Water Soldiers (*Stratiotes aloides)*

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, August 2020
Revised, January 2021
Web Version, 4/7/2021

Organism Type: Plant
Overall Risk Assessment Category: Uncertain

Photo: J Hempel. Licensed under Creative Commons Attribution-Share Alike 3.0 Germany license. Available: https://commons.wikimedia.org/wiki/File:Stratiotes_aloides_LC0258.jpg. (July 2020).

1 Native Range and Status in the United States

Native Range

From Fusaro et al. (2017):

"*Stratiotes aloides* is native from the United Kingdom through to Asia. Specifically, the United Kingdom, Spain, Italy, Bulgaria, and Siberia (UK Natural History Museum 2013)."

From Suutari et al. (2009):

"*S. aloides* is a perennial whose range of occupancy includes Central, Eastern and Northern Europe and Central Asia (Cook and Urmi-König 1983)."

From Efremov and Sviridenko (2008):

"It is found in the continental water bodies of European Russia, the Caucasus [Armenia, Azerbaijan, Georgia, and Russia], Scandinavia [Sweden, Finland, and Denmark], the Baltic Region [Germany, Poland, Lithuania, Russia Latvia, and Estonia], the Mediterranean Region, Atlantic Europe [Spain, Britain, and the Netherlands], western Siberia, and northern Kazakhstan."

Status in the United States

From Snyder et al. (2016):

"In the United States, there is no federal legislation, but *S. aloides* is currently regulated in several American states. The Alabama Department of Agriculture and Industries (2006) lists it as a Class C noxious weed. The Florida Department of Environmental Protection lists it as a Class 1 prohibited aquatic plant (USDA, NRCS 2012). Purchase, sale, transport and distribution of the species have been totally prohibited by the Washington State Department of Agriculture (Washington State 2015); and the Minnesota Department of Natural Resources lists it as a prohibited invasive aquatic species that is unlawful to possess, purchase, transport or introduce except under a permit (Minnesota DNR 2012). Similarly, the Illinois Department of Natural Resources lists it as an injurious species requiring a permit to possess, propagate, buy, sell, trade, loan or transport (Illinois Joint Committee on Administrative Rules 2015). Under a 2015 Invasive Species Order, the Michigan Commission of Agriculture and Rural Development has prohibited the import, sale and distribution of *S. aloides* (Michigan CARD 2015). Wisconsin has likewise listed the species as prohibited (Wisconsin DNR 2014).

From USDA (2017):

"U.S. distribution and status: In the early 1900s, this species was sold in the United States by at least one supplier (Tricker, 1909). Snyder et al. (2016) report that the species is still sold in the United States, which is based upon several assumptions made from the literature (Snyder, 2016a) that may not necessarily be true. During our review of the literature and online sources, we found no evidence indicating that this species is currently present or cultivated in the United States (e.g., GBIF, 2015; NGRP, 2015; NRCS, 2015; Kartesz, 2015; Monrovia, 2016; Lowe's, 2016; Bailey Nurseries, 2011; Greenleaf Nursery Company, 2016; San Marcos Growers, 2001). *Stratiotes aloides* is regulated as an injurious or noxious weed in five states: Alabama (Harden, 2015), Florida (Smith, 2015), Illinois (17 Illinois Administrative Code § 805, 2015), Michigan (Rosenbaum et al., 2015), Washington (White et al., 2015), and Wisconsin (WDNR, 2015)."

From Fusaro et al. (2017):

"Michigan prohibits the introduction, importation, movement, sale, or distribution of *S. aloides* (NREPA Part 413 as amended, MCL 324.41302(3)(a)). Illinois lists *S. aloides* as an injurious species as defined by 50 CFR 16.11-15. Therefore, *S. aloides* cannot be possessed, propagated, bought, sold, bartered or offered to be bought, sold, bartered, transported, traded, transferred or loaned to any other person or institution unless a permit is first obtained from the Department of Natural Resources. Illinois also prohibits the release of any injurious species, including *S. aloides* (17 ILL. ADM. CODE, Chapter 1, Sec. 805). Wisconsin prohibits the transport, possession, or introduction of *S. aloides* (Wisconsin Chapter NR 40). It is also prohibited for a person to possess, import, purchase, sell, propagate, transport, or introduce *S. aloides* in Minnesota (Minnesota Rule 6216.0250)."

According to EDDMaps (2020), this species is also listed on the New Jersey Invasive Species Strike Team 2017 Invasive Species List, and Oregon Noxious Weeds.

Means of Introductions in the United States

This species has not been reported in the wild of the United States.

Remarks

From Forbes (2000):

"The map produced by Cook & Urmi-Konig (1983) shows *S. aloides* occurring in the British Isles and in Europe south to Spain, Italy, Bulgaria and European Turkey, north to Finland, and east to Siberia […] This is a particularly interesting disjunction in the species range, as it is generally accepted that *S. aloides* is not native to France on grounds of its late first mention in the relevant literature (1810), a series of documented introductions, and the lack of any fossil finds. A similar puzzle exists with respect to Italy (where it is considered native in the eastern part of the Po Plain) and Switzerland ("certainly not native") (Cook & Urmi-Konig 1983). Cook revised his opinion of the native range of *S. aloides* two years later, asserting that it is indigenous only in Central Europe and is introduced and established in Western Europe (Cook 1985)."

From Snyder et al. (2016):

"*Stratiotes aloides* is present in most of northern and eastern Europe extending south to northern Italy and possibly to Spain, east throughout most of European Russia and into Asia from the northern Caucasus region to the western part of Central Siberia (Nolte 1825; Cook and Urmi-König 1983; Czerepanov 1995). Similar distribution maps were published by Meusel et al. (1965), Cook and Urmi-König (1983), and Hultén and Fries (1986), although each map shows small differences in outlying occurrences. Timokhina (2000) provided more precise mapping of the Asian distribution, and Forbes (2000) updated the map of Cook and Urmi-König (1983) with additional records from the United Kingdom. Because of its long history as an ornamental plant, it is difficult to determine what the pre-cultivation natural range might have been. However, *S. aloides* is believed to have been introduced to France, Switzerland and Turkey (Egloff 1974; Cook and Urmi-König 1983; Davis et al. 1984) and its native status in Northern Ireland is controversial (Forbes 2000)."

"Stratiotes aloides is considered a noxious weed in some regions of Australia (Weeds Australia 2015) and import of either seed or nursery stock is prohibited in both Australia and New Zealand (Australian Government 2015; New Zealand Government 2015)."

From USDA (2017):

"In Europe, *Stratiotes aloides* has spread and naturalized outside its native range. Cultivation escapes resulting in naturalized populations of *S. aloides* have made it difficult to precisely delimit the native and introduced ranges of this species (Cook and Urmi-König, 1983; Forbes, 2000). Despite this spread into new areas, there are several areas in Europe, largely considered native, where *S. aloides* appears to be declining. In Spain, it is considered extinct (Aedo et al., 2015). In certain localities of Germany it is considered endangered (Cook and Urmi-König, 1983), and in the Netherlands it has also significantly declined (Smolders et al., 2003)."

From Fusaro et al. (2017):

"It is illegal to import, possess, deposit, release, transport, breed/grow, buy, sell, lease or trade *S. aloides* in Ontario [Canada] (Invasive Species Act 2015)."

This species is sometimes referred to as a singular water soldier instead of the more commonly seen plural, water soldiers.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to WFO (2021), *Stratiotes aloides* is the accepted name for this species.

From ITIS (2020):

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

Size, Weight, and Age Range

From Fusaro et al. (2017):

"Stem length: 10-18mm long, Leaf length: 40-60 cm long, 1-4 cm wide (Cook and Urmi-König 1983)."

From Snyder et al. (2016):

"However, individual plants are short lived, persisting for only 2–3 years (Cook and Urmi-König 1983)."

Environment

From Fusaro et al. (2017):

"*Stratiotes aloides* usually inhabits shallow stagnant waters, mainly eutrophic and mesotrophic, with substratum of mud and organic deposits (Strzalek and Koperski 2009). *Stratiotes aloides* can grow in depths of up to 6.5m (Tarkowska-Kukuryk 2006). *Stratiotes aloides* is found mainly in sheltered bays of larger lakes, backwater ponds, ditches and canals (UK Natural History Museum 2013). *Stratiotes aloides* is limited to freshwater."

From Snyder et al. (2016):

"Aquatic habitats include shallow (generally <5 m), still to moderately flowing water in ponds, lakes, and rivers. In the Trent River, patches of plants grow in communities of submergent, floating and emergent aquatic plants at depths of 0.3–2.5 m. Substrates along the Trent River where *S. aloides* occurs are sandy to organic. The substrate of the pond in Trent Hills is organic detritus over clay at the edges and sloping to bedrock at the deepest (1.75 m) central portion.

In Europe, plants are generally found under lentic conditions in sheltered freshwater bays or inlets of large lakes, ponds, or slow-moving streams or canals at depths of 2–5 m where they may float or can become rooted in nutrient-rich bottom mud or sapropel (oxygen-depleted organic sediment) of fine to course sediments (Erixon 1979a; Prins and De Guia 1986; Strzałek 2004; Efremov and Sviridenko 2008); and, can persist submerged in deep water or under ice. In the Netherlands it is abundant in many drainage ditch systems (Smolders et al. 1995a). Surface waters in Stratiotes habitats are frequently rich in electrolyte ions, notably calcium (Ca), magnesium (Mg), sodium (Na), iron (Fe) and potassium (K) (Kornatowski 1976; Brammer and Wetzel 1984) or with high concentrations of calcium and sulphate ions and poor in phosphate ions (Kłosowski et al. 2011). Habitats are characterized by a moderate pH (6–8), moderate alkalinity 1–4 mol m−3, and a high content of dissolved inorganic carbon and high free CO2 concentration (Prins and De Guia 1986)."

Climate

From Snyder et al. (2016):

"Today the species is present mainly in inland aquatic sites between 45° and 55° N in Eurasia but has reached up to 67° N in sheltered creeks and near peat shores with thick mud layers in northern Finland (Kotilainen 1954) and Sweden (Erixon 1976, 1979b), and to 64° N in river basins of arctic western Russia (Vekhoff 1994). Under water overwintering rosettes are quite tolerant of harsh conditions, although plants will perish if the basal rosette becomes frozen solid (Erixon 1976, 1979b). In Canada, its presence in Ontario is at roughly 44° N in a continental climate zone where submerged plants will overwinter under ice, as in the more northerly parts of its habitat in Eurasia. However, if the water column freezes to the bottom, *S. aloides* will perish (Efremov and Sviridenko 2008)."

Distribution Outside the United States

Native

From Fusaro et al. (2017):

"*Stratiotes aloides* is native from the United Kingdom through to Asia. Specifically, the United Kingdom, Spain, Italy, Bulgaria, and Siberia (UK Natural History Museum 2013)."

From Suutari et al. (2009):

"*S. aloides* is a perennial whose range of occupancy includes Central, Eastern and Northern Europe and Central Asia (Cook and Urmi-König 1983)."

From Efremov and Sviridenko (2008):

"It is found in the continental water bodies of European Russia, the Caucasus [Armenia, Azerbaijan, Georgia, and Russia], Scandinavia [Sweden, Finland, and Denmark], the Baltic Region [Germany, Poland, Lithuania, Russia Latvia, and Estonia], the Mediterranean Region, Atlantic Europe [Spain, Britain, and the Netherlands], western Siberia, and northern Kazakhstan."

Introduced

From Fusaro et al. (2017):

"The only wild populations of *S. aloides* in North America occur in five locations within the Trent River and Black River in Ontario, Canada: (1) In the Trent River approximately between the town of Trent River and the south end of Crowe Bay, but scattered plants have been found as far as the east end of Percy Reach, County of Northumberland; (2) in a watering pond for cattle in Trent Hills, County of Northumberland; (3) in a pond at Blackstock in the Township of Scugog, Regional municipality of Durham; (4) in an artificial pond near Bayfield, Huron County; and (5) in the Black River, near Sutton, Regional Municipality of York (Snyder et al. 2016)."

"The only invasive population reported has been in Ontario. What would have likely started from a few plants has grown to 22,000 plants in seven populations."

From Forbes (2000):

"The map produced by Cook & Urmi-Konig (1983) shows *S. aloides* occurring in the British Isles and in Europe south to Spain, Italy, Bulgaria and European Turkey, north to Finland, and east to Siberia […] This is a particularly interesting disjunction in the species range, as it is generally accepted that *S. aloides* is not native to France on grounds of its late first mention in the relevant literature (1810), a series of documented introductions, and the lack of any fossil finds. A similar puzzle exists with respect to Italy (where it is considered native in the eastern part of the Po Plain) and Switzerland ("certainly not native") [Cook & Urmi-Konig 1983]. Cook revised his opinion of the native range of *S. aloides* two years later, asserting that it is indigenous only in Central Europe and is introduced and established in Western Europe [Cook 1985]."

From Snyder et al. (2016):

"Because of its long history as an ornamental plant, it is difficult to determine what the pre-cultivation natural range might have been. However, *S. aloides* is believed to have been introduced to France, Switzerland and Turkey (Egloff 1974; Cook and Urmi-König 1983; Davis et al. 1984) and its native status in Northern Ireland is controversial (Forbes 2000)."

Means of Introduction Outside the United States

From Fusaro et al. (2017):

"Potential pathway(s) of introduction: Dispersal, Hitchhiking/Fouling, and Stocking/Planting/Escape from Recreational Culture"

Short Description

From Fusaro et al. (2017):

"Water Soldiers, *Stratiotes aloides* (Family: Hydrocharitaceae), is a loosely rooted aquatic species with emergent and submerged growth forms (Cook and Urmi-König 1983; Erixon 1979). *S. aloides* has depressed conical stems with a complex but regular branching system that can resemble the household spider plant (Campbell 2009). Water soldiers' serrated leaf edges distinguish it from similar looking aquatic plants in the Great Lakes (MNRF 2014). Submerged leaves are thin, brittle and droop at an angle. Submerged leaves can grow up to 60 cm (or rarely 110 cm long) and up to 1 cm wide with somewhat weak spines. Emergent leaves are thick, rigid, brittle, and dark green and are usually less than 40 cm long and 1-4 cm wide, with well-developed spines along leaf margins. The emergent form develops rosettes at the surface of the water (Cook and Urmi-König 1983). The roots of *S. aloides* can be up to 180 cm long but are usually less."

From Snyder et al. (2016):

"Plants are dioecious (with either staminate or pistillate flowers) or very rarely monoclinous (pistillate flowers with a few stamens), perennial, submersed to more or less emergent at anthesis. The roots are simple and fibrillose (covered with long, silky fibers), arising adventitiously from the stem and growing up to 180 cm in length, their tips anchoring in the substratum. Stems are short, 10–18 mm long, 25–37 mm wide, and stoloniferous (branching from the base). Stolons bearing terminal rosettes which are either open leafy plantlets (usually referred to as offsets) or closed and bud-like turions about 5 cm long. The sessile (stalkless), slightly clasping leaves are linear, lanceolate or narrowly triangular and arranged in more or less three vertical, spiraling rows to form a large rosette. Emergent leaves are somewhat fleshy in texture, usually less than 40 cm long, 1–4 cm wide, and the margins are strongly serrate with conspicuous spines. The submerged leaves are thinner, flaccid, lighter green (in Ontario often reddishpurple), growing to 60 (−110) cm in length, and typically 1–2 cm in width, sometimes undulate-margined (frequently so in Ontario) with relatively weak spines and usually lacking stomata. In the axil of each leaf are 2–14 minute mucilage-secreting scales (called squamulae intravaginales); the scales are narrowly triangular to linear, entire or occasionally longitudinally split or forked, 2–5.5 mm long and 0.15–0.7 mm wide. Inflorescence with flowers solitary to several, borne within a spathe consisting of two carinate and overlapping (conduplicate) bracts; bracts (17–) 26–44 mm long; sepals 3, ovate; petals 3, white with a yellow base; nectar secreted at the abaxial base of the staminodes. Pistillate flowers are usually solitary (sometimes two, rarely more) on a stout pedicel up to 20 cm long; spathe bracts usually hooked and turned inwards at the apex; sepals green with purplish stripes; petals sub-orbicular; styles 6, bifurcated to the base, each bearing 2 stigmatic lobes; androecium of 15–30 linear staminodes (vestigial sterile stamens); ovary uni-locular, consisting of 3–6 carpels with 4–6 ovules in each carpel. Staminate flowers 2–6 per inflorescence, the upper flower subtended by a floral bract; peduncle flattened and up to 30 cm long (longer than female inflorescence); bracts rounded and erect or turned outward at the apex; petals ovate to sub-orbicular, sepals translucent, white with green central part and apex; androecium of 34–41 segments arranged in 5 whorls, the outer staminodial and the inner fertile, functional stamens 5–17. The fruit is a berry-like capsule, ovoid or somewhat barrel-shaped, tapering to a cone-like apex, outer pericarp thick, leathery, brownish-green to green, with 12–24 seeds, locules filled with mucilage. Seeds cylindrical, often curved at the micropylar end with a more or less pronounced beak, 5.8–10.6 mm long, 2–3.1 mm wide (Beijerinck 1947; Cook and Urmi-König 1983; Smolders et al. 1995), brown to ochre-coloured, translucent with mucilaginous hairs when fresh, woody and ribbed or smooth and shiny when dry."

Biology

From Fusaro et al. (2017):

"This species has vegetative reproduction. Vegetative propagules are formed as axillary buds. When the bottom leaves of the rosette decay, these buds are released. On average 4.7 (±0.28 SE) buds are formed per mature rosette (n = 83) (Sarneel 2013). Buds have high capacity to disperse over long distances via water (84% of propagules re-sprouted, and 92% were still floating after 187 days) (Sarneel 2013)."

From Snyder et al. (2016):

"Plants are dioecious (with either staminate or pistillate flowers) or very rarely monoclinous (pistillate flowers with a few stamens), perennial, submersed to more or less emergent at anthesis."

Human Uses

From Snyder et al. (2016):

"In continental Europe, *S. aloides* has been regarded as an attractive aquatic ornamental since the mid Eighteenth Century, if not before, when its planting was promoted in moats, ponds and canals (Miller 1754). Today it continues to be planted in ornamental ponds and botanic gardens (Egloff 1974; Cook and Urmi-König 1983). The species became an ornamental novelty in North America early in the last century and is valued as a water garden plant in parts of Canada today. A 2008 survey of members of the Ontario water garden industry identified four large distributors that both grow and sell *S. aloides* and seven distributors or retailers that sell it (E. Funnell, unpublished data)."

From USDA (2017):

"U.S. distribution and status: In the early 1900s, this species was sold in the United States by at least one supplier (Tricker, 1909). Snyder et al. (2016) report that the species is still sold in the United States, which is based upon several assumptions made from the literature (Snyder, 2016a) that may not necessarily be true. During our review of the literature and online sources, we found no evidence indicating that this species is currently present or cultivated in the United States (e.g., GBIF, 2015; NGRP, 2015; NRCS, 2015; Kartesz, 2015; Monrovia, 2016; Lowe's, 2016; Bailey Nurseries, 2011; Greenleaf Nursery Company, 2016; San Marcos Growers, 2001)."

Diseases

From Snyder et al. (2016):

"*Fusarium roseum* Link has attacked *S. aloides* and other aquatic species in The Netherlands (Cook and Urmi- König 1983); and *Leptosphaeria stratiotis* Oudem., *Phoma exigua* var. *exigua* Desm. and *Phyllosticta aloides* Oudem [the latter two taxa now considered synonymous with *Boeremia exigua* (Desm.) Aveskamp, Gruyter & Verkley] have been reported on *S. aloides* in The Netherlands, Poland and Russia (Farr and Rossman 2015). A fungus reported as *Fusarium roseum* 'Culmorum' [= *Fusarium culmorum* (Wm. G. Sm.) Sacc.] was isolated from diseased *S. aloides* in the Netherlands […]"

Threat to Humans

From Fusaro et al. (2017):

"*Stratiotes aloides*'s sharp leaves can cut skin (Campbell 2009). Dense floating mats of water soldier can hinder recreational activities, such as boating, angling, and swimming."

3 Impacts of Introductions

The following information pertains to potential impacts of introduction and not actual documented impacts.

From Snyder et al. (2016):

"No reports were found in the literature to suggest that *S. aloides* is considered invasive or weedy in its native distribution, although it can be highly productive with maximum growth rates up to 46 g m−2 day−1 in the Netherlands (De Geus-Kruyt and Segal 1973). Because it is prevalent in the horticultural trade as a water-garden and aquarium plant, possible escape into the natural environment has been of concern outside of its native region, with importation and sales of the species prohibited in some jurisdictions. […] It can form dense floating masses (Cook and Urmi-König 1983) and thereby both compete with other aquatic plants and influence the hydrosere. Growth of *S. aloides* has the potential to crowd out other aquatic plant species and to inhibit navigation and recreational activities on inland waterways (Renman 1989; Minchin and Boelens 2011; OISAP 2015; E. Snyder, personal observation). The first reported instance of such detrimental impact in North America is from the Trent River, Ontario, where the species was discovered in 2008 and has since spread to new locations downstream. It is now an invasive species of concern, not only to the Ontario Government, but also to the United States since invasive species in the Great Lakes watershed are of concern on both sides of the border."

From Fusaro et al. (2017):

"*Stratiotes aloides* has been described by government agencies as likely to crowd out native vegetation (Ontario Ministry of Natural Resources 2009, 2014), though no primary literature exists to support this in introduced habitats. It does form "dense, almost monospecific stands" in native habitat (Strzalek and Koperski 2009). Most species in the genus produce vegetative fragments and reproduce easily. *Stratiotes aloides* can overwinter in the Great Lakes; the population in Finland overwinters fine in temperatures similar to those experienced in the Great Lakes."

"*Stratiotes aloides* has the potential to alter surrounding water chemistry, which may harm phytoplankton and other aquatic organisms (Ontario Ministry of Natural Resources 2009). The exact mechanism has not been elucidated, but the likely cause is allelopathy (Mulderij et al. 2006)."

"It has not been indicated that *Stratiotes aloides* can be used for the control of other organisms or improving water quality. There is no evidence to suggest that this species is commercially, recreationally, or medically valuable. It does not have significant positive ecological impacts."

"*Stratiotes aloides*'s sharp leaves can cut skin (Campbell 2009). Dense floating mats of water soldier can hinder recreational activities, such as boating, angling, and swimming."

From USDA (2017):

"Very little is known about the impacts of *S. aloides*. […] Dense stands exclude native wetland plants (NSW DPI, 2014), and it crowds out native vegetation, resulting in decreased plant biodiversity (OISAP, 2015). […] Thick growth could potentially increase the risk of flooding and the cost of water delivery (Oregon Department of Agriculture, 2015), as well as limiting recreational activities such as boating and fishing."

4 History of Invasiveness

This species is introduced and established in Canada. Multiple potential impacts of introduction have been identified, however no actual impacts of introduction have been documented. This species has previously been found in trade in the United States according to literature, however based on the literature, this species currently appears not to be in trade in the United States. Multiple State agencies have listed *S. aloides* as a prohibited species, an injurious species, or a noxious weed. It is possible it has been introduced and become established in parts of Europe (e.g. France, Ireland, Italy, Turkey), but there is debate within the literature as to its status. The history of invasiveness is classified as Data Deficient because it has become established outside its native range (Canada) but there is a lack of documented impacts of introduction.

5 Global Distribution

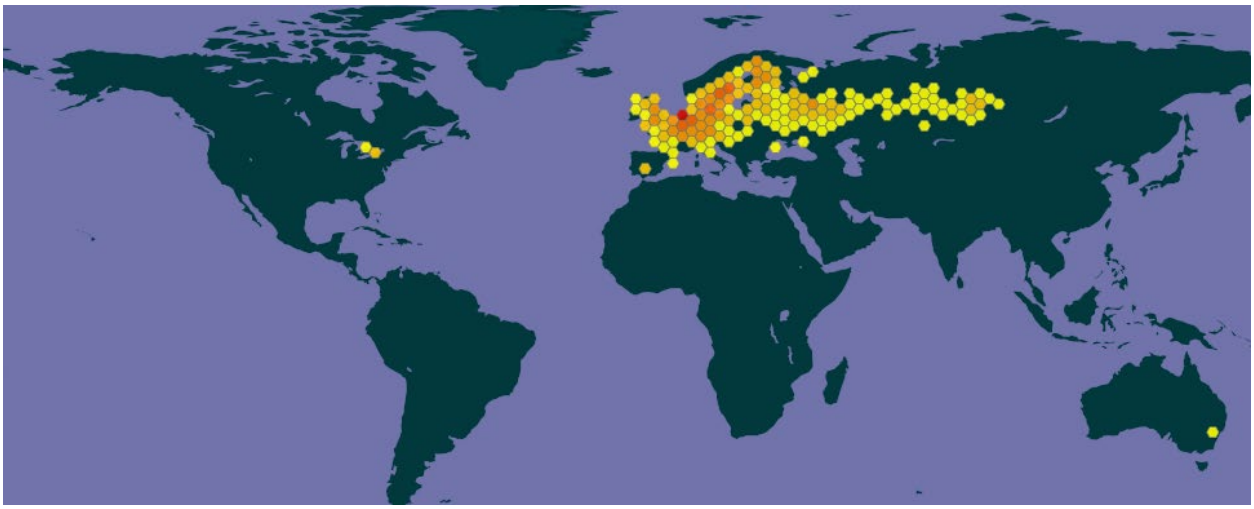

Figure 1. Known global distribution of *Stratiotes aloides*. Observations are reported from Central, Eastern and Northern Europe, Central Asia, Canada, and Australia. Map from GBIF Secretariat (2020). There was no record or reference of *Stratiotes aloides* being introduced to Australia in the literature, therefore this reference point will not be used during the climate matching analysis.

6 Distribution Within the United States

Stratiotes aloides has not been reported in the wild in the United States.

7 Climate Matching

Summary of Climate Matching Analysis

A majority of the United States had medium to high climate match. Areas with a high match could be found in the Northeast, the Great Lakes region, the Midwest, and the Northern Great Plains, with isolated pockets in the Rocky Mountains and Southwest region. The areas of low match were found primarily in the Pacific Northwest, peninsular Florida, far south Texas, along the Gulf Coast and into parts of the Mississippi Valley, and in southwest Arizona. The overall Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.437, high (scores of 0.103, or greater, are classified as high). Most States had high individual climate 6 scores. Kansas, North Carolina, Oregon, Rhode Island, Tennessee, and Washington had medium individual Climate 6 scores. Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas had low individual scores.

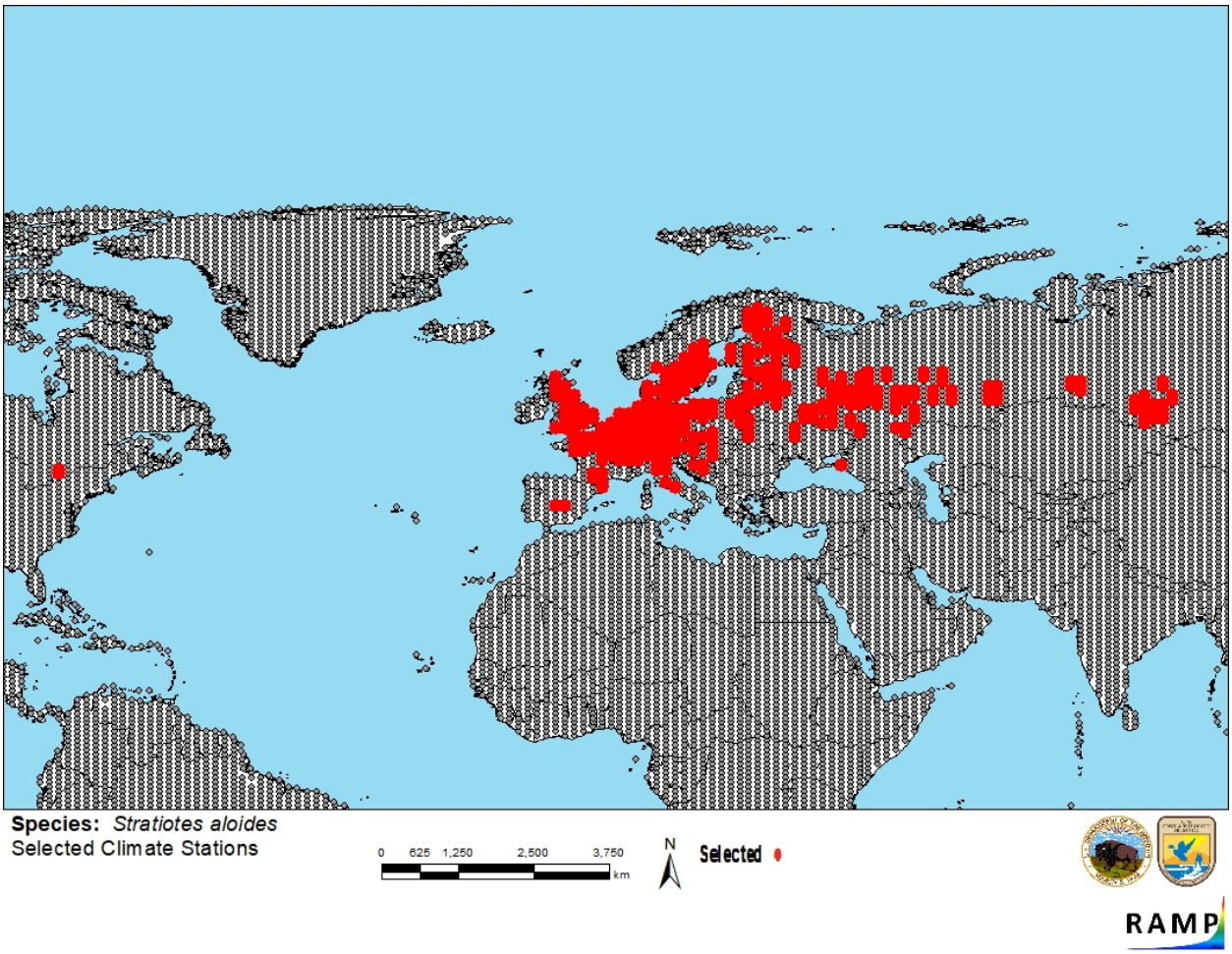

Figure 2. RAMP (Sanders et al. 2018) source map showing weather stations in Central, Eastern and Northern Europe, Central Asia, and Canada selected as source locations (red; Canada, Great Britain, the Netherlands, Finland, Sweden, Germany, Belgium, Russia, Denmark, Estonia, Austria, Lithuania, Belarus, Czechia, Poland, Ukraine, Hungary, Kazakhstan, and Luxembourg) and non-source locations (gray) for *Stratiotes aloides* climate matching. Source locations from GBIF Secretariat (2020). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

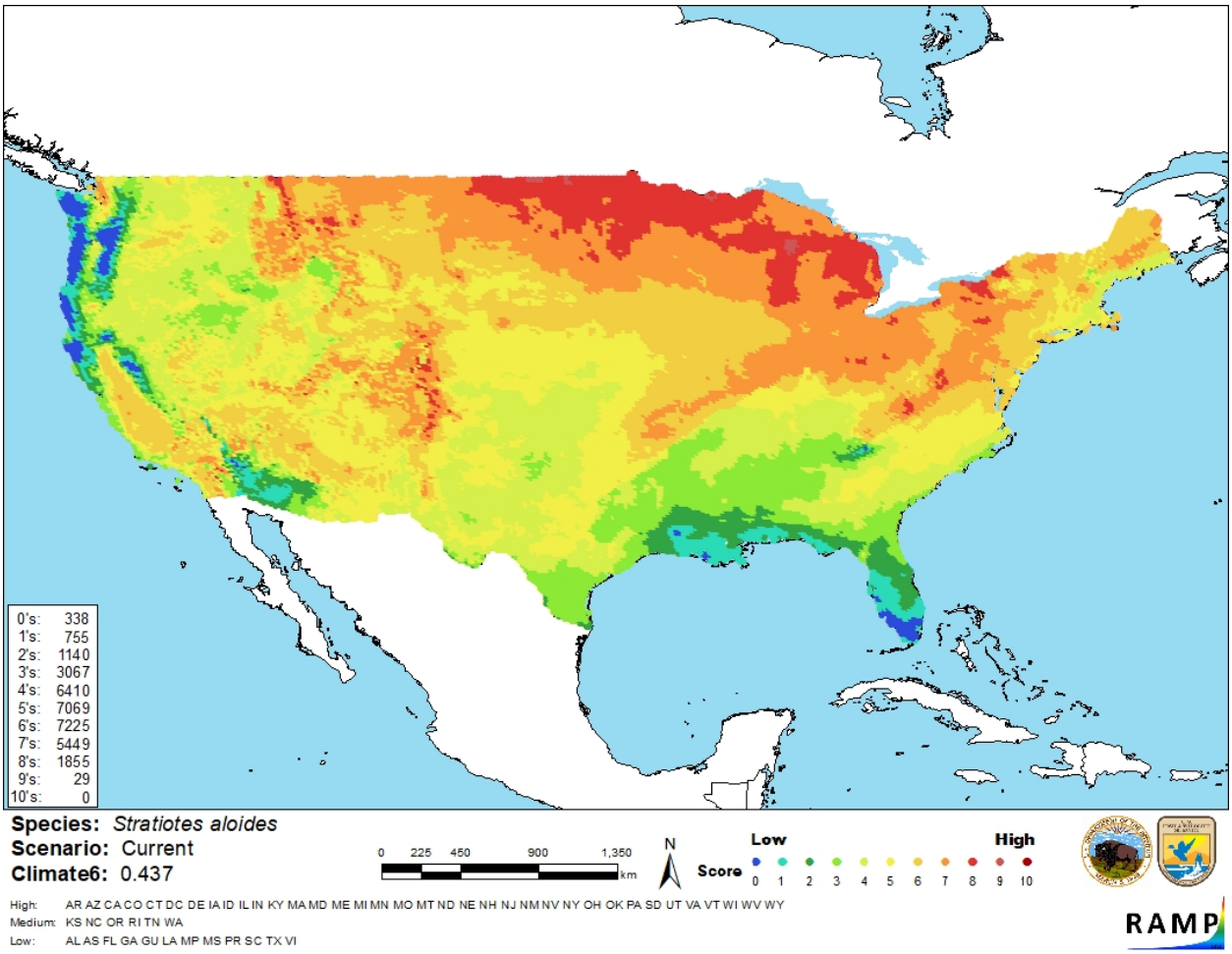

Figure 3. Map of RAMP (Sanders et al. 2018) climate matches for *Stratiotes aloides* in the contiguous United States based on source locations reported by GBIF Secretariat (2020). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

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

Information regarding the biology, ecology and distribution of *Stratiotes aloides* was available. Records of introduction resulting in established nonnative populations were found. No records regarding the observed impacts of introduction were found. Due to the lack of information

regarding impacts this species may have caused in introduced areas, the certainty of assessment for this species is Low.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Stratiotes aloides, water soldiers, is a rooted, flowering aquatic plant with serrated leaf edges native to Europe and Asia (Great Britain, the Netherlands, Finland, Sweden, Germany, Belgium, Russia, Denmark, Estonia, Austria, Lithuania, Belarus, Czechia, Poland, Ukraine, Hungary, Kazakhstan, and Luxembourg). Some authors proposed that *S. aloides* is introduced to some parts of Europe (e.g. France, Ireland) but those interpretations are under debate. This species has been used as an ornamental garden plant, and is still available in trade internationally today. It has sharp leaves that can cut skin, and can form dense mats. In Canada, it has escaped into the wild and has established nonnative populations in Ontario. *Stratiotes aloides* is on several international, and State invasive, prohibited, and restricted lists. In the United States, this species is listed as a noxious weed in Alabama, Florida, Oregon, Wisconsin, prohibited in Michigan, Minnesota, Washington, and injurious in Illinois. The history of invasiveness for this species is Data Deficient. The climate match for the contiguous United States was High, with the highest matches occurring in the Northeast, the Great Lakes region, and the Midwest with isolated pockets of high match in the Rocky Mountains and Southwest region. The certainty of assessment was Low due to the limited information regarding this species impacts in areas where it has become established. The overall risk assessment category for *Stratiotes aloides* is Uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 4): Data Deficient**
- **Overall Climate Match Category (Sec. 7): High**
- **Certainty of Assessment (Sec. 8): 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.

EDDMapS. 2020. Early Detection and Distribution Mapping System. Tifton: University of Georgia, Center for Invasive Species and Ecosystem Health. Available: https://www.eddmaps.org/species/subject.cfm?sub=6488 (July 2020).

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