceae
Genus *Nymphoides*
Species *Nymphoides peltata* (S.G. Gmel) Kuntze"

"Taxonomic Status:
Current Standing: accepted"

Size, Weight, and Age Range

From CABI (2017):

"The circular to slightly heart shaped floating leaves are 3-15 cm in diameter […]."

From Pfingsten et al. (2018a):

"Size: 2 meters average stem length (Sivarajan and Joseph 1993)."

Environment

From CABI (2017):

"It occurs primarily in slow-moving, eutrophic, alkaline waters at depths less than 3.0 m (Van der Velde et al. 1979)."

From Pfingsten et al. (2018a):

"*Nymphoides peltata* can grow in water 0.5-4.0 m deep and it tolerates anaerobic environments (Grosse and Mevi-Schutz 1987, OISAP 2013). This species can also survive on mudflats (Campbell et al. 2010)."

From Lansdown (2014):

"*N. [p]eltata* typically occurs in naturally eutrophic, calcareous, slow-flowing rivers and large ditches."

Climate/Range

From GISD (2017):

"Asia-temperate, Asia-tropical, and Europe (USDA-ARS NGRP 2002)."

From Cai (1995):

"[…]; below 100-1800m [elevation]"

From Darbyshire and Francis (2008):

"The persistence of *N. peltata* over many years at several sites confirms the ability of the plant to overwinter and persist in freshwater lakes and waterways in southern Canada"

Distribution Outside the United States

Native

GISD (2017) lists *Nymphoides peltata* as native in Albania, Austria, Azerbaijan, Belarus, Belgium, Bulgaria, China, Czech Republic, Estonia, Europe, France, Georgia, Germany, Greece, Hungary, India, Iran, Italy, Japan, Democratic People's Republic of Korea, Republic of Korea, Latvia, Lithuania, Republic of Moldova, Mongolia, Netherlands, Poland, Portugal, Romania, Russian Federation, Slovakia, Spain, Turkey, Ukraine and the United Kingdom.

From Lansdown (2014):

"*N. peltata* is native to Europe and northern Asia, from the Baltic States south to the Iberian Peninsula and east through the Middle East, the Caucasus, Jammu and Kashmir in India, Siberia and Mongolia to the Russian Far East, China, Japan and Korean Peninsula."

From Cai (1995):

"Essentially throughout China except Hainan, Qinghai, and Xizang [Japan, Korea, Mongolia, Russia; C and SW Asia, Europe]"

In addition to the ranges listed above, Lansdown (2014) lists *Nymphoides peltata* as native to Bosnia and Herzgovina, Canada (Ontario, Quebec), Croatia, Montenegro, Serbia, and Slovenia.

Introduced

From CABI (2017):

"*N. peltata* was introduced to North America during the late nineteenth century, and has steadily spread and been repeatedly introduced across […] parts of Canada. In Sweden, *N. peltata* was first reported as being introduced in 1870, and has been repeatedly introduced and spread to approximately 40 lakes and rivers (Larsson and Willén 2006). *N. peltata* was relatively recently recorded in New Zealand in 1988 and its establishment is known from only one field site (ENVBOP 2003). There are also reports that *N. peltata* has been introduced to Ireland (BioChange 2007), although the origin of the introduced plant is stated as Brazil (FAO-UK 2000), which was not found to be part of the native range of *N. peltata* during this review."

NOBANIS (2018) lists *Nymphoides peltata* as invasive in Norway and Sweden, as well as potentially invasive in Ireland.

From Darybshire and Francis (2008):

"The freshwater aquatic species *Nymphoides peltata* has been introduced to Canada as an ornamental plant and has been found at sites in Newfoundland, Nova Scotia, Quebec, Ontario and British Columbia."

Means of Introduction Outside the United States

From CABI (2017):

"*N. peltata* has been introduced accidently through flooding of ornamental ponds into surrounding natural waterways. It is also possible for *N. peltata* to be a 'hitchhiker' plant with other species ordered through water garden catalogues. *N. peltata* has been repeatedly intentionally planted as an ornamental in different water bodies throughout Sweden […] since its first introduction in the late nineteenth century (Josefsson and Andersson 2001, Stuckey 1973). The trade of this plant as an ornamental through the internet and mail order has greatly increased its availability and ease of spread into new environments."

"*N. peltata* is very difficult to control due to its ability to form a new plant from rhizomes, stolons, separated leaves, or seeds. The dispersal of *N. peltata* to new locations may be aided by the transport of seeds by avian vectors (Cook 1990); however, the trade and potential escape of *N. peltata* through the water garden industry may play a larger role in its spread (Les and Mehrhoff 1999)."

From EDDMapS (2018):

"*N. peltata* is still commonly sold as a plant for water gardens and can be carelessly disposed of into local waterbodies. […] It is often found in water gardens, which are the source of many of its introductions."

From Darbyshire and Francis (2008):

"It is currently available through the aquatic nursery trade in Canada […]."

Short Description

From EDDMapS (2018):

"Appearance
Nymphoides peltata is an herbaceous, perennial, aquatic plant that has stout, branching stems up to 0.1 in. (2-3 mm) thick. It is often found rooted in the mud of still bodies of water."

"Foliage
The leaves, which arise from rhizomes and are usually opposite and unequal. The leaves are cordate to subrotund in shape measuring from 2-6 in. (5-15 cm) long and wide."

"Flowers
The bright yellow flowers of *Nymphoides peltata* have five petals, and measure from 1-1.5 in. (3-4 cm) in diameter when fully open. There is one to several flowers on each stalk. The edges of the petals are fringed. This plant flowers from June to September."

"Fruit
The seeds of are [sic] contained in beaked capsules that measure 0.5-1 in. (1.2-2.5 cm) in length. The seeds themselves are flat and oval in shape, and have ciliate margins that measure 0.1 in. (3.5mm) in length."

From Cai (1995):

"Rhizomes horizontal. Stem cylindric, unbranched, sometimes producing rootlets from nodes. Leaves alternate at stem base but opposite at apex; petiole cylindric, 5-10 cm, base widened into an amplexicaul sheath; leaf blade ovate-orbicular to orbicular, 1.5-8 cm in diam., subcoriaceous, abaxially purple-brown and densely glandular, adaxially glabrous, base cordate, margin entire, veins indistinct. Flowers usually densely clustered at nodes, 5-merous, distylous. Pedicel 3-7 cm. Calyx 7-9 mm, lobed to near base; lobes elliptic-lanceolate to elliptic, apex obtuse. Corolla golden yellow, 2.5-3 cm, rotate, lobed to near base; lobes obovate, margin broadly membranous and irregularly laciniate, apex rounded to emarginate. Filaments sparsely pilose. Short styled flowers: ovary 5-7 mm; style 1-2 mm; stigma small, filaments 3-4 mm; anthers curved, sagittate, 4-6 mm. Long styled flowers: ovary 0.7-1.7 cm; style to 1 cm; stigma large, 2lobed [sic], suborbicular; filaments 1-2 mm; anthers 2-3.5 mm. Glands golden yellow. Capsules elliptic, 1.7-2.5 × 0.8-1.1 cm. Seeds brown, compressed, elliptic, 4-5 mm, densely ciliate. Fl. and fr. Apr-Oct. 2n = 54."

Biology

From Josefsson and Andersson (2001):

"Attempts to control *Nymphoides* have failed because of its ability to propagate vegetatively, through rhizomes, and roots tightly attached to the sediment. Rhizomes and roots survive mechanical harvesting and rhizome and plant fragments root elsewhere, thus increasing its distribution."

From CABI (2017):

"*N. peltata* prefers slow moving rivers, lakes, reservoirs and ponds, but can also grow in damp mud, swamps and wetlands. It is also known to occur in ditches, canals, waterways, and "break-through" pools of dikes (Van der Velde 1979). Backwaters which are influenced by high river levels and flooding in the winter are frequently habited by *N. peltata* (Van der Voo and Westhoff 1961)."

"*N. peltata* is able to reproduce prolifically by vegetative and sexual means. It can reproduce by seeds, stolons, or broken-off leaves with part of a stem attached. Seed production usually requires cross-pollination between the long- and short-styled floral morphs, but self-pollination may result in the formation of small capsules with 10-20 seeds, a quarter of the number of seeds

usually found in capsules from cross-pollinations. In addition, the seeds from self-pollinated capsules have a lower viability compared with those seeds formed from cross-pollination (Ornduff 1966). […] The release of developed seeds occurs 32-60 days after the anthesis of the flowers (Van der Velde and Van der Heijden 1981). Van der Velde and Van der Heijden (1981) also found an average density of 180 fruits per square meter in natural populations, and a max density of 310 fruits per square meter in experimental populations. The seeds of *N. peltata* are unable to germinate under hypoxic conditions, and need only a short cold period to overcome their innate dormancy (Smits et al. 1990). *N. peltata* seeds also show great tolerance with respect to desiccation (Smits et al. 1989)."

From Pfingsten et al. (2018a):

"*Nymphoides peltata* can move nitrogen and phosphorus up from the sediment into the aboveground biomass and back down into the root structure during the winter (Brock et al. 1983). Areas dominated by *N. peltata* were associated with higher macroinvertebrate species richness, densities, and biomass than in areas without macrophytes (Brock and Van der Velde 1996), although this may be due to macrophyte structure and not strictly *N. peltata*."

Human Uses

From Darbyshire and Francis (2008):

"Reported medicinal applications include fever reduction, treatment of intestinal worms, diuretic, lactation agent, skin problems and headaches (Sobti and Singh 1961; Anonymous 2006c)."

From CABI (2017):

"Ornamental plants of *N. peltata* are sold for water gardens and ponds, though the specific economic value of this particular species in the ornamental plant trade is unknown."

"Botanical garden/zoo."

Diseases

Poelen et al. (2014) lists *Puccinia scirpi* and *Macroplea appendiculata* as a parasite of *Nymphoides peltata*.

Threat to Humans

No information on threats to humans from *Nymphoides peltata* was found.

3 Impacts of Introductions

From Gren et al. (2009):

"As a weed, it causes problems by overgrowing water bodies and interfering with boat traffic as well as recreational activities, such as fishing, swimming, and canoeing."

From CABI (2017):

"*N. peltata* is declared a noxious weed in New Zealand and parts of North America (NWCB 2007), and is also declared as invasive in Sweden (Gren et al. 2007)."

From GISD (2017):

"WSDE (2003) states that "[…] The structural complexity of its mats make it difficult to fish, water ski, swim, or even paddle a canoe through. NWCB (2003) would add "fish and wildlife habitat, recreation and water quality is negatively impacted when the dense mats of *N. peltata* outcompete native and beneficial plant species."

From Pfingsten et al. (2018a):

"*Nymphoides peltata* typically develops monotypic dense patches which may exclude other native plants and create stagnant, low-oxygen conditions in the water below (DiTomaso and Healey 2003). These areas of stagnant waters can be an ideal location for mosquitos to breed (OISAP 2013). If the population of yellow floating heart is large enough, fish and other wildlife may be forced to relocate (CEH 2004). The mat-like patches impede recreational activities such as fishing, water skiing, swimming and boating. (CEH 2004, Lui et al. 2010, WI DNR 2012)."

From Pfingsten et al. (2018b):

"*Nymphoides peltata* can form dense floating mats of vegetation that block sunlight from reaching native plants and algae (IL DNR 2005, Lui et al. 2010, OISAP 2013). Depending on the extent of the yellow floating heart population, the algae population could decline and disrupt the food web (Kelly and Maguire 2009)."

From EDDMapS (2018):

"In warmer areas it has formed large stands that can block waterways."

From Darybyshire and Francis (2008):

"In Canada and elsewhere, colonies of *N. peltata* can produce dense mats of leaves in a floating canopy, which will reduce flow, reduce light penetration, lower oxygen levels, and alter nutrient cycling (House 1937; Gaevskaya 1969; Stuckey 1974; Anonymous 2006a; S. Darbyshire and A. Francis, personal observation)."

4 Global Distribution

Figure 1. Known global distribution of *Nymphoides peltata*. Map from GBIF Secretariat (2018).

5 Distribution Within the United States

Figure 2. Known distribution of *Nymphoides peltata* in the contiguous United States. Map from Pfingsten et al. (2018a).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Nymphoides peltata* was high for the vast majority of the contiguous United States. A small portion in the northwest part of Washington State had a low to medium match. There are already many established populations of *N. peltata* in much of the United States. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous United States was 0.907, high (scores 0.103 and greater are classified as high). All States in the contiguous United States had high individual Climate 6 scores.

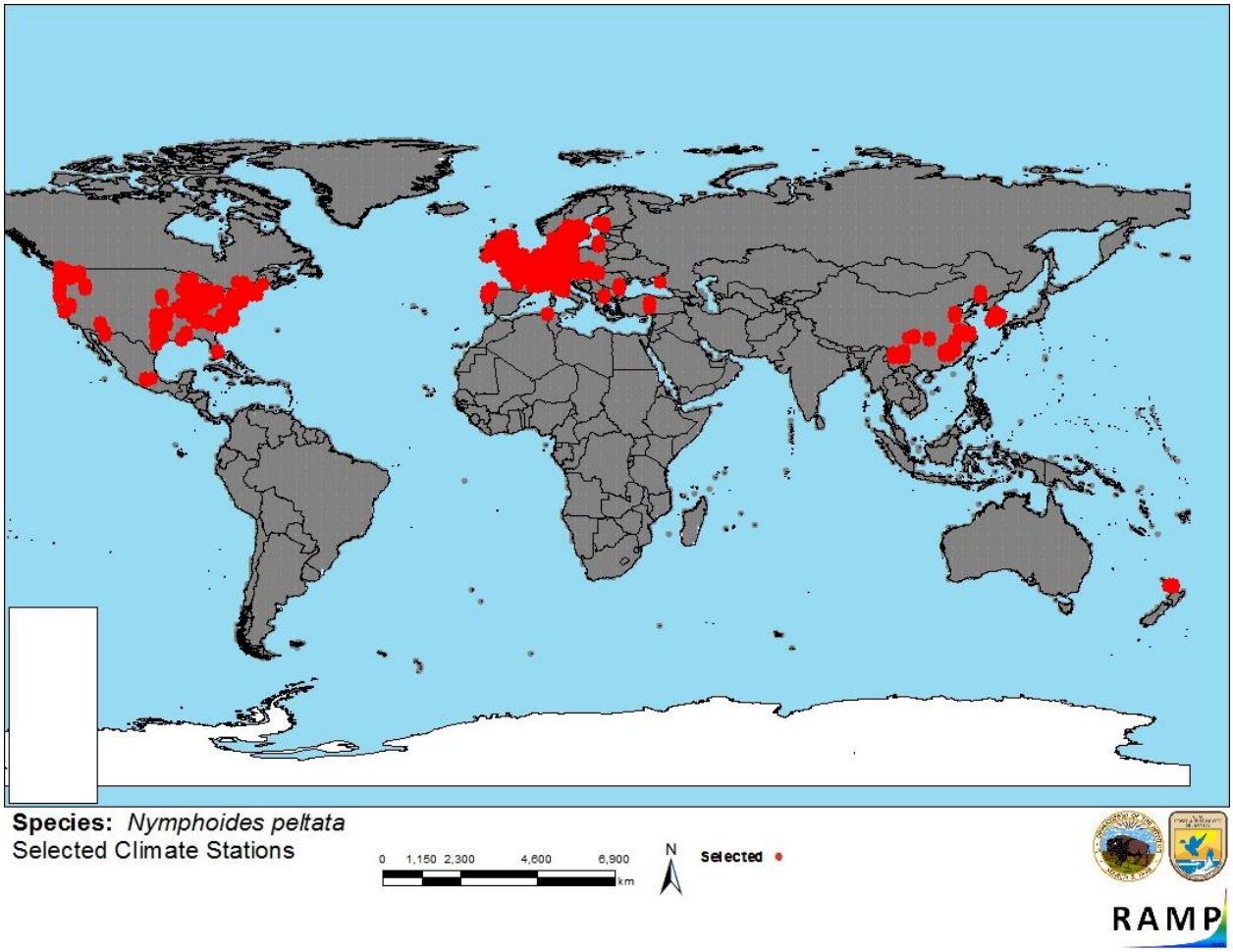

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations in North America, Europe, Asia, and New Zealand selected as source locations (red) and non-source locations (gray) for *Nymphoides peltata* climate matching. Source locations from GBIF Secretariat (2018) and Pfingsten et al. (2018a). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

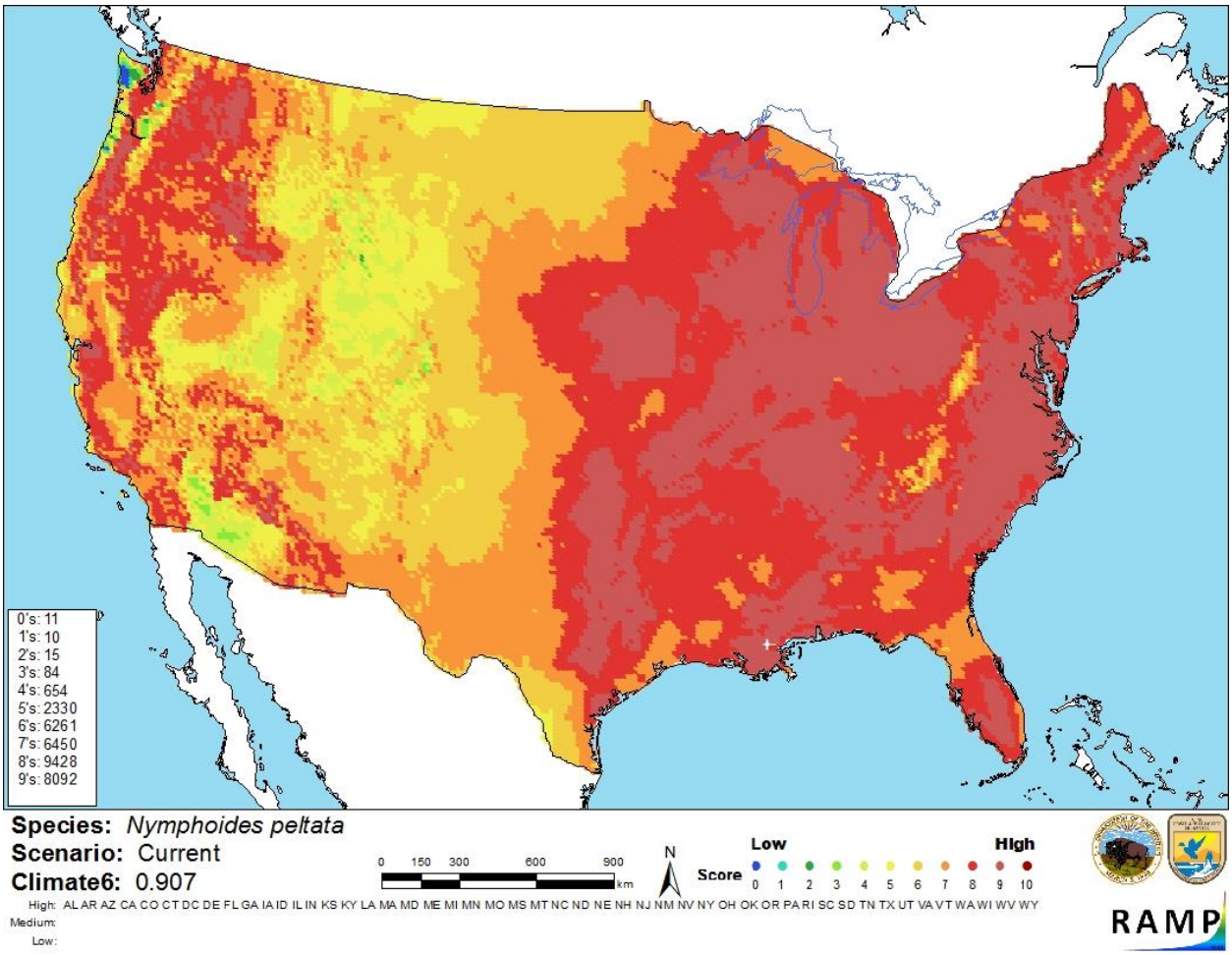

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Nymphoides peltata* in the contiguous United States based on source locations reported by GBIF Secretariat (2018) and Pfingsten et al. (2018a). Counts of climate match scores are tabulated on the left. 0 = Lowest match, 10 = Highest match.

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

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

7 Certainty of Assessment

Certainty of this assessment is high. Information on the biology, invasion history and impacts of this species is available, with some peer-reviewed literature. There is enough information available to describe the risks posed by this species.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Yellow floatingheart (*Nymphoides peltata*) is an aquatic plant native to Eurasia, Mediterranean, China, Japan and India. The history of invasiveness is high, it has been introduced to much of the world through multiple vectors including the aquatic plant trade, careless disposal, and flooded water gardens. *N. peltata* outcompetes native vegetation, congests waterways inhibiting navigation, and reduces biodiversity. Climate matching indicated the contiguous United States has a high climate match. There are already established *N. peltata* populations in much of the United States The certainty of assessment is high. The overall risk assessment category is high.

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): High**
- **Remarks/Important additional information:** There are already established populations throughout many parts of the United States.
- **Overall Risk Assessment Category: High**

9 References

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

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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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