RISK ASSESSMENT SUMMARY SHEET

Updated August 2018

Golden club (*Orontium aquaticum*)

- Sole member of the genus *Orontium;* closest relative is American skunk cabbage
- Present in Hertfordshire since 1990 and two other sites
- Disposal of garden waste is most likely entry pathway
- Preference for shallow water may limit growth to ponds though slow spread along rivers may be possible

Image: Dave Pape, public domain

History in GB

First recorded in the wild in Chorleywood, Hertfordshire in 1990. Sold as ornamental plant by a limited number of suppliers. At the three sites where it has been found, it has been controlled using repeated herbicide treatments.

Native distribution

Eastern coastal plain of North America from New York to Florida, west to Texas and inland from Tennessee to Pennsylvania

Citizens United to Protect the Maurice River

Distribution in GB

Present in three sites: ponds in the New Forest and Hertfordshire and upland lake near Aberystwyth, Wales.

Botanical Society of Britain and Ireland

Impacts

Environmental (minimal)

- Impacts largely unknown but predicted to be minor given rarity in its native range and narrow environmental niche (shallow water or bare mud).

Economic (minimal)

- Aside from management costs, economic costs are thought to be negligible

Introduction pathway

Ornamental plant established at three sites presumably from discarded garden waste or as a result of deliberate planting

Spread pathways

Natural (slow) - spreads slowly, possibly because it requires large expanses of shallow water or bare mud

Human-aided (slow) – Accidental escapees from gardens or deliberate planting as an ornamental or to provide habitat for fish

Summary

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

RISK ASSESSMENT COVERING PAGE - ABOUT THE PROCESS

It is important that policy decisions and action within Great Britain are underpinned by evidence. At the same time it is not always possible to have complete scientific certainty before taking action. To determine the evidence base and manage uncertainty a process of risk analysis is used.

Risk analysis comprises three component parts: risk assessment (determining the severity and likelihood of a hazard occurring); risk management (the practicalities of reducing the risk); and risk communication (interpreting the results of the analysis and explaining them clearly). This tool relates to risk assessment only. The Non-native Species Secretariat manages the risk analysis process on behalf of the GB Programme Board for Non-native Species. During this process risk assessments are:

- Commissioned using a consistent template to ensure the full range of issues is addressed and maintain comparable quality of risk and confidence scoring supported by appropriate evidence.
- Drafted by an independent expert in the species and peer reviewed by a different expert.
- Approved by the NNRAP (an independent risk analysis panel) only when they are satisfied the assessment is fit-for-purpose.
- Approved 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 and GB Programme Board if necessary.

Common misconceptions about risk assessments

The risk assessments:

- Consider only the risks (i.e. the chance and severity of a hazard occurring) posed by a species. They do not consider the practicalities, impacts or other issues relating to the management of the species. They also only consider only the negative impacts of the species, they do not consider any positive effects. They therefore cannot on their own be used to determine what, if any, management response should be undertaken.
- Are advisory and therefore part of the suite of information on which policy decisions are based.
- Are not final and absolute. They are an assessment based on the evidence available at that time. Substantive new scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.

Period for comment

Once placed on the NNSS website, risk assessments are open for stakeholders to provide comment on the scientific evidence which underpins them for three months. Relevant comments are collated by the NNSS and sent to the risk assessor for them to consider and, if necessary, amend the risk assessment. Where significant comments are received the NNRAP will determine whether the final risk assessment suitably takes into account the comments provided.

To find out more: published risk assessments and more information can be found at http://www.nonnativespecies.org/index.cfm?pageid=143

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: *Orontium aquaticum* L. (Araceae) Goldenclub, Floating Arum
Author: Dr Kevin John Walker
Risk Assessment Area: Great Britain (England, Scotland, Wales and their islands)

Version: Draft 1 (*August 2017*), Draft 2 (*May 2018*), Draft 3 (*June 2018*)
Signed off by NNRAP: *June 2018*
Approved by Programme Board: *June 2019*
Placed on NNSS website: *to be completed*

EU CHAPPEAU	
QUESTION	**RESPONSE**
1. In how many EU member states has this species been recorded? List them.	Sweden UK
2. In how many EU member states has this species currently established populations? List them.	Sweden UK
3. In how many EU member states has this species shown signs of invasiveness? List them.	UK
4. In which EU Biogeographic areas could this species establish?	Alpine Atlantic Boreal Continental
5. In how many EU Member States could this species establish in the future [given current climate] (including those where it is already established)? List them.	Austria Belgium Bulgaria Czech Republic Denmark Estonia Finland France Germany Hungary Ireland Italy Latvia Lithuania Luxembourg

	Netherlands Poland Portugal Romania Slovakia Spain Sweden UK
6. In how many EU member states could this species become invasive in the future [given current climate] (where it is not already established)?	All the above

SECTION A – Organism Information and Screening		
Stage 1. Organism Information	**RESPONSE** **[chose one entry, delete all others]**	**COMMENT**
1. Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	Yes	*Orontium aqauticum* is the sole living member of the genus *Orontium* and is unique within the Araceae in that the flower-stalks lack apparent spathes, and are instead encompassed by small basal sheaths. Two related species, *O. mackii* and *O. wolfei*, have been identified from the Upper Cretaceous and Paleogene deposits in western North America but are now extinct (Bogner et al., 2007). The closest living relatives to goldenclub are the North American skunk cabbages *Symplocarpus* and *Lysichiton* and together they comprise the subfamily Orontioideae.
2. If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	NA	
3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	No	
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	NA	
5. Where is the organism native?		*Orontium aquaticum* is endemic to the eastern coastal

		plain of North America and the Piedmont and Appalachian Mountains. Its range extends from New York and Massachusetts, south to Florida along the eastern coast, west to Texas, and inland to Tennessee, Kentucky, West Virginia and Pennsylvania.
6. What is the global distribution of the organism (excluding Great Britain)?	Outside North America and GB *Orontium aquaticum* has only been recorded as an established alien in a lake in southern Sweden (Västragötland) where it was first recorded in 1982 (Lenfors & Nilsson 1987). CABI (2015) also lists it as present in Denmark, Norway and Finland but these appear to be errors (due to the published map showing presence in Scandinavia with all countries highlighted). These errors were duplicated in Hussner (2012).	
7. What is the distribution of the organism in Great Britain?	In GB *Orontium aquaticum* has been recorded from three sites: small ponds in the New Forest (Turf Hill) and in Hertfordshire (Chorelywood) and the shore of a small upland lake near to Aberystwyth in west Wales (Llyn Syfydrin). *O. aquaticum* has been present at Chorleywood, Hertfordshire, since at least 1990 but does not appear to have spread or become invasive and still survives in small numbers (Figure 1; James, 2009; Trevor James, pers. comm.).	

Figure 1. *Oronticum aquaticum* growing on the margin of a pond at Chorleywood, Hertfordshire.

O. aquaticum was first noted in the pond at Turf Hill, South Hampshire, in April 2016 when it was growing abundantly all around the edge of the pond (Chatters, 2016; Figure 2); it was still present in small numbers in the spring of 2017 (Figure 3) despite being treated with herbicide in the previous autumn (C. Chatters, pers. comm.).

Figure 2. *Orontium aquaticum* growing in a pond at Turf Hill, South Hampshire, 7th May 2016. Photograph © Clive Chatters.

Figure 3. *Orontium aquaticum* growing on the margin of a pond at Turf Hill, South Hampshire, April 2017, following control with herbicide in the previous winter. Photograph © Catherine Chatters.

O. aquaticum was first recorded on the shore of an oligotrophic upland lake (Llyn Syfydrin) in west Wales in 2010 (Alan Morton, pers. comm.). When originally discovered it was growing in small quantity with

	Pontederia cordata at 352 m altitude (Alan Morton, pers. comm.). By July 2017 the population had increased slightly from 3-4 small patches to around 8 large and 5 smaller patches extending over about 6 m of shoreline, with 1 small patch several metres away (Alan Morton & Arthur Chater, pers. comm.; Figure 4).  **Figure 4.** *Oronticum aquaticum* (foreground) growing with *Pontederia cordata* (background) on the margin of Llyn Syfydrin, Cardiganshire, July 2017. Photograph © Alan Morton.	
8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?	Yes	*Orontium aquaticum* has not been reported as invasive within its native range in North America. Indeed, *O. aquaticum* is threatened and declining in many parts of the US (USDA, 2017) leading to attempts to conserve and restore populations in some areas such as New York State (e.g. Les & Kiviat, 2016). A recent study in Sweden categorised it as having a relatively high 'index' of 'invasive concern' (a score of 15 out of a maximum of 38 with the highest ranked species scoring 28) based on its competitive ability (4/5), population density (3/5), dispersal capacity (2/5), hybridisation/geneflow potential (1/5), residence time (1/1) and isolation from native range (0.9/1.1) (Tyler et

		al., 2015). This placed it towards the bottom of the list of the 150 potentially most invasive species in Sweden. In a similar 'horizon-scanning' exercise for GB, but using a different methodology, *O. aquaticum* was ranked as 'critical' in terms of its invasive potential, along with 32 other freshwater aquatic taxa (Thomas, 2012). Despite these obvious concerns the species has displayed only limited capacity to spread at two of its GB sites, whereas at a third (Turf Hill) it did appear invasive initially, covering a large section of the pond (Figure 2) although it has since been controlled. No information is available on the invasiveness of the species in Sweden.
9. Describe any known socio-economic benefits of the organism in the risk assessment area.		*Orontium aquaticum* is sold as an ornamental and is occasionally grown in public and private gardens. In 2017, it was listed as available from 9 suppliers on the RHS Plant Finder website (https://www.rhs.org.uk/plants/details?plantid=1356).
Stage 2. Screening Questions		
10. Has this risk assessment been requested by the GB Programme Board? (If uncertain check with the Non-native Species Secretariat)	Yes If yes, go to section B (detailed assessment) If no, got to 10	

SECTION B – Detailed assessment

PROBABILITY OF ENTRY

Important instructions:

- Entry is the introduction of an organism into GB. Not to be confused with spread, the movement of an organism within GB.
- For organisms which are already present in GB, only complete the entry section for current active pathways of entry or if relevant potential future pathways. The entry section need not be completed for organisms which have entered in the past and have no current pathways of entry.

QUESTION	RESPONSE [chose one entry, delete all others]	CONFIDENCE [chose one entry, delete all others]	COMMENT
1.1. How many active pathways are relevant to the potential entry of this organism? (If there are no active pathways or potential future pathways respond N/A and move to the Establishment section)	very few	very high	*Orontium aquaticum* is likely to have very few active pathways related to its ornamental use in both public and private gardens in GB.
1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways. For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary).	Horticulture		*Orontium aquaticum* is grown as an aquatic ornamental in both public and private gardens. It is available for sale by a number of commercial suppliers (9 listed on the RHS Plant Finder in 2017) including by mail order. Escapes from gardens are likely to be via disposal of unwanted garden waste/plants in wild locations. Once established, secondary spread by seed/rhizomes, along watercourses, is also a possibility but extant populations in GB are in situations where spread is likely to be 'contained' (i.e. isolated ponds, lakes).
Pathway name:	Horticultural use		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the	intentional	very high	Introduction of *O. aquaticum* to GB is intentional (i.e.

organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)			introduction for ornamental use/sale).
1.4. 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? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	unlikely	high	Large numbers of *O. aquaticum* are unlikely to be imported to GB each year as the number of suppliers is limited and many suppliers are likely to cultivate their own material.
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	unlikely	high	Most ornamental populations of *O. aquaticum* are grown in ponds in private gardens that are isolated from watercourses and therefore unable to spread by natural means. Garden escapes are more likely to result from waste material disposed in wild locations. However, the three extant British populations all occur in isolated waterbodies and are therefore unlikely to colonise new sites.
1.10. Estimate the overall likelihood of entry into GB based on this pathway?	very likely	very high	Entry to GB has already occurring via ornamental use/horticultural sale.
End of pathway assessment, repeat as necessary.			
1.11. Estimate the overall likelihood of entry into GB based on all pathways (comment on the key issues that lead to this conclusion).	very likely	very high	Entry to GB has already occurring via ornamental use/horticultural sale.

PROBABILITY OF ESTABLISHMENT

Important instructions:

- For organisms which are already well established in GB, only complete questions 1.15 and 1.21 then move onto the spread section. If uncertain, check with the Non-native Species Secretariat.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
1.12. How likely is it that the organism will be able to establish in GB based on the similarity between climatic conditions in GB and the organism's current distribution?	very likely	high	*Orontium aquaticum* occurs throughout temperate regions of the eastern North America with similar climates to many parts of GB, especially lowland parts of southern England.
1.13. How likely is it that the organism will be able to establish in GB based on the similarity between other abiotic conditions in GB and the organism's current distribution?	very likely	high	In North America *O. aquaticum* grows on sandy, muddy or peaty shorelines in relatively still and shallow waters, and can be found in freshwater tidal wetlands, bogs, marshes, rivers, streams, ponds, lakes and swamps (Koltz, 1992). It has a slightly preference for acidic soils but can grow in conditions from just under pH 5 to 7. All these conditions are widely distributed in GB.
1.14. How likely is it that the organism will become established in protected conditions (in which the environment is artificially maintained, such as wildlife parks, glasshouses, aquaculture facilities, terraria, zoological gardens) in GB? Subnote: gardens are not considered protected conditions	very unlikely	high	Virtually all introduced populations of *O. aquaticum* are likely to be grown in ornamental ponds in public or private gardens, or fishing lakes.
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in GB?	widespread	high	Suitable habitats for *O. aquaticum* are widespread (see 1.13).
1.16. If the organism requires another species for critical	NA	NA	

stages in its life cycle then how likely is the organism to become associated with such species in GB?			
1.17. How likely is it that establishment will occur despite competition from existing species in GB?	very likely	high	The behaviour of *O. aquaticum* at its three introduced locations suggests that it is capable of establishing in the wild despite competition from existing species in GB, including other non-natives such as *Pontederia cordata* that is already established with it in west Wales.
1.18. How likely is it that establishment will occur despite predators, parasites or pathogens already present in GB?	likely	high	The tissue of *O. aquaticum* contains needle-like crystals which cause intense irritation in the mouth when eaten raw (Kloltz, 1992). However, populations in North America are grazed by a range of animals (deer, muskrats, beavers) and birds (Canada Geese). Canada Geese have also been noted to graze leaves of *O. aquaticum* in west Wales (Alan Morton, pers. comm.). The impact of pests and pathogens within its native or non-native range is unknown.
1.19. How likely is the organism to establish despite existing management practices in GB?	likely	high	There is no published information of the impact of management on the establishment and spread of *O. aquaticum*. The margins of two of three GB sites are grazed by sheep or horses but it is unlikely that this management will impact established populations in shallow water.
1.20. How likely are management practices in GB to facilitate establishment?	unlikely	medium	There is no evidence to suggest that current management of water bodies will facilitate the establishment of *O. aquaticum*.
1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in GB?	moderately likely	medium	The evidence from Turf Hill suggests that *O. aquaticum* has some resistance to control with herbicide, presumably due to the difficulties of treating large populations with extensive rhizome networks in shallow water. Smaller populations

			will be much easier to control, and may be effectively controlled by hand-pulling.
1.22. How likely are the biological characteristics of the organism to facilitate its establishment?	very likely	medium	*O. aquaticum* grows best in shallow water where its contractile roots pull the stout rhizomes deep into the substrate (Klotz, 1992). Under these conditions, the species appears to have great capacity to spread locally and consequently, may be difficult to eradicate once well established. It is likely to be much less of a problem on the margins of deeper water bodies where there is less shallow water or bare mud to allow colonisation and spread.
1.23. How likely is the capacity to spread of the organism to facilitate its establishment?	very likely	medium	*O. aquaticum* can spread by rhizome and seed which are dispersed by animals or by water (Klotz, 1992). In GB, established populations are unlikely to spread from isolated ponds but may disperse along watercourses where they occur in lakes (as in west Wales) or along river systems.
1.24. How likely is the adaptability of the organism to facilitate its establishment?	very likely	high	*O. aquaticum* is adapted to a wide range of abiotic and climatic conditions in North America (see 1.13) and this is likely to aid its establishment throughout GB. This is reflected by the conditions at the three sites where it has been recorded: shallow ponds on acid and circumneutral soils in lowland England and an oligotrophic upland lake.
1.25. How likely is it that the organism could establish despite low genetic diversity in the founder population?	moderately likely	low	No information is available on the genetic diversity of native or introduced populations of *O. aquaticum*.
1.26. Based on the history of invasion by this organism elsewhere in the world, how likely is to establish in GB? (If possible, specify the instances in the comments box.)	moderately likely	low	Outside GB and North America *O. aquaticum* has only been recorded as an established non-native in a lake in southern Sweden.

1.27. If the organism does not establish, then how likely is it that transient populations will continue to occur? Subnote: Red-eared Terrapin, a species which cannot re-produce in GB but is established because of continual release, is an example of a transient species.	likely	medium	*O. aquaticum* is widely grown for ornament and so it seems likely that it will continue to occur as an escape in ponds and lakes due to deliberate planting (possibly by anglers) or as an accidental introduction in discarded garden waste.
1.28. Estimate the overall likelihood of establishment (mention any key issues in the comment box).	very likely	high	*O. aquaticum* seems very likely to become established in GB given its ecological/climatic adaptability and rhizomatous growth. However, its preference for shallow water suggests that it will only become abundant in isolated ponds with low water-levels.

PROBABILITY OF SPREAD

Important notes:

- Spread is defined as the expansion of the geographical distribution of a pest within an area.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
2.1. How important is the expected spread of this organism in GB by natural means? (Please list and comment on the mechanisms for natural spread.)	moderate	medium	The ability of *O. aquaticum* to spread naturally is largely unknown but is likely to be limited where it occurs in isolated waterbodies such as ponds. Spread is likely to be much more extensive where it invades riverine systems due to water-borne dispersal of root-fragments and seed. Within its limited native range it is widely distributed within many river/estuarine systems suggesting effective spread although the speed with which it can colonise new areas is unknown.
2.2. How important is the expected spread of this organism in GB by human assistance? (Please list and comment on the mechanisms for human-assisted spread.)	moderate	medium	Accidental introduction by man is likely to be the main means by which *O. aquaticum* spreads in GB through the discarding of garden waste into ponds, lakes and watercourses. It might also be deliberately planted as an ornamental or to provide habitat for fish.
2.3. Within GB, how difficult would it be to contain the organism?	difficult	low	Evidence from Turf Hill suggests that *O. aquaticum* can be relatively easily controlled using herbicide within isolated water bodies although repeated treatments are likely to be necessary to achieve complete eradication. It is likely to much more difficult to control in open systems (rivers, lakes, etc.) due to restrictions in using such herbicides. Therefore the overall assessment is given as 'difficult' with 'low' reflecting the lack of information on

			establishment and control in more open systems.
2.4. Based on the answers to questions on the potential for establishment and spread in GB, define the area endangered by the organism.	Wetland habitats throughout GB	medium	*O. aquaticum* has the potential to occur in a wide variety of wetland habitats throughout GB but is most likely to occur in seasonal pools and ponds with low water levels on acid or circumneutral soils.
2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of GB were the species could establish), if any, has already been colonised by the organism?	0-10	very high	*O. aquaticum* is currently known from three sites but may occur in more although the total is very unlikely to exceed >1% of suitable habitats.
2.6. What proportion (%) of the area/habitat 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	*O. aquaticum* is very unlikely to significantly spread over the next 5 years.
2.7. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in Great Britain? (Please comment on why this timeframe is chosen.)	10	medium	The distribution of *O. aquaticum* should be re-assessed within the next decade in order to assess whether accidental introductions are increasing and already established populations are spreading. The population at Turf Hill (where it was invasive) should be monitored (and controlled) annually to ensure that the plant does not re-appear.
2.8. In this timeframe what proportion (%) of the endangered area/habitat (including any currently occupied areas/habitats) is likely to have been invaded by this organism?	0-10	high	*O. aquaticum* is very unlikely to significantly spread over the next 10 years.
2.9. Estimate the overall potential for future spread for this organism in Great Britain (using the comment box to indicate any key issues).	very slowly	medium	*O. aquaticum* is predicted to spread very slowly in GB over the coming decades. Accidental introductions are likely to be a rare and natural spread very slow due to vegetative growth and the isolation of established populations from other water bodies. Spread is predicted to be higher if *O. aquaticum* invades riverine systems although this has yet to occur in these habitats outside of its native range.

PROBABILITY OF IMPACT

Important instructions:

- When assessing potential future impacts, climate change should not be taken into account. This is done in later questions at the end of the assessment.
- Where one type of impact may affect another (e.g. disease may also cause economic impact) the assessor should try to separate the effects (e.g. in this case note the economic impact of disease in the response and comments of the disease question, but do not include them in the economic section).
- Note questions 2.10-2.14 relate to economic impact and 2.15-2.21 to environmental impact. Each set of questions starts with the impact elsewhere in the world, then considers impacts in GB separating known impacts to date (i.e. past and current impacts) from potential future impacts. Key words are in bold for emphasis.

QUESTION	RESPONSE	CONFIDENCE	COMMENTS
2.10. How great is the economic loss caused by the organism within its existing geographic range **excluding GB**, including the cost of any current management?	minimal	very high	The current economic costs of managing *O. aquaticum* are very modest and are associated with the conservation and restoration of populations in North American regions where it is threatened and declining (e.g. Les & Kiviat, 2016).
2.11. How great is the economic cost of the organism **currently** in GB **excluding management** costs (include any past costs in your response)?	minimal	very high	With the exclusion of management, there are currently no economic costs associated with presence of *O. aquaticum* in GB.
2.12. How great is the economic cost of the organism likely to be **in the future** in GB **excluding management** costs?	minimal	high	With the exclusion of management, future costs of *O. aquaticum*, are predicted to be non-existent or negligible.
2.13. How great are the economic costs **associated with managing** this organism **currently** in GB (include any past costs in your response)?	minimal	very high	To date the only costs associated with managing *O. aquaticum* in GB have been payment for a single control event (herbicide spraying) at Turf Hill (Catherine Chatters, pers. comm.).
2.14. How great are the economic costs **associated with managing** this organism likely to be **in the future** in GB?	minor	medium	The future costs of managing *O. aquaticum* in GB are predicted to be minimal given its apparent low capacity

			for spread and confinement to shallow waters.
2.15. How important is environmental harm caused by the organism within its existing geographic range **excluding GB**?	minimal	high	*O. aquaticum* is considered to be rare throughout its range in eastern North America, rarely occurring in large stands to the exclusion of other native species (Klotz, 1992). There is no information on its impact on invaded communities in Sweden or GB, although these are likely to be negligible in Hertfordshire and west Wales where it occurred in very small numbers. It was certainly more invasive at Turf Hill (see Figure 3) but the composition of the pond pre-and post-invasion has not been monitored. In the absence of more detailed information its overall impact is assessed as 'minimal'.
2.16. How important is the impact of the organism on biodiversity (e.g. decline in native species, changes in native species communities, hybridisation) **currently** in GB (include any past impact in your response)?	minimal	high	See 2.15.
2.17. How important is the impact of the organism on biodiversity likely to be in the **future** in GB?	minor	medium	If, as predicted, *O. aquaticum* increases in occurrence then its overall impact on biodiversity is likely to increase, especially if it invades shallow wetland habitats adjacent to rivers where its spread to other sites will be largely be unhindered. However, the overall impacts are likely to be relatively minor given its apparent limited capacity to spread at two of its established sites in GB.
2.18. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism **currently** in GB (include any past impact in your response)?	minimal	medium	The current impacts of *O. aquaticum* on ecosystem functions/services is currently unknown but likely to be minimal given the small size of populations.
2.19. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic	minimal	medium	If, as predicted, *O. aquaticum* increases in occurrence then its overall impact on ecosystem functions/services

interactions), including losses to ecosystem services, caused by the organism likely to be in GB in the **future**?			is likely to increase, especially if it invades shallow wetland habitats adjacent to rivers where its spread to other sites will be largely be unhindered. However, the overall impacts are likely to be relatively low given its apparent limited capacity to spread at two of its established sites in GB.
2.20. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism **currently** in GB?	minimal	high	Two of the three British populations of *O. aquaticum* receive no statutory protection as nature reserves (e.g. NNRs, SSSIs) whereas Turf Hill occurs on the northern edge of the New Forest SSSI which is also a SPA, SAC and Ramsar site. However, the presence of *O. aquaticum* is unlikely to have a significant impact on the nature conservation value of the SSSI unless it spreads considerably in the future.
2.21. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism likely to be in the **future** in GB?	minimal	medium	See 2.20
2.22. How important is it that genetic traits of the organism could be carried to other species, modifying their genetic nature and making their economic, environmental or social effects more serious?	minimal	very high	*O. aquaticum* has no near living relatives in the GB flora and is therefore unlikely to transfer its genes to other species. (*Lysichiton americanus* is its nearest relative in GB and this species is already invasive.)
2.23. How important is social, human health or other harm (not directly included in economic and environmental categories) caused by the organism within its existing geographic range?	minimal	high	No negative socio-economic impacts have been reported for *O. aquaticum*; its tissues contain needle-like crystals giving the plant an unpleasant acrid taste and intense irritation when eaten raw but these effects are removed by drying or cooking (Klotz, 1992). Its seeds and rhizomes are starchy and were a source of carbohydrates for North American Indians (Klotz, 1992).
2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging	minimal	low	None known.

organisms (e.g. diseases)?			
2.25. How important might other impacts not already covered by previous questions be resulting from introduction of the organism? (specify in the comment box)	NA	low	None known.
2.26. 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 GB?	minimal	low	No predators, parasites or pathogens of *O. aquaticum* have been reported for either its native or introduced ranges.
2.27. Indicate any parts of GB where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).	Lowland regions with acid soils	high	The preference of *O. aquaticum* to slightly acid soils suggest that establishment may be greatest in heathland regions with small waterbodies close to cities in southwest, southern and southeast England (e.g. Dorset Heaths, New Forest, Surrey Heaths, Suffolk Sandlings, etc.).

RISK SUMMARIES			
	RESPONSE	**CONFIDENCE**	**COMMENT**
Summarise Entry	very likely	very high	*O. aquaticum* is an ornamental garden plant that is already established at three sites in GB where it presumably originated from discarded garden waste dumped in wild locations, or possibly as a result of deliberate planting by anglers (e.g. in west Wales).
Summarise Establishment	likely	very high	*O. aquaticum* is established at all three sites, although it was only abundant at one site (Turf Hill) where it has now almost been eradicated by herbicide spraying.
Summarise Spread	very slowly	high	With the exception of Turf Hill, *O. aquaticum* appears to have spread only very slowly, possibly because it requires large expanses of shallow water or bare mud.
Summarise Impact	minor	medium	The likely impacts of *O. aquaticum* are largely unknown but are predicted to be relatively minor given the rarity of the plant in its native range and its rather narrow niche (shallow water or bare mud).
Conclusion of the risk assessment	low	medium	Although *O. aquaticum* is predicted to increase its distribution in GB in the future its overall social, economic and environmental impacts are likely to be minor given its apparent limited capacity to spread.

Additional questions are on the following page ...

ADDITIONAL QUESTIONS - CLIMATE CHANGE			
3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	Droughts	low	Climate warming may increase the availability of suitable habitat for *O. aquaticum* if droughts lead to increased fluctuations in water-levels and greater exposure of bare mud although these could well be offset by increased rainfall/flooding in some regions.
3.2. What is the likely timeframe for such changes?	20	low	Such changes are unlikely to become apparent until the species has become established and been monitored at many more sites.

Please provide a reference list on the following page ...

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