

## 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](http://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@fera.gsi.gov.uk](mailto:nnss@fera.gsi.gov.uk)

**GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME**

For more information visit: [www.nonnativespecies.org](http://www.nonnativespecies.org)

<b>Name of Organism</b>		<b><i>Eucalyptus nitens</i> - Shining Gum</b>	
<b>Objectives:</b>		Assess the risks associated with this species in GB	
<b>Version:</b>		Original draft 26/09/11	
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<b>Suggested citation:</b>		Dickinson, B. (2011). GB Non-native Organism Risk Assessment for <i>Eucalyptus nitens</i> <a href="http://www.nonnativespecies.org">www.nonnativespecies.org</a>	
<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>COMMENT</b>
1	What is the reason for performing the Risk Assessment?		Request by the GB Programme Board for Non-native Species. <i>E. nitens</i> (also known as "Shining Gum") is mainly used as an ornamental shrub or amenity tree grown for its attractive foliage. It is a common plantation species in other parts of the world including Europe (particularly Iberia) and there is increasing interest in its use as a short rotation crop for biomass in GB (Purse,J.2009).
2	What is the Risk Assessment area?	Great Britain	
3	Does a relevant earlier Risk Assessment exist?	NO OR UNKNOWN (Go to 5)	
4	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?		
<b>Stage 2: Organism Risk Assessment</b>			
<b>SECTION A: Organism Screening</b>			
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)	<i>Eucalyptus nitens</i> (H. Deane & Maiden) Maiden. <i>E. nitens</i> can hybridise when in proximity to other species e.g. with <i>E. dalympheana</i> , <i>E. globulus</i> and <i>E. crenulata</i> , though this would not normally occur in its native range (Trabado 2008). Natural hybrids in its natural range have been suggested between <i>E. nitens</i> and <i>E. denticulata</i> (CABI 2005). Reputed natural hybrids have been observed between <i>E. nitens</i> , <i>E. badjensis</i> and <i>E. cypellocarpa</i> (Griffin et al 1988), <i>E. glaucescens</i> (Tibbits, 2000), and <i>E. viminalis</i> (CABI 2005). Hybrids can normally be distinguished by morphological measurements. In GB, a hybrid of <i>E. nitens</i> with possibly <i>E. gunnii</i> , <i>E. johnstonii</i> and <i>E. parviflora</i> has shown some potential for natural regeneration (Macpherson per com 2009).
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?	NO or Uncertain (Go to 8)	<i>E. nitens</i> , alongside other Eucalypt species is listed on several databases as 'non-aboriginal' (Portugal) or naturalized and 'potentially invasive' (Australia, Chile, China, France, Lesotho & S. Africa) (FAO 2008, Yoshioka 2009). The greatest area of concern appears to be Australia where <i>E. nitens</i> has been planted outside its natural range and has the potential to hybridise with other rarer species of eucalypt (Barbour 2003). There is no evidence of pure <i>E. nitens</i> regenerating naturally in GB, though artificial hybrids involving <i>E. nitens</i> may have shown this ability (Macpherson pers com).
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)	Seed is fairly small (~400+ per gram, Forestart 2009, Royston Petrie Seeds 2011; 270 viable seeds + chaff per gram, Turnbull & Doran 1987) and can be numerous (CABI 2005), and presumably liable to some wind dispersal. It can show rapid growth but is less able to tolerate coppicing than other eucalypts (CABI 2005). It is only rarely able to reproduce vegetatively by means of lignotubers and epicormic buds (Trabado 2007). There is no indication that it would not be susceptible to standard herbicides if control was needed. In GB, dispersal appears to have been intentional and there is no indication that natural regeneration occurs. However on at least one site, a particular artificially produced hybrid (involving <i>E. nitens</i> , <i>E. gunnii</i> , <i>E. johnstonii</i> and <i>E. parvifolia</i> ) has been observed to produce viable seed and possibly to naturally regenerate outside the original trial areas (Macpherson pers com 2009). <i>E. nitens</i> is originally from upland areas of Victoria and New South Wales, Australia (George, A.S. ed. 1980), areas with climatic similarities to parts of GB. However, although mature trees have been shown to be frost tolerant (e.g. Trabado 2008), seedlings can be more vulnerable to frosts and shading, especially for the first few years. (Howard Lloyd pers com 2009). Production of viable seed by pure <i>E. nitens</i> in GB could not be confirmed, but may be possible for certain hybrids.
9	Does the organism occur outside effective containment in the Risk Assessment area?	NO (Go to 11)	There is no evidence of pure <i>E. nitens</i> occurring outside effective containment. However, a possible hybrid of <i>E. nitens</i> has been noted as regenerating naturally at one trial site, where it is currently contained. (Macpherson pers com 2009)
10	Is the organism widely distributed in the Risk Assessment area?		
11	Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in the Risk Assessment area, in the open, in protected conditions or both?	YES (Go to 12)	<i>E. nitens</i> has been intentionally planted at numerous managed sites such as gardens and trial plantations but there is no evidence of natural regeneration. A possible hybrid of <i>E. nitens</i> has been noted as regenerating naturally at one trial site, where ground conditions were relatively bare and light conditions high following felling of mature parent trees. (Macpherson pers com 2009).
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.	YES (Go to 13)	Requires generalist pollinators (bees and other insects) (Free 1993), which are present in GB. For Eucalypts in general, growth is improved by the presence of micorrhizal fungi, but these may not be essential. (CABI 2005)
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.	YES (Go to 14)	Suitable generalist pollinators are present throughout GB.
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)	Yes, the climate of its native area (Victoria, Australia) and many other areas where it is grown (China, Italy, Russia, USA, Australia, New Zealand, France, Portugal, Spain, Ireland) is somewhat comparable in climate to parts of GB. It is also grown in India, Iran, S. Africa, Zimbabwe, Argentina, Brazil, Chile, Colombia.
15	Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in the Risk Assessment area?		

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)	This species is intentionally planted and grown to maturity when viable seed is produced. There is unconfirmed evidence of complex hybrids of <i>E nitens</i> being capable of natural regeneration in the wild. (Macpherson pers com 2009). However, there is no confirmed evidence of self-seeding by pure <i>E. nitens</i> , though theoretically this could occur. Orwa et al (2009) suggests that regeneration of <i>E nitens</i> from seed can be prolific on ash beds following burning, but do not indicate whether this has been observed only within its original range, or elsewhere.
17	Can the organism spread rapidly by natural means or by human assistance?	NO (Go to 20)	Natural seed spread from parent trees is likely to be slow and conditions for natural regeneration limited. However, intentional planting in commercial plantations could increase rapidly.
18	Could the organism as such, or acting as a vector, cause economic, environmental or social harm in the Risk Assessment area?		There are some indications that rapid water loss may cause a lowering of local water tables, and a build up of leaf litter could increase fire risk. Potentially, biodiversity could be reduced where large volumes are planted in monocultures.
19	This organism could present a risk to the Risk Assessment area and a detailed risk assessment is appropriate.		
20	This organism is not likely to be a harmful non-native organism in the Risk Assessment area and the assessment can stop.	Detailed Risk Assessment Not Appropriate - STOP	A full risk assessment has been requested by the GB Programme Board and so Section B is also completed.

<b>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</b>				
<b>Probability of Entry</b>				
	<b>RESPONSE</b>	<b>UNCERTAINTY</b>	<b>COMMENT</b>	
1.1	List the pathways that the organism could be carried on. How many relevant pathways can the organism be carried on?	few - 1	LOW - 0	This species has already entered GB and is widely established as an ornamental garden tree and in trial plantations. Entry pathway is by intentional importation of seed by seed merchants, nurseries, garden centres, research organisations and individuals. Most imported seed is from Australia, but also from tree breeding establishments in Europe (mainly Holland & Spain) and available from USA, Brazil and other countries. (CABI 2005). Research is being carried out on various vegetative propagation techniques including stem cuttings and micropropagation using tissue cultures, but so far with only limited commercial success. (e.g. Gomes & Canhoto 2003).
1.2	Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.			Importation of seed through horticultural trade channels and direct online sales.
1.3	How likely is the organism to be associated with the pathway at origin?			Not required. Deliberate introduction.
1.4	Is the concentration of the organism on the pathway at origin likely to be high?			Not required. Deliberate introduction.
1.5	How likely is the organism to survive existing cultivation or commercial practices?			Not required. Deliberate introduction.
1.6	How likely is the organism to survive or remain undetected by existing measures?			Not required. Deliberate introduction.
1.7	How likely is the organism to survive during transport /storage?			Not required. Deliberate introduction.
1.8	How likely is the organism to multiply/increase in prevalence during			Not required. Deliberate introduction.
1.9	What is the volume of movement along the pathway?	minor - 1	MEDIUM -1	Small quantities of seed are likely to be imported each year as few companies appear to be involved in re-selling seed or growing-on. This may change in the future if there is commercial interest in establishing short-rotation forestry plantations with this species..
1.10	How frequent is movement along the pathway?	occasionally - 2	HIGH -2	Probably imports are fairly regular, but no precise information is available. Online purchase of seed from Australia and USA seems to be available throughout the year.
1.11	How widely could the organism be distributed throughout the Risk Assessment area?	very widely - 4	LOW - 0	Companies importing and re-selling seed are rather few, but well distributed across GB. Most seed is probably purchased on-line either from these companies or directly from Australia / USA. Seed is usually delivered by post and purchasers will be widely distributed across GB.
1.12	How likely is the organism to arrive during the months of the year most appropriate for establishment ?			Not required. Deliberate introduction.
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?			Not required. Deliberate introduction.
1.14	How likely is the organism to be able to transfer from the pathway to a suitable habitat?	unlikely - 1	MEDIUM -1	It is unlikely that E nitens will spread rapidly from the intended planting areas. Seed is normally sold in small quantities to be grown under managed conditions in commercial or private nursery areas, usually indoors. Seed germination is erratic (Jungleseeds 2009) and particular conditions suitable for germination are needed (full sunlight, moisture, bare soil, protection from predators and possibly a period of cold stratification) (Krugman & Whitesell 1974, John Purse 2009). Seedlings are delicate and do not tolerate droughting, frosts or competition with other vegetation (Krugman & Whitesell 1974, Bell & Williams 1997, Meskimen & Francis 1990). Mature trees can produce viable seed quite early (from 4-5 years, Potts et al 2001, Celyn Vale 2011) and can produce large quantities of seed, but dispersal away from the parent is likely to be slow (Cremer 1977).

	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	LOW - 0	E nitens grows well in USDA climatic zones 8a through to 9b (average annual minimum temperature between -12.2 to -1.2 °C) and can tolerate up to 150 days of frost per year. (Randy Stewart Landscape designs 2011). The majority of GB apart from the high Pennines and Scottish uplands comes into the USDA plant hardiness categories 8a to 10a (e.g. Trebrown Nursery 31/03/2011), and provides the broad annual rainfall requirements and similar climatic conditions to those required for establishment. E nitens occurs naturally in the mountains of south-eastern Australia at between 600-1600m asl. In these areas, the climate is cool to warm, humid to subhumid, (500-2160mm precipitation, with a dry season of between 0-3 months duration) with mild summers rarely having very high temperatures (max temp of hottest month 19-29°C and the mean minimum of the coldest month about -3°C to 7°C). Winter frosts are numerous and severe, with 50-150 days annually and an absolute minimum of -12°C. Snow occurs over most of the distribution and may remain on the ground for several days to a week or more at a time. E nitens is one of the most frost tolerant of the fast-growing commercial Eucalyptus species and is moderately drought resistant. (Orwa et al 2009, CABI 2005). Established trees are hardy to approximately -12°C. (John Purse 2009). The current worldwide distribution of E nitens includes: SE Australia & Tasmania, New Zealand, South Africa, USA, Russian Federation, China, India, Iran, Zimbabwe, Argentina, Chile and Colombia. It is also increasingly grown in several countries in western Europe including France, Italy, Spain, Portugal Great Britain and Ireland. Optimum temperature for germination for two varieties of E nitens was between 18°C and 28°C (Humara, J.M. et al, 2000). Krugman & Whitesell (1974) state that a pre-germination cold stratification is required. Growers recommend that seeds are germinated early in the year so that seedlings are well-grown enough to deal with the following winters cold conditions. This might mean that warmer areas with a longer growing season (i.e. the south and west of GB) may favour establishment from seed, though this remains theoretically possible elsewhere
1.16	How similar are other abiotic factors that would affect establishment in the Risk Assessment area and in the area of present distribution?	similar - 3	LOW - 0	E. nitens prefers deep, moist loams, but it will grow satisfactorily on a wide range of moderately fertile soils, especially if there is clay in the subsoil. The sites are usually well drained and their pH values fall within the range of 4.5 to 6.0. (Turnbull and Pryor, 1984). Such soil conditions are fairly widely distributed in GB. However, natural regeneration may depend on the availability of freshly burnt areas (CABI 2005), cleared of vegetation, which are relatively uncommon.
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.	moderate number - 2	MEDIUM -1	In its natural habitat, E. nitens occurs in the hills and valleys in mountain areas (Orwa et al 2009). In GB it is likely that the majority of habitats that might support the growth of woodland or scrub could be suitable. However, due to the small size of the seed, the seedlings have very small reserves and so are unable to tolerate shade or weedy competition. In order to germinate and establish, Eucalyptus seed need contact with bare mineral soil and sunlight to develop, and the seedlings are delicate and cannot suffer competition with other plants (Krugman & Whitesell 1974, Bell & Williams 1997, Meskimen & Francis 1990). Hence, areas of bare soil where weeds are suppressed (e.g land prepared for agricultural crops, or burnt areas) that are immediately adjacent to large numbers of parent trees could provide the most optimal conditions. In GB these conditions may be relatively uncommon. If E nitens is similar to other Eucalypts, then only generalist pollinators are required, of which there are numerous species throughout GB
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?	frequent - 3	MEDIUM -1	Suitable habitats (potential woodland / scrub) and species vital for multiplication (generalist pollinators) are very widespread in the Risk Assessment area. However, the specific conditions necessary for survival and development within these habitat types (i.e. bare ground with little competition from other vegetation) may be relatively uncommon.
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?	very likely - 4	LOW - 0	If like other Eucalypts, then probably only generalist pollinators are required (Hingston et al 2004), and these should easily come into contact with this species.
1.20	How likely is it that establishment will not be prevented by competition from existing species in the Risk Assessment area?	moderately likely - 2	MEDIUM -1	Seedlings are vulnerable to shading at the early seedling stage and both germinating seeds and mature trees prefer full sun (Krugman & Whitesell 1974, John Purse 2009). Where natural regeneration of hybrids has been observed, a grass and shrubby layer was present (MacPherson pers com). However, there is little information on the precise conditions that are most favourable.
1.21	How likely is it that establishment will not be prevented by natural enemies already present in the Risk Assessment area?	moderately likely - 2	MEDIUM -1	Seeds may be vulnerable to predation from rodents, birds and insects (Krugman & Whitesell 1974). Like other Eucalypts, mature E nitens may be vulnerable to psyllids, aphids, beetles and mildews but damage is likely to be merely cosmetic. It is vulnerable to chrysomelid beetles, leaf fungi and powdery mildews (CABI 2005). E nitens is considered relatively unpalatable to browsing animals. (Orwa et al 2009, John Purse 2009)
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)	moderately likely - 2	MEDIUM -1	Outside its native range, E nitens is grown either as an ornamental garden tree, in small plantations for foliage, or in experimental trials as a short-rotation biomass crop. In all these situations trees are initially grown from seed in carefully managed conditions (greenhouse or nursery) before being transplanted as a seedling in prepared ground, and with little or no competition with other plants. Herbicides may be used to control weeds around seedlings / saplings in such plantations so there may be potential for unintended growth of E nitens on these sites. Artificial burning or weed control in sites adjacent to mature E nitens could aid establishment.
1.23	How likely is it that existing control or husbandry measures will fail to prevent establishment of the organism?	unlikely - 1	MEDIUM -1	Natural regeneration of pure E. nitens has not been recorded in GB and self-seeding of hybrids appears to have remained very localised at controlled sites. It is likely that any natural regeneration occurring on recent trial plantation sites would be controlled.
1.24	How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	frequent - 3	LOW - 0	E nitens saplings are available from numerous nurseries (mainly in S England) where it is initially grown under glass. It is still an uncommon garden plant. It is grown in a small number of plantations for its foliage and has recently been planted at several trial sites for biomass, so may become more popular in the future.
1.25	How likely is the reproductive strategy of the organism and duration of its life cycle to aid establishment?	unlikely - 1	MEDIUM -1	E. nitens can hybridise naturally. It can produce fine seed from age 3 years onwards (Potts et al 2001) but may not flower heavily and produce large quantities of seed until 7-10 years (Eldridge et al 1993). This species has a reputation for small seed crops and slow flowering (CABI 2005). Seed can potentially remain viable for several years, although it is palatable to small animals (John Purse pers com).
1.26	How likely is it that the organism's capacity to spread will aid establishment?	unlikely - 1	LOW - 0	Current spread is probably mainly through deliberate planting of small numbers if trees in gardens though there is increasing interest in larger scale plantations. Natural spread from these loci is likely to be slow.
1.27	How adaptable is the organism?	moderately adaptable - 2	HIGH -2	E. nitens can hybridise naturally with other Eucalypt species (Barbour 2003, Trabado 2008).
1.28	How likely is it that low genetic diversity in the founder population of the organism will not prevent establishment?	likely - 3	MEDIUM -1	The species has substantial genetic variation with a geographic structure (Raymond & Apiolaza 2004, Dutkowski et al 2001).

1.29	How often has the organism entered and established in new areas outside its original range as a result of man's activities?	many - 3	MEDIUM -1	Natural regeneration in GB has not been recorded for E nitens. There appears to be no evidence of natural regeneration in other countries outside Australia. The current worldwide distribution of E nitens through cultivation includes: Tasmania, New Zealand, South Africa, USA, Russian Federation, China, India, Iran, Zimbabwe, Argentina, Chile and Colombia. It is also increasingly grown in several countries in western Europe including France, Italy, Spain, Portugal Great Britain and Ireland (Barclay 2004, Krugman & Whitesell 1974, Orwa et al 2009, FCS 2009).
1.30	How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	very unlikely - 0	MEDIUM -1	Although E. nitens does survive coppicing when young it becomes less tolerant to this as it ages, though this trait varies with provenance (John Purse pers com). There is no evidence to suggest that it would not be vulnerable to standard herbicide treatments.
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)?	likely - 3	LOW - 0	The population of E nitens in GB is increasing. At least 12 trial sites researching the usefulness of this species in short rotation forestry have recently been set up in Scotland by Forest Commission Scotland & in England for the Department of Energy & Climate Change (DECC) (FCS 2010). If these trials prove successful it is likely that larger scale deliberate planting and possibly more experimental trials will follow, thereby maintaining populations in GB. As hardier varieties are established sales of seed and small saplings may also increase for use as ornamental garden plants.

	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	Any spread of E nitens from the parent trees is likely to be slow. Generally, seed dispersal is limited in the Eucalyptus genus (Potts & Reid 1988), the key agent being wind (Turnbull & Doran 1987). E nitens seeds are small (170-400 per gram germinable Forestart 2008; 270 per g Turnbull & Doran 1987) and unwinged. The seeds would be expected to fall close (less than twice the tree height) to the parent i.e. within <80m (Cremer 1977). Greater drift of seeds might be possible in storm conditions. It is possible that seed could be transported by water either by falling into streams, or in surface water especially in storm events. Dispersal by birds or animals is unlikely: whilst the capsules of some species of Eucalypt have been observed to be eaten by birds, (probably parrots), it is not common and seed is unlikely to survive passage through the gut. (O'Sullivan 2011). The capsules and seed are smooth and are unlikely to be transported accidentally by animals by adhering to hair or skin. This species is considered fairly unpalatable and saplings only occasionally browsed heavily by deer and rabbits (Purse, J), though there is no specific information available on the palatability of the seeds or capsules to animals in GB. The seed is fine and unlikely to be cached underground by rodents. Under natural conditions Eucalyptus seed viability falls rapidly after about 2 months and is very low after 12 months (Carey 2002), so even if seed were transported, high volumes are unlikely to build up.
2.2	How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	intermediate - 2	MEDIUM -1	E nitens are deliberately cultivated in garden environments and small trials and amenity plantings have been established since the 1980's, particularly in S. England (John Purse 2009). Recently there has been increased interest in using this species for biomass production in 'short rotation forestry' plantations. At present there are at least 6 trial plots in Scotland (Caithness, Aberdeen, Perth, Fife, Lanark & Mull) & 6 in England (Cumbria, South Yorkshire, Lincs, Oxon, Sussex & Devon) (FCS 2010). Should these prove successful, then it is very likely that much larger areas will be planted as commercial crops. However, spread from these sites to unintended areas is likely to be slow.
2.3	How difficult would it be to contain the organism within the Risk Assessment area?	easily - 1	LOW - 0	Trees are easily recognised even when small, and if similar to other Eucalypt species, should be susceptible to herbicides (e.g. Little & Eccles 2000).
2.4	Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.		MEDIUM -1	Endangered areas are most likely to be unmanaged habitats adjacent to plantations, gardens or nurseries. The seedlings do not thrive well in shade or in competition to other vegetation. Hence, areas of bare soil where weeds are suppressed (e.g. prepared areas for forestry and agricultural crops, or recently burnt areas) that are immediately adjacent to large numbers of parent trees could provide the most optimal conditions. Ideal germination conditions may suggest that warmer areas with a longer growing season in the south and west could favour establishment from seed.

	Impacts	RESPONSE	UNCERTAINTY	COMMENT
2.5	How important is economic loss caused by the organism within its existing geographic range?	minimal - 0	MEDIUM -1	No information available on natural regeneration outside GB. Within GB economic loss to date is insignificant.
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?	minor - 1	MEDIUM -1	Any negative economic impacts are likely to be very localised and small. Natural regeneration, should it occur, is likely to be restricted small numbers of individuals in areas adjacent to parent trees. Potential impacts should E nitens acquire the ability to establish naturally are likely to be greatest at sites of high conservation or social value should it need to be eradicated. Commercial agriculture may suffer if natural regeneration of E nitens occurs on farmland and established trees have to be removed. Commercial forestry may also suffer additional costs when plantations of E nitens are to be replaced by other species. It is unlikely that significant cover of E nitens would occur before control would be initiated.
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?	minimal - 0	MEDIUM -1	Costs of E nitens control are not likely to be large. Spread by natural regeneration, should it occur, is likely to be very slow and initially localised to areas adjacent to parent trees. Re-planting on established E nitens plantation sites may be difficult and costly, but possibly no more than on other short rotation coppice sites.
2.8	How great a reduction in consumer demand is the organism likely to cause in the Risk Assessment area?	minimal - 0	LOW - 0	Consumer demand is potentially for the woody biomass of E nitens, natural regeneration of E nitens growing outside commercial plantations is unlikely to have any significant effect.
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	Natural regeneration of E nitens unlikely to affect commercial exports.
2.10	How important would other economic costs resulting from introduction be? (specify)	minimal - 0	MEDIUM -1	Spread by natural regeneration, should it occur, is not expected to create large additional economic costs.
2.11	How important is environmental harm caused by the organism within its existing geographic range?	minor - 1	MEDIUM -1	There is no indication that this species causes environmental harm within its current range. However, large scale planting is relatively new, so little data is so far available.
2.12	How important is environmental harm likely to be in the Risk Assessment area?	minor - 1	MEDIUM -1	In common with other Eucalypt species E nitens has the potential for a high level of water loss through transpiration and cause a consequent lowering of the local water table, especially when grown in dense monoculture. Shedding of oil-rich leaves and bark which may not break down immediately could increase fire-risk. Information from trial plantations should help clarify potential issues in the next few years.
2.13	How important is social and other harm caused by the organism within its existing geographic range?	minimal - 0	HIGH -2	Very little information available on social & other harm outside GB.
2.14	How important is the social harm likely to be in the Risk Assessment area?	minimal - 0	MEDIUM -1	Within GB social & other harm is unlikely to be significant.
2.15	How likely is it that genetic traits can be carried to native species, modifying their genetic nature and making their economic, environmental or social effects more serious?	very unlikely - 0	LOW - 0	There are no native Eucalypts in GB.
2.16	How probable is it that natural enemies, already present in the Risk Assessment area, will have no effect on populations of the organism if introduced?	very likely - 4	MEDIUM -1	No significant natural enemies have been identified in GB.
2.17	How easily can the organism be controlled?	easily - 1	MEDIUM -1	Little information available, but probable that coppicing and/or standard herbicides would provide effective control.
2.18	How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	very unlikely - 0	MEDIUM -1	Herbicide application and/or prolonged coppicing of selected individual trees would be involved.
2.19	How likely is the organism to act as food, a host, a symbiont or a vector for other damaging organisms?	moderately likely - 2	HIGH -2	There is some evidence that Eucalypts in general provide a host for certain psyllids and aphids. (e.g. Celyn Vale Nurseries undated, Kerr 2007). Leaf fungi (e.g. Phaeophleospora eucalypti in Australia), Cossid moths (Gebeyehu et al 2004), and Mildews affecting E nitens could potentially affect other species. (MAF 2004). There are also growing examples of host-specific pathogens native to areas where eucalypts have been planted as non-natives, which have undergone sometimes surprising host jumps (Wingfield et al 2008).
2.20	Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur		HIGH -2	Should natural regeneration occur in the future, the greatest impact would possibly be on existing plantation sites after removal of mature E nitens. Areas of high conservation or social value which are adjacent to plantations of E nitens may also be vulnerable. It is possible that warmer sites in the south of GB may favour survival of seedlings, and could suffer through increased fire risk and lowering of local water tables. The most vulnerable sites might be arable, or recently burned areas, immediately adjacent to plantations of E nitens.

<b>Summarise Entry</b>	very likely - 4	LOW - 0	E nitens seed and seedlings are currently imported for deliberate planting in GB. Due to increased interest in growing this species for short rotation forestry and cut foliage, imports may well increase. If trials are successful, it is likely that established trees in GB will be used to produce more planting stock. There is also increasing interest in developing varieties and hybrids of E nitens for greater frost-hardiness and these hybrids
<b>Summarise Establishment</b>	moderately likely - 2	HIGH -2	There appears to be no evidence of natural regeneration of pure E. nitens in GB. It is a widespread ornamental garden tree but there is no indication that significant self-seeding has been observed. However, artificial hybrids involving E.nitens may have shown this ability. There is interest in developing this species for short-rotation forestry and in the future selected varieties or artificial hybrids involving E nitens may show a greater ability for natural regeneration, so the situation needs to be monitored. Recent forestry trials should provide more data on this.
<b>Summarise Spread</b>	very slow - 0	MEDIUM -1	There is no evidence of any spread of pure E nitens and evidence of self-seeding in GB has come from artificially produced hybrids at controlled sites. The potential for spread currently appears small.
<b>Summarise Impacts</b>	minor - 1	MEDIUM -1	Potential impacts should E nitens acquire the ability to establish naturally are likely to be greatest at sites of high conservation or social value should it need to be eradicated. Commercial agriculture may suffer if natural regeneration of E nitens occurs on farmland adjacent to parent trees. Commercial forestry may also suffer additional costs when plantations of E nitens are to be replaced by other species. The most important environmental impacts may be loss of biodiversity, increased fire risk and a reduced water table.
<b>Conclusion of the risk assessment</b>	LOW - 0	HIGH -2	This species is probably in the upper level of the 'Low Risk' category, but given the potential for rapid developments in both the volumes that may be grown, and new varieties which could quickly be developed, the situation should be closely monitored. Pure E nitens is currently being grown in GB as an amenity tree, for cut foliage and as a potential plantation species for short rotation biomass trials. It can produce viable seed but there is little evidence for significant natural regeneration or rapid spread from areas where it is being grown. However, there is interest in identifying more frost-tolerant varieties and hybrids of E nitens crossed with other Eucalypt species. The potential for invasiveness of these is not yet known and will need to be monitored.
<b>Conclusions on Uncertainty</b>		MEDIUM -1	There appears to be no evidence of natural regeneration of pure E nitens in GB at the current time. Eucalypts in general tend to be highly genetically variable and it is possible that new provenances or hybrids will be rapidly developed and the invasiveness risk of these may need to be assessed.

## References

- Barbour, R.C. (2003) Gene flow from introduced *Eucalyptus* plantations into native *Eucalypt* species. Unpubl. DPhil Thesis, University of Tasmania 2003
- Barclay, Ian (2004) Hardy *Eucalyptus* website. Accessed March 2011 at: <http://www.angelfire.com/bc/eucalyptus/G.html>
- Bell, D. T. & Williams, J.E. 1997. *Eucalyptus* ecophysiology. Pages 168-196 in J. E. Williams and J. Woinarski, editors. *Eucalyptus Ecology: Individuals to Ecosystems*. Cambridge University Press, Cambridge
- CAB International (2005) *Forestry Compendium*. Wallingford, UK
- Celyn Vale Nurseries Newsletter, 7th edition. Accessed April 2011 at: [www.blueram.net/eucalyptus/CelynValeNurseries7thEd.pdf](http://www.blueram.net/eucalyptus/CelynValeNurseries7thEd.pdf)
- Cremer K. W., 1977. Distance of seed dispersal of eucalypts estimated from seed weights. *Australian Forestry Research* 7, 225-8.
- Dutkowski, G.W., Potts, B.M., Williams, D., Kube, P.D. and McArthur, C. (2001) Geographic genetic variation in central Victorian *Eucalyptus nitens*. In IUFRO Conference "Developing the Eucalypt of the Future". Valdivia, Chile, September 2001
- Eldridge K.J, Davidson J, & Hardwood Ch. (1993) *Eucalyptus* domestication and breeding. Oxford, New York.
- FAO Invasive Forest Tree Species, Country Species List: <http://www.fao.org/forestry/24107/en/>
- FCS (2009) *Forestry Commission Scotland (2009) Energy Forestry Exemplar Trials*. Ed. Alan Harrison
- FCS (2010) *Forestry Commission Scotland . Energy Forestry Trials*. Ed. Alan Harrison CSWF. FCS
- Free, J. (1993) *Insect pollination of crops*. Academic Press, London, UK. Accessed April 2011 at: <http://www.internationalpollinatorsinitiative.org/jsp/manage/manage.jsp>
- Forestart (2009) Online seed catalogue January 2009: <http://www.forestart.co.uk>
- Gebeyehu S, Hurley BP and Wingfield MJ (2004) A new Lepidopteran insect pest discovered on commercially grown *Eucalyptus nitens* in South Africa. *South African Journal of Science* 101: 26-28
- George, A.S. ed. (1980) *Flora of Australia Volume 19—Myrtaceae - Eucalyptus - Angophora*
- Gomes, F & Canhoto, J.M. (2003) Micropropagation of *Eucalyptus nitens* MAIDEN (Shining Gum). *In Vitro Cellular Development Biology*. 39: 316-321.
- Griffin AR, Burgess IP, Wolf L, 1988. Patterns of natural and manipulated hybridisation in the genus *Eucalyptus* L'Hérit. - a review. *Australian Journal of Botany*, 36(1):41-66
- Hingston, A.B., McQuillan, P.B., & Potts, B.M.(2004) Pollinators in seed orchards of *Eucalyptus nitens* (Myrtaceae) *Australian Journal of Botany* 52(2) 209-222
- Humara, J.M., López, M., Casares, A., and Majada, J. (2000) Temperature and provenance as two factors affecting *Eucalyptus nitens* seed germination *Forestry (2000) 73(1): 87-90*.
- Kerr, D. (2007) *Eucalyptus* as cut foliage. Interim report 2007, to Crops & Horticulture Development Branch, College of Agriculture, Food & Rural enterprise, Greenmount Campus, Ireland.
- Krugman, S.L. & Whitesell, C.D. (1974) *Eucalyptus* L'Her. *Eucalyptus*. In *Seeds of woody plants in the United States*. p. 384-392. C. S Schopmeyer, tech. coord. U.S. Department of Agriculture Agriculture Handbook 450. Washington, DC.
- Little, K.M. & Eccles, N.S. (2000) Control of *Eucalyptus grandis* cut-stumps of single-stem origin. *Southern African Journal of Forestry* 187 pp45-49
- Lloyd, H. (2009): *Eucalyptus Passion*, France 82400. <http://eucalyptus-passion.com> January 2009
- MAF - Ministry of Agriculture & Forestry Biosecurity Authority (2004) *Biosecurity Issue* 52, 15 June 2004. Australia
- Meskimen, G. and J. K. Francis. (1990) *Rose Gum Eucalyptus*.in R. M. Burns and B. H. Honkala, editors. *Silvics of North America: Volume 2. Hardwoods*. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC
- Orwa C, Mutua A , Kindt R , Jamnadass R, Simons A. 2009. *Agroforestry Database: a tree reference and selection guide version 4.0* (<http://www.worldagroforestry.org/af/treedb/>)
- O'Sullivan (2011) *Environmental Weed Risk Assessment for Eucalyptus occidentalis*. Future Farm Industries CRC [Accessed April 2011 at: <http://www.futurefarmonline.com.au/> ]
- Purse, J. (2009), *Primabio*, <http://www.primabio.co.uk> January 2009
- Potts B. M. and Reid J. B., (1988) Hybridization as a dispersal mechanism. *Evolution* 42(6), 1245-55
- Potts, B.M., Barbour, R. & Hingston, A. (2001) The risk of genetic pollution from farm forestry using *Eucalypt* species and hybrids. *Rural Industries Research and Development. Joint Venture Agroforestry Program Report* 01/114
- Randy Stewart Landscape designs. Website accessed April 2011 at: <http://rslandscape.blogspot.com/search/label/Eucalyptus>
- Raymond, C.A. & Apiolaza, L.A (2004) Chapter 5 Incorporating wood quality and deployment traits in *Eucalyptus globulus* and *Eucalyptus nitens*. In: *Plantation Forest Biotechnology for the 21st Century*, Editors Christian Walter & Mike Carson. 2004: 87-99 ISBN: 81-7736-228-3
- Royston Petrie seeds. Website accessed April 2011 at: [http://www.roystonpetrieseeds.com.au/seed\\_catalogue\\_lines.php?id=3](http://www.roystonpetrieseeds.com.au/seed_catalogue_lines.php?id=3)
- Tibbits, W.N. (2000). Evaluation of hybrids with *Eucalyptus nitens*. In *Hybrid Breeding and Genetics of Forest Trees*. Proceedings of QFRI/CRC-SPF Symposium, 9-14th April 2000 Noosa, Queensland, Australia.. (Ed. H.S. Dungey, M.J. Dieters and D.G. Nikles.)
- Tibbits, W.N. & Reid, J.B. (1987) Frost Resistance in *Eucalyptus nitens* (Deane & Maiden) Maiden: Physiological Aspects of Hardiness *Australian Journal of Botany* 35 (3) 235 - 25
- Trabado 2007 (Gustavo Iglesias Trabado, GIT Forestry Consulting (Eucalyptologies) Accessed March 2011 at: <http://git-forestry-blog.blogspot.com/2007/06/natural-regeneration-in-eucalyptus-2-e.html>)
- Trabado 2008 (Gustavo Iglesias Trabado, GIT Forestry Consulting (Eucalyptologies) at: [www.git-forestry.com](http://www.git-forestry.com) January 2009)
- Trebrown Nursery. Accessed 31/03/2011 at: <http://www.trebrown.com/hrdzone.html>
- Turnbull J W, Doran JC, 1987. Seed development and germination in the Myrtaceae. In: Langkamp, P. ed. *Germination of Australian native plant seed*. Melbourne, Australia: Inkata Press, 46-57.
- Turnbull, J.W. and Pryor, L.D. (1984). Choice of species and seed sources. In: Hillis, WE, Brown AG (eds). *Eucalypts for wood production*. CSIRO, Academic Press. Sydney, Australia
- Wingfield, MJ, Slippers, B., Hurley, BP, Coutinho, TA, Wingfield, BD, Roux, J. (2008) *Eucalypt* pests and diseases: growing threats to plantation productivity. *Southern Forests: a Journal of Forest Science* 70(2) 139-144
- Yoshioka T. (2009) *Invasive Plants database* (2009) <http://invasive.m-fuukei.jp/> January 2009