

Giant cane (*Arundo donax*)

- Native to the Middle East and Asia, has been transported from temperate and sub-tropical regions to similar climates across the globe.
- Invades riparian habitats where it suppresses native vegetation, dramatically modifies ecological processes and increases fire and flood risk.
- Recently becoming widely sold for ornamental use as a bamboo alternative.
- GB is at the edge of climatic limit, so may not be as invasive as in warm temperate and subtropical regions.

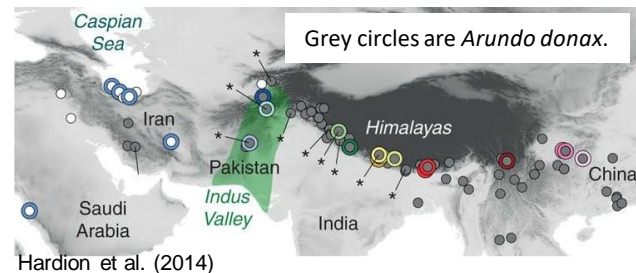


History in GB

Widely propagated and sold for ornamental use. It has also been grown in at least one trial in GB to assess its potential as a biofuel crop. As of this assessment, it has yet to be recorded in the wild.

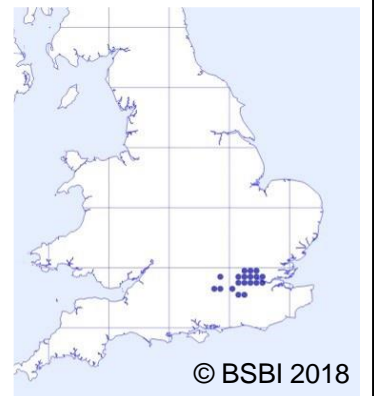
Native Distribution

Tropical and temperate regions of Asia from Middle East to China. Introduced to Mediterranean in antiquity from Iran or Indus Valley.



GB Distribution

Yet to be recorded in the wild in GB. The distribution shown is plantings in urban and suburban gardens.



Impacts

Environmental (moderate)

- Displacement of native vegetation
- Replacement of nesting and feeding habitats for riparian species
- Alters flow regimes and natural successional dynamics

Economic (minor)

- Has potential to cause economic costs due to increased flooding and increased fire risk

Introduction pathway

Grown as ornamental reed in urban and suburban gardens in London and surrounds; widely sold in nurseries

Spread pathway

Natural (fast) - reproduces vegetatively; once within riparian systems, dispersal of fragments along water-courses is likely to be relatively rapid

Human-aided (slow) – intentional planting in gardens and subsequent unintentional dispersal in waste or soil

Summary

	Response	Confidence
Entry	VERY LIKELY	VERY HIGH
Establishment	MODERATE	HIGH
Spread	SLOW	HIGH
Impact	MODERATE	HIGH
Overall risk	MEDIUM	HIGH

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: *Arundo donax* L. (Poaceae) Giant Reed

Author: Dr K. J. Walker, Botanical Society of the British Isles

Risk Assessment Area: Great Britain (England, Scotland, Wales and their islands)

Version: Draft 1 (Jul 2017), Peer Review (Jan 2018), NNRAP 1 (Feb 2018), Draft 2 (May 2018), NNRAP 2 (May 2018), Draft 3 (Jun 2018), approved by Programme Board (Jun 2019), placed on GBNNSS website (Oct 2020)

Signed off by NNRAF: December 2022

Approved by GB Committee: January 2024

Updated on NNSS website: January 2024

What is the principal reason for performing the Risk Assessment?

The GB Committee for non-native species is considering whether to add this species to the list of species of special concern. This assessment will form part of the evidence used to inform the Committee's decision. This species was selected for consideration by the Committee following concerns raised by the Environment Agency and an initial risk assessment started in 2017.

SECTION A – Organism Information and Screening

Stage 1. Organism Information	RESPONSE and 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. <i>Arundo donax</i> is one of the tallest grasses in the world reaching 6 -10 m in height. It is an erect, perennial cane- or reed-like grass that spreads by knobby rhizomes to form extensive patches sometimes covering several acres (GISD, 2015). It is unlikely to be confused with any other species, with the exception of Common Reed <i>Phragmites australis</i> which is much smaller and spreads by above-ground stolons to form dense continuous stands known as reed beds (Minogue & Wright, 2016). There are several varieties of <i>A. donax</i> including a variegated form (var. <i>versicolor</i>) with white striped leaves that is only known in cultivation and is frequently planted for ornament (CABI, 2015).
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?	<i>Arundo donax</i> is native to freshwaters of tropical and temperate regions of Asia extending from the Middle East and the Arabian Peninsula to China, Japan and Vietnam in the Far East. It is a characteristic species of Mediterranean wetlands where it was introduced in antiquity for a variety of human uses, probably from southern Iran or the Indus Valley (Hardion et al., 2014).
6. What is the global distribution of	<i>Arundo donax</i> has been transported from warm temperate and subtropical regions of Asia to similar

the organism (excluding Great Britain)?

climates across the globe and has become naturalised and invasive in many regions including southern Africa, sub-tropical USA, Mexico, the Caribbean, South America, Australia, and the Pacific Islands. It was probably first introduced to southern Europe from the Middle East as early as 2500 BC (Hardion et al., 2014). From the Mediterranean region, it is believed to have been transported worldwide, originally by Spanish and Portuguese travellers, from the sixteenth Century onwards (Ahmad et al., 2008). Over the last century it has become a major horticultural and landscaping grass in many regions, with potential for biofuel production in subtropical and tropical regions. Mediterranean and American populations display very low levels of genetic diversity, high ploidy and a lack of seed production all suggesting the widespread introduction of single or a few clones (Ahmad et al., 2008; Hardion et al., 2014).

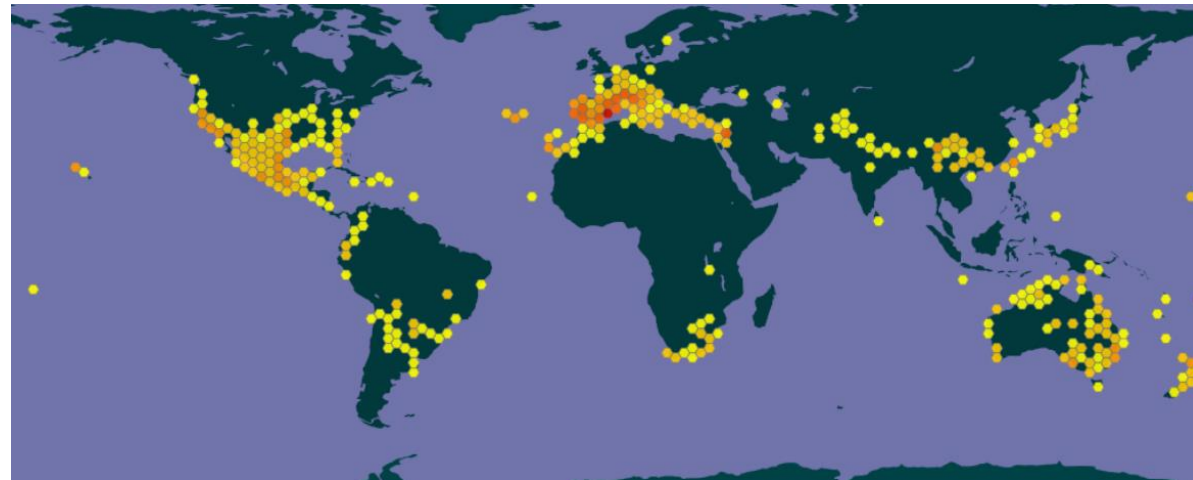
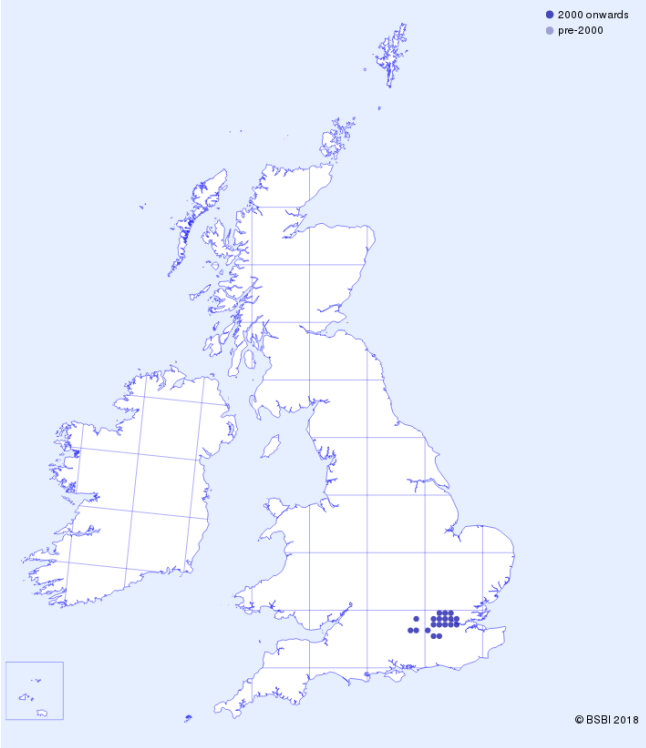


Figure 1. Global distribution of *Arundo donax*. Map taken from GBIF (accessed 9/5/2018 - <https://www.gbif.org/species/2703041>).

7. What is the distribution of the organism in Great Britain?

Arundo donax has yet to be recorded in the wild in GB; all records collated by the Botanical Society of the British Isles (BSBI) are from plantings in urban and suburban gardens in London and the adjacent home counties (Fig. 2). In GB it is widely sold for horticultural/ornamental use and planted in public and private gardens, often as an alternative to bamboo. The most common variety grown is 'Variegata' which is a diminutive form with variegated leaves. It has also been planted in at least one experimental trial in GB [location unknown] to assess its potential for biomass production (Smith & Slater, 2010).

	 <p>Figure 2. The hectad distribution of <i>Arundo donax</i> in Great Britain and Ireland. Data from the BSBI Distribution Database (accessed 9th May 2018; https://bsbi.org/maps?taxonid=2cd4p9h.3hkd3p).</p>
<p>8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?</p>	<p>Yes. <i>Arundo donax</i> is considered invasive in many warm regions, including Africa, Oceania and the Americas where it has invaded riparian habitats such as ditches, stream banks and lake shores (Herrera & Dudley, 2003). In these regions <i>A. donax</i> competes for water, nutrients and radiation, suppresses and excludes native vegetation, dramatically modifies ecological and successional processes, degrades the value of wildlife habitat, increases fire risks and interferes with flood control often increasing flood risk due to alterations to channels and creating debris-dam hazards (Bell, 1997; Coffman et al., 2010).</p>
<p>9. Describe any known socio-economic benefits of the organism</p>	<p>In GB <i>Arundo donax</i> is now quite widely sold for horticultural/ornamental use and planted in public and private gardens, often as an alternative to bamboo. The most common variety grown is 'Variegata' which</p>

in the risk assessment area.	is a diminutive form with variegated leaves. In addition, giant cane is now seen as one of the most promising biomass crops for biomass/biofuel production (Lewandowski et al., 2003; Sablock, 2014) and has been planted in at least one experimental trial in GB to assess its potential for biomass production (Smith & Slater, 2010).
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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	CONFIDENCE	COMMENT
<p>1.1. How many active pathways are relevant to the potential entry of this organism?</p> <p>(If there are no active pathways or potential future pathways respond N/A and move to the Establishment section)</p>	few	high	In GB <i>Arundo donax</i> is widely propagated and sold for horticultural and ornamental use. It has also been grown in at least one trial in GB to assess its potential as a biofuel crop (Smith & Slater, 2010) and in China it has been tested in the treatment of domestic sewage (http://en.cnki.com.cn/Article_en/CJFDTOTAL-GSPS200905025.htm).
<p>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.</p> <p>For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary).</p>	Ornamental use Biofuel production Sewage treatment		
Pathway name:	Ornamental use		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the	intentional	high	<i>Arundo donax</i> is currently being propagated and sold for horticultural and ornamental use in GB.

organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)			
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.	moderately likely	medium	<i>Arundo donax</i> is being increasingly grown as an ‘architectural’ plant, especially to add structure to urban gardens, and as a cheaper alternative to bamboo. Although there are no detailed figures on the amount of sold annually, the overall figure is likely to be relatively large, given the number of suppliers (e.g. The Palm Centre, Tropical Plants, etc.); in May 2018, the RHS plant finder listed 22 suppliers for the species and 26 suppliers for the variegated variety (https://www.rhs.org.uk/Plants/1675/Arundo-donax/Details).
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	moderately likely	medium	Currently <i>Arundo donax</i> is restricted to private gardens and there are no reports of it occurring in the wild (from discarded garden waste) but this is possibly only a matter of time given the increased fashion for growing it, its large size (relative to urban gardens) and its ability to regenerate from root fragments.
1.10. Estimate the overall likelihood of entry into GB based on this pathway?	very likely	very high	<i>Arundo donax</i> is a very adaptable species that appears to grow well in urban and suburban gardens in southeastern England. Although it is native to subtropical regions it appears to be hardy throughout the GB (Hardiness Zone 4) which indicates a tolerance to temperatures down to -10°C although it is recommended that plants are insulated with mulch during the coldest months (https://www.rhs.org.uk/Plants/1675/Arundo-donax/Details).
Pathway name:	Biofuel production		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)?	intentional	high	Although <i>Arundo donax</i> has been grown in at least one trial to assess its potential as a biofuel crop (Smith & Slater, 2010) it is not currently grown on a commercial scale in GB (unlike <i>Miscanthus x giganteus</i> , <i>Phalaris arundinacea</i> and <i>Panicum virgatum</i>). However, it has the potential to be grown in the future if the climate becomes warmer and

(If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)			more 'Mediterranean-like'.
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	medium	The amount of <i>A. donax</i> currently being grown for biofuel in GB at present is unknown but is likely to be nil or close to zero.
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	unlikely	low	See 1.4 above.
1.10. Estimate the overall likelihood of entry into GB based on this pathway?	unlikely	medium	Given that there appear to be no active trials or usage biofuel production the likely entry via this pathway is likely to be small or nil.
Pathway name:	Sewage treatment		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	intentional	high	In China <i>A. donax</i> has been used to treat domestic sewage (http://en.cnki.com.cn/Article_en/CJFDTOTAL-GSPS200905025.htm).
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over	very unlikely	high	<i>A. donax</i> is currently not being grown for sewage treatment in GB.

the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.			
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	very unlikely	high	If <i>A. donax</i> was used for sewage treatment it is likely to be very carefully controlled and managed due to its potential invasiveness.
1.10. Estimate the overall likelihood of entry into GB based on this pathway?	very unlikely	high	It seems very unlikely that <i>A. donax</i> would be used for sewage treatment in GB due to climatic limitations.
<i>End of pathway assessment, repeat as necessary.</i>			
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	<i>Arundo donax</i> is already being grown as an ornamental in private gardens in southeastern England. It does not appear to be being grown commercially for biofuel at present but this could change in the future if the climate becomes warmer and more 'Mediterranean-like'. Its potential for sewage treatment is largely untested although this could potentially become an introduction pathway in the future.

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?	moderately likely	high	<i>Arundo donax</i> is a very adaptable species that appears to grow well in urban and suburban gardens in southeastern England. Although it grows best in warm temperate or subtropical wetlands its native distribution extends into the cooler temperate zone. Although it can survive frost, serious damage is caused to new growth if they coincide with spring growth (Perdue, 1958). GB would therefore appear to be at the climatic limit of the species. It has a hardiness rating of 4 which means it is hardy throughout GB (Hardiness Zone 4), tolerating temperatures down to -10°C, although it is recommended that plants are insulated with mulch during the coldest months (https://www.rhs.org.uk/Plants/1675/Arundo-donax/Details).
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?	moderately likely	high	<i>Arundo donax</i> tolerates a wide range of ecological conditions. It prefers well-drained soils with abundant moisture but often grows where the water table is at or near to the soil surface. Likewise, it can grow on wide range of soil types, including heavy clays, sands and gravels, from freshwater to semi-saline sites along estuaries (Perdue, 1958; Lewandowski et al., 2003). Such conditions are widespread 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?	very likely	very high	<i>Arundo donax</i> will probably grow very well in tropical houses/greenhouses as these will protect it from frost and potential pests and pathogens.

Subnote: gardens are not considered protected conditions			
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in GB?	moderately widespread	very high	<i>Arundo donax</i> is a hydrophyte that grows in a variety of riparian habitats including floodplain and estuarine wetlands, ditches, river and stream banks and lake shores. Such habitats occur throughout GB.
1.16. 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 GB?	NA	very high	NA
1.17. How likely is it that establishment will occur despite competition from existing species in GB?	very likely	high	Under suitable conditions, <i>Arundo donax</i> is an extremely fast-growing, competitive C ₃ grass that is unlikely to be out-competed by dominant natives in wetlands such as <i>Phragmites australis</i> or <i>Phalaris arundinacea</i> .
1.18. How likely is it that establishment will occur despite predators, parasites or pathogens already present in GB?	likely	medium	Relatively few pests and pathogens have been identified in its native range, possibly due to the presence of toxic and unpalatable chemicals and minerals in the leaves. Even less is known about predators that can damage or kill <i>A. donax</i> in its invasive range (CABI, 2015), although given the genetic uniformity of introduced populations in the USA and Europe (Ahmad et al., 2008; Hardion et al., 2014) and the infrequency with which predators have been reported, their impacts are likely to be negligible.
1.19. How likely is the organism to establish despite existing management practices in GB?	moderately likely	high	There are relatively few management practices that are likely to hinder the establishment of <i>Arundo donax</i> in GB. Few riparian wetlands are heavily grazed by large livestock (e.g. bison, cattle, horses), at levels that might reduce the abundance of <i>A. donax</i> , and the practice of cutting reed for thatching is now only practiced on a very small scale in a few areas.
1.20. How likely are management practices in GB to facilitate	moderately likely	medium	Management practices such as creating reedbeds could provide suitable habitat for <i>Arundo donax</i> ; however, this would only facilitate establishment if

establishment?			this species were planted or otherwise allowed to escape into these environments. In addition, created and restored reedbeds are often monitored and managed for various ecological interests – it is unlikely that <i>Arundo donax</i> would establish or spread unnoticed.
1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in GB?	very likely	very high	<i>Arundo donax</i> has a number of properties that will allow it to evade eradication. First, giant reed is seed sterile in its introduced range and reproduces entirely by vegetative spread and the waterborne dispersal or rhizome fragments (Lewandowski et al., 2003). The rhizomes are very robust and establish readily following dispersal to new sites, often following floods. Second, once established <i>A. donax</i> grows very rapidly to form very dense stands with extensive rhizome networks that are difficult to remove completely. Third, <i>A. donax</i> often occurs in relatively inaccessible locations that are difficult to manage with machinery. Finally, disturbance associated with management activities to suppress dominants (e.g. burning, grazing, etc.) can stimulate further growth (Coffman et al., 2010).
1.22. How likely are the biological characteristics of the organism to facilitate its establishment?	very likely	very high	<i>Arundo donax</i> has a number of biological characteristics that facilitate successful establishment; an ability to regenerate from small vegetative fragments, rapid growth rate (up to 5 cm per day), large biomass and high competitive ability, and wide ecological range in terms of soil structure, pH and moisture (Bell, 1997).
1.23. How likely is the capacity to spread of the organism to facilitate its establishment?	likely	high	Although <i>Arundo donax</i> does not produce seed in GB it is likely to spread very effectively by vegetative fragments when growing close to water (Bell, 1997) or when transported in top-soil or on machinery.
1.24. How likely is the adaptability of the organism to facilitate its establishment?	likely	high	<i>Arundo donax</i> is a highly adaptable species that tolerates a wide range of ecological conditions and can grow in a wide range of soils from heavy clays to loose sands and gravelly soils. It can survive just as well under very wet as under dry conditions for long periods and tolerates frost, heavy metals and saline soils (Perdue, 1958).
1.25. How likely is it that the organism could establish despite low genetic diversity in the founder population?	likely	high	<i>Arundo donax</i> has become widely established throughout the USA and Europe despite being seed sterile and having very low levels of genetic diversity (Ahmad et al., 2008; Hardion et al., 2014). Indeed, US populations may represent a single genetic clone (Ahmad et al., 2008).

<p>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.)</p>	<p>moderately likely</p>	<p>medium</p>	<p><i>Arundo donax</i> has become invasive, mainly in warm temperate and subtropical climates where it has been cultivated or planted for erosion control (e.g. southern Europe, southern USA, southern Africa, Australia, etc.). It is much less frequently naturalised in cool temperate regions where it is only grown for ornament, for example in northern Europe. In GB there are currently no reports of <i>A. donax</i> established in the wild but this is possibly only a matter of time given the increased fashion for growing it, its large size (relative to urban gardens) and its ability to regenerate from root fragments. However, under current climatic conditions and use it is unlikely to become established on a large scale.</p>
<p>1.27. If the organism does not establish, then how likely is it that transient populations will continue to occur?</p> <p>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.</p>	<p>very likely</p>	<p>medium</p>	<p>If <i>Arundo donax</i> fails to establish, then transient populations are likely to occur where garden waste has been discarded in semi-natural habitats.</p>
<p>1.28. Estimate the overall likelihood of establishment (mention any key issues in the comment box).</p>	<p>likely</p>	<p>medium</p>	<p><i>Arundo donax</i> appears to be a relatively recent addition to urban and suburban gardens having been first recorded in London in 2010 (Fig. 1). This is presumably due to a recent fashion for ‘architectural’ plants that add structure to small gardens. It is therefore possibly only a matter of time before <i>A. donax</i> becomes established in waste-ground or along urban water-courses and then spreads from there to an adjacent wetland.</p>

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.)	high	medium	As stated in 1.28 above it is possibly only a matter of time before <i>A. donax</i> spreads by natural dispersal of root fragments along watercourses and from there colonises wetland habitats where it has the potential to become invasive. Once within riparian systems the rate of natural spread is likely to be relatively fast given the speed with which the plant regenerates within wetland habitats.
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	Non-waterborne spread of <i>Arundo donax</i> will rely on intentional planting in gardens and then subsequent unintentional dispersal of root fragments to other semi-habitats in garden waste or soil or on machinery. However, overall spread by this route is likely to be slow as dumped material will only have a limited capacity to spread unless close to watercourses or in wetland habitats.
2.3. Within GB, how difficult would it be to contain the organism?	with some difficulty	medium	<i>Arundo donax</i> is likely to be difficult to control given its ability to regenerate from root fragments, speed of growth, dispersal ability and tolerance to disturbance. However, this will largely depend on the severity of infestations.
2.4. Based on the answers to questions on the potential for establishment and spread in GB, define the area endangered by the organism.	Riparian systems/wetlands in southeastern, southern and southwest England	medium	Again, it is difficult to predict the areas that might be endangered by <i>Arundo donax</i> if it becomes established in the future. At present, there is a potential threat to riparian systems in southeastern England, particularly in the River Thames basin. However, <i>A. donax</i> is probably grown in gardens in most cities and so could potentially establish throughout GB.
2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of	0	very high	There are no reports of <i>Arundo donax</i> having become established anywhere in the wild in GB.

GB were the species could establish), if any, has already been colonised by the organism?			
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	medium	It seems likely that <i>Arundo donax</i> will be reported from the wild in southeastern England in the near future given its increased popularity in gardens and its ability to grow under British climatic conditions.
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	very high	Once <i>Arundo donax</i> has become established an 'alert' system should be put in place to provide an early warning of new populations and to allow for eradication measures to be put in place. Following establishment its spread should be monitored on at least a decadal basis.
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	low	With or without control, <i>Arundo donax</i> is likely to spread relatively slowly in GB and is very unlikely to have spread to more than 10% of all available habitat within the next decade.
2.9. Estimate the overall potential for future spread for this organism in Great Britain (using the comment box to indicate any key issues).	slowly	medium	Given that <i>Arundo donax</i> spreads entirely by root fragments, colonisation is likely to happen relatively slowly, due to the isolated nature of river catchments. Therefore, spread throughout the country will require multiple introductions at a variety of locations, although unintentional spread between catchments by humans may also occur (e.g. in soil, on machinery, etc.).

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?	major	medium	Globally the main economic impacts of <i>Arundo donax</i> are the costs of control, management and restoration of invaded wetlands and the losses due to flooding, including clean-up operations, damage to flood structures (e.g. bridges, banks, etc.), insurance claims following damage to property, etc. There are no precise figures available for control measures but in the US control/removal of <i>A. donax</i> is relatively inexpensive when compared to the restoration of riparian habitats following removal which can cost tens of thousands of dollars per hectare (Bell, 1997). Its contribution to the losses caused by flooding are difficult to quantify, given the multiple contributory factors involved.
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	There are currently no economic costs associated with <i>Arundo donax</i> in GB as it has yet to become established in the wild.
2.12. How great is the economic cost of the organism likely to be in the future in GB excluding management costs?	minor	low	If <i>Arundo donax</i> becomes invasive, then there are likely to be economic costs due to increased flooding caused by changes to flow regimes and an increase in debris-dam hazards. However, these are likely to be relatively minor assuming that <i>A. donax</i> does not become as invasive as in warm temperate and subtropical regions

			(e.g. southern USA, southern Europe).
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	There are currently no costs associated with managing <i>Arundo donax</i> in GB as it has yet to become established in the wild.
2.14. How great are the economic costs associated with managing this organism likely to be in the future in GB?	minor	low	If <i>Arundo donax</i> becomes invasive, then there are likely to be economic costs due to the need to remove it from sensitive wetland habitats. As many of the reedbeds that it is likely to invade are managed as wildlife sites, these costs will be mainly borne by governmental and non-governmental land management organisations responsible for maintaining their conservation interest (e.g. Natural England, RSPB, Wildlife Trusts, National Trust, etc.). However, these are likely to be relatively minor assuming that <i>A. donax</i> does not become as invasive as in warm temperate and subtropical regions (e.g. southern USA, southern Europe).
2.15. How important is environmental harm caused by the organism within its existing geographic range excluding GB ?	moderate	high	Within warm temperate and subtropical regions <i>Arundo donax</i> has a range of environmental impacts. <i>A. donax</i> is an extremely aggressive competitor for space, water and nutrients and displaces native plants and other wildlife (Bell, 1997). In the USA, this has resulted in the replacement of nesting and feeding habitats for a range of riparian species including threatened birds (e.g. Bell's Vireo, Willow Flycatcher). Its substantial rhizomes stabilise banks and capture huge quantities of sediment thereby altering flow regimes and natural successional dynamics. <i>A. donax</i> also provides less shading than native riparian dominants leading to increased water temperatures, lower oxygen levels and reduced habitat quality for aquatic wildlife (Herrera & Dudley, 2003). It is also highly flammable throughout the year, which increases the frequency and intensity of wildfires in riparian habitats that are usually free from such events (Coffman et al., 2010).
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	very high	<i>Arundo donax</i> has no impact on biodiversity in GB at present as it has yet to become established in the wild.

2.17. How important is the impact of the organism on biodiversity likely to be in the future in GB?	moderate	low	If <i>Arundo donax</i> becomes invasive, then it is likely to have negative impact on native riparian species and habitats (as set out in 2.15). However, these are predicted to be relatively minor assuming that <i>A. donax</i> does not become as invasive as in warm temperate and subtropical regions (e.g. southern USA, southern Europe).
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)?	minor	very high	<i>Arundo donax</i> has no impact on ecosystem function in GB at present as it has yet to become established.
2.19. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism likely to be in GB in the future ?	moderate	low	If <i>Arundo donax</i> becomes invasive, then it is likely to have negative impact on ecosystem function (as set out in 2.15). These are predicted to be relatively moderate assuming that <i>A. donax</i> does not become as invasive as in warm temperate and subtropical regions (e.g. southern USA, southern Europe).
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	very high	<i>Arundo donax</i> has no impact on conservation value in GB at present as it has yet to become established.
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	moderate	low	If <i>Arundo donax</i> becomes invasive, then it is likely to have negative impacts on the conservation value of wildlife sites in GB, especially riparian and wetland reedbeds currently dominated by <i>Phragmites australis</i> . These have very high conservation value in GB due to their utilisation as nesting habitat by a wide range of threatened species, most notably bittern, marsh harrier, bearded tit and water

future in GB?			vole, and large amounts of GO and NGO resources are currently invested in their creation and management (White et al., 2014). Given its impacts in southern USA, invasion by <i>A. donax</i> would significantly reduce the value of reedbeds for such specialists, although less than in warm temperate and subtropical regions (e.g. southern USA, southern Europe) due to the suboptimal climatic conditions in GB.
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	Geneflow between <i>Arundo donax</i> and closely related species is very unlikely to occur in GB due to sterility and meiotic barriers to exchange with native congenors (e.g. <i>Phragmites australis</i> , <i>Phalaris arundinacea</i>).
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	medium	There are few social or human health impacts associated with invasion by <i>Arundo donax</i> , with the possible exception of increased flood and fire risks to properties adjacent to invaded wetlands/rivers.
2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	minimal	medium	<i>Arundo donax</i> has not been reported as a host for any pests or pathogens, although in the southern USA it provides habitat for the Norway Rat (<i>Rattus norvegicus</i>) which has been implicated in the extinction/range reduction of a number of other species via predation and competition (CABI, 2015).
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 medium high very high	NA
2.26. How important are the	minimal	low	There have been relativeley few reports of natural enemies on <i>Arundo donax</i> in its

<p>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?</p>			<p>introduced range (CABI, 2015) and so these are unlikely to have any impact on its spread in GB.</p>
<p>2.27. Indicate any parts of GB where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).</p>	<p>Riparian systems in southeastern, southern and southwest England</p>	<p>medium</p>	<p>It is difficult to predict precisely the areas that might be endangered by <i>Arundo donax</i> if it becomes established in the future. The most suitable areas are riparian/wetland systems in southeastern England, particularly those connected to the River Thames and its tributaries. However, <i>A. donax</i> has presumably been planted in most GB cities and so could potentially spread to riparian systems throughout the country.</p>

RISK SUMMARIES			
	RESPONSE	CONFIDENCE	COMMENT
Summarise Entry	very likely	very high	<i>Arundo donax</i> is already present in GB as an ornamental grown in urban and suburban gardens. As of May 2018 it had not been reported as established anywhere in the wild in GB.
Summarise Establishment	moderately likely	medium	<i>Arundo donax</i> appears to be growing in popularity as an ‘architectural’ ornamental and it is therefore only a matter of time before it becomes established on waste-ground or along urban water-courses from where it could potentially spread to adjacent wetland habitats.
Summarise Spread	slowly	medium	The colonisation of wetlands by <i>Arundo donax</i> is likely to happen relatively slowly, due to vegetative spread and the isolated nature of river catchments. Spread throughout the country will require multiple introductions at a variety of locations, although unintentional spread between catchments by humans may also occur (e.g. in garden waste/soil, on machinery, etc.).
Summarise Impact	moderate	medium	<i>Arundo donax</i> is likely to have moderate environmental impacts on native species and ecological processes assuming that it does not become as invasive as in warm temperate and subtropical regions. Consequently, its economic, health and social impacts are likely to be relatively minor, including the costs of eradication and control. Although the costs associated with increased flooding are likely to be very high, it will be difficult to attribute these directly to <i>A. donax</i> alone given the complexity of causes of recent flood events in GB.
Conclusion of the risk assessment	medium	medium	We would expect <i>Arundo donax</i> to become naturalised along the margins of major waterbodies (rivers, lakes, reservoirs) in southeast England over the coming decades following escape from cultivation. We expect the impact of these populations to be less invasive than in more optimal warm temperate and subtropical regions due to the severity of frosts in GB. However, we only have medium confidence due to the uncertainty surrounding its likely invasiveness as well as changes to the climate, which may make conditions in GB more suitable for it in the future.

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?	Decreased frequency and severity of frosts	moderate	<i>Arundo donax</i> is thought to be sensitive to severe frosts and, as a consequence this will presumably restrict its spread and invasiveness in parts of GB. However, the frequency and severity of frosts is predicted to decline in the future, especially in milder regions and this will therefore increase the suitability of the climate.
3.2. What is the likely timeframe for such changes?	50	low	
3.3. What aspects of the risk assessment are most likely to change as a result of climate change?	Introduced range & invasiveness	low	If the frequency and severity of frosts decline then the climate will become more suitable allowing <i>Arundo donax</i> to survive further north and become more invasive in the warmest parts of southern and southeastern England.
ADDITIONAL QUESTIONS - RESEARCH			
4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here.	Growth trials in GB	high	Performance trials of <i>Arundo donax</i> across GB would help to quantify climatic suitability and identify regions that are most likely to be invaded in the future under current and predicted climate scenarios.

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

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