African Elodea (*Lagarosiphon major*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, June 2015
Revised, April 2018
Web Version, 8/21/2018

Photo: Michael Wunderli. Licensed under Creative Commons BY 2.0. Available: http://eol.org/data_objects/32796945. (April 13, 2018).

1 Native Range and Status in the United States

Native Range
GISD (2018) lists *Lagarosiphon major* as native in Botswana, Lesotho, South Africa, Zambia, and Zimbabwe.

Status in the United States
Not currently found in the United States.

According to USDA, NRCS (2018), *Lagarosiphon major* is a federally listed noxious weed; a Class A noxious weed in Alabama, North Carolina, and Vermont; a quarantine species in California, Oregon, and Washington; a Class 1 prohibited aquatic plant in Florida; a prohibited species in Massachusetts; an invasive aquatic plant and plant pest in South Carolina; and a noxious plant in Texas.

Means of Introductions in the United States
Not currently found in the United States.

Remarks
From CABI (2018):

"Several other species in the family Hydrocharitaceae look very similar to *L. major*, including *Egeria densa*, *Elodea canadensis*, and *Hydrilla verticillata*. However, unlike the leaves of the other species, which grow in groups or whorls circularly around the stem, the leaves of *L. major* are distinguishably alternately spiralled [*sic*] (Australia Natural Heritage Trust, 2003). The presence of recurved leaves and a downward curving stem towards the apex also help to distinguish *L. major* from these similar species (Scher, 2007). *L. major* is often also mislabelled [*sic*] as *'Elodea crispa'*, usually by those dealing with the plant in the aquarium trade."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing
From ITIS (2018):

"Taxonomic Status:
Current Standing: accepted"

"Kingdom Plantae
  Subkingdom Viridiplantae
    Infrakingdom Streptophyta
      Superdivision Embryophyta
        Division Tracheophyta
          Subdivision Spermatophytina
            Class Magnoliopsida
              Superorder Lilianae
                Order Alismatales
                  Family Hydrocharitaceae
                    Genus *Lagarosiphon*
                      Species *Lagarosiphon major* (Ridl.) Moss."

From CABI (2018):

"*Lagarosiphon major* was first named *Lagarosiphon muscoides* Harvey in 1841, was revised to *L. muscoides* var. *major* by Ridley in 1886, and further revised to its current accepted scientific name, *L. major* (Ridl.) Moss in 1928. *L. major* is synonymous with *'Elodea crispa'*, a name that is often used by those using the plant in aquaria (Mason, 1960)."

Size, Weight, and Age Range

From CABI (2018):

"The brittle, sparsely branched stem can grow up to 20 feet long, […]"

Environment

From CABI (2018):

"It prefers the cool waters of the temperate zone, and grows best under high light intensity. *L. major* can grow to depths of 6.6 m (Coffey and Wah, 1988), but may grow to only 1 m in murky water (Australia Natural Heritage Trust, 2003)."

"*L. major* can live in a range of nutrient levels, however, in lakes with accelerated eutrophication and severely decreased water clarity, *L. major* abundance declines. *L. major* prefers high light intensity, and its best growth is recorded at 600 micro-einsteins/m2/h (Schwarz and Howard-Williams, 1993). *L. major* is able to withstand a relatively high pH, and its own photosynthetic activity has been recorded as raising pH levels to 10-10.4 in the surrounding water (CAPM-CEH, 2004). In conjunction with pH, *L. major* can survive in high alkalinity conditions as well. The optimum [water] temperature of *L. major* is 20-23°C, with a maximum temperature of approximately 25°C. *L. major* is thought to be absent below temperatures of 10°C (Australia Natural Heritage Trust, 2003)."

Climate/Range

From CABI (2018):

"It prefers the cool waters of the temperate zone, […]"

Distribution Outside the United States

Native

GISD (2018) lists *Lagarosiphon major* as native in Botswana, Lesotho, South Africa, Zambia, and Zimbabwe.

Introduced

GISD (2018) lists *Lagarosiphon major* as alien, established, and invasive in Australia, France, Ireland, Italy, New Zealand, Reunion, Switzerland, and the United Kingdom including the Channel Islands.

CABI (2018) lists *Lagarosiphon major* as present, introduced, and invasive in France and New Zealand; as present and introduced in Germany, Ireland, Italy, Netherlands, Portugal, Spain, Switzerland, and UK; and as present in Belgium.

From GISD (2018):

"It naturalised in a dam near Melbourne in 1977 but was removed (Parsons and Cuthbertson 1992)."

"*L. major* is a declared plant under Queensland legislation. Declaration requires landholders to control declared pests on the land and waters under their control. Local Government may serve a notice upon a landholder requiring control of declared pests (The State of Queensland, 2004)."

From CABI (2018):

"*L. major* was introduced to New Zealand in the 1950s, and has naturalized in many freshwater lakes in the country. *L. major* was first recorded in Britain in 1944, and was first reported in Germany and Ireland in 1966. In southern Australia, *L. major* has been found and eradicated from a few small dams, and it is currently not known to be naturalized (Australia Natural Heritage Trust, 2003)."

Kadono (2004) lists *Lagarosiphon major* as having been observed in the wild in Japan.

Means of Introduction Outside the United States

From CABI (2018):

"*L. major* was first reported as being naturalized in New Zealand in 1950, and by 1957 the population had grown to nuisance levels in Lake Rotorua. It is believed that *L. major* was intentionally introduced to Lake Rotorua with the intention of improving the oxygen levels (Cronk and Fuller, 1995), although the dense mats of vegetation that occurred actually decreased the lake oxygen levels. *L. major* spread to Lake Taupo around 1966, and was probably introduced to the lake by recreational boat traffic (Cronk and Fuller, 1995). *L. major* continues to spread to many other freshwater lakes in New Zealand, and is a major concern in the region.

L. major was first recorded in a chalk pit in Britain in 1944, and has since spread to several other locations throughout Europe. *L. major* was first recorded both in Germany and Ireland in 1966, and its introductions were intentional horticultural and ornamental releases (NOBANIS, 2005; BioChange, 2007). In Ireland, the occurrence of *L. major* between 1987-1999 [*sic*] was recorded as being present in 7 hectads (1 hectad = 10km X 10km) (BioChange, 2007), though many additional *L. major* occurrences have been reported during the last five years (NBGI, 2007).

There are currently no naturalized populations of *L. major* in Australia, but there have been small invasions near Melbourne in Victoria, and Newcastle in New South Wales that were eradicated in the 1970s. These introductions were believed to have been plants that had originated in aquariums or ponds. In addition, there is a record of a cultivated specimen near Queensland in 1990 (Australia Natural Heritage Trust, 2003)."

"*L. major* can be spread accidentally to new locations by the movement of boats, trailers, nets, sea planes, and other recreational equipment between water bodies (McGregor and Gourlay, 2002; Australia Natural Heritage Trust, 2003). It is also possible for *L. major* to be a 'hitchhiker' plant with other species ordered through water garden catalogues. *L. major* can also be accidentally introduced by flooding of ornamental ponds into surrounding natural waterways. *L. major* has also been introduced through hobbyists emptying unwanted aquarium species directly into surrounding waterways."

Short Description

From CABI (2018):

"*L. major* is a dioecious, perennial submerged aquatic plant with adventitious roots and rhizomes that attach the plant to the substrate. The brittle, sparsely branched stem can grow up to 20 feet long, is 3-5 mm in diameter and curves like a 'J' towards the base. The dark green leaves are alternately spiralled [*sic*] around the stem, though often crowded towards the stem tip. The leaves are minutely toothed, 5-20 mm long, 2-3 mm wide and generally have tapered tips that curve down towards the stem, though in low alkalinity waters the leaves can appear straight (Australia Natural Heritage Trust, 2003). The female flower is very small, with three transparently white/pink petals that are attached to a filament-like stalk above the water's surface. Only the female plant is known outside of its native range. The fruit is a beaked capsule, containing approximately nine seeds, each seed being approximately 1/8 inch long (UFL-CAIP, 2001)."

Biology

From CABI (2018):

"*L. major* prefers lakes, reservoirs, and slow moving rivers with silty or sandy bottoms. *L. major* is also known to occur in wetlands, water courses, riparian zones (ISSG, 2006), canals and drainage ditches (CAPM-CEH, 2004)."

"*L. major* is a dioecious plant, which refers to a species in which the male and female reproductive organs occur on different individuals. *L. major* has the ability to reproduce by both vegetative and sexual means, though only vegetative reproduction has been observed outside of its native range."

"In the Northern hemisphere, *L. major* becomes dormant in the winter and emerges in the spring from rhizomes and shoots. *L. major* is capable of producing two types of flowers; the male flowers break free from the plant and float along the water's surface, while the female flowers remain attached to the plant by long, filament-like stalks. All populations of *L. major* outside of its native range have consisted of plants with only female flowers, and male flowers, fruits, and seeds have not been recorded outside of Africa. Female flowers appear from summer to early autumn, and the overall growth of *L. major* decreases as day length and light intensity decreases (Australia Natural Heritage Trust, 2003)."

Human Uses

From GISD (2018):

"Davies et al. (2003) demonstrated that, \"*L. major* and other aquatic species grown in small outdoor tanks can be used successfully to assess the effects of crop-protection products on non-target aquatic flora.\"McGregor and Gourlay (2002) state that, \"*L. major* has some beneficial attributes. In some freshwaters, this species and some other exotic species are the only aquatic plants that can tolerate particular conditions, and removal of these plants can further degrade the habitats. It also provides habitat for aquatic fauna, and its leaf surfaces support periphyton. Where stands of the plant grow, sedimentation is increased and while this may be detrimental in some areas, elsewhere it is a benefit.\""

"Chapman and Coffey (1971) reviewed the possible utilization by harvesting for stock food in New Zealand lakes. Though harvesting was considered practicable the use of the plants as fodder was thought to be unsuitable because of the content of arsenic accumulated by the plants from the thermal waters that enter the lakes. Arsenic in amounts of 35–75 ppm dry weight are common, and extreme values up to 2 000 ppm have been recorded. It is possible in other countries that the use of plants as fodder could be practical."

From CABI (2018):

"*L. major* has been intentionally planted as an 'oxygenator' or ornamental in different water bodies throughout its current distribution. 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 (Australia Natural Heritage Trust, 2003)."

"Ornamental plants of *L. major*, often sold under the name *'Elodea crispa'*, are sold for aquariums and ponds, though the specific economic value of this particular species in the ornamental plant trade is unknown. *L. major* was also once sold as capable of 'water purification', though the continuance of this practice is unknown (NBGI, 2007).

The utilization of *L. major* as fodder for stock food was explored as a possible usage of harvested biomass, though the high levels of arsenic accumulated by the plants proved unsuitable (ISSG, 2006)."

Diseases

From CABI (2018):

"McGregor and Gourlay (2002) report the nematode *Aphelenchoides fragariae* attacking the apical tips of *L. major*. *Nymphula nitens* has also been reported as feeding on several aquatic weeds, though it is not specific to *L. major*."

Threat to Humans

No records of threats to humans from *Lagarosiphon major* were found.

3 Impacts of Introductions

From Matthews et al. (2012):

“The major adverse impacts of Curly Waterweed (*Lagarosiphon majo*r) are related to interference and exploitation competition. In the heavily colonised Lough Corrib, Ireland the impact on native and other non-native species has been dramatic. Assuming that the surrounding lakes of Lough Corrib feature a similar species composition to that that existed in Lough Corrib prior to *L. major* invasion, characteristic dense meadows of charophyte vegetation, mixed with tall stands of *Myriophyllum spicatum*, *Elodea canadensis* and a range of *Potamogeton* species have been lost (Caffrey & Acavedo, 2007). These impacts have also been observed in other locations where *L. major* has invaded. Following the invasion of Lake Taupo in New Zealand, the number of native species decreased markedly, the most noticeable decrease occurring at 4 m depth. Moreover, large weed beds of *L. major* attracted herbivorous birds and detritivores such as swans and crayfish which also adversely affect the native flora (Howard-Williams & Davies, 1988). The replacement of an established invasive weed, by another from the same family has previously been thought to be of little consequence. However, in New Zealand, *L. major* was able to grow taller and denser than *E. canadensis,* with the result that biodiversity was further reduced and surface-reaching weed beds posed even greater interference to water body usage (Champion & Clayton, 2000). In other locations, however, *L. major* has proven to be less aggressive. In some areas of New Zealand *L. major* has been displaced by other species and may co-exist with native species (McGregor & Gourley, 2002).”

“Low light levels and the deep, often anoxic mud deposits that exist beneath the *L. major* canopy make it very difficult for other aquatic plant species to exist (Caffrey & Acavedo, 2007). One of the main physical habitat modification is due to the canopy formed by *L. major*. Where mature surface-reaching stands have become established, the canopy is able to shade out, and competitively exclude, even tall submerged species […]. It has been demonstrated that as little as 1% sunlight can penetrate a canopy of 0.5 m deep (Schwarz & Howard-Williams, 1993). The presence of dense stands of macrophytes can have a number of other effects including changes in nutrient availability and resource pools. *L. major* presence increases dissolved reactive phosphorous and dissolved inorganic nitrogen and results in changes in temperature and dissolved oxygen level (Schwarz & Howard-Williams, 1993; Department of Primary Industries, 2011).”

“Colonisation of Lough Corrib in the west of Ireland by *L. major* has led to changes in the survival and composition of fish species that could have major impacts on the Brown Trout and Salmon fishery (Caffrey, 2009).”

“Significant changes in abundance and species composition within the macroinvertebrate community have been observed following invasion by *L. major*. Particular differences have been noted in the abundance of sedentary taxa, including Chironomidae and Mollusca. The most notable difference, however, reflected the significant increase in the abundance of certain macroinvertebrate groups e.g. Chironomidae (Caffrey & Acavedo, 2007). This observation has been repeated in other studies. In Lake Wanaka, a large alpine New Zealand lake, *L. major* and *E. canadensis* contributed to greater standing stocks and productivity of epiphyton. Invertebrate communities were less dense (1890/m^2 vs 4030/m^2) and less diverse (richness = 9 vs 12).

Invertebrate communities in native beds were dominated by snails, oligochaetes, and nematodes, whereas chironomids, snails, and caddisflies were dominant in non-native beds (Kelly & Hawes, 2005). However, other literature evidence contradicts these observations. Biggs and Malthus (1982) conducted research into the preference of macroinvertebrate groups for native and non-native macrophytes. There appeared to be no preference by the invertebrate fauna (in terms of either numbers of taxa, abundance, or biomass) for either native plants or the non-native *L. major* as a habitat."

"In its native range (South Africa) as well as in introduced areas prolific growth of *L. major* can interfere with commercial navigation and water-based recreation (Centre for Ecology and Hydrology, 2004; Caffrey & Acavedo, 2007). Swimming maybe impossible in areas of dense weed growth […] and the snarling of weeds in outboard motors may put recreational boaters at risk (Caffrey & Acavedo, 2007). Storms can tear the weed loose and deposit large masses of rotting vegetation on beaches, spoiling their amenity value; and effect power stations (Brown, 1975; Rowe and Hill, 1989). Water velocity is slowed in dense beds of aquatic plants, particularly in those where there is a canopy and under-storey [*sic*] (Frodge et al., 1990). Large beds of *L. major* may increase the risk of flow impedance as the discharge capacity of an invaded water body is reduced (Department of Primary Industries, 2011). Extensive growth can block the turbine screens of hydro-electric power stations in quantities too great for the cleaning machinery to clear, causing temporary shutdowns, economic losses and power shortages (Chapman et al., 1974)."

"In the United Kingdom the estimated yearly economic cost of *L. major* alone is 1,173,214 Pounds or approximately 1,466,400 Euros (Hulme, 2012). Controlling *L. major* by mechanical means was estimated to be 1,000 pounds or 1,250 Euros per hectare per year assuming that each 10 km square contains at least 1 hectare of plants (GB Non-Native Species Secretariat, 2011)."

From GISD (2018):

"In New Zealand, the plant has blocked intakes of hydro-electric systems and has formed dense floating mats in deep-water reservoirs and other water bodies."

"McGregor and Gourlay (2002) state that, \"*L. major* replaces native vegetation; dense infestations restrict the passage of boats and limit recreational activities like swimming and angling; storms can tear loose the weed and deposit large masses of rotting vegetation on beaches, spoiling their amenity value."

"James et al. (1999) report that, \"*L. major* has been reported to be actively displacing *E. nuttallii* and appears to be competitively superior to Elodea spp. in at least some habitats.\""

"The small adverse affect [*sic*] *L. major* has on some recreational use of Lake Dunstan is more than offset by the environmental benefits it provides as shelter and feeding areas for a range of aquatic fauna."

From CABI (2018)

"*L. major* alters the chemical composition of the water body by creating stressful conditions of high pH and low carbon dioxide (James et al., 1999). The photosynthesis of *L. major* has been recorded as raising surrounding pH to levels over 10, and has the ability to raise levels to 10.4, (the limit of bicarbonate uptake) in small water bodies (CAPM-CEH, 2004). These high pH levels inhibit other native species from effectively photosynthesizing, giving *L. major* a competitive advantage."

"*L. major* can also be an excellent competitor for light, and has been known to out-compete native aquatic vegetation and associated invertebrate populations (ISSG, 2006). Despite this species' common name of 'oxygen weed', the dense mats of vegetation that are characteristic of this species when introduced outside of its native range actually decrease the oxygen levels by limiting water circulation and increased decomposition of dead plants. Dense mats of *L. major* also have the ability to change water hydrology and quality, negatively affecting the ecosystem in which it occurs."

"*L. major* reduces biodiversity by competing with and displacing native vegetation, and is capable of changing the fauna and flora of an ecosystem. *L. major* has out-competed native species wherever it has colonized, due in part to its ability to out-compete submerged vegetation for light and photosynthesize in the inhospitable, stress-inducing water conditions that it creates. In particular, *L. major* has out competed *Myriophyllum* spp., *Potamogeton* spp., (Rattray et al., 1994), and *Elodea* spp. (James et al., 1999). Decomposing mats of *L. major* also have the ability to cause fish kills by creating low oxygen levels in the water."

"*L. major* can form dense mats that impede recreational activities such as boating, fishing, swimming, water skiing, canoeing, and kayaking. In addition, unsightly mats of vegetation decrease aesthetic values. These declines in recreational and aesthetic values can decrease tourism, which can be a major source of income within the community."

4 Global Distribution

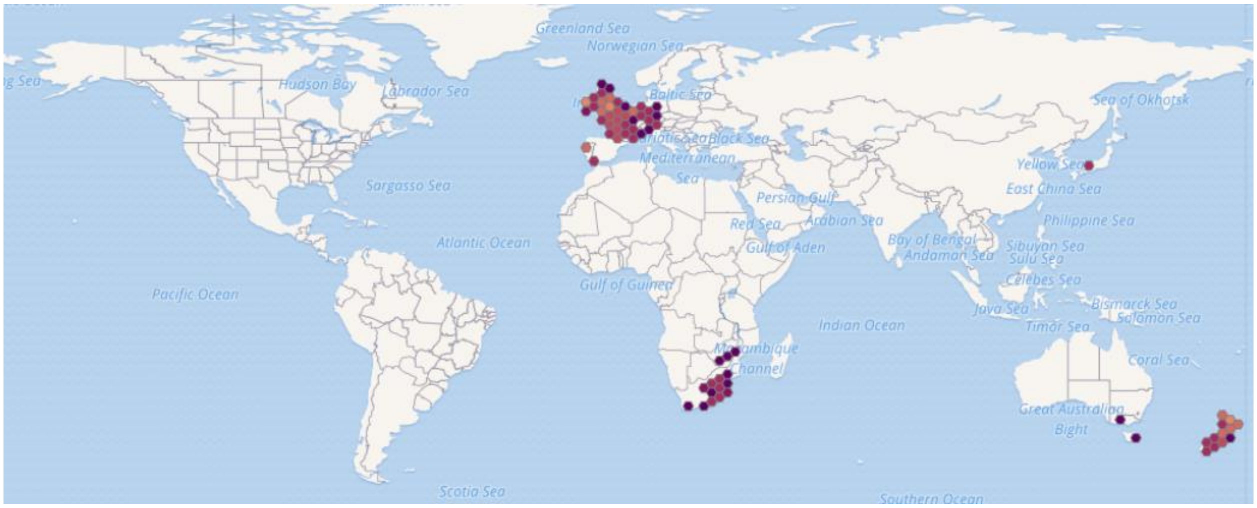

Figure 1. Known global distribution of *Lagarosiphon major*. Locations are in Europe, southern Africa, Japan, Australia, and New Zealand. Map from GBIF Secretariat (2018).

5 Distribution Within the United States

Lagarosipohon major is currently not found in the United States.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Lagarosiphon major* was high in the Southwest, particularly southwest Texas and the southern California coast. There were other areas of high match in California and in a band from northeast Texas to the southern Great Lakes and mid-Atlantic States. There were areas of low match in the Pacific Northwest, northern Great Plains, New England, and the South, including central parts of the Gulf Coast. Everywhere else had a medium match. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous United States was 0.245, high. The following States had individually high climate matches: Arizona, Arkansas, California, Delaware, Illinois, Indiana, Kansas, Kentucky, Maryland, Massachusetts, Michigan, Missouri, New Jersey, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Rhode Island, Texas, Virginia, and West Virginia.

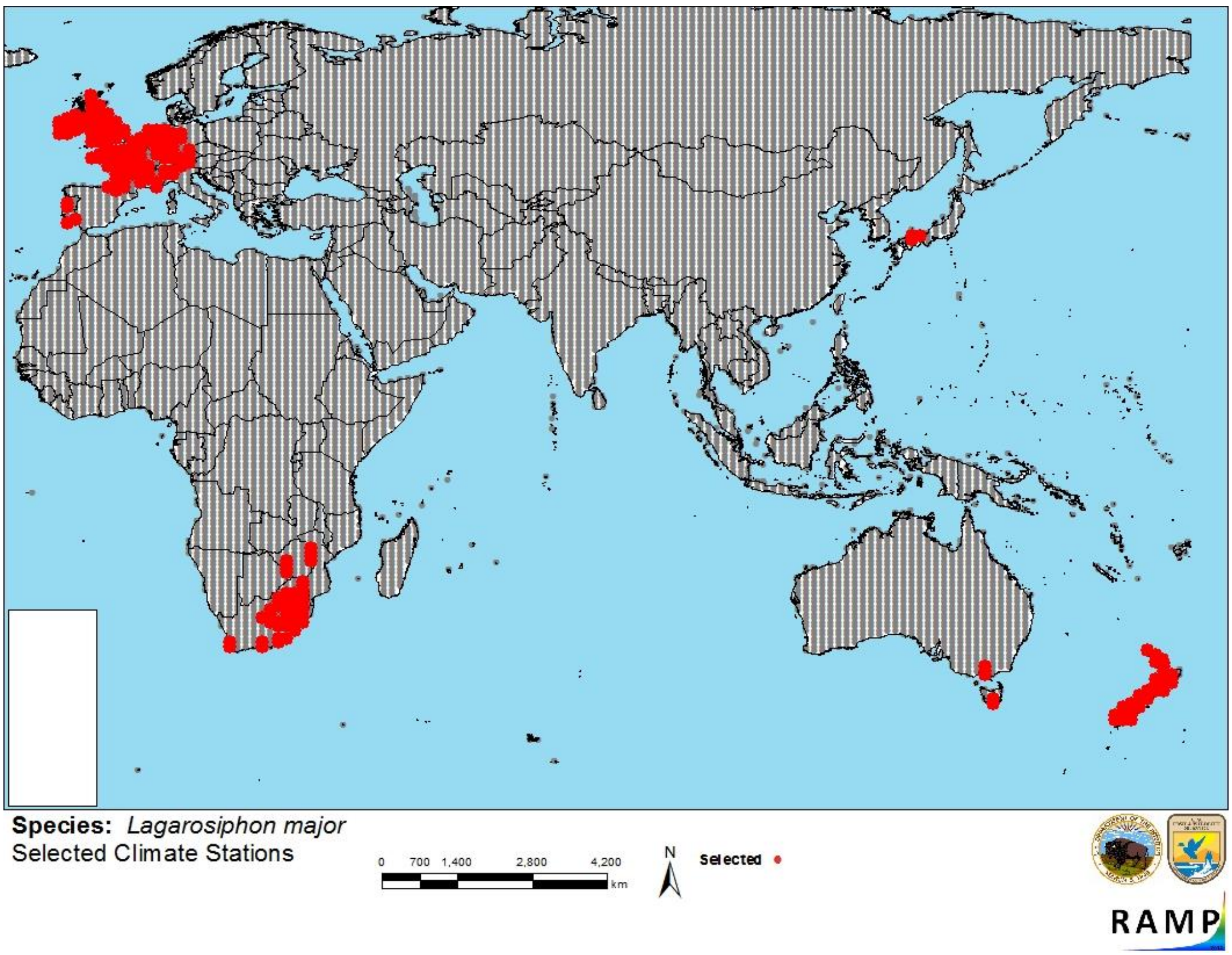

Figure 2. RAMP (Sanders et al. 2014) source map showing weather stations in Europe, southern Africa, Japan, Australia, and New Zealand selected as source locations (red) and non-source locations (gray) for *Lagarosiphon major* climate matching. Source locations from GBIF Secretariat (2018).

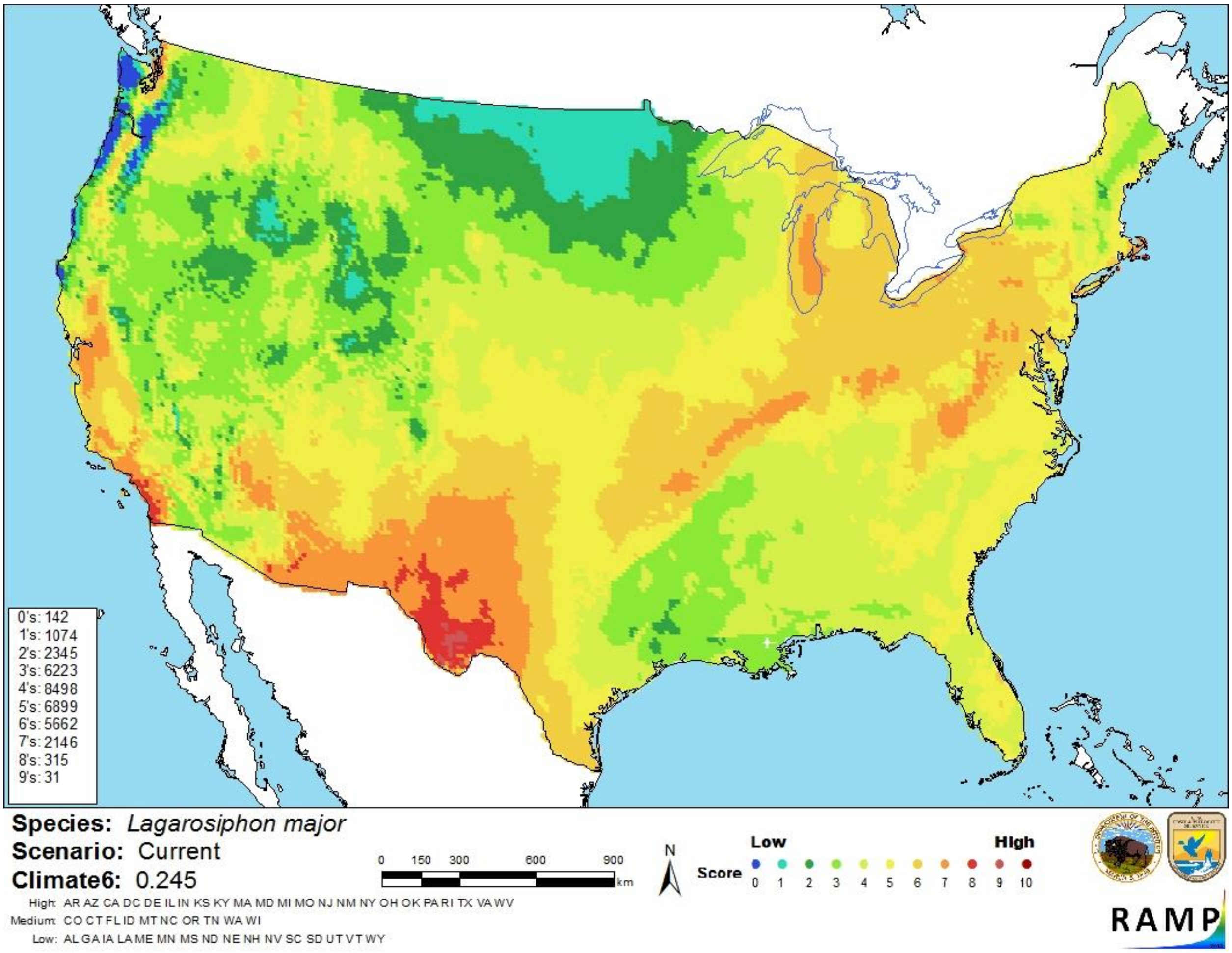

Figure 3. Map of RAMP (Sanders et al. 2014) climate matches for *Lagarosiphon major* in the contiguous United States based on source locations reported by GBIF Secretariat (2018). 0 = Lowest match, 10 = Highest match.

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 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

Lagarosiphon major is an aquatic plant native to southern Africa and has been introduced in Europe, New Zealand, and parts of Australia. The history of invasiveness for *L. major* is high. Invasions of *L. major* have resulted in the loss of native plant species. Climate matching indicated the contiguous United States has a high climate match. The areas of high match are scattered across the contiguous United States from the southwest through the lower Great Lakes. The certainty of this 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:** No additional remarks
- **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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10 References Quoted But Not Accessed

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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