Carolina Fanwort (*Cabomba caroliniana*)

- Perennial aquatic plant with dissected leaves, from South America and southern parts of North America
- A few populations established in south-east England, but these are not yet invasive due to current climatic conditions. Has caused problems in the Netherlands.
- Potentially large impacts on native aquatic communities; may also affect aquaculture, damage equipment, and impede recreational activities

History in GB

First recorded in GB in south-east England in 1969, where it is now established. Populations have also been detected in the Basingstoke canal in 1991, and the Forth and Clyde canal in Scotland in 1969 (though the latter is no longer present). Current climatic conditions in GB have so far limited its spread; the native range of *C. caroliniana* tends to have a longer growing season and warmer summer temperatures. However, this may change in coming decades under projected climatic change. In the Netherlands it has become invasive in one site where it is established, which has a climate comparable to that in the risk assessment area.

Native distribution

Native to South America (Argentina, Brazil, Georgia, Uruguay) and some southern areas of North America

(no native range map found)

Distribution GB

Source: NBN 2014

Impacts

Environmental (moderate)

- In areas where it is invasive (e.g. Queensland, parts of China), *C. caroliniana* can seriously threaten native aquatic communities
- Affects water levels, water quality, oxygen and light availability, and nutrient status
- Capable of displacing native species; possible negative impacts on fish and invertebrate communities

Economic (moderate)

- Infestations can affect aquaculture causing financial losses
- Reduced water quality (see environmental impacts) may increase water treatment costs
- Costs of control operations in the Netherlands in 1987 were €350,000

Social (moderate)

- Dense infestations can impede recreational use of water bodies and have negative aesthetic impacts

Introduction pathways

Horticulture (moderately likely) — introduced into garden ponds and aquaria, from which it may escape or be dumped in the wild

Spread pathways

Natural (very slow) — Primarily spread by stem fragments or rhizomes

Human (slow) — Activities such as boating and manual control activities encourage fragmentation and spread.

Summary

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

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	***Cabomba caroliniana* - Carolina fanwort**
	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?		Request made by GB Programme Board. This aquatic plant is native to South America and some southern areas of North America. It is not clear to what extent it is native to northern parts of the USA. It was first detected in UK in south-east England in 1969 (Hill *et al* . 2005). It is present as a self-sustaining population in Southern England. It has been detected in the Forth and Clyde Canal in Scotland but this population is no longer present. *C. caroliniana* has not been documented from any other part of GB although it may be present in other locations. This PRA assesses the risks of its further spread and establishment in GB.
2	What is the Risk Assessment area?	GB	
3	Does a relevant earlier Risk Assessment exist?	YES (Go to 4)	Three earlier risk assessments are known to the assessor. A Risk assessment 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 18 and a recommendation of: reject the plant for import (Australia) or species likely to be of high risk (Pacific). Scores of greater than 6 = reject the plant for import (Australia) or species likely to be of high risk (Pacific). A risk assessment was prepared by the Plant Health Risk Assessment Unit of the Canadian Food Inspection Agency for Canada in 2001 (Wilson and Watler 2001). The overall risk associated with *C. caroliniana* was calculated to be "MEDIUM" suggesting that specific phytosanitary measures might be necessary. A risk assessment was undertaken under the EPPO Decision support scheme for quarantine pests (EPPO Secretariat 2007a). Its overall conclusions were "The plant would really represent a threat if released in huge quantities in the wild. As it is an aquarium plant, releases in the wild are just accidents, but they have proven to happen. The plant may have the potential to establish and to be a threat in the Mediterranean area." Based upon this risk assessment, the EPPO Council decided that this species should not be recommended for regulation (Council decision in 2008). No specific risk assessments have been undertaken for 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 Australian risk assessment was prepared for a location with a very different climate from GB. Both the Canadian and the EPPO region risk assessment are much more relevant. The environments of southern Canada and UK are much more similar than those of Australia as parts of Canada have similar climatic conditions to UK at least for part of the year. GB is part of the EPPO region.
	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: *Cabomba caroliniana* Gray. Synonyms: *Cabomba australis, Cabomba pulcherrima* (R.M. Harper) Fassett. Common names: Carolina fanwort, Gray fanwort, Purple cabomba, Washington grass, Washington plant, Green cabomba, Carolina water-shield, fish grass (English), Cabomba (Portuguese-Brazil) Haarnixenkraut, Carolina (German), Cabomba de Caroline (French). Family: Cabombaceae. Kingdom: Plantae.
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)	*Cabomba caroliniana* is native to southern Brazil, northeast Argentina, Paraguay and Uruguay, Central America and the West Indies. It is possibly native to the southern parts of North America. It has been recorded as being invasive in Japan, Australia (New South Wales, Northern Territory and Queensland; USA (Alabama, Arkansas, California, Connecticut, Delaware, District of Columbia, Georgia, Florida, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Missouri, New Hampshire, New Jersey, New York, North Carolina, Oklahoma, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, Washington) and Canada (Ontario). It has been introduced to Asia (Malaysia and India), New Guinea, New Caledonia and Europe (UK, the Netherlands, Hungary, France and Belgium). The plant has been recorded from New Zealand for over 30 years but it has not yet become naturalised. Though generally not classified as invasive in European locations where it is known to be present, *Cabomba caroliniana* is known to have displayed invasive behaviour in one site in the Netherlands and one site in France (information compiled from the EPPO risk assessment - EPPO Secretariat 2007a and the EPPO Reporting Service No. 11 - EPPO Secretariat 2007b)
8	Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?	YES or UNCERTAIN (Go to 9)	
9	Does the organism occur outside effective containment in the Risk Assessment area?	YES (Go to 10)	*Cabomba caroliniana* has been present in South-East England since 1969. It is considered an "established taxon reproducing vegetatively or sexually and thus present as self-sustaining" (Hill et al. 2005). *C. caroliniana* was found in the Forth and Clyde Canal in 1969, having been introduced from discarded aquarium material, but is no longer present. In 1991 it was found in the Basingstoke Canal, and was still present there in 1995. It may be overlooked elsewhere (Preston et al. 2002).

10	Is the organism widely distributed in the Risk Assessment area?	NO (Go to 11)	*See Question 9*
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)	*Cabomba caroliniana* has established in the Risk Assessment area so suitable habitat for the survival, development and multiplication of the organism must exist. *C. caroliniana* usually grows in the beds of slow flowing or stagnant freshwater habitats - streams, small rivers, lakes, reservoirs, ditches and canals. It is usually found in waters of less than 3 m depth but it can survive in waters up to 10 m deep. It can grow in turbid waters. It grows well in high nutrient environments with a low pH (Australian Department of the Environment and Heritage (2003). Habitat availability and suitability may increase in the future under climate change projections.
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)	
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)	The climate in the sites where *Cabomba caroliniana* is invasive in the Netherlands are comparable with the climate in much of the Risk Assessment area as is the climate in parts of Canada and Northern USA, at least for part of the year.
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)	*Cabomba caroliniana* thrives as a warm water 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 *Cabomba caroliniana* . It has been spread through the aquarium trade (Global Invasive Species Database 2006).
17	Can the organism spread rapidly by natural means or by human assistance?	YES (Go to 18)	*Cabomba caroliniana* spreads by primarily by stem fragments or rhizomes. The plant fragments readily facilitate vegetative spread (Orgaard 1991). Fragmentation is encouraged by human activities that break up the plants e.g. boating and manual control activities (Wilson and Watler 2001). Fragments can disperse locally by water movement but the main means of range expansion is likely to be through human assistance e.g. use of boats and discarding of aquarium plants (Mackey and Swarbrick 1997). *C. caroliniana* does not readily set seed and sexual reproduction is low to non-existent in the northern parts of the its range (Orgaard 1991).
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)	*Cabomba caroliniana* infestations can affect water levels, water quality and availability and nutrient status. It is capable of displacing native species with possible negative impacts on native fish and invertebrate communities although very little information exists about the ecological impacts of *Cabomba caroliniana* (Wilson and Watler 2001). Dense infestations impede swimming and boating and can have negative aesthetic impacts (EPPO 2007).
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	LOW - 0	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) Intentional introduction - discarding of old aquarium/pond plants (Orgaard 1991); (iii) unintentional introduction: recreational activities - plant fragments carried along waterways attached to boats and other equipment (Schooler et al. 2005).
1.2	Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.			(i) intentional introduction as an ornamental plant for garden ponds and aquaria: 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?	moderately likely - 2	MEDIUM -1	If the area of origin is taken to refer to sale in garden centres and other outlets that sell aquatic plants which would include *Cabomba caroliniana* (often labelled as *C. pulcherrima*). *C. caroliniana* is still available, and ignorance in the industry 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?	unlikely - 1	MEDIUM -1	A moderate 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?	moderate - 2	HIGH -2	C. caroliniana is not widely traded in GB
1.10	How frequent is movement along the pathway?	occasionally - 2	HIGH -2	C. caroliniana is not widely traded in GB
1.11	How widely could the organism be distributed throughout the Risk Assessment area?	widely - 3	HIGH -2	Although not widely distributed in the Risk Assessment area (Q9), the species' introduced range elsewhere (Q7) indicates that it may have the potential for a much wider distribution in the Risk Assessment area. A map of at risk areas is provided here: http://www.q-bank.eu/Plants/Controlsheets/Cabomba%20caroliniana%20fieldguide%20EN.pdf
1.12	How likely is the organism to arrive during the months of the year most appropriate for establishment ?	moderately likely - 2	HIGH -2	*Cabomba caroliniana* could be traded and plants/plant fragments transferred into water bodies at any time of the year.
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?	moderately likely - 2	MEDIUM -1	The fact that aquarium/pond plants are frequently disposed of in water bodies makes it moderately 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.

	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?	similar - 3	HIGH -2	Climatic conditions in the area of origin vary widely but include conditions similar to those in the assessment area (authors obs.). However, The native range of *Cabomba caroliniana* tends to have longer growing season and warmer summer temperatures than those currently found in the risk assessment area. Again, it can be seen from the current extent of establishment that whilst elements of climate could be limiting, they will not preclude establishment.
1.16	How similar are other abiotic factors that would affect establishment in the Risk Assessment area and in the area of present distribution?	very similar - 4	HIGH -2	There is only limited information readily available, although extensive and detailed desk study could probably provide more information. However, again the fact that the species is widely established and spreading suggests that abiotic factors are compatible with its establishment. *Cabomba caroliniana* is reported to favour waters of pH 4-6 and can tolerate low temperatures including survival under ice, although favouring temperatures of 13-27˚C (Hodgson et al. 2007, Riemer & Ilnicki, 1968).
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.	very many - 4	LOW - 0	Suitable habitats clearly exist because the species is established, they are primarily: standing water (canals and ponds); running water (ditches and a few streams and slow-flowing rivers). There appears to be no information on the dependence of this taxon on other species.
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	Suitable habitats occur more or less throughout the Risk Assessment area and habitat availability is unlikely to exert a controlling influence on establishment, it is possible that winter minimum temperatures could be a limiting influence on expansion (see 1.11). There appears to be no information on the dependence of this taxon on other species.
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	LOW - 0	There is no evidence to suggest that the species requires any other 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	HIGH -2	The species is widely established and spreading, it therefore seems unlikely that establishment will be prevented by competition. However, the species is not widespread within the RA area, but is naturalised widely outside of its native range.
1.21	How likely is it that establishment will not be prevented by natural enemies already present in the Risk Assessment area?	very likely - 4	HIGH -2	The species is widely established and spreading, it therefore seems unlikely that establishment will be prevented by natural enemies
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		Whilst there are certainly differences in man's management of habitats in the native and non-native ranges of the species, there is no evidence that these have implications for success or failure of establishment.
1.23	How likely is it that existing control or husbandry measures will fail to prevent establishment of the organism?	very likely - 4	HIGH -2	Existing control and husbandry measures have clearly failed to prevent establishment. The more recent cessation of sale is more likely to lead to a decline in both deliberate and accidental introductions, but transmission from existing populations is unlikely to decline. It is illegal to trade or sell *Cabomba caroliniana* in all states and territories in Australia (Australian Department of the Environment and Heritage 2003), however such legislation is ineffective unless supported by identification guidance and training.
1.24	How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	widespread - 4	LOW - 0	There is no published information on availability, but the plant is widely available as an aquarium plant in GB – particularly via the internet. It is known that it reached the Risk Assessment area via trade in ornamental plants and has spread into the wild without needing to occur in protected habitats. In the past it has been on sale in most garden centres.
1.25	How likely is the reproductive strategy of the organism and duration of its life cycle to aid establishment?	very likely - 4	HIGH -2	It is likely that the main reproductive strategy is vegetative (Preston *et al*. 2002). Like many aquatic plants, it is likely that very small fragments are able to root, thus aiding establishment.
1.26	How likely is it that the organism’s capacity to spread will aid establishment?	very likely - 4	HIGH -2	Its widespread and increasing establishment suggests that this may be aided by its capacity to spread.
1.27	How adaptable is the organism?	very adaptable - 4	LOW - 0	The plant is able to exploit a wide variety of existing habitats.
1.28	How likely is it that low genetic diversity in the founder population of the organism will not prevent establishment?	very likely - 4	HIGH -2	Like many native aquatic plants that are capable of reproduction through vegetative fragmentation, single clones of *Cabomba caroliniana* may be capable of colonising wide areas. Low genetic diversity will therefore almost certainly not be a controlling factor.
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	MEDIUM -1	*Cabomba caroliniana* has become established in Australia (Australian Department of the Environment and Heritage 2003), The EPPO risk assessment (EPPO Secretariat 2007a) states that it is "Found in the Netherlands, with an invasive behaviour" and that "The plant is also recorded in England, Hungary, Belgium, but it is not widespread and not known as invasive“. *Cabomba caroliniana* is also naturalised in Peru, China, India, Japan, Malaysia, the south east of the USA and parts of Australia and Canada (Global Invasive Species Database 2006).
1.30	How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	very likely - 4	HIGH -2	Cutting may suppress growth, but without extremely thorough collection and controlled disposal of fragments, is likely to exacerbate spread and colonisation. Chemical control using aquatic glyphosate can be used during a drawdown (Australian Department of the Environment and Heritage 2003) but the use of herbicides must be limited around public water supplies and effects are likely to be broad spectrum. Shade through tree planting has been suggested (Australian Department of the Environment and Heritage 2003) although not only is this an extremely slow-acting method, but any gaps in the canopy would allow survival of plants which would then serve as reservoirs for re-establishment outside the shaded area and again this method would have adverse impacts on the distribution of native aquatic plants. Biological control agents for *Cabomba caroliniana* are not currently available but research is being undertaken (Schooler et al. 2009).
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	Even if control measures appear to be effective, it is highly likely that cryptic or isolated populations would remain that could serve as reservoirs for re-infection. Re-introduction is also likely through the same processes as noted above 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?	very slow - 0	MEDIUM -1	The plant was first noted in GB in 1969 in South-East England (Hill et al. 2005). A transient population has been documented from the Forth and Clyde Canal in Scotland. Clearly, the spread of the plant under the conditions prevailing during the past 40 years has been very slow. A priori, one would expect a slow rate of natural spread between unconnected water bodies given the plant's likely mode of reproduction in the Risk Assessment area.
2.2	How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	slow - 1	LOW - 0	A priori, human assistance would appear to be the likely principal mode of spread of *Cabomba caroliniana* in the Risk Assessment area. Its high potential for human assisted spread comes from its ability to establish from small plant fragments which can be spread by the movement of plants, people and objects between water bodies. However, the small number of *C. caroliniana* populations would indicate that human assisted spread in the Risk Assessment area has been relatively ineffective under the conditions prevailing during the past 40 years.
2.3	How difficult would it be to contain the organism within the Risk Assessment area?	with some difficulty - 2	MEDIUM -1	A priori, containment should be relatively easy in view of the limited number of populations of *Cabomba caroliniana* in the Risk Assessment area. The large number of plants in protected conditions that can serve as a reservoir for reinfestation make containment more difficult than it would first appear. UK climate change scenarios (UK Met Office 2007), which are likely to enhance the Risk Assessment area's suitability for *Cabomba caroliniana* may also make containment more difficult in the future.
2.4	Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.	Freshwater habitats in UK	HIGH -2	To date *Cabomba caroliniana* has not become invasive in GB freshwater habitats. The degree to which it may become invasive in future depends upon its response to projected changes in the country's climate. There may also be specific factors in the local environment that facilitate invasion as appears to have been the case in the single site in the Netherlands in which *C. caroliniana* has become invasivs (EPPO Secretariat 2007a) or the potential for particular genotypes to become invasive in the Risk Assessment area.

	Impacts	RESPONSE	UNCERTAINTY	COMMENT
2.5	How important is economic loss caused by the organism within its existing geographic range?	moderate - 2	MEDIUM -1	Dense *Cabomba caroliniana* infestations adversely impact upon the recreational use of water bodies by interfering with navigation, fishing, swimming and the pursuit of water sports (Wilson et al. 2007). However, the assessor could not find many quantitative estimates of the economic impact of *C. caroliniana.* There have been reports of the forced closure of fishing camps in the USA with resultant great losses in income. Infestations can affect aquaculture and hydro power generation equipment causing significant financial losses (Wilson & Watler 2001). Infestations can reduce water availability, raise water levels and affect water quality. Water treatment costs in infested areas in Australia can be increased by up to $50 a megalitre (Australian Department of the Environment and Heritage 2003). The cost of control operations in the infested area in the Netherlands in 1987 were EUR 350,000. Its main economic benefit is its use as an aquarium and pond plant. Trade in *C. caroliniana* in Australia is a $AU300,000 a year industry (Commonwealth of Australia and the National Weeds Strategy Executive Committee 2000).
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 possible that *Cabomba caroliniana* could cause problems such as interference with leisure uses of water bodies and loss of storage capacity which could 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 GB (outside Scotland) is less than in many of the locations in which *C. caroliniana* is invasive. The high degree of uncertainty reflects our poor understanding of possible changes in the suitability of the Risk Assessment area for *C. caroliniana* 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 C*abomba caroliniana* are minor.
2.8	How great a reduction in consumer demand is the organism likely to cause in the Risk Assessment area?	moderate - 2	HIGH -2	*Cabomba caroliniana* invasion could adversely affect prices of services that depend upon 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	LOW - 0	The assessor could find no information on this. It is unlikely that export goods will be contaminated with *Cabomba caroliniana* 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)	moderate - 2	HIGH -2	It is likely that other costs will increase but to some extent incremental costs resulting from *Cabomba caroliniana* 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	MEDIUM -1	Where it is invasive, *Cabomba caroliniana* can seriously threaten native aquatic communities. Dense infestations in New Hampshire, USA reduce the diversity of native plants (Sheldon 1994). Extensive infestations in Queensland have displaced almost all submerged vegetation including native species (Mackey & Swarbrick 1997) and in China *C. caroliniana* has become the dominant species in Jiangsu and Zhenjiang provinces (Zhung et al. 2003). It is also suspected that *C. caroliniana* infestations also have impacts on some native fish and invertebrate populations although research is needed (Mackey & Swarbrick 1997). Infestations in the far north of Queensland have resulted in reduced numbers of platypus and water rats (Australian Department of the Environment and Heritage 2003). Other environmental impacts include changed nutrient regimes with the plant absorbing nutrients during the growing season and subsequent release at the end of the growing season. Massive amounts of decomposing vegetation can result in dramatic oxygen reductions at the end of the growing season (Mackey & Swarbrick 1997). Beneficial impacts include the plant being a source of food for waterfowl and some fish and its function as cover for some small fish and plankton (Orgaard 1991) (although these functions can be provided by native plants as well).
2.12	How important is environmental harm likely to be in the Risk Assessment area?	moderate - 2	HIGH -2	With projected climate change it is possible that *Cabomba caroliniana* 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?	moderate - 2	MEDIUM -1	There is evidence that where *Cabomba caroliniana* 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	HIGH -2	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?	unlikely - 1	MEDIUM -1	The assessor could find no evidence of *Cabomba caroliniana* carrying its genetic traits to native species. There are no native species in the RA area of 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	*Cabomba caroliniana* is palatable to the Chinese grass carp (*Ctenopharyngodon idella*) that are present in some UK water bodies. However, it is not their preferred food (Gibbons et al. 1994). Grass carp are not native and therefore although waterfowl may graze C. caroliniana there are unlikely to be any native predators for the plant in the UK able to act as a control.
2.17	How easily can the organism be controlled?	with some difficulty - 2	LOW - 0	Accounts of control methods for *Cabomba caroliniana* control are given in a variety of sources, e. g. (Australian Department of the Environment and Heritage 2003, Global Invasive Species Database 2006, Mackey & Swarbrick 1997, EPPO 2007, Schooler et al. 2005, Bowcher & Wingrave 2003). The species needs direct sunlight and can therefore be controlled by shading. This control method can work well for small infestations. Drawdown will kill plants if the substrate dries out completely. This control method can be effective where it is feasible, if done to an adequate depth and for a sufficient duration. Hand pulling is expensive and only possible for small infestations and even in such a case can be ineffective because the plant is likely to fragment thus creating a further opportunity for spread. Mechanical removal suffers the same drawback and equipment must be subject to strict hygiene protocols if it is not to become a vector. The contact herbicide Endothal has given excellent control in North America and the systemic herbicide Fluridone has given good control. Chinese grass carp have been used successfully as biological control agents for fanwort in Florida and Arkansas, apparently without adverse affects on native fish and waterfowl populations. No classical biological control on *C. caroliniana* has been attempted. An Australian project is currently looking for biocontrol agents in the native range of the plant.
2.18	How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	moderately likely - 2	MEDIUM -1	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 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	MEDIUM -1	The assessor could find very little information on this. Where it is invasive, *Cabomba caroliniana* has been shown to act as a food and host for other organisms but its importance in this regard is unclear (Mackey & Swarbrick 1997, Wilson et al. 2007). It has been reported as a food source for wild fowl and omnivorous fish, though these are not always necessarily damaging. Several species of phytoparasitic and free-living nematodes have been reported from samples of *C. caroliniana* though these are genera that are commonly fond on many aquatic plant species (Mackey & Swarbrick 1997).
2.20	Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur	Freshwater habitats in UK	HIGH -2	The extent to which *Cabomba caroliniana* 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 UK water bodies more suitable for *C. caroliniana* proliferation.

Summarise Entry	very likely - 4	MEDIUM -1	*Cabomba caroliniana* has entered the risk assessment area. The main pathway of entry, intentional introduction for aquaria and ponds, continues to be important.
Summarise Establishment	moderately likely - 2	MEDIUM -1	*Cabomba caroliniana* is established in a limited number of locations in the Risk Assessment area. However, it has yet to become invasive. Its only persistent populations are found in Southern England. It is not found over large contiguous areas.
Summarise Spread	very slow - 0	MEDIUM -1	The spread of Cabomb*a caroliniana* in GB has been very slow to date. It is possible that projected climate changes will increase the rate of natural spread.
Summarise Impacts	moderate - 2	MEDIUM -1	*Cabomba caroliniana* 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. *C. caroliniana* can have adverse biodiversity impacts and can result in reduced water movement, raised water levels, trapping of sediment, reduced oxygen availability, decreasing light penetration and changing nutrient regimes. Beneficial impacts include it being a source of food for waterfowl and some fish and its function as cover for some small fish and plankton (although these functions can be provided by native plants as well) as well as its commercial value as an aquarium and pond plant.
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	MEDIUM -1	*Cabomba caroliniana* has already entered GB and has established in a limited number of areas in Southern England and there are records of transient populations further north. The species is not yet invasive. It was felt by the EPPO Risk Assessment panel that under current climatic conditions, the summers in England are likely to be too short for C. caroliniana to become invasive. The main pathway is intentional importation for aquaria/ponds. It is possible that the plant will become invasive in UK in the coming decades (particularly in the southern part of the country) if climate change projections are realised. If so it is may have adverse effects on the recreational use of water bodies, biodiversity and on the aquatic environment. These changes could have moderate socio-economic impacts.
Conclusions on Uncertainty			The fact that the potential impact of *Cabomba caroliniana* in the Risk Assessment area is dependent on projected climate changes, uncertain effects of genetic variability and possible effects of as yet unclear traits in the receptor environment, makes prediction inherently uncertain. It would be useful to undertake quantitative studies on the factors that make *C. caroliniana* invasive in a single population in the Netherlands and in the more northerly parts of its range.

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