

## Risk Assessment of *Egeria densa*

|                          |  |
|--------------------------|--|
| <b>Name of Organism:</b> | <i>Egeria densa</i> Planchon – Large-flowered Waterweed  |
| <b>Objective:</b>        | Assess the risks associated with this species in Ireland |
| <b>Version:</b>          | Final 15/09/2014   |
| <b>Author(s)</b>         | Michael Millane and Joe Caffrey                          |
| <b>Expert reviewer</b>   | Jonathan Newman  |

### Stage 1 - Organism Information

### Stage 2 - Detailed Assessment

Section A - Entry  
Section B - Establishment  
Section C - Spread  
Section D - Impact  
Section E - Conclusion  
Section F - Additional Questions

### ***About the risk assessment***

This risk assessment is based on the **Non-native species APplication based Risk Analysis (NAPRA)** tool (version 2.66). NAPRA is a computer based tool for undertaking risk assessment of any non-native species. It was developed by the European and Mediterranean Plant Protection Organisation (EPPO) and adapted for Ireland and Northern Ireland by Invasive Species Ireland. It is based on the Computer Aided Pest Risk Analysis (CAPRA) software package which is a similar tool used by EPPO for risk assessment.

**Notes:** Confidence is rated as low, medium, high or very high.  
Likelihood is rated as very unlikely, unlikely, moderately likely, likely or very likely.  
The percentage categories are 0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%.  
N/A = not applicable.

This is a joint project by Inland Fisheries Ireland and the National Biodiversity Data Centre to inform risk assessments of non-native species for the European Communities (Birds and Natural Habitats) Regulations 2011. It is supported by the National Parks and Wildlife Service.

## DOCUMENT CONTROL SHEET

|                                 |  |      |                |                 |                |
|---------------------------------|--|------|----------------|-----------------|----------------|
| <b>Name of Document:</b>        | Risk Assessment of <i>Egeria densa</i> |      |                |                 |                |
| <b>Author (s):</b>              | Dr Michael Millane and Dr Joe Caffrey  |      |                |                 |                |
| <b>Authorised Officer:</b>      | Dr Joe Caffrey                         |      |                |                 |                |
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|                                 | n/a                                    | YES  | n/a            | n/a             | 0              |

### Version Control Table

| Version No.         | Status   | Authors(s)         | Reviewed by        | Approved by         | Date of issue |
|---------------------|----------|--------------------|--------------------|---------------------|---------------|
| Draft 1             | Complete | Dr Michael Millane | Dr Joe Caffrey     |                     | 26/05/2014    |
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| <b>Stage 1 - Organism Information</b>   |   |                 |  |
|---|---|-----------------|--|
| <i>The aim of this section is to gather basic information about the organism.</i> |   |                 |  |
| <b>N</b>  | <b>QUESTION</b>   | <b>RESPONSE</b> | <b>COMMENT</b>   |
| 1   | What is the reason for performing the risk assessment?  |                 | A risk assessment is required as this species is listed as a "Non-native species subject to restrictions under Regulations 49 and 50" in the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011, SI 477/2011.  |
| 2   | Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank? | YES             | <i>Egeria densa</i> (Planchon), <i>Anacharis densa</i> (Planchon) Vict., <i>Elodea densa</i> (Planch.) Casp, <i>Philotria densa</i> (Planchon) Small. Leafy Elodea (preferred common name), Brazilian Elodea, Brazilian Waterweed, Common Waterweed, Dense Waterweed, and Egeria (CABI 2014), Large-flowered Waterweed (Botanic Gardens 2007) and South American Waterweed (Global Invasive Species Database 2006).  |
| 3   | If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)           | N/A             |  |
| 4   | Describe the organism.  |                 | <i>Egeria densa</i> is a "herbaceous, tender plant, with cauline leaves regularly disposed in close whorls, resembling cylinders 2-6 <b>mm wide</b> and 10- <b>30 mm</b> long. Stems sparsely branched, with short internodes, delicate, breaking easily with the parts forming new plants. In shallow water, plants can be anchored to the bottom, otherwise free-floating. Filament-like roots at the base of plants and at some nodes, especially in broken pieces. Leaves sessile, lanceolate, 1-3 cm long and 2 - <b>6 mm wide</b> , apex rounded or acute, margins finely serrated, surface smooth, intensely green when receiving natural light, more pale in aquaria. <i>E. densa</i> normally presents four leaves per whorl, but can present five or six. Plants are dioecious. From the axils of some leaves arise spathes and from their interior emerge floral peduncles 2-6 cm long that expose solitary flowers <i>ca.</i> 2 cm above the water surface. Male flowers are in groups of 2-4, from one spathe, the perianth formed by a calyx of 3 green sepals, corollas with 3 white petals, 10-15 mm long, stamens 9. Female flowers one per spathe, perianth like that of males, ovary unilocular formed by 3 carpels, androecium only residual with 3 yellow staminodes. Fruits are berry-like, ovate, 7-8 mm long and 3 mm wide with membranaceous and transparent pericarp. Seeds numerous, fusiform, 7-8 mm long, with a 2 mm filament present at the end." (CABI 2014; with minor amendments by J. Newman highlighted in bold font). |

| <b>Stage 1 - Organism Information</b>   |   |                 |  |
|---|---|-----------------|--|
| <i>The aim of this section is to gather basic information about the organism.</i> |   |                 |  |
| <b>N</b>  | <b>QUESTION</b>   | <b>RESPONSE</b> | <b>COMMENT</b>   |
| 5   | Does a relevant earlier risk assessment exist? (give details of any previous risk assessment) | YES             | A preliminary risk assessment was previously carried out for Ireland. This was a stage one and two risk assessment as part of <i>Ireland's National Plant Conservation Strategy - Target 10 - Managing Invasive Alien Species</i> (Botanic Gardens 2007); It designated <i>Egeria densa</i> as a "most significant invasive plant".<br><br>Further to this, Invasive Species Ireland (2010) rates this plant as of medium risk and has placed it on its amber list as its "impact on conservation goals remains uncertain due to lack of data showing impact or lack of impact".                                 |
| 6   | If there is an earlier risk assessment is it still entirely valid, or only partly valid?      | PARTIAL         | Only a preliminary risk assessment was previously conducted in Ireland (refer to Question 5).  |
| 7   | Where is the organism native?   |                 | <i>Egeria densa</i> is native to parts of Argentina, Brazil and Uruguay (Yarrow <i>et al.</i> 2009; CABI 2014).  |
| 8   | What is the current global distribution of the organism (excluding Ireland)?                  |                 | Africa (South Africa and Swaziland [Global Invasive Species Database 2006]), Americas (Argentina, Bolivia, Brazil, Chile, Columbia, Costa Rica, Cuba, Mexico, Nicaragua, Paraguay, Puerto Rica, Uruguay and USA); Asia (Bangladesh [Alfasane <i>et al.</i> 2010], Georgia, Indonesia, Japan [Global Invasive Species Database 2006], Nepal and Turkey); Europe (Belgium, Denmark [Global Invasive Species Database 2006], France, Germany, Hungary, Italy, The Netherlands, Russia, Spain, Switzerland and UK); and Oceania (Australia, Cook Islands, French Polynesia and New Zealand) (reviewed in CABI 2014). |
| 9   | What is the current distribution of the organism in Ireland?                                  |                 | <i>Egeria densa</i> has been recorded at a single wild location in Ireland in Lough Nasool near Riverstown, Co. Sligo in 1988 (National Biodiversity Data Centre 2009). This lake periodically drains through a sink hole (last time occurring in 2006). Therefore, its current status there is uncertain. However, a recent survey of the lake by IFI field staff (2014) failed to detect the plant. There is also a single record of <i>Egeria densa</i> from Northern Ireland where it is present in a "small lined pond" in Helen's Bay, Co. Down (National Biodiversity Data Centre 2009).                  |
| 10  | Is the organism known to be invasive anywhere in the world?                                   | YES             | South-eastern Brazil (Barreto <i>et al.</i> 2000); Chile (Yarrow <i>et al.</i> 2009); Cook Islands, Cuba, France, French Polynesia, Germany, Italy, New Zealand, Switzerland, Puerto Rico, The Netherlands, UK and USA (reviewed in CABI 2014).<br><br>According to the Global Invasive Species Database (2006), " <i>Egeria densa</i> is a submersed, freshwater perennial herb that forms dense monospecific stands that restrict water movement, trap sediment, and cause fluctuations in water quality. It   |

**Stage 1 - Organism Information**

*The aim of this section is to gather basic information about the organism.*

| <b>N</b> | <b>QUESTION</b> | <b>RESPONSE</b> | <b>COMMENT</b>   |
|----------|-----------------|-----------------|--|
|          |                 |                 | has also affected the status of certain threatened species. It has been introduced worldwide through the aquarium trade, and even in its native range can become a nuisance species causing local economic impacts.” |

**Stage 2 - Detailed assessment: Section A - Entry**

This section evaluates the probability of entry of an organism into Ireland. For organisms which are already present, only complete the entry section for currently active pathways of entry and potential future pathways. The entry section need not be completed for pathways which have allowed an organism to enter in the past but are no longer active.

| N    | QUESTION   | RESPONSE                            | CONFIDENCE | JUSTIFICATION  |
|------|--|-------------------------------------|------------|--|
| 1.01 | How many active/future pathways are relevant to the potential entry of this organism (n/a, very few, few, moderate number, many or very many)?                 | MODERATE                            | VERY HIGH  | Horticultural and aquarium trade, boating, angling and other water activities.   |
| 1.02 | List <u>significant</u> pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways. | 1. Horticultural and aquarium trade |            | <i>Egeria densa</i> is imported into Ireland via the horticultural and aquarium sectors for sale in outlets such as aquarium / pet shops and garden centres. It is also available to purchase from private vendors on the internet for use in aquaria (e.g. on the 12/05/2014 it was advertised for sale on Adverts.ie and Donedeal.ie).<br><br>Presently, it is considered that there is a low risk that <i>Egeria densa</i> could be introduced or transferred by boaters, anglers or other water users as its occurrence on the island of Ireland is very low (only two records) and in the nearest neighbour to Ireland, Britain, it is low, albeit increasing (refer to response to Question 1.08). |

**Pathway 1 - Horticultural and aquarium trade**

| N    | QUESTION  | RESPONSE    | CONFIDENCE | JUSTIFICATION  |
|------|---|-------------|------------|--|
| 1.03 | Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)? | INTENTIONAL | VERY HIGH  | <i>Egeria densa</i> is deliberately imported for trade. It is also feasible to assume it could be a contaminant in the trade of other species of aquatic plants (CABI 2014).   |
| 1.04 | How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year?             | VERY LIKELY | HIGH       | <i>Egeria densa</i> is deliberately imported for trade and subsequently sold in a range of outlets in Ireland as an oxygenator / ornamental plant for artificial watercourses, garden ponds and aquaria. However, there is a paucity of information to assess the level of annual imports to Ireland. A study by Brunel (2009) based on data from 10 European and Mediterranean Plant Protection Organisation (EPPO) countries from mainland Europe, found that <i>Egeria densa</i> was the most imported aquatic plant for use in aquaria and that almost 2,000,000 specimens were imported to these countries per annum. |

| Pathway 1 - Horticultural and aquarium trade |  |             |            |   |
|--|--|-------------|------------|---|
| N  | QUESTION   | RESPONSE    | CONFIDENCE | JUSTIFICATION   |
| 1.05   | How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities? | VERY LIKELY | HIGH       | Awareness by the relevant competent authorities at points of entry to recognise and identify this species is limited or non-existent at present.  |
| 1.06   | How likely is the organism to survive during passage along the pathway?  | VERY LIKELY | VERY HIGH  | As the organism is distributed deliberately <i>via</i> trade, survival is considered very likely.   |
| 1.07   | How likely is the organism to arrive during the months of the year appropriate for establishment?                  | VERY LIKELY | VERY HIGH  | <p>Trade imports and purchases of <i>Egeria densa</i> may occur throughout the year. Outside of its native range, the vast majority of established populations consist solely of male plants (CABI 2014) and all plants in cultivation are male, reproducing vegetatively (Botanic Gardens 2008). Therefore, any plants arriving to Ireland or which escape to the wild are most likely capable of reproducing solely by vegetative means. The information presented below suggests that there is no known seasonal restriction to inhibit the establishment of <i>Egeria densa</i> from viable plant material in a suitable aquatic environment in Ireland. Plant material is likely capable of immediate growth in some periods of the year or able to remain viable until such a suitable period arises.</p> <p>The Washington State Department of Ecology (2003) states that, "The absence of sexual reproduction in introduced populations of Brazilian elodea (i.e. <i>Egeria densa</i>) emphasizes the importance of the vegetative growth phase of the plant. Specialized nodal regions described as double nodes occur at intervals of 6 to 12 nodes along a shoot. A double node consists of 2 single nodes separated by a greatly shortened internode. Double nodes produce lateral buds, branches, and adventitious roots. Only shoot fragments of Brazilian elodea, which contain double node regions, can develop into new plants. The plant fragments readily and each fragment containing a double node has the potential to develop into a new plant. Plant root crowns also develop from double nodes along an old shoot. When a shoot sinks to the bottom during autumn and winter senescence, a new root crown may develop at one or several double nodes along the new shoot. Brazilian elodea lacks specialized storage organs such as rhizomes or tubers and stores carbohydrates in stem tissues."</p> <p>In North American populations, growth is reported to commence when water temperatures reach 10 °C, with two major periods of growth occurring in spring and autumn followed by intermittent senescence.</p> |

| Pathway 1 - Horticultural and aquarium trade |   |          |            |   |
|--|---|----------|------------|---|
| N  | QUESTION  | RESPONSE | CONFIDENCE | JUSTIFICATION   |
|  |   |          |            | Senescence results in a loss of biomass through sloughing and decay of tips and branches. During the summer, profuse branching forms a canopy. The branches form dense, tangled mats on the water's surface (reviewed in Global Invasive Species Database 2006). In a Japanese study, <i>Egeria densa</i> biomass had two maxima in August and December-January. Lateral shoots with roots developed and elongated to the surface of the water when the bottom-water temperature increased above c. 15°C and the plant demonstrated an ability to adapt to the seasonal changes in temperature. The shortage in the balance of organic matter for over-wintering was found to be maintained by stored starch in the leaf and the stem where the maximum starch concentrations reached 25.4% in the leaf and 22.6% in the stem in December (Haramoto and Ikusima 1988).  |
| 1.08   | How likely is the organism to be able to transfer from the pathway to a suitable habitat or host? | LIKELY   | HIGH       | <p>Any direct transfer to a suitable habitat is most likely to be anthropogenic-mediated <i>via</i> an aquarium dump or planting out. Secondary spread may then occur through subsequent fragmentation caused by water turbulence from wind/wave action or flow, by water users or wildlife. There are many potentially suitable freshwaters in Ireland which are amenable to the establishment of <i>Egeria densa</i>. The plant can grow in mildly acidic, alkaline and eutrophic conditions in still or slow-moving freshwaters including lakes, rivers, canals, reservoirs, ponds, ditches, quarry pools and quiet streams (Washington State Department of Ecology 2007; Curt <i>et al.</i> 2010; Lansdown 2011; CABI 2014). It will grow in water up to six metres deep (Lansdown 2011).</p> <p>In Britain, the current distribution of <i>Egeria densa</i> strongly suggests that anthropogenic introductions rather than natural spread from naturalised populations are principally responsible for its occurrence in the wild (Lansdown 2011). In Britain, the plant has increased its range from the first record in 1953 to five 10 km squares by 1986, nine by 1995, 12 by 2000 and 17 by 2010 (Lansdown 2011). At present, the National Biodiversity Network's Gateway (UK) database lists this species in 49 x 10 km squares in Britain (NBN 2014). The increase in Britain may be partly a result of recording effort (Lansdown 2011).</p> <p>Although more relevant to other potential pathways of introduction or spread, it is worth noting that <i>Egeria densa</i> has some tolerance to desiccation which can aid its overland dispersal on a vector (boating,</p> |



| Pathway 1 - Horticultural and aquarium trade |  |             |            |  |
|--|--|-------------|------------|--|
| N  | QUESTION   | RESPONSE    | CONFIDENCE | JUSTIFICATION  |
|  |  |             |            | angling or water sports equipment). A study by Barnes <i>et al.</i> (2013) established that after one 1 hour of drying at 25°C, all replicate vegetative fragments remained fully viable. This reduced to c. 40 % after two hours and to c. 8 % after 3 hours. |
| 1.09   | Estimate the overall likelihood of entry into Ireland based on this pathway? | VERY LIKELY | VERY HIGH  | It is already deliberately imported for trade.   |
| 1.10   | Do other pathways need to be considered?                                     | NO          |            | If the plant were to become more established in the island of Ireland or cross-channel in Britain other pathways such as angling and boating may need to be included in this risk assessment (refer to response to Question 1.02).                             |

| Overall likelihood |   |             |            |   |
|--------------------|---|-------------|------------|---|
| N                  | QUESTION  | RESPONSE    | CONFIDENCE | JUSTIFICATION   |
| 1.11               | Estimate the overall likelihood of entry into Ireland based on all pathways (comment on the key issues that lead to this conclusion). | VERY LIKELY | VERY HIGH  | The primary pathway of entry into Ireland is through deliberate trade <i>via</i> the horticultural and aquarium sectors. It is sold in a range of outlets and on the internet in Ireland as an oxygenator / ornamental plant for artificial watercourses, garden ponds and aquaria. |

**Stage 2 - Detailed assessment: Section B – Establishment**

*This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.*

| N    | QUESTION   | RESPONSE    | CONFIDENCE | JUSTIFICATION  |
|------|--|-------------|------------|--|
| 2.01 | Is the organism well established in Ireland (if there is any uncertainty answer 'unsure')  | NO          | -          | Refer to Question 9.   |
| 2.02 | How likely is it that the organism will be able to establish in Ireland based on the similarity between local <u>climatic conditions</u> and the organism's current global distribution? | VERY LIKELY | HIGH       | <p><i>Egeria densa</i> has already demonstrated its ability to establish under Irish climatic conditions in at least one site in Ireland (Lough Nasool in Co. Sligo) and in a single site in Northern Ireland (Helen's Bay, Co. Down) (National Biodiversity Data Centre 2009). It is suspected that there are other instances of <i>Egeria densa</i> in private ponds in Ireland because the plant is regularly sold in Irish outlets. However, at present, such instances are unknown to the authors. In Britain, which experiences similar climatic conditions to Ireland, the plant is present in 49 x 10 km squares (NBN 2014). British <i>Egeria densa</i> populations appear to be considered largely naturalised and non-invasive (Lansdown 2011). However, there are some instances reported where the plant is considered invasive (e.g. in Cornwall; Plantlife 2010), which has a climate more similar to Ireland than the rest of the UK, increasing the likelihood of successful establishment.</p> <p>The global distribution of the organism (refer to response to Question 8) is predominantly in regions which experience a warmer climate than Ireland and the optimum temperature for growth is reported to be between 16°C and 28°C (Curt <i>et al.</i> 2010 and references therein; also reviewed in Yarrow <i>et al.</i> 2009). The plant does not directly tolerate freezing (Leslie 1992 as cited in Yarrow <i>et al.</i> 2009) but some genotypes are capable of surviving very cold winter temperatures, even in conditions where surface ice is present (Haramoto and Ikusima 1988). According to Cabrera Walsh <i>et al.</i> (2013), "In its adventive range, the plant has established across wide climatic zones, even wider than warranted by its native distribution, thanks to its capacity to store energy in its basal stems and root crown (Pennington and Sytsma 2009) that allows it to recover from winter senescence, and rapidly reinvade water bodies."</p> <p>Global climate niche modelling (based on the International Panel on Climate Change low and high emissions climate change scenarios) project that there will be a progressive increase in the suitable climatic range for <i>Egeria densa</i> in the island of Ireland in the next six decades (Kelly <i>et al.</i> 2014).</p> |

**Stage 2 - Detailed assessment: Section B – Establishment**

*This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.*

| N    | QUESTION  | RESPONSE    | CONFIDENCE | JUSTIFICATION  |
|------|---|-------------|------------|--|
| 2.03 | How likely is it that the organism will be able to establish in Ireland based on the similarity between other local <u>abiotic conditions</u> and the organism's current global distribution? | VERY LIKELY | HIGH       | <p><i>Egeria densa</i> is subjected to a wide range of abiotic conditions throughout its global range and it is highly unlikely that there are any over-riding abiotic factors in Ireland that would inhibit its further establishment. As mentioned previously, the plant can grow in mildly acidic, alkaline and eutrophic conditions in still or slow-moving freshwaters including lakes, rivers, canals, reservoirs, ponds, ditches, quarry pools and quiet streams (Washington State Department of Ecology 2007; Curt <i>et al.</i> 2010; Lansdown 2011; CABI 2014). The plant has a good adaptability to temperature as described in response to Question 2.02 above and thus this is unlikely to affect survival and establishment in Ireland, but there is some uncertainty as to how growth could be negatively affected under current Irish climatic conditions. This is because the optimum temperatures for growth are considered to be between 16°C and 28°C (Curt <i>et al.</i> 2010 and references therein; also reviewed in Yarrow <i>et al.</i> 2009). A study from a lake near Seattle (Washington State, USA), reported that 25 % of the biomass of <i>Egeria densa</i> was observed to overwinter along the lake bottom in a dormant-like, evergreen condition with growth initiated when water temperatures reached 10°C (Washington State Department of Ecology 2007). This area would have a broadly similar winter, spring and late autumn climate as regards temperature to Ireland, albeit a slightly warmer summer and early autumn (<a href="http://www.met.ie">www.met.ie</a> and <a href="http://www.wrh.noaa.gov">http://www.wrh.noaa.gov</a>). Nevertheless, as Yarrow <i>et al.</i> (2009) surmise in their review on the ecology of <i>Egeria densa</i>, “ultimately, the literature shows that <i>E. densa</i> is highly adaptable, presenting continual or seasonal growth as the local conditions dictate”.</p> <p><i>Egeria densa</i> also has a number of adaptive physiological traits related to its metabolism which confer the plant with a “flexible carbon incorporation strategy” not common to many other aquatic plants. This is considered to contribute to its success as an introduced species (reviewed in Yarrow <i>et al.</i> 2009). As a plant with a C4-like photosynthetic pathway, it is well adapted to successfully respond to factors such as very low CO<sub>2</sub> and high O<sub>2</sub> concentrations in water. This allows the species to continue to grow and photosynthesise in otherwise prohibitive conditions (reviewed in Yarrow <i>et al.</i> 2009). In addition, <i>Egeria densa</i> is able to adapt to photosynthesise with ease in both low and high light conditions (reviewed in Yarrow <i>et al.</i> 2009). However, an established population can be locally extirpated if a freshwater system shifts from a clear to very turbid state</p> |

**Stage 2 - Detailed assessment: Section B – Establishment**

*This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.*

| N    | QUESTION  | RESPONSE    | CONFIDENCE | JUSTIFICATION   |
|------|---|-------------|------------|---|
|      |   |             |            | <p>(Marín <i>et al.</i> 2009).</p> <p>The presence of <i>Egeria densa</i> in various locations in Britain (49 x 10 km squares; NBN 2014), further indicates that the species is suited to the similar abiotic conditions that would be encountered in suitable habitats throughout Ireland.</p>   |
| 2.04 | How likely is the organism to encounter habitats necessary for the survival, development and multiplication of the organism in Ireland? | VERY LIKELY | HIGH       | Ireland has a high density and abundance of freshwaters amenable to colonisation by <i>Egeria densa</i> (refer to Pathway 1, Question 1.08) which could facilitate its subsequent survival, development and multiplication. As alluded to previously, there is some uncertainty as to how growth could be negatively affected under current Irish climatic conditions and this may ultimately determine whether the species can become invasive or not.   |
| 2.05 | How likely is it that establishment will occur despite competition from existing species in Ireland?                                    | LIKELY      | LOW        | It is uncertain how competition from existing species would affect the establishment of <i>Egeria densa</i> as the species is very rare in the wild Ireland. In Britain, there appears to have been no obvious impediment from existing species that negatively affected its establishment where it was introduced. The establishment in Ireland of related non-native Hydrocharitaceae such as <i>Elodea nuttallii</i> (Planch.) H. St. John, <i>Elodea canadensis</i> Michaux and <i>Lagarosiphon major</i> (Ridley) Moss have not been obviously affected by competition from existing species and this may provide some indication as to the likely situation for <i>Egeria densa</i> . |
| 2.06 | How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?                    | LIKELY      | MEDIUM     | There are no known natural predators, parasites or pathogens of this species that will have an adverse effect on its establishment in Ireland (CABI 2014). This is also believed to be the case in Britain (Lansdown 2009). Confidence is given as medium as it is difficult to be conclusive on this when the species is currently very rare in the wild in Ireland.   |

**Stage 2 - Detailed assessment: Section B – Establishment**

*This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.*

| N    | QUESTION   | RESPONSE | CONFIDENCE | JUSTIFICATION  |
|------|--|----------|------------|--|
| 2.07 | How likely is it that establishment will occur despite existing management practices?  | UNLIKELY | HIGH       | In general, the State management of waterways is undertaken cognisant of ensuring biosecurity measures are in place to mitigate for the spread of aquatic invasive species. An increase in awareness by some private stakeholders of the threat from aquatic invasive species has also somewhat reduced this risk. The very limited occurrence of <i>Egeria densa</i> in the wild in Ireland at present also makes it very unlikely the existing management practices could affect the establishment status of this species in the near future.  |
| 2.08 | How likely is it that management practices in Ireland will facilitate the establishment of the organism?                         | UNLIKELY | HIGH       | Refer to Question 2.07.  |
| 2.09 | How likely is it that the biological characteristics of the organism would allow it to survive eradication campaigns in Ireland? | LIKELY   | MEDIUM     | <p>As only male <i>Egeria densa</i> plants are very likely present in Ireland (Botanic Gardens 2008), any reproduction is exclusively by vegetative means. Mechanical removal (e.g. cutting and harvesting) would only result in short- to medium-term control at best and not achieve eradication. This is particularly the case, if it is conducted with disregard for the generation of vegetative fragments which would facilitate the plant's survival and re-establishment in a treated area and increase the potential for spread to adjacent areas (Lansdown 2009).</p> <p>The absence of a capability to reproduce by sexual means and therefore maintain a seed reserve in colonised habitats, may increase the efficacy of the following two control methods. Light-excluding benthic barriers, such as jute matting, may effect control in sites where <i>Egeria densa</i> colonisation is localised (as it has for <i>Lagarosiphon major</i>; Caffrey <i>et al.</i> 2010) and the eradication of low density infestations can be achieved via careful manual removal which avoids plant fragmentation (Lansdown 2011; CAISIE 2013). The eradication of extensive infestations in a large, open water would not be feasible.</p> |
| 2.10 | How likely is it that the biological characteristics of the organism will facilitate its establishment?                          | LIKELY   | HIGH       | The ability of <i>Egeria densa</i> to reproduce asexually from vegetative fragments (Botanic Gardens 2008) is the principal biological characteristic that could facilitate its further establishment and spread in Ireland. As mentioned previously, there is some uncertainty as to how growth could be negatively affected under current Irish climatic conditions and this may ultimately determine whether the species can become invasive or not.  |

**Stage 2 - Detailed assessment: Section B – Establishment**

*This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.*

| N    | QUESTION   | RESPONSE    | CONFIDENCE | JUSTIFICATION  |
|------|--|-------------|------------|--|
| 2.11 | How likely is it that the organism's capacity to spread will facilitate its establishment? | VERY LIKELY | VERY HIGH  | <p>The absence of sexual reproduction in introduced populations of <i>Egeria densa</i> means that spread only occurs vegetatively via the dispersal of plant stems and fragments. Fragments can break off from the parent plant quite easily. Each fragment that contains a double node has the potential to develop into a new plant (Washington State Department of Ecology 2007 as reviewed in Csurhes <i>et al.</i> 2006). Following initial establishment in a particular area, the subsequent spread of <i>E. densa</i> occurs when crowns and buds on stem fragments separate from the parent colony by water movement; a fact that highlights the danger of mechanical control measures (Parsons and Cuthbertson 2001 as cited in Csurhes <i>et al.</i> 2006). This mode of dispersal is also assisted by human recreational activities as fragments of <i>Egeria densa</i> get caught in the propellers of boats, or to boat trailers and can start new populations when the boat is subsequently launched into another waterbody (Westerdahl and Getsinger 1988 as cited in Csurhes <i>et al.</i> 2006). According to the Californian State Parks (2014), "the plant can spread at a rate of approximately 100 acres a year depending on environmental conditions."</p> <p>Between watersheds, there is a very low potential for natural spread, although there is some potential for transfer to occur via viable plant fragments attached to migratory animals e.g. waterfowl (CABI 2014). Overall, anthropogenic-mediated introductions of <i>Egeria densa</i> are considered as the principal pathway responsible for the establishment and spread of the plant in its introduced range (CABI 2014).</p> |
| 2.12 | How likely is it that the organism's adaptability will facilitate its establishment?       | VERY LIKELY | HIGH       | <p>The reviewed literature presented heretofore in <i>Section B – Establishment</i> in response to Questions 2.02 - 2.11 suggest that <i>Egeria densa</i> has a number of key attributes which indicate it is an adaptable plant species. These include having a wide temperature tolerance and other adaptive physiological traits such as an ability to respond to changes in CO<sub>2</sub> and light, and the ability to establish in more than one habitat type). These characteristics are very likely to facilitate its more widespread establishment in Ireland.</p>   |

**Stage 2 - Detailed assessment: Section B – Establishment**

*This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.*

| N    | QUESTION  | RESPONSE    | CONFIDENCE | JUSTIFICATION  |
|------|---|-------------|------------|--|
| 2.13 | How likely is it that the organism could establish despite low genetic diversity in the founder population?   | LIKELY      | LOW        | The genetic diversity of different <i>Egeria densa</i> populations has not been extensively examined (Yarrow <i>et al.</i> 2009). However, where this has been investigated (e.g. between South and North American populations), “remarkably similar genotypes” have been found (Carter and Sytsma 2001 as cited in Yarrow <i>et al.</i> 2009). Further to this, low levels of genetic diversity were also found in New Zealand <i>Egeria densa</i> populations, likely due to “highly homogeneous founding gene pools” (Lambertini <i>et al.</i> 2010). This may also be the case for introduced populations in Europe and those imported to Ireland for sale as cultivars are propagated vegetatively (Botanic Gardens 2008). Nevertheless, there are no indications that low diversity in a founder population would negatively affect establishment. For example, related non-native Hydrocharitaceae such as <i>Elodea nuttallii</i> , <i>Elodea canadensis</i> and <i>Lagarosiphon major</i> have established robust populations in Ireland in spite of apparent low genetic diversity in their founder populations. |
| 2.14 | Based on the history of invasion by this organism elsewhere in the world, how likely is it to establish in Ireland? If possible, specify the instances of invasion elsewhere in the justification box | VERY LIKELY | VERY HIGH  | <i>Egeria densa</i> has already demonstrated this capacity on the island of Ireland in at least two isolated locations (refer to response to Question 9). In Britain, it is presently recorded in 49 x 10 km squares (NBN 2014) where the plant has increased its range from the first record in 1953 to five 10 km squares by 1986, nine by 1995, 12 by 2000 and 17 by 2010 (Lansdown 2011). This provides some indication of the plant’s capacity for further establishment in Ireland as Britain has a similar climate to this country.   |
| 2.15 | If the organism does not establish, then how likely is it that transient populations will continue to occur?  | N/A         |            |  |
| 2.16 | Estimate the overall likelihood of establishment. Mention any key issues in the comments box  | VERY LIKELY | VERY HIGH  | <i>Egeria densa</i> has already demonstrated this capacity on the island of Ireland in at least two isolated locations and there are likely to be other instances of this species established in private ponds as the plant is regularly sold in Irish outlets.<br><br>There are numerous freshwaters in Ireland likely suitable for colonisation  |

**Stage 2 - Detailed assessment: Section B – Establishment**

*This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.*

| N | QUESTION | RESPONSE | CONFIDENCE | JUSTIFICATION   |
|---|----------|----------|------------|---|
|   |          |          |            | by <i>Egeria densa</i> with any further introductions highly likely to be anthropogenic -mediated. There is some uncertainty as to how growth could be negatively affected under current Irish climatic conditions and this may ultimately determine how vigorous the establishment of any newly introduced population becomes. |



**Stage 2 - Detailed assessment: Section C - Spread**

*This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.*

| N    | QUESTION  | RESPONSE                        | CONFIDENCE | JUSTIFICATION  |
|------|---|---------------------------------|------------|--|
| 3.01 | What area (given in % or 10km squares) in Ireland could the organism establish (0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%)? | 68% - 90%<br>(of 10 km squares) | VERY HIGH  | <i>Egeria densa</i> has the potential to establish in a wide range of freshwater habitats which are abundant in Ireland notably in still or slow-moving freshwaters including lakes, rivers, canals, reservoirs, ponds, ditches, quarry pools and quiet streams with mildly acidic, alkaline or eutrophic conditions (Washington State Department of Ecology 2007; Curt <i>et al.</i> 2010; Lansdown 2011; CABI 2014).   |
| 3.02 | How important is the expected spread of this organism in Ireland by <u>natural</u> means (minimal, minor, moderate, major or massive)?    | MAJOR / MINOR                   | HIGH       | Major within catchments and minor between catchments (refer to response to Question 2.11 for details).   |
| 3.03 | How important is the expected spread of this organism in Ireland by <u>human assistance</u> (minimal, minor, moderate, major or massive)? | MAJOR                           | HIGH       | Anthropogenic-mediated transfer is the principal pathway to facilitate the introduction of the plant and its subsequent spread from colonised to uncolonised waters (CABI 2014).   |
| 3.04 | Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?                           | MAJOR                           | HIGH       | <p>The rare occurrence of <i>Egeria densa</i> in Ireland suggests that it would be very feasible to contain the plant within its current range (it should be noted that its present status in Lough Nasool is uncertain as the lake periodically drains through a sink hole and a recent survey (2014) by IFI failed to detect the plant there).</p> <p>In general, should the plant become widely established, containment in colonised areas of large open water systems is considered unlikely. However, external spread could be mitigated through the implementation of routine biosecurity measures. Eradication in small isolated waters (e.g. ponds) is considered feasible. Jute matting, developed for <i>Lagarosiphon major</i> control (see Caffrey <i>et al.</i> 2010), is likely to be an effective option against <i>Egeria densa</i> in the latter circumstances as both species are morphologically similar and do not set seed in Ireland.</p> |
| 3.05 | What proportion (%) of the area in Ireland suitable for establishment, if any, has already been colonised by the organism?                | 0% - 10%                        | HIGH       | <i>Egeria densa</i> has been recorded at a single wild location in Ireland in Lough Nasool near Riverstown, Co. Sligo in 1988 (National Biodiversity Data Centre 2009). This lake periodically drains through a sink hole (last time occurring in 2006) and a recent survey (2014) by IFI failed to detect the plant there. There is also a single record of <i>Egeria densa</i> from Northern Ireland where it is present in a "small lined pond" in Helen's Bay, Co. Down (National Biodiversity Data Centre 2009). It is suspected that there are other instances of <i>Egeria densa</i> in private ponds in Ireland  |

**Stage 2 - Detailed assessment: Section C - Spread**

*This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.*

| N    | QUESTION   | RESPONSE | CONFIDENCE | JUSTIFICATION  |
|------|--|----------|------------|--|
|      |  |          |            | because the plant is regularly sold in Irish outlets. However, at present, such instances are unknown to the authors.  |
| 3.06 | What proportion of the area in Ireland suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?  | 0% - 10% | HIGH       | Based on its current distribution on the island of Ireland, <i>Egeria densa</i> is very unlikely to spread extensively in the next five years. The enactment and enforcement of proposed restrictions on the sale and import of <i>Egeria densa</i> (Regulation 50 of the European Communities (Birds and Natural Habitats) Regulations 2011, SI 477/2011) should largely mitigate for any future introductions to the wild as anthropogenic-mediated spread is considered the principal risk factor in this regard. The potential for spread from any small artificial waters where it may be present (e.g. private ponds) is considered low as these are generally confined systems. |
| 3.07 | What other timeframe would be appropriate to estimate any significant further spread of the organism (10, 20, 40, 80 or 160 years)? Please comment on why this timeframe is chosen.  | 10 years | MEDIUM     | In the absence of restrictions on sale and import, further anthropogenic-mediated spread is considered likely, although the rate of spread is highly uncertain.  |
| 3.08 | In this timeframe, what proportion of the endangered area (including any currently occupied areas) is likely to have been invaded by this organism?  | 0% - 10% | MEDIUM     | Refer to Questions 3.06 and 3.07.  |
| 3.09 | Based on the answers to questions on the potential for establishment and spread in Ireland, define the area endangered by the organism. Be as specific as possible. If available, provide a map showing the area most likely to be endangered. | -        | HIGH       | 68% - 90% of 10 km squares in Ireland are considered at risk of colonisation (refer to Question 3.01).   |
| 3.10 | Estimate the overall potential for future spread for this organism in Ireland (very slowly, slowly, moderately, rapidly or very rapidly). Use the justification box to indicate any key issues .   | SLOWLY   | MEDIUM     | In the absence of restrictions on sale and import, further anthropogenic-mediated spread is considered likely, although the rate of spread is uncertain.   |

**Stage 2 - Detailed assessment: Section D – Impact**

*This section evaluates the probability of impact of an organism within Ireland.*

| N    | QUESTION  | RESPONSE         | CONFIDENCE | JUSTIFICATION  |
|------|---|------------------|------------|--|
| 4.01 | How great is the economic loss caused by the organism within its global distribution (excluding Ireland), including the cost of any current management?   | MODERATE         | HIGH       | <p><i>Egeria densa</i> can form dense, monospecific stands that negatively impact water sports, fishing, navigation, delivery of irrigation water, and hydropower production (reviewed in Cabrera Walsh <i>et al.</i> 2013).</p> <p>According to Barreto <i>et al.</i> (2000), "In southeast Brazil <i>Egeria densa</i>, together with <i>Egeria najas</i>, causes great annual losses to the hydroelectric companies. Interruptions of electricity generation and damage to grids and equipment are common in reservoirs belonging to CESP in São Paulo." According to (CABI 2014), "Removal of <i>Egeria densa</i> from lakes and reservoirs in the USA costs some states several million dollars per annum." For example, the Californian State's Division of Boating and Waterways fund a programme to control the plant in the Sacramento-San Joaquin Delta where it has infested "thousands of acres" and has a "significant impact on recreation and commercial activity. Dense mats of vegetation create safety hazards for boaters, obstructing navigation channels, marinas and irrigation systems." (Californian State Parks 2014).</p> |
| 4.02 | How great has the economic cost of the organism been in Ireland from the <u>time of introduction to the present</u> ? Exclude any costs associated with managing the organism from your answer. | MINIMAL          | VERY HIGH  | There have been no known costs incurred to date – there are only two records known of this species <i>in the wild</i> on the island of Ireland.  |
| 4.03 | How great is the economic cost of the organism likely to be in the <u>future</u> in Ireland? Exclude any costs associated with managing the organism from your answer.                          | MINOR / MODERATE | MEDIUM     | <p>This is difficult to quantify and will ultimately depend on the future rate of introduction coupled with the capability of <i>Egeria densa</i> to establish dense stands in introduced habitats. There is the potential for significant control costs to be incurred if <i>Egeria densa</i> does establish dense stands and cause impacts as described in response to Question 4.01.</p> <p>It is worth noting that the economic value of recreational angling to Ireland (including sea angling) is estimated at €755 million per annum (Inland Fisheries Ireland 2013) and recreational boating is estimated to be worth €70 million to the Irish economy (Martin 2012). There may also be financial implications if conservation goals such as those specified in the EC Habitats Directive and the EU Water Framework Directive were put under threat.</p>  |

| <b>Stage 2 - Detailed assessment: Section D – Impact</b>                               |  |                   |                   |   |
|--|--|-------------------|-------------------|---|
| <i>This section evaluates the probability of impact of an organism within Ireland.</i> |  |                   |                   |   |
| <b>N</b>   | <b>QUESTION</b>  | <b>RESPONSE</b>   | <b>CONFIDENCE</b> | <b>JUSTIFICATION</b>  |
| 4.04   | How great have the economic costs of managing this organism been in Ireland from the <u>time of introduction to the present</u> ?  | MINIMAL           | VERY HIGH         | There have been no known costs incurred to date – there are only two records known of this species <i>in the wild</i> on the island of Ireland  |
| 4.05   | How great is the economic cost of managing this organism likely to be in the <u>future</u> in Ireland?   | MINOR / MODERATE  | MEDIUM            | This is difficult to quantify and depends on range expansions of the plant and future levels of infestation in colonised waters.  |
| 4.06   | How important is environmental harm caused by the organism within its global distribution?   | MODERATE TO MAJOR | HIGH              | “In areas of significant infestation (such as the USA or Australia) large-flowered waterweed is reputed to disrupt natural erosion-deposition processes, disrupt the movement of animals, out-compete native aquatic plants, block light needed for photosynthesis, disrupt predator - prey relationships, prevent wind mixing, leading to localised oxygen depletion, create mosquito breeding areas and increase water temperature by absorbing sunlight, while die back can increase nutrient loads to the water.” (Lansdown 2011). According to CABI (2014), “When dense mats of <i>E. densa</i> have formed, native species are displaced, oxygen may be depleted and the character of stream and lakes may be changed. The effects on the environment may be substantial, affecting the hydrology also.” A review by Yarrow <i>et al.</i> (2009) states that, “As an invasive species, <i>E. densa</i> can negatively affect ecosystem functions and services. The dense canopies of <i>E. densa</i> favour mono-specific stands which can lower biodiversity through competition and exclusion (Roberts <i>et al.</i> 1999). The presence of invasive submerged macrophytes in New Zealand led to significant decrease in size and diversity of the sediment seed bank. This in turn can decrease the resilience of aquatic system to disturbances that could remove the one or few dominant species (Winton and Clayton 1996).” |
| 4.07   | How important has the impact of the organism on biodiversity* been in Ireland from the time of introduction to the present? *e.g. decline in native species, changes in community structure, hybridisation | MINIMAL           | VERY HIGH         | There have been no such impacts reported to date, presumably because of its confined distribution in Ireland.   |
| 4.08   | How important is the impact of the organism on biodiversity likely to be in the <u>future</u> in Ireland?  | MINOR / MODERATE  | MEDIUM            | This is difficult to quantify and is dependent on a substantial range expansion of the plant and the levels of infestation achieved in colonised waters. If <i>Egeria densa</i> is introduced to and establishes dense populations in rivers, lakes or reservoirs in Ireland, detrimental impacts on biodiversity, as outlined in answer to Question 4.06, are considered   |

| <b>Stage 2 - Detailed assessment: Section D – Impact</b>                               |   |                  |                   |  |
|--|---|------------------|-------------------|--|
| <i>This section evaluates the probability of impact of an organism within Ireland.</i> |   |                  |                   |  |
| <b>N</b>   | <b>QUESTION</b>   | <b>RESPONSE</b>  | <b>CONFIDENCE</b> | <b>JUSTIFICATION</b>   |
|  |   |                  |                   | <p>likely. Diminutive aquatic keystone plant communities (e.g. charophytes) are likely to be locally extirpated where dense shading stands form as was the case when a closely-related species <i>Lagarosiphon major</i> infested Lough Corrib (Caffrey <i>et al.</i> 2010). There may also be implications for the classification of ecological status under the EU Water Framework Directive and the conservation status of certain species and habitats and under the EU Habitats Directive.</p> <p>There is a paucity of published literature documenting the impact of <i>Egeria densa</i> in Britain (which has a similar climate to Ireland) despite it being recorded in 49 x 10 km squares there. Indeed, an overview on the global environmental impacts of the plant provided by the Centre for Ecology and Hydrology concludes, “None of these impacts is likely in Great Britain unless populations increase significantly.” (Lansdown 2011).</p> |
| 4.09   | How important has alteration of ecosystem function* caused by the organism been in Ireland from the time of introduction to the present? *e.g. habitat change, nutrient cycling, trophic interactions | MINIMAL          | HIGH              | There have been no such impacts reported to date, specifically because of its confined distribution in Ireland and lack of any studies in this regard where it occurs.   |
| 4.10   | How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the <u>future</u> ?   | MINOR / MODERATE | MEDIUM            | <p>Again, this is difficult to quantify and depends on a range expansion of the plant and the levels of infestation achieved in colonised waters. If <i>Egeria densa</i> is introduced to and establishes dense populations in rivers, lakes or reservoirs in Ireland, detrimental impacts on ecosystem function, as outlined in answer to Question 4.06, are considered likely.</p> <p>As stated previously, there is a paucity of published literature documenting the impact of <i>Egeria densa</i> in Britain (which has a similar climate to Ireland) despite it being recorded in 49 x 10 km squares there. Indeed, an overview on the global environmental impacts of the plant provided by the Centre for Ecology and Hydrology concludes, “None of these impacts is likely in Great Britain unless populations increase significantly.” (Lansdown 2011).</p>  |

| <b>Stage 2 - Detailed assessment: Section D – Impact</b>                               |  |                  |                   |  |
|--|--|------------------|-------------------|--|
| <i>This section evaluates the probability of impact of an organism within Ireland.</i> |  |                  |                   |  |
| <b>N</b>   | <b>QUESTION</b>  | <b>RESPONSE</b>  | <b>CONFIDENCE</b> | <b>JUSTIFICATION</b>   |
| 4.11   | How important has decline in conservation status* caused by the organism been in Ireland from the time of introduction to the present? *e.g. sites of nature conservation value, WFD classification, etc.      | MINIMAL          | VERY HIGH         | There has been no official decline in conservation status caused by <i>Egeria densa</i> to date.   |
| 4.12   | How important is decline in conservation status caused by the organism likely to be in the <u>future</u> in Ireland?   | MINOR / MODERATE | MEDIUM            | Again, this is difficult to quantify and depends on a range expansion of the plant and the levels of infestation achieved in colonised waters. If <i>Egeria densa</i> is introduced to and establishes dense populations in rivers, lakes or reservoirs in Ireland, detrimental impacts to native habitats and species as outlined in answer to Question 4.06, are considered likely. Such detrimental impacts may result in the downgrading of ecological status under the Water Framework Directive and have implications for Natura 2000 sites. |
| 4.13   | How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within its global distribution?   | MINOR            | HIGH              | According to a summary by Lansdown (2011), “ In areas of significant infestation large-flowered waterweed can form dense mats which create a safety hazard for boaters, obstruct channels, marinas and irrigation systems, disrupt navigation and make water-sports, fishing, and swimming impractical. It may also have been a contributing factor to the drowning of a doctor who was trying to rescue another person struggling in the water.”  |
| 4.14   | How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?   | MINIMAL          | VERY HIGH         | None reported.   |
| 4.15   | How important is it that genetic traits of the organism could be carried to other organisms / species, modifying their genetic nature and making their economic, environmental or social effects more serious? | MINIMAL          | VERY HIGH         | Highly unlikely - there is no evidence for this.   |
| 4.16   | How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?  | MINIMAL          | HIGH              | After a review of the literature, <i>Egeria densa</i> is considered to have little or no specific impact as a food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases) at least in an Irish context. Some potentially invasive non-native fish species such as Grass Carp (which is not present in the wild in Ireland) feed on <i>Egeria densa</i> (CABI 2014). The plant is likely to offer a colonisation substrate for Zebra Mussel as is the   |

| <b>Stage 2 - Detailed assessment: Section D – Impact</b>                               |   |                 |                   |  |
|--|---|-----------------|-------------------|--|
| <i>This section evaluates the probability of impact of an organism within Ireland.</i> |   |                 |                   |  |
| <b>N</b>   | <b>QUESTION</b>   | <b>RESPONSE</b> | <b>CONFIDENCE</b> | <b>JUSTIFICATION</b>   |
|  |   |                 |                   | case with a number of other related non-native aquatic plant species (e.g. <i>Lagarosiphon major</i> and <i>Elodea canadensis</i> ).   |
| 4.17   | How important might other impacts not already covered by previous questions be resulting from introduction of the organism? Specify in the justification box.   | MINIMAL         | HIGH              | All known impacts have been covered already in this risk assessment.   |
| 4.18   | How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Ireland?                    | MINIMAL         | HIGH              | To the knowledge of the authors, <i>Egeria densa</i> is not naturally controlled by any predator, parasite or pathogen in Ireland. Known predators such as Grass Carp or Tilapia (CABI 2014) are not present in the wild in Ireland.   |
| 4.19   | Indicate any parts of Ireland where economic, environmental and social impacts are particularly likely to occur. Provide as much detail as possible, where possible include a map showing vulnerable areas. | -               | MEDIUM            | This is difficult to assess and is dependent on a range expansion of the plant and the levels of infestation achieved in colonised waters. If it were to expand its range and prove to be invasive, impacts could occur in still or slow-moving freshwaters including lakes, rivers, canals, reservoirs, ponds, ditches, quarry pools and quiet streams with mildly acidic, alkaline or eutrophic conditions.  |
| 4.20   | Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.  | MODERATE        | MEDIUM            | <i>Egeria densa</i> has already demonstrated its ability to establish a transient population in the wild in Ireland. Its capacity to cause negative impacts in a number of countries where it has established has also been documented (refer to elsewhere in this risk assessment). What is uncertain is how invasive this plant may or may not become should it become established in other suitable waters in Ireland. Closely related Hydrocharitaceae such as <i>Lagarosiphon major</i> and <i>Elodea nuttallii</i> have caused notable ecological and socio-economic impacts in the country (Caffrey <i>et al.</i> 2011 and Caffrey <i>et al.</i> 2006, respectively) and <i>Egeria densa</i> has the potential to emulate this. However, to date in Britain, <i>Egeria densa</i> has not been documented as causing any major negative ecological or socio-economic impacts (except in Cornwall in south-west England; Plantlife 2010). In general, according to a summary by Lansdown (2011), environmental, health and social and economic impacts as seen elsewhere in its global range are unlikely in Britain unless populations increase significantly. |

**Stage 2 - Detailed assessment: Section E – Conclusion**

This section requires the assessor to provide a score for the overall risk posed by an organism, taking into account previous answers to entry, establishment, spread and impact questions.

| N    | QUESTION   | RESPONSE          | CONFIDENCE | JUSTIFICATION   |
|------|--|-------------------|------------|---|
| 5.01 | Estimate the overall risk of this organism in Ireland (noting answers given in 1.11, 2.16, 3.10 & 4.20). | MODERATE to MAJOR | MEDIUM     | <i>Egeria densa</i> has already demonstrated its ability to establish a transient population in the wild in Ireland. Its capacity to cause negative impacts in a number of countries where it has established has also been documented (refer to elsewhere in this risk assessment). What is uncertain is how invasive this plant may or may not become should it become established in other suitable waters in Ireland. Closely related Hydrocharitaceae such as <i>Lagarosiphon major</i> and <i>Elodea nuttallii</i> have caused notable ecological and socio-economic impacts in the country (Caffrey <i>et al.</i> 2011 and Caffrey <i>et al.</i> 2006, respectively) and <i>Egeria densa</i> has the potential to emulate this. Therefore, with the limited information available to inform this risk assessment and in acknowledgement of the knowledge gaps that exist, the overall risk of this organism in Ireland is presently considered to be 'moderate to major' with 'medium confidence'. |



**Stage 2 - Detailed assessment: Section F – Additional questions**

This section is used to gather information about the potential effects of climate change on the risk posed by an organism. It is also an opportunity for the risk assessor to highlight high priority research that could help improve the risk assessment.

| N    | QUESTION   | RESPONSE    | CONFIDENCE | JUSTIFICATION   |
|------|--|-------------|------------|---|
| 6.01 | What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?   |             | MEDIUM     | Climate change is expected to increase water temperatures over time in Ireland, with increased periods of drought in summer and higher rainfall in winter leading to more flooding events (Desmond <i>et al.</i> 2008). An increase in water temperatures may favour <i>Egeria densa</i> growth and enhance its capacity for establishment (Riis <i>et al.</i> 2012). Drought conditions on the other hand, could locally extirpate the species where water levels drop considerably. Global climate niche modelling (based on the International Panel on Climate Change low and high emissions climate change scenarios) project that there will be a progressive increase in the suitable climatic range for <i>Egeria densa</i> in the island of Ireland in the next six decades (Kelly <i>et al.</i> 2014). |
| 6.02 | What is the likely timeframe for such changes (5, 10, 15, 20, 50 or 100 years)?  | 10-50 YEARS | LOW        | This response is based on global climate niche modelling (Kelly <i>et al.</i> 2014) as outlined above.  |
| 6.03 | What aspects of the risk assessment are most likely to change as a result of climate change  |             | MEDIUM     | Climate change is likely to increase the potential for <i>Egeria densa</i> to become invasive in Ireland as a warmer climate may favour its growth and enhance its capacity for establishment.  |
| 6.04 | If there is any research that would significantly strengthen confidence in the risk assessment, please note this here. If more than one research area is provided, please list in order of priority. | YES         |            | In general, there is a paucity of information available to assess its invasive potential in Ireland. Such information would significantly strengthen this risk assessment. Information from Irish gardeners or stockists who have first-hand knowledge of its growth, reproduction and general suitability to the Irish climate may also be useful in this regard. It would be useful to determine the present status of the plant in Helen's Bay in Northern Ireland and to resurvey Lough Nasool in Co Sligo in 2015 for any signs of re-establishment there. More detailed information on the status of the plant in Britain would also contribute to the assessment because of the similarity in climate between the two countries.   |

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