RISK ASSESSMENT SUMMARY

Updated: September 2015

Large-flowered Waterweed (*Egeria densa*)

- Submerged freshwater perennial aquatic plant from South America
- Sold as an ornamental plant for aquaria
- Established in GB
- Infestations can impact entire aquatic communities by changing water quality and reducing light and oxygen availability
- Can impede recreational use of waterbodies

History in GB

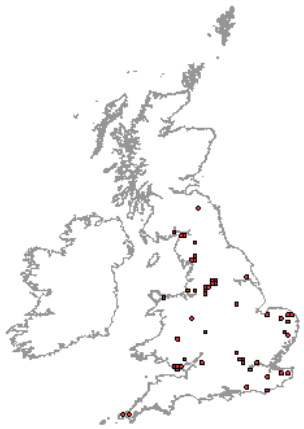
First recorded in 1953 in the Ashton Canal, Greater Manchester. *E. densa* has since become locally widespread across GB, including south Scotland and central and south Wales. Widely traded in GB as an ornamental aquatic plant. Currently limited by low summer water temperatures, but this is likely to change in coming decades under projected climatic change.

Native distribution

Native to South America (Brazil, Uruguay, Argentina and perhaps Chile)

(no native range map found)

Distribution in GB



Source: NBN 2014

Impacts

Environmental (moderate)

- Infestations can result in complex community changes through changes to water quality and reduction in light and oxygen availability

Economic (moderate)

- Possible negative impacts on fishing and other water uses
- May increase flood risk

Social (moderate)

- Impacts on recreational use of water bodies (see economic impacts)

Introduction pathways

Horticulture (likely)— primarily through dumping plant material , but may also escape from garden ponds and aquaria

Spread pathways

Natural (slow) - recorded in a number of locations but has not covered a large area, consistent with human assisted spread

Human (intermediate)—as a contaminant on plants offered for sale, and on boats and other equipment

Summary

	Risk	Confidence
Entry	VERY LIKELY	HIGH
Establishment	LIKELY	HIGH
Spread	SLOW	HIGH
Impacts	MODERATE	HIGH
Conclusion	MEDIUM	LOW

Information about GB Non-native Species Risk Assessments

The Convention on Biological Diversity (CBD) emphasises the need for a precautionary approach towards non-native species where there is often a lack of firm scientific evidence. It also strongly promotes the use of good quality risk assessment to help underpin this approach. The GB risk analysis mechanism has been developed to help facilitate such an approach in Great Britain. It complies with the CBD and reflects standards used by other schemes such as the Intergovernmental Panel on Climate Change, European Plant Protection Organisation and European Food Safety Authority to ensure good practice.

Risk assessments, along with other information, are used to help support decision making in Great Britain. They do not in themselves determine government policy.

The Non-native Species Secretariat (NNSS) manages the risk analysis process on behalf of the GB Programme Board for Non-native Species. Risk assessments are carried out by independent experts from a range of organisations. As part of the risk analysis process risk assessments are:

- Completed using a consistent risk assessment template to ensure that the full range of issues recognised in international standards are addressed.
- Drafted by an independent expert on the species and peer reviewed by a different expert.
- Approved by an independent risk analysis panel (known as the Non-native Species Risk Analysis Panel or NNRAP) only when they are satisfied the assessment is fit-for-purpose.
- Approved for publication by the GB Programme Board for Non-native Species.
- Placed on the GB Non-native Species Secretariat (NNSS) website for a three month period of public comment.
- Finalised by the risk assessor to the satisfaction of the NNRAP.

To find out more about the risk analysis mechanism go to: www.nonnativespecies.org

Common misconceptions about risk assessments

To address a number of common misconceptions about non-native species risk assessments, the following points should be noted:

- Risk assessments consider only the risks posed by a species. They do not consider the practicalities, impacts or other issues relating to the management of the species. They therefore cannot on their own be used to determine what, if any, management response should be undertaken.
- Risk assessments are about negative impacts and are not meant to consider positive impacts that may also occur. The positive impacts would be considered as part of an overall policy decision.
- Risk assessments are advisory and therefore part of the suite of information on which policy decisions are based.
- Completed risk assessments are not final and absolute. Substantive new scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.

Period for comment

Draft risk assessments are available for a period of three months from the date of posting on the NNSS website*. During this time stakeholders are invited to comment on the scientific evidence which underpins the assessments or provide information on other relevant evidence or research that may be available. Relevant comments are collated by the NNSS and sent to the risk assessor. The assessor reviews the comments and, if necessary, amends the risk assessment. The final risk assessment is then checked and approved by the NNRAP.

*risk assessments are posted online at:
https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=51
comments should be emailed to nnss@apha.gsi.gov.uk

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

For more information visit: www.nonnativespecies.org

Name of Organism	***Egeria densa* - Large-flowered Waterweed**	
Objectives:	Assess the risks associated with this species in GB	
Version:	Final (April 2016) - Original draft January 2012; signed off by NNRAP February 2012; approved by GB Programme Board March 2015; published on NNSS website September 2015.	
Author:	J. Mauremootoo	

N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the Risk Assessment?		A request was made by the GB Programme Board. *Egeria densa* has been subject to this risk assessment as it is known to be a highly competitive species in meso-eutrophic waters. This submerged perennial aquatic plant can form dense monospecific stands which are capable of restricting water movement, cutting off light, producing anoxic conditions and trapping sediment. Where it has become invasive *E. densa* has been reported to outcompete native aquatic plants and to adversely affect fish communities. Dense infestations interfere with recreation activities such as fishing and boating and increase the risk of flooding for adjacent land.
2	What is the Risk Assessment area?	GB	
3	Does a relevant earlier Risk Assessment exist?	YES (Go to 4)	A risk assessment of *Egeria densa* for Australia was prepared by Pacific Island Ecosystems at Risk (PIER) using the Australian risk assessment system (Pheloung *et al*. 1999). The result was a score of 22 and a recommendation to: reject the plant for import (Australia) or species likely to be a pest (Pacific). *Egeria densa* was rated as the joint fourth most problematic submerged weed in terms of its potential impact on hydroelectricity generating plants in New Zealand lakes, according to a risk assessment method developed by Clayton and Champion (2006). In Belgium *Egeria densa* has been subject to the simplified environmental impact assessment protocol (ISEIA) which identifies organisms of most concern for preventive and mitigation actions (Invasive species in Belgium - *Egeria densa*). Under this system *E. densa* was classified an A1 - an alert, black and watch list species that exists in isolated populations. No previous risk assessment has been conducted in GB.
4	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?	PARTLY VALID OR NOT VALID (Go to 5)	The locations for which these risk assessments were prepared have warmer climates than the Risk Assessment Area. These risk assessments do not look at species interactions, which limits their utility.
	Stage 2: Organism Risk Assessment **SECTION A: Organism Screening**		
5	Identify the Organism. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES (Give the full name & Go to 7)	Species name: *Egeria densa* Planch. Synonyms: *Anacharis densa* (Planch.) Victorin, *Elodea densa* (Planch.) Caspary, *Philotria densa* (Planch.) Small & St. John. Common Names: Brazilian elodea, Brazilian waterweed, Brazilian-waterweed, common waterweed, South American waterweed, dense waterweed, egeria, leafy elodea, waterpes, large-flowered water-thyme. Order: Hydrocharitales. Family: Hydrocharitaceae. Kingdom: Plantae. While the taxonomy of the *E. densa* is not in question, it can easily be confused with other species in the same family, particularly to the untrained eye – e.g. *Lagarosiphon major*, *Elodea nuttallii* and *Elodea canadensis* are all similar in form and habit. Poor identification in the aquarium trade may exacerbate problems caused by this species.
6	If not a single taxonomic entity, can it be redefined?		
7	Is the organism in its present range known to be invasive, i.e. to threaten species, habitats or ecosystems?	YES (Go to 9)	*Egeria densa* - a submerged freshwater perennial herb, is a pest species in its native range. In Southeast Brazil this species, together with *Egeria najas*, causes great annual losses to hydroelectricity companies and it has been cited as the 'worst submerged aquatic weed in most Neotropical areas (Barreto *et al.* 2000). *Egeria densa* has been cited as being invasive or a pest in Australia (Growns & Gehrke 2003, Clunie *et al*. 2002), New Zealand (Coffey & Clayton 1988, distribution data in FBIS 2005), USA (USDA Plants Profile 2007), Pacific Islands (Hawaii - Pacific Island Ecosystems at Risk - PIER and Tahiti - Florence *et al.* 2007), Asia (Japan - Hamabata & Kobayashi 2002), South America (Chile - Washington State Department of Ecology Non-native plants site), Africa (Macdonald *et al*. 2003) and in France (Dutartre *et al.* 1999). The EPPO lists *Egeria densa* as an invasive species in Europe and lists it as being established in Austria, Belgium, Switzerland, Denmark, Spain, France, Great Britain (EPPO Reporting Service No.1 Paris 2007-01-01) (where is has been recorded as naturalised - Clapham *et al*. 1987), Italy and The Netherlands. In the USA *Egeria densa* is present but not considered to be problematic in southern New England (Les & Mehrhoff 1999). However, according to the Washington State Department of Ecology (2003) 'State officials in Oregon consider Brazilian *elodea* to be their worst aquatic plant problem.' Oregon (42°N to 46° 15'N) is at about the same latitude as much of New England (40° 58' N to 47° 28'N) although its rainfall and temperature regimes are different. *Egeria densa* is also established in British Colombia (Canada).

8	Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?		*Egeria densa* is invasive in a range of lake, wetland, riparian zone and water course habitat (ISSG database). It is found in depths of up to about 6 m or drifting (Washington State Department of Ecology Non-native plants site). Its establishment is facilitated by moderate eutrophication with mesotrophic conditions being optimal (Mazzeo *et al.* 2003). *Egeria densa* is capable of establishing and spreading over an extensive climatic range. In the USA for example, it ranges from Washington State in the north-west to Florida in the south-east, and is on the state noxious weed list in 46 states (USDA Plants Profile 2007), though it is most widespread between 33º and 35º latitude. Introduced populations to the USA are male only and reproduce from shoot fragments that contain a double node (Weldon *et al.* 1973). Plants fragment readily and this is a highly effective mode of reproduction. *Egeria densa* can spread very rapidly as a consequence (Washington State Department of Ecology Non-native plants site). The plant can form monotypic stands, doubling its extent in one year (Tanner *et al.* 1990), outcompeting native vegetation (Les & Mehrhoff 1999) and reducing native seedbank density and diversity (de Winton & Clayton 1996). *Egeria densa* infestations can cover substantial areas, restricting water movement, trapping sediment, reduced oxygen availability, decreasing light penetration, changing nutrient regimes and causing complex trophic level responses and causing fluctuations in water quality (Washington State Department of Ecology Non-native plants site). The plant senesces in autumn and overwinters at the bottom of the waterbody, initiating growth when the water temperature reaches 10º C; the optimal temperature for growth is between 15º and 25º C. The potential of *Egeria densa* to spread vegetatively precludes effective control by mechanical removal due to the fragmentation of plants and subsequent spread of viable propagules.
9	Does the organism occur outside effective containment in the Risk Assessment area?	YES (Go to 10)	*Egeria densa* is naturalised in GB (Clapham *et al* . 1987).
10	Is the organism widely distributed in the Risk Assessment area?	NO (Go to 11)	*Egeria densa* was first recorded in the Risk Assessment area in 1953 in the Ashton Canal, Droylsden, Greater Manchester. It has been recorded in 21 10km squares mapped in the Ecological Flora Database (Fitter & Peat 1994). It has been recorded from south Scotland, north-west England, north-central England, north-east England, central Wales, south Wales, south-central England, east England and south-east England. Although *Egeria densa* has been found over many parts of GB, these populations do not cover an extensive area.
11	Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in the Risk Assessment area, in the open, in protected conditions or both?	YES (Go to 12)	*Egeria densa* has established in the Risk Assessment area so suitable habitat for the survival, development and multiplication of the organism must exist (see 1.15 - 1.21 for more details).
12	Does the organism require another species for critical stages in its life cycle such as growth (e.g. root symbionts), reproduction (e.g. pollinators; egg incubators), spread (e.g. seed dispersers) and transmission, (e.g. vectors)?	NO (Go to 14)	*Egeria densa* fragments readily. Each fragment containing a double node has the potential to form a new plant (Washington State Department of Ecology Non-native plants site).
13	Is the other critical species identified in question 12 (or a similar species that may provide a similar function) present in the Risk Assessment area or likely to be introduced? If in doubt, then a separate assessment of the probability of introduction of this species may be needed.		
14	Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of the Risk Assessment area or sufficiently similar for the organism to survive and thrive?	YES (Go to 16)	*Egeria densa* is found in comparable ecoclimatic zones (e.g. Belgium, Austria, and Denmark) but areas from which it has been recorded as being invasive have warmer climates than the Risk Assessment Area.
15	Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in the Risk Assessment area?	YES (Go to 16)	*Egeria densa* thrives as a tropical aquarium plant and therefore is a potential colonist of freshwater habitats, particularly in waters with artificial heating and thermal pollution.
16	Has the organism entered and established viable (reproducing) populations in new areas outside its original range, either as a direct or indirect result of man's activities?	YES (Go to 17)	See 7 for information on the worldwide distribution of *Egeria densa* . It has been spread through the aquarium trade.
17	Can the organism spread rapidly by natural means or by human assistance?	YES (Go to 18)	
18	Could the organism as such, or acting as a vector, cause economic, environmental or social harm in the Risk Assessment area?	YES OR UNCERTAIN (Go to 19)	
19	This organism could present a risk to the Risk Assessment area and a detailed risk assessment is appropriate.	Detailed Risk Assessment Appropriate GO TO SECTION B	
20	This organism is not likely to be a harmful non-native organism in the Risk Assessment area and the assessment can stop.		

B	SECTION B: Detailed assessment of an organism's probability of entry, establishment and spread and the magnitude of the economic, environmental and social consequences			
	Probability of Entry	**RESPONSE**	**UNCERTAINTY**	**COMMENT**
1.1	List the pathways that the organism could be carried on. How many relevant pathways can the organism be carried on?	moderate number - 2	MEDIUM -1	As a pathway for entry into the Risk Assessment Area: (i) Intentional introduction - aquarium/ponds/amenity/water - as an ornamental plant. Pathways within the Risk Assessment Area: (ii) As a contaminant on plants offered for sale (Kay & Hoyle 2001); (iii) Unintentional introduction: recreational activities - plant fragments carried along waterways attached to boats (Les & Mehrhoff 1999).
1.2	Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.			(i) Intentional introduction - aquarium/ponds/amenity/water - as an ornamental plant: plants escape from there into unintended habitats. Given the isolated nature of the sites in which the plant has been observed, it is likely that they are almost all derived from human activity e.g. throwing away unwanted plants, cleaning tropical aquaria or garden ponds and plant fragments entering water bodies through the sewage system.
1.3	How likely is the organism to be associated with the pathway at origin?	very likely - 4	LOW - 0	If the area of origin is taken to refer to sale in garden centres and other outlets that sell aquatic plants which would include *E. densa* (often labelled as *Elodea densa*). *Egeria densa* is still available, and ignorance in the industry as to the potential effects of release is still likely to be widespread, but attitudes do appear to have shifted and some suppliers now follow the guides to good practice for the industry. It is uncertain if this has had any impact on the current risk of escape/colonisation.
1.4	Is the concentration of the organism on the pathway at origin likely to be high?	very likely - 4	LOW - 0	A large number of garden centres, etc. sell this plant.
1.5	How likely is the organism to survive existing cultivation or commercial practices?	very likely - 4	LOW - 0	The species is very hardy in cultivation.
1.6	How likely is the organism to survive or remain undetected by existing measures?	N/A		This pathway is a deliberate introduction pathway.
1.7	How likely is the organism to survive during transport /storage?	N/A		This pathway is a deliberate introduction pathway.
1.8	How likely is the organism to multiply/increase in prevalence during transport /storage?	N/A		This pathway is a deliberate introduction pathway.
1.9	What is the volume of movement along the pathway?	major - 3	LOW - 0	*Egeria densa* is widely traded in GB.
1.10	How frequent is movement along the pathway?	often - 3	LOW - 0	*Egeria densa* is widely traded in GB.
1.11	How widely could the organism be distributed throughout the Risk Assessment area?	limited - 1	MEDIUM -1	Although not widely distributed in the Risk Assessment Area (Q10), the species' introduced range elsewhere (Q7) indicates that it may have the potential for a much wider distribution in the Risk Assessment Area under current GB climate change projections.
1.12	How likely is the organism to arrive during the months of the year most appropriate for establishment ?	likely - 3	MEDIUM -1	*Egeria densa* could be traded and plants/plant fragments transferred into water bodies at any time of the year. It has been reported that the species can survive in ditches under ice but freezing is lethal (Yarrow *et al*. 2009).
1.13	How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) or other material with which the organism is associated to aid transfer to a suitable habitat?	likely - 3	MEDIUM -1	The fact that aquarium/pond plants are frequently disposed of in water bodies makes it likely that its intended use will aid in its transfer to a suitable habitat. Many retailers do not provide information on responsible disposal of aquaria plants (or other material) at the point of sale.
1.14	How likely is the organism to be able to transfer from the pathway to a suitable habitat?	moderately likely - 2	HIGH -2	The fact that the species is established suggests that that it is able to transfer to a suitable habitat. However, it is not widely established which indicates that this transfer may be a rare event or that habitat in the Risk Assessment Area is marginal.

	Probability of Establishment	RESPONSE	UNCERTAINTY	COMMENT
1.15	How similar are the climatic conditions that would affect establishment in the Risk Assessment area and in the area of current distribution?	moderately similar - 2	MEDIUM -1	*Egeria densa* has become established in the Risk Assessment Area but is not yet invasive. This area is therefore, strictly speaking, part of the plant's present distribution. In this risk assessment 'present distribution' is taken to mean 'areas in which *Egeria densa* is native and areas in which it has become invasive. This distinguishes 'present distribution' from the Risk Assessment Area in which *Egeria densa* is established but not yet invasive. *Egeria densa* can successfully overwinter vegetatively as short green shoots, which can survive at 1º C under 15 cm of ice (Catling & Wojtas 1986, Champion & Tanner 2000). *Egeria densa* initiates growth when temperatures reach 10º C and the optimal temperature for growth is between 15º and 25º C (Haramoto & Ikusima 1988). Current summer water temperatures are probably too low for *Egeria densa* to become invasive in still and slow flowing freshwater habitats in the Risk Assessment Area although this may change with projected climate change (UK Met Office 2007). *Egeria densa* is invasive in France and has spread along the entire Atlantic coast (Dutartre *et al*. 1999). This would imply that a great deal of southern Britain will be suitable habitat for *Egeria densa* in the coming decades under current GB climate change projections.
1.16	How similar are other abiotic factors that would affect establishment in the Risk Assessment area and in the area of present distribution?	similar - 3	LOW - 0	*Egeria densa* is established in the Risk Assessment Area. Other abiotic factors such as salinity, nutrient status, pH, current, and water body type are similar to those in locations where *Egeria densa* has become invasive.
1.17	How many species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism species are present in the Risk Assessment area? Specify the species or habitats and indicate the number.	many - 3	LOW - 0	The species is established so suitable habitats must exist. A large number of freshwater habitats in UK are suitable for *Egeria densa* survival, development and multiplication.
1.18	How widespread are the species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism in the Risk Assessment area?	widespread - 4	LOW - 0	Surveys based on those carried out by the Nature Conservancy Council (NCC) in GB, e.g. Duigan *et al*. (2006) indicate that there are many habitats that would be suitable for the multiplication of *Egeria densa*.
1.19	If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in the risk assessment area?	N/A		The assessor could find no evidence to suggest that the species requires any other species for critical stages in its life cycle.
1.20	How likely is it that establishment will not be prevented by competition from existing species in the Risk Assessment area?	moderately likely - 2	MEDIUM -1	It appears that competition from both submerged and floating macrophytes is an important determinant of *Egeria densa* biomass (e.g. Dutartre *et al.* 1999, Feijoó *et al*. 1996). However, competition is unlikely to prevent the establishment of *Egeria densa* if climatic and other abiotic factors are conducive and suitable habitats are available. There is evidence to suggest *Egeria densa* has a competitive advantage at low light and hence possibly more competitive in turbid or shaded waters (Rodrigues & Thomaz 2010).
1.21	How likely is it that establishment will not be prevented by natural enemies already present in the Risk Assessment area?	moderately likely - 2	LOW - 0	The assessor could find no evidence to suggest that establishment is prevented by natural enemies that are already present, in view of the fact that the species is established and spreading. There is currently no effective control on similar non-native species in GB, e.g. *Lagarosiphon major* and *Elodea nuttallii*.
1.22	If there are differences in man's management of the environment/habitat in the Risk Assessment area from that in the area of present distribution, are they likely to aid establishment? (specify)	N/A	LOW - 0	Intermediate levels of eutrophication are likely to aid establishment (Mazzeo *et al*. 2003). Such conditions are present in both the Risk Assessment Area and the area of present distribution.
1.23	How likely is it that existing control or husbandry measures will fail to prevent establishment of the organism?	very likely - 4	LOW - 0	Control and husbandry measures to date have failed to prevent establishment.
1.24	How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	widespread - 4	LOW - 0	There are a large number of establishments cultivating and selling *Egeria densa* in GB.
1.25	How likely is the reproductive strategy of the organism and duration of its life cycle to aid establishment?	very likely - 4	LOW - 0	*Egeria densa* can reproduce from seed or from shoot fragments that contain double node regions. The literature accessed by the assessor only documents vegetative reproduction in its introduced range, e.g. Mazzeo *et al*. 2003, Haramoto & Ikusima 1988 and Sculthorpe 1967 cited in de Winton & Clayton 1996. Plants fragment readily and this is a highly effective mode of reproduction. *Egeria densa* can spread very rapidly as a consequence (Washington State Department of Ecology Non-native plants site).
1.26	How likely is it that the organism's capacity to spread will aid establishment?	very likely - 4	LOW - 0	Its ability to spread, mainly through human assistance, is likely to aid establishment (see 2.1 and 2.2).
1.27	How adaptable is the organism?	very adaptable - 4	LOW - 0	*Egeria densa* has colonised a variety of water bodies over an extensive latitudinal range (see 7 and 8). Riis *et al*. (2010) show that phenotypic variation aids survival of *E. densa* in New Zealand.
1.28	How likely is it that low genetic diversity in the founder population of the organism will not prevent establishment?	likely - 3	MEDIUM -1	*Egeria densa* has become established through clonal reproduction in a wide range of habitats, probably from small founder populations. A comparative study of introduced populations of *Egeria densa* in Oregon (USA) and southern Chile (Carter & Sytsma 2001) found little genetic variability among samples, suggesting that similar bottlenecking affected both populations or that there is low genetic variability among native populations.
1.29	How often has the organism entered and established in new areas outside its original range as a result of man's activities?	very many - 4	LOW - 0	See 7 for information on the worldwide distribution of *Egeria densa*. *Egeria densa* continues to be widely sold as an aquarium plant so it is likely that further introduction will happen if trade in the species is not restricted. However, the risks may be becoming less acute following the introduction of guidance on good practice for the aquarium trade.

1.30	How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	moderately likely - 2	MEDIUM -1	There are reports of successful control of *Egeria densa* and eradication in small water bodies using techniques such as chemical control, mechanical control and management of water levels including complete drawdown (Washington State Department of Ecology Non-native plants site), but complete eradication over large areas would seem unlikely. Mechanical control can increase the plant's rate of spread through enhanced fragmentation. The plant can successfully overwinter at the bottom of the water body and sources of reinvasion from domestic aquaria are present.
1.31	Even if permanent establishment of the organism is unlikely, how likely is it that transient populations will be maintained in the Risk Assessment area through natural migration or entry through man's activities (including intentional release into the outdoor environment)?	moderately likely - 2	MEDIUM -1	Re-introduction is possible through the processes noted in Section B

	Spread	RESPONSE	UNCERTAINTY	COMMENT
2.1	How rapidly is the organism liable to spread in the Risk Assessment area by natural means?	slow - 1	MEDIUM -1	*Egeria densa* was first recorded in the Risk Assessment Area in 1953 in the Ashton Canal Droylsden, Greater Manchester. According to NBN records, it was not until 1978 that *Egeria densa* was recorded in a grid square outside north-west England (recorded in neighbouring north-east England) (NBN Gateway records for England and Wales). Since this date *Egeria densa* has been recorded in a diverse range of locations but its distribution has not been contiguous over a large number of grid squares. Such a distribution would be consistent with spread through human assistance.
2.2	How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	intermediate - 2	MEDIUM -1	See 2.1 for an account of *Egeria densa* spread in the Risk Assessment Area. *Egeria densa* can be spread by human assistance through the dumping of aquarium plants into water bodies. *Egeria densa* can grow from small plant fragments which can be spread by the movement of plants, people and objects between water bodies. However, the discontinuous distribution of *Egeria densa* in GB would indicate that this mode of dispersal has not been highly effective to date.
2.3	How difficult would it be to contain the organism within the Risk Assessment area?	with some difficulty - 2	MEDIUM -1	The slow rate of spread of *Egeria densa* in the Risk Assessment Area to date would appear to offer some hope for its containment. However, the fact that its distribution is expanding indicates that current risk management efforts are not effectively containing *Egeria densa* . If containment is planned, more stringent procedures will be necessary. The difficulties of containment could be exacerbated by climate change.
2.4	Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.	Still and slow flowing freshwater habitats - lakes, ponds, pools, ditches and gently flowing rivers and streams	HIGH -2	According to NBN Gateway data, the most northerly record of *Egeria densa* is in southern Scotland (NBN Gateway records for Scotland). The species is likely to spread further north given GB climate change projections (UK Met Office 2007). *Egeria densa* , which can successfully overwinter vegetatively as short green shoots and which can survive at 1ºC under 15 cm of ice (Catling & Wojtas 1986, Champion & Tanner 2000), could certainly overwinter in colder northerly areas.

	Impacts	RESPONSE	UNCERTAINTY	COMMENT
2.5	How important is economic loss caused by the organism within its existing geographic range?	major - 3	LOW - 0	Dense *Egeria densa* infestations adversely impact upon the recreational use of water bodies by interfering with navigation, fishing, swimming and the pursuit of water sports (Washington State Department of Ecology Non-native plants site). Infestations can damage hydro power generation equipment causing great financial losses (Barreto *et al* . 2000). The Washington State Department of Ecology non-native plants site summarised the economic losses caused by *Egeria densa* as follows: It 'forms dense monospecific stands that restrict water movement, trap sediment, and cause fluctuations in water quality. Dense beds interfere with recreational uses of a waterbody by interfering with navigation, fishing, swimming, and water skiing. An estimated 1500 acre feet of storage capacity were lost annually in Lake Marion, South Carolina due to sedimentation caused by Brazilian *elodea* growth. In New Zealand, electric generating plants were shut down when fragments of Brazilian *elodea* clogged intake structures on the Waikato River. In Washington State, local and state government and lake residents spend thousand of dollars every year to manage Brazilian *elodea* infestations. The cost of the control project in Silver Lake, Cowlitz County is over one million dollars!' Economic benefits have been realised from its use as an aquarium plant. It can also have beneficial impacts through its function as a natural filter, particularly for trapping fine sediments especially phosphorus and for restricting cyanobacterial blooms through competition for nutrients (Dutartre *et al* . 1999). Its morphological and physiological properties make *Egeria densa* an ideal model organism for use in laboratory research and teaching (Global Invasive Species Database: *Egeria densa*).
2.6	Considering the ecological conditions in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, livestock health and production, likely to be? (describe) in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, likely to be?	moderate - 2	HIGH -2	With projected climate change it is likely that *Egeria densa* could cause problems such as interference with leisure uses of water bodies and loss of storage capacity which are likely to have economic consequences in the Risk Assessment Area. The impact on hydroelectricity generation is likely to be less serious in the Risk Assessment Area, as the potential for hydroelectricity generation in UK (outside Scotland) is less than in many of the locations in which *Egeria densa* is invasive. There are possible negative impacts on fishing and other water uses and an increased flood risk. The high degree of uncertainty reflects our poor understanding of possible changes in the suitability of the Risk Assessment Area for *Egeria densa* invasion with projected changes in the GB climate.
2.7	How great a loss in producer profits is the organism likely to cause due to changes in production costs, yields, etc., in the Risk Assessment area?	moderate - 2	HIGH -2	The above consequences could cause a loss in producer profits in the Risk Assessment Area with projected climate changes. Current losses from *Egeria densa* are likely to be minimal.
2.8	How great a reduction in consumer demand is the organism likely to cause in the Risk Assessment area?	moderate - 2	HIGH -2	*Egeria densa* invasion could adversely affect prices of services that depend upon the infested water bodies thus reducing demand.
2.9	How likely is the presence of the organism in the Risk Assessment area to cause losses in export markets?	very unlikely - 0	MEDIUM -1	The assessor could find no information on this. It is unlikely that export goods will be contaminated with *Egeria dens* a so its presence in the Risk Assessment Area is unlikely to have any impact on export considerations.
2.10	How important would other economic costs resulting from introduction be? (specify)	minor - 1	HIGH -2	It is likely that other costs will increase but to some extent incremental costs resulting from *Egeria densa* invasion will be incorporated into programmes and projects to tackle invasive species as a whole.
2.11	How important is environmental harm caused by the organism within its existing geographic range?	major - 3	LOW - 0	Where it is invasive, *Egeria densa* can seriously threaten native aquatic communities. It has been cited as a threat to a rare species in Oregon (Les & Mehrhoff 1999). *Egeria densa* reduces the abundance and diversity of native plant seeds in lake bottoms which is probably accentuated by increased sediment accumulation beneath the weed beds (de Winton & Clayton 1996). *Egeria densa* infestations can result in complex community changes whose biodiversity consequences are difficult to predict (Mazzeo *et al* . 2003, Lake *et al.* 2002). Other environmental impacts include reduced water movement, trapping of sediment, reduced oxygen availability, decreasing light penetration and changed nutrient regimes (Washington State Department of Ecology Non-native plants site).
2.12	How important is environmental harm likely to be in the Risk Assessment area?	moderate - 2	MEDIUM -1	With projected climate change it is likely that *Egeria densa* could cause similar environmental harm in the Risk Assessment Area.
2.13	How important is social and other harm caused by the organism within its existing geographic range?	major - 3	LOW - 0	There is evidence that where *Egeria densa* is invasive, it can cause social and other harm, e.g. on recreational use of water bodies (see 2.5).
2.14	How important is the social harm likely to be in the Risk Assessment area?	moderate - 2	MEDIUM -1	Similar social harm to that outlined above could occur in the Risk Assessment Area if GB water bodies become climatically more suitable, but under current conditions social harm is likely to be low.
2.15	How likely is it that genetic traits can be carried to native species, modifying their genetic nature and making their economic, environmental or social effects more serious?	very unlikely - 0	LOW - 0	The assessor could find no evidence of *Egeria densa* carrying its genetic traits to native species. There are no native species in the same genus.
2.16	How probable is it that natural enemies, already present in the Risk Assessment area, will have no affect on populations of the organism if introduced?	moderately likely - 2	MEDIUM -1	*Egeria densa* is highly palatable to the Chinese grass carp (*Ctenopharyngodon idella*) that are present in some UK water bodies. Grass carp are not native to UK and therefore there are no effective natural predators for the plant in GB. Although waterfowl may graze *E. densa* they do not appear to significantly affect populations.

2.17	How easily can the organism be controlled?	with some difficulty - 2	MEDIUM -1	Accounts of *Egeria densa* control methods are given in a variety of sources, e.g. (Washington State Department of Ecology Non-native plants site, *Egeria densa* by: Anderson and Hoshovsky, National Plant Data Center, Baton Rouge, LA., Global Invasive Species Database: *Egeria densa*). Mechanical methods are costly, need to be regularly repeated and encourage spread by fragmentation. Cultural methods such as covering infested areas, lowering water levels and successive drawdowns can be very effective for localised control. A variety of herbicides have been used on *Egeria densa* with some success but impact on non-target plants are likely. Two fish, the Chinese grass carp and the Congo tilapia (*Tilapia melanopleura*), have been introduced into water bodies to control *Egeria densa*. *Fusarium* species show promise as the basis for a mycoherbicide against *egerias*.
2.18	How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	moderately likely - 2	HIGH -2	Most of the above methods have the potential to disrupt existing biological or integrated systems of control for other organisms in possibly unpredictable ways because, with the exception of the yet to be developed mycoherbicide, they are all examples of non-specific ecosystem interventions.
2.19	How likely is the organism to act as food, a host, a symbiont or a vector for other damaging organisms?	moderately likely - 2	HIGH -2	Where it is invasive, *Egeria densa* has been shown to act as a food and host for other organisms (Lake *et al*. 2002, Collier *et al.* 1999) though these are not always necessarily damaging. In some systems it appears that *Egeria densa* infestations helps to restrict cyanobacterial blooms (Dutartre *et al.* 1999).
2.20	Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur	Still and slow flowing freshwater habitats - lakes, ponds, pools, ditches and gently flowing rivers and streams in Southern UK	HIGH -2	The extent to which *Egeria densa* becomes a problem in these systems in the Risk Assessment area depends to a large extent upon the degree to which projected climate changes make GB water bodies more suitable for *Egeria densa* proliferation.

Summarise Entry	very likely - 4	LOW - 0	*Egeria densa* has entered the risk assessment area. The main pathway of entry, intentional introduction for aquaria, continues to be important.
Summarise Establishment	likely - 3	LOW - 0	*Egeria densa* is established in the Risk Assessment Area. However, it has yet to become invasive. It has been found at locations from southern England to southern Scotland but it is not found over large contiguous areas.
Summarise Spread	slow - 1	LOW - 0	The spread of *Egeria densa* in GB has been slow to date. Its discontinuous distribution would indicate that *Egeria densa* has been independently spread to individual areas (possibly by dumping of plants in water bodies). Projected climate changes are likely to increase the rate of natural spread.
Summarise Impacts	moderate - 2	LOW - 0	*Egeria densa* has the potential to adversely impact upon the recreational use of water bodies by interfering with navigation, fishing, swimming and the pursuit of water sports. Infestations can damage hydro power generation equipment. *Egeria densa* can have adverse biodiversity impacts and can result in reduced water movement, trapping of sediment, reduced oxygen availability, decreasing light penetration and changed nutrient regimes. There are also some potential beneficial impacts such as water purification and reduction in cyanobacteria levels.
For pathway/policy risk assessment Assess the potential for establishment and economic/environmental/social impacts of another organism or stop			
Conclusion of the risk assessment	MEDIUM -1		*Egeria densa* has already entered the UK and is successfully established but not yet invasive. The main pathway is intentional importation for aquaria. It is likely to become invasive in GB in the coming decades (especially in the southern part of the country) if climate change projections are realised. If so, it is likely to have adverse effects on the recreational use of water bodies, biodiversity and on the aquatic environment. These changes are likely to have moderate socio-economic impacts.
Conclusions on Uncertainty		HIGH -2	The fact that the potential impact of *Egeria densa* in the Risk Assessment Area is dependent on projected climate changes makes prediction inherently uncertain.

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