FORMAT FOR A PRA RECORD (version 3 of the Decision support scheme for PRA for quarantine pests)

	European and Mediterranean Plant Protection Organisation		
	Organisation Européenne et Méditerranéenne pour la Protection des Plantes		
	Guidelines on Pest Risk Analysis		
	Lignes directrices pour l'analyse du risque phytosanitaire		
	Decision-support scheme for quarantine pests Version N°3		
PEST RISK ANALYSIS FOR *DENDROLIMUS PINI*			
Pest risk analyst(s):	Forest Research, Tree Health Division		Dr Roger Moore and Dr Hugh Evans
Date:	24 June 2009 (revised on 3 September and 21 October 2009)		
			This PRA is for the UK as the PRA area. It has been developed in response to concerns arising from capture(s) of adult male moths of the pine-tree lappet moth (*Dendrolimus pini*) and known serious infestations of this insect in Europe. It has been carried out at the request of the Outbreak Management Team of the Forestry Commission. This PRA has been revised on 3/9/09 following pheromone and light trap surveys and again on 21/10/09 following captures of caterpillars and confirmation of a breeding population.
Stage 1: Initiation			
1 What is the reason for performing the PRA?			This PRA was initially produced due to a suspected colonisation of *Dendrolimus pini* in the Scottish Highlands around Inverness. The colonisation has now been confirmed by the capture of caterpillars and pupae at a number of separate breeding sites. *D. pini* could cause serious defoliation of pine (*Pinus*) species in the area and this PRA is to determine whether the pest requires statutory action.
2 Enter the name of the pest			Pine-tree lappet moth (*Dendrolimus pini* L.)
2A Indicate the type of the pest			Insect
2B Indicate the taxonomic position			Insecta: Lepidoptera: Lasiocampidae

3 Clearly define the PRA area		UK, including Northern Ireland and the Channel Islands
4 Does a relevant earlier PRA exist?	No	There are PRA's for other species in the same genus
5 Is the earlier PRA still entirely valid, or only partly valid (out of date, applied in different circumstances, for a similar but distinct pest, for another area with similar conditions)?		
Stage 2A: Pest Risk Assessment - Pest categorization		
6 Specify the host plant species (for pests directly affecting plants) or suitable habitats (for non parasitic plants) present in the PRA area.		Pinus species. The primary host is Scots pine (*Pinus sylvestris*).
7. Specify the pest distribution		*Dendrolimus pini* is widely distributed throughout Europe and Asia and even recorded in N Africa.
8. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	Yes	
9. Even if the causal agent of particular symptoms has not yet been fully identified, has it been shown to produce consistent symptoms and to be transmissible?		
10. Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products?	Yes in parts of its range	*D. pini* is known to cause heavy and sometimes total defoliation, dieback and death of pine trees in many parts of Europe and especially in Poland (Sierpinska, 1998) and Germany (Le Mellec and Michalzik, 2008). However, elsewhere in Europe outbreaks are rare or unreported.
11. Does the organism have intrinsic attributes that indicate that it could cause significant harm to plants?	Yes	The larval stages can cause heavy, sometimes complete, defoliation of pine trees. It is known to feed on other tree genera (see 14), but there is little information on the scale of the damage other than on pine.

12 Does the pest occur in the PRA area?	Yes	A single moth was caught in 2004, two in 2007 and six in 2008 (all in light traps) and four were caught in pheromone traps in 2008. In 2009 a total of 98 moths were trapped (90 in light traps and 8 in pheromone traps). Thus far all adult moths have been males and in Sept 2009 breeding populations were located at 3 sites, indicated by the presence of larvae and a pupal cocoon.
13. Is the pest widely distributed in the PRA area?	No	The male moth, larval and pupal captures have all occurred in a discrete area of approximately 7 km radius within 20km of Inverness. There have also been sporadic records of captures of males in light traps in Hampshire, Cornwall and the Channel Islands. These are regarded as migrant male moths rather than from local breeding populations of the moth.
14. Does at least one host-plant species (for pests directly affecting plants) or one suitable habitat (for non parasitic plants) occur in the PRA area (outdoors, in protected cultivation or both)?	Yes	The primary host is Scots pine (*Pinus sylvestris*). However, *D. pini* feeds on other pine spp. and coniferous host plants including fir, cedar, juniper, spruce, Douglas-fir and larch. *D. pini* may also represent a risk to Lodgepole pine (*Pinus contorta* var. *latifolia*) and Corsican pine (*Pinus ni*gra subsp. Laricio) as well as Scots pine in the UK.
15. If a vector is the only means by which the pest can spread, is a vector present in the PRA area? (if a vector is not needed or is not the only means by which the pest can spread go to 16)	Not relevant	No vectors required.
16. Does the known area of current distribution of the pest include ecoclimatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?	Yes	The moth is a continental European pest that is also known to extend to the western part of Asia as well as the Ukraine (Meshkova, 2003) and Russia (Mozolevskaya et al., 2003) and N. Africa. Consequently, it is adapted to a fairly wide range of ecoclimatic conditions. Its main outbreak areas appear to be in northern Germany and parts of Poland particularly after periods of dry and hot weather. It has now been confirmed as breeding in the PRA area and could potentially outbreak during periods of suitable climatic conditions. The frequency of occurrence of these conditions is likely to be highly influenced by climate change.
17. With specific reference to the plant(s) or habitats which occur(s) in the PRA area, and the damage or loss caused by the pest in its area of current distribution, could the pest by itself, or acting as a vector, cause significant damage or loss to plants or		The PRA area and especially those parts of the PRA area near to the confirmed captures of *D. pini* contain particularly important areas of native Scots pine in a national context eg Caledonian pine forests. *Dendrolimus pini* can cause extensive and sometimes complete defoliation of Scots pine trees in parts of Europe (Sierpinska, 1998, le Mellec and Michalzik, 2008) and these defoliation episodes are cyclic and can last for between 2 and 12 years (Sierpinska, 1998). However, through much of its range it is not

other negative economic impacts (on the environment, on society, on export markets) through the effect on plant health in the PRA area?		considered a pest species.
18. This pest could present a risk to the PRA area.	Yes	The species poses a potential risk particularly in areas of low rainfall or during periods of drought.
19. The pest does not qualify as a quarantine pest for the PRA area and the assessment for this pest can stop.		

Section 2B: Pest Risk Assessment - Probability of introduction/spread and of potential economic consequences

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
		Note: If the most important pathway is intentional import, do not consider entry, but go directly to establishment. Spread from the intended habitat to the unintended habitat, which is an important judgement for intentionally imported organisms, is covered by questions 1.33 and 1.35.
1.1. Consider all relevant pathways and list them		The relevant potential pathways are: • Plants for planting of woody hosts of *D. pini* These will be principally in the genus *Pinus* and are linked mainly to presence of over-wintering larvae that can be present in the soil from October to April. They are, therefore, likely to be present during the dormant period of the host plant which is the most likely period for trade and international movement of plants for planting. Egg, larval and pupal cocoon stages on plant needles, shoots and living bark between April to October could also allow the moth to survive and move along this pathway. Any non-host plants for planting could also be a potential pathway, as larvae may over-winter in any soil. This could be especially true where nurseries are in forested settings with infested pine trees in the vicinity. • Cut branches of host plants of *D. pini* Eggs are laid on needles of host trees, larvae and pupal cocoons are on needles and in branches in the canopy. This could represent a possible pathway, but it is thought that trade in this commodity is unlikely. • Roundwood of pine with bark present Depending on the time of year, there could be eggs or pupal cocoons present on the bark of cut stems of pine. Trade is prohibited with all pine timber entering the UK, other than from another EU Protected Zone, being either bark free or treated to comply with requirements against several species of *Ips* bark beetles (Curculionidae: Scolytinae). None of the countries where *D. pini* is known to occur are Protected Zones.

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
		• Isolated/ separated bark of conifers Eggs could be associated with this pathway and, after hatching, could successfully find their way to a host tree. This is considered to be an unlikely pathway, since isolated bark of conifers is also subject to EU Protected Zone requirements to ensure freedom from bark beetles. • Contamination of machinery or contaminated soil on machinery Branches with eggs or pupal cocoons may get stuck in machinery or soil transported on machinery working in infested areas and coming back to UK. • Natural spread The adult male is a strong flier and is known to be able to fly from Europe to the south coast of the UK. However, the female is not such a strong flier and is unlikely to be able to migrate directly to the PRA area. There are no previous records of migration into the outbreak area near Inverness. • Overlooked resident It is possible that the species may be an overlooked resident as it occurs in a very under-recorded part of Scotland in relation to moth survey and monitoring by entomologists. This is thought to be unlikely due to its very limited distribution in the area it has been found breeding in when compared to the wide distribution of the host tree. Many contiguous Scots pine hosts are growing under similar climatic conditions and appear not yet to be colonised by *D.pini*. In addition, initial DNA analysis reveals a lower genetic diversity when compared to a small number of German specimens.
1.2. Estimate the number of relevant pathways, of different commodities, from different origins, to different end uses.	Few	Mainly relating to the genus *Pinus* moving along the plants for planting route.
1.3. Select from the relevant pathways, using expert judgement, those which appear most important. If these pathways involve different origins and end uses, it is sufficient to consider only the realistic		

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
worst-case pathways. The following group of questions on pathways is then considered for each relevant pathway in turn, as appropriate, starting with the most important.		
Pathway n°: 1 **This pathway analysis should be conducted for all relevant pathways**		Plants for planting of host-plants
1.4. How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	Likely	Plants for planting in a nursery or other site of production in an area where the pest is present could be a source for egg, larval or pupal stages of the moth.
1.5. How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	Moderately likely	Larvae would not be easy to detect in soil during the plant dormant period and could be present at moderately high concentration, especially in outbreak years. During the growing season of the plants, larvae and pupae could be present on bark and foliage.
1.6. How large is the volume of the movement along the pathway?	Moderate	There is increasing movement of plants for planting of a wide range of plant genera throughout the EU and from the rest of the EU to the PRA area. Provisional estimates are that up to 50 million plants enter the UK annually.
1.7. How frequent is the movement along the pathway?	Often	There is an increasing volume and frequency of movement (see 1.6).
1.8. How likely is the pest to survive during transport/storage?	Very likely	Survival of over wintering larvae in soil associated with plants for planting is likely to be high. Survival of eggs and pupae during the growing season of the plant is also likely to be good and of larvae also relatively high.
1.9. How likely is the pest to multiply/increase in prevalence during transport /storage?	Very unlikely	The only likelihood of increase is if adults emerge during transit, mate and lay eggs. This is considered to be very unlikely.

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
1.10. How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	**Very likely**	If plants for planting, complete with soil, are imported there is low likelihood of detecting over-wintering larval stages in the soil. Eggs, larvae or pupae on the trunk and foliage would be more easily detected, particularly in the final instar larval stages, which are large and distinctive. However, the earlier instar larvae are small and therefore not readily detectable.
1.11. In the case of a commodity pathway, how widely is the commodity to be distributed throughout the PRA area?	Widely	It is assumed that plants for planting would be distributed anywhere within the PRA area.
1.12. In the case of a commodity pathway, do consignments arrive at a suitable time of year for pest establishment?	Yes	Most plants for planting are shipped during the dormant season of the plant. This is linked to the over-wintering larval stage of the pests. In this case the larvae will emerge when the trees commence growing in the spring. If plants are shipped during the growing season, depending on the time of year of shipment, *D. pini* present may continue to develop through the egg, larval, pupal and adult stages.
1.13. How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	Very likely	Since the principal pathway is plants for planting, larvae hatching from eggs or emerging from the soil will be able to feed immediately on both the original plant and on other suitable host plants in the vicinity. Larvae or pupae already present could complete development and emerge as adults, which could fly to local pine and conifer hosts.
1.14. In the case of a commodity pathway, how likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	Very likely	Planting is the intended use and it is very likely to aid transfer.
1.15. Do other pathways need to be considered?	Yes	Contaminated machinery or transport: see section 3.10

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
Conclusion on the probability of entry. Risks presented by different pathways.		
1.16. Estimate the number of host plant species or suitable habitats in the PRA area (see question 6).		
1.17. How widespread are the host plants or suitable habitats in the PRA area? (specify)	Very widely distributed	Widespread throughout the PRA area especially in non-urban locations throughout Scotland and much of the rest of the UK.
1.18. If an alternate host or another species is needed to complete the life cycle or for a critical stage of the life cycle such as transmission (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or spread (e.g. seed dispersers), how likely is the pest to come in contact with such species?	Not relevant	
1.19. How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the current area of distribution?	Similar	The climatic conditions in the UK are similar to parts of the continent where the species occurs. However, in Poland, Germany and Russia where *D. pini* is known to outbreak most frequently climatic conditions are more extreme. However, climate change may produce conditions thought to cause this pest species to outbreak in the very near future (perhaps as early as 2020).
1.20. How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the current area of distribution?		There are no known other abiotic factors that would affect establishment of the pest.
1.21. If protected cultivation is important in the PRA area, how often has the pest been recorded on crops in protected cultivation elsewhere?	Not relevant	

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
1.22. How likely is it that establishment will occur despite competition from existing species in the PRA area?	Very likely	There are other defoliators on pine in the UK that could affect food availability for young larvae of pine-tree lappet moth. Many of these such as pine beauty moth are also present in Europe and do not prevent outbreaks there (Sukovata, 2003). Consequently, it is unlikely that this would affect establishment in the UK unless there was complete coincidence of life cycle and direct competition for limited food resources on the same plant very early in the establishment phase.
1.23. How likely is it that establishment will occur despite natural enemies already present in the PRA area?	Very likely	Generalist natural enemies could have some impact on pest population build up, but this is not likely during the establishment phase. The species has many natural enemies including bats, several species of birds, entomogenous fungi and parasitic flies and wasps. In diverse woodlands these may prevent *D .pini* populations from building up to pest levels but this is probably less likely in forestry plantations.
1.24. To what extent is the managed environment in the PRA area favourable for establishment?	Highly favourable	The linkage to plants for forestry planting as the main pathway means that the insect will be in close proximity to other food resources in a forestry environment.
1.25. How likely is it that existing pest management practice will fail to prevent establishment of the pest?	Very likely	Although there is an element of post-planting care of the host trees, this may miss the inherently low populations of the moth during an early establishment phase. Population growth during the endemic phase may be slow but this is likely to lead to highly apparent tree-damaging populations in the epidemic phase. This type of population dynamic cycle is typical for this insect in its natural range. Although there have been insecticide applications against pine beauty moth and pine looper moth in Scotland in the past, these were done only when populations exceeded levels leading to heavy defoliation or tree mortality. There is, therefore, no routine pest management practice that would prevent establishment of *D. pini*.
1.26. Based on its biological characteristics, how likely is it that the pest could survive eradication programmes in the PRA area?	Likely	Pine-tree lappet moth is difficult to spot during the early establishment phase. If populations can be located, then application of insecticides to the young larvae in autumn and older larvae in spring/ early summer, could result in eradication. Even though it would be possible to apply insecticides twice to one generation of the lifecycle, it is not likely to be possible to eradicate it in one generation and would be dependent on location and size of all incipient populations.

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
1.27. How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment?	Moderately likely	This pest's development is probably spread over two seasons. This should make it possible to hit the late instar larvae of one generation and the early instar larvae of the next generation in the same year. However, it will be difficult to locate any low density populations in the environment which could mean they build up in many separate locations. Fortunately, the female stage does not fly long distances but, nevertheless, local dispersal could result in many foci of infestation and these would all be liable to result in viable populations due to their high reproductive rates.
1.28 How likely are relatively small populations to become established?	Highly likely	It is apparent from its lifecycle in mainland Eurasia that small local populations of the moth are viable and that genetic diversity is, therefore, not likely to be a restriction on establishment.
1.29. How adaptable is the pest?	High	The pest and its genus are very widespread throughout Europe and Asia and frequently cause severe defoliation. However, damaging outbreaks of *D. pini* are often cyclic and probably occur due to predator/prey interactions and their interaction with suitable climatic conditions. Outbreaks are only common in a small part of *D. pini*'s range but climate change will undoubtedly play a part in altering the temporal and spatial distribution of these outbreaks in the future.
1.30. How often has the pest been introduced into new areas outside its original area of distribution? (specify the instances, if possible)	Very infrequently	The male moth has been captured very infrequently in the PRA area but is previously believed to have been a migrant rather than introduced. A single larval specimen was introduced and reported on an imported pine tree from Italy and was bred through to a female moth in Essex in 1999. There are no records in Europe of establishment of pest populations remote from the known distribution range of the moth.

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
1.31. If establishment of the pest is very unlikely, how likely are transient populations to occur in the PRA area through natural migration or entry through man's activities (including intentional release into the environment) ?	Unlikely	It is unlikely, but possible at low probability, that gravid female moths could fly or be blown from continental Europe after depositing the majority, but not all, of their eggs. However, this is felt to be insignificant and certainly not demonstrated compared with the plants for planting pathway. Until recently only very infrequent male migrant moths (c 6 specimens) have been collected in light traps on the south coast of England (in c. 60 years). None had been reported from Scotland until 2004 and now a total of 111 male moths have been captured up to 2009 (1 in 2004, 2 in 2007 10 in 2008 and 98 in 2009) and these have now been shown to be from a resident population rather than migrants. Human assisted movement into the PRA area through the identified pathways is the most likely route of entry and establishment although the species may be an overlooked resident (see section 1.1).
Conclusion on the probability of establishment		The pest has established in a restricted part of the PRA area and surveys during 2009 have confirmed this to be the case. Climatic conditions in the PRA region are suitable and host plants are widely distributed.
1.32. How likely is the pest to spread rapidly in the PRA area by natural means?	Likely	The moth could spread rapidly through a combination of suitable climate and the wide distribution of host trees in the genus Pin*us*. The related *D. sibiricus* is believed to be expanding its range westward in Europe with estimates ranging from 12km per year to between 40-50km per year (EPPO PRA 00-8481). However, the rainfall in many parts of Scotland may be too high currently and thus restrict the initial, and possibly the future, establishment and distribution of the species.
1.33. How likely is the pest to spread rapidly in the PRA area by human assistance?	Very likely	Plants for planting are moved both nationally and internationally which, combined particularly with the cryptic nature of the egg and over-wintering larval stage, could result in rapid movement of the pest within the PRA area.
1.34. Based on biological characteristics, how likely is it that the pest will not be contained within the PRA area?	Very likely	If the pest is not contained by local climatic conditions then the likelihood of containing the pest within the currently identified infested area depends on whether the extent of the infestations can be identified quickly in order to attempt eradication in the near future. If it is felt that the infested areas are limited, then consideration would need to given to phytosanitary containment measures to prevent further spread. It is important to stop the pest before it establishes or spreads in areas of native Caledonian pine.

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
Conclusion on the probability of spread		The probability of spread is high if it is not possible to eradicate or severely contain the moth near to its initial foci. However, there is a very small possibility that the species may be an overlooked resident restricted by local climatic conditions and unlikely to spread, at least in the near future, due to the high rainfall outside the current breeding area.
Conclusion on the probability of introduction and spread **The overall probability of introduction and spread should be described. The probability of introduction and spread may be expressed by comparison with PRAs on other pests.**		The overall probability of further introductions is likely and spread after introduction is highly likely.
Conclusion regarding endangered areas **1.35. Based on the answers to questions 1.16 to 1.34 identify the part of the PRA area where presence of host plants or suitable habitats and ecological factors favour the establishment and spread of the pest to define the endangered area.**		The pest is reported as feeding on *Pinus sylvestris* but is highly likely to be able to feed and reproduce on many species of *Pinus* as it also feeds on a number of trees in other genera. The former genus is widespread in the PRA area, both in urban and rural environments. Although formal climate matching has not been carried out, the presence of very large populations of the moth across most of Europe especially in Poland, Germany and Lithuania indicates that it is unlikely to be climatically limited in the UK. Indeed, many of the reported serious outbreaks appear to occur in for example, N and NE Germany and N and NW Poland that have a very similar climate to the UK (Klimetzek, 1971; Wulf and Schumacher, 2008; Habermann *et al*. 2006; Anon, 2000; Patek *et al*. 2005; Adomas, 2003). Outbreaks have also been reported in Norway from 1900-03 (Hopkins, 1907) and Ukraine (Meshkova, 2003). However, these outbreaks only occur after extremely hot and dry summers as the moth is thought to favour a continental to an oceanic climate despite outbreaks occasionally occurring in the latter.
2. In any case, providing replies for all hosts (or all habitats) and all situations may be laborious, and it is desirable to focus the assessment as much as possible. The study of a single worst-case may be sufficient. Alternatively, it may be appropriate to consider all hosts/habitats		Pine as both a timber tree and as an important ecological tree species, is the main host considered in relation to economic and other consequences.

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
together in answering the questions once. Only in certain circumstances will it be necessary to answer the questions separately for specific hosts/habitats.		
2.1. How great a negative effect does the pest have on crop yield and/or quality to cultivated plants or on control costs within its current area of distribution?		The impacts of the moth in its range in Europe where it is a pest are through loss of growth increment as a result of severe or complete defoliation of host trees. Severe defoliation can also lead to the weakening of the trees allowing attacks by other organisms.
2.2. How great a negative effect is the pest likely to have on crop yield and/or quality in the PRA area without any control measures?	Major/Moderate	Similar tree damage could occur in the PRA area, where pine trees are a major component of forests and woodlands and of high economic, social and environmental value. Other biotic agents, such as pine sawfly (*Neodiprion sertifer*), pine beauty moth (*Panolis flammea*) and pine looper moth (*Bupalus piniaria*), cause defoliation of pine species in the PRA and could combine with *D. pini* to increase tree damage and possible mortality.
2.3. How easily can the pest be controlled in the PRA area without phytosanitary measures?	Difficult	It would be difficult and expensive to control the pest especially after the initial establishment phase. Although aerial application of insecticides has been carried out in the PRA area against other damaging moth species, there are strong environmental reasons to avoid such processes unless they are essential.
2.4. How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area?	Moderate	Increased surveillance in relation to protection of the pine forests and woodlands in the UK is likely to increase costs of management of forest protection measures. There is also the possibility that other countries, notably Ireland, would require phytosanitary measures to avoid possible importation of the pest, thus adding to costs of exportation of wood from the PRA area.
2.5. How great a reduction in consumer demand is the pest likely to cause in the PRA area?	Moderate	There will be some loss of production of pine and weakening of the trees following attacks that may be exacerbated by bark beetles, particularly *Tomicus piniperda*, killing weakened trees. The areas of forest that are colonised by *D. pini* may be devalued as a result of the known potential of this moth to reduce timber revenue. This may have considerable economic consequences.

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
2.6. How important is environmental damage caused by the pest within its current area of distribution?	Moderate	As a periodic pest of Scots pine there are some outbreak periods (sometimes over a number of years) when severe defoliation makes it necessary to control the moth using insecticides (Sierpinska 1998; Adomas, 2003; Gowacka et al. 2000; Moeller *et al*. 1998; Valent Biosciences Corporation).
2.7. How important is the environmental damage likely to be in the PRA area (see note for question 2.6)?	Major/Moderate	*Dendrolimus pini* could cause considerable damage and loss of vigour to pine trees in the ancient Caledonian Pine Forests of Scotland as well as to pine of economic, amenity and social value across the UK as a whole.
2.8. How important is social damage caused by the pest within its current area of distribution?	Major/Moderate	The interaction of people and trees is in increasingly important element in determining the potential of social damage arising from biotic, abiotic or anthropogenic influences (Cheng, Kruger & Daniels 2003). The various episodes of defoliation from *D.pini* and other defoliating species of pine have received considerable attention in Europe, leading to frequent applications of pesticides to protect the trees.
2.9. How important is the social damage likely to be in the PRA area?	Major/Moderate	Defoliation of trees is a significant social issue when they are valued highly as part of the landscape, as is the case for the ancient Caledonian Pine Forests of Scotland.
2.10. How likely is the presence of the pest in the PRA area to cause losses in export markets?	Unlikely	Since the pest is already widespread in Europe, which would represent the main market for any plants for planting originating in the UK, the effects on export markets would be small. However, as indicated in 2.4, trade with Ireland could be affected since the moth is not present in that country.
As noted in the introduction to section 2, the evaluation of the following questions may not be necessary if the responses to question 2.2 is "major" or "massive" and the answer to 2.3 is "with much difficulty" or "impossible" or any of the responses to questions 2.4, 2.5, 2.7, 2.9 and 2.10 is "major" or "massive" or "very likely" or "certain". You may go directly to point 2.16 unless a detailed study of impacts is required or the answers given to these		

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
questions have a high level of uncertainty.		
2.11. How likely is it that natural enemies, already present in the PRA area, will not reduce populations of the pest below the economic threshold?		
2.12. How likely are control measures to disrupt existing biological or integrated systems for control of other pests or to have negative effects on the environment?		
2.13. How important would other costs resulting from introduction be?		
2.14. How likely is it that genetic traits can be carried to other species, modifying their genetic nature and making them more serious plant pests?		

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
2.15. How likely is the pest to cause a significant increase in the economic impact of other pests by acting as a vector or host for these pests?		
2.16. Referring back to the conclusion on endangered area (1.35), identify the parts of the PRA area where the pest can establish and which are economically most at risk.		The economic and social impacts are likely to be most significant in Scotland but important throughout the UK, being periodically high, depending on the cyclic nature of the defoliation episodes, as observed in continental Europe.
Degree of uncertainty **Estimation of the probability of introduction of a pest and of its economic consequences involves many uncertainties. In particular, this estimation is an extrapolation from the situation where the pest occurs to the hypothetical situation in the PRA area. It is important to document the areas of uncertainty (including identifying and prioritizing of additional data to be collected and research to be conducted) and the degree of uncertainty in the assessment, and to indicate where expert judgement has been used. This is necessary for transparency and may also be useful for identifying and prioritizing research needs.** **It should be noted that the assessment of the probability and consequences of environmental hazards of pests of uncultivated plants often involves greater**		

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
uncertainty than for pests of cultivated plants. This is due to the lack of information, additional complexity associated with ecosystems, and variability associated with pests, hosts or habitats.		
Evaluate the probability of entry and indicate the elements which make entry most likely or those that make it least likely. Identify the pathways in order of risk and compare their importance in practice.		Probability of entry is high • Plants for planting of woody host plants *D. pini* is a high risk pathway • Contamination of machinery or contaminated soil on machinery The probability of entry is considered high because there is active trade in the plants for planting pathway. Contamination of machinery is considered a medium level risk pathway.
Evaluate the probability of establishment, and indicate the elements which make establishment most likely or those that make it least likely. Specify which part of the PRA area presents the greatest risk of establishment.		Probability of establishment is high for parts of Britain.
List the most important potential economic impacts, and estimate how likely they are to arise in the PRA area. Specify which part of the PRA area is economically most at risk.		The economic impact is considered medium. The main impact is on wood yield and quality, especially due to the weakening of the tree (direct loss of growth increment) and consequent interaction with secondary pests such as bark beetles. There could also be an impact on, for example, tourism in areas such as the Highlands of Scotland that have significant and important pine components.

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
The risk assessor should give an overall conclusion on the pest risk assessment and an opinion as to whether the pest or pathway assessed is an appropriate candidate for stage 3 of the PRA: the selection of risk management options, and an estimation of the associated pest risk.		The pest poses a potential threat to pine trees in both forest and woodland situations as well as in the urban environment. Consequently, it represents a potential phytosanitary threat that, alone, would indicate the need for appropriate action to attempt eradication or longer-term management of the pest now it has been found in the PRA area.

This is the end of the Pest risk assessment	

Stage 3: Pest risk Management

Question	Y/N	Explanatory text
3.1. Is the risk identified in the Pest Risk Assessment stage for all pest/pathway combinations an acceptable risk?	No	
Pathway 1		
3.2. Is the pathway that is being considered a commodity of plants and plant products? **If yes, go to 3.11,** **If no, go to 3.3**	Yes	
3.3. Is the pathway that is being considered the natural spread of the pest? (see answer to question 1.32) **If yes, go to 3.4,** **If no, go to 3.9**	No	
3.4. Is the pest already entering the PRA area by natural spread or likely to enter in the immediate future? (see answer to question 1.32)	No	Colonisation of a breeding population by natural spread is unlikely as although specimens of the adult male moth have been captured in the PRA area, the adult female moth is a much poorer disperser by flight and considered unlikely to colonise the PRA area naturally.

3.5. Is natural spread the major pathway? **If yes, go to 3.29,** **If no, go to 3.6**	No	
3.6. Could entry by natural spread be reduced or eliminated by control measures applied in the area of origin? **If yes, possible measures: control measures in the area of origin, go to 3.7**	No	
3.7. Could the pest be effectively contained or eradicated after entry? (see answer to question 1.26, 1.34) **If yes, possible measures: internal containment and/or eradication campaign, Go to 3.8**	Possibly	Containment is likely to be extremely difficult but eradication may be possible during the initial establishment phase.
3.8. Was the answer "yes" to either question 3.6 or question 3.7? **If yes, go to 3.38,** **If no, go to 3.44**		
3.9. Is the pathway that is being considered the entry with human travellers? **If yes, possible measures: inspection of human travellers, their luggage, publicity to enhance public awareness on pest risks, fines or incentives. Treatments may also be possible, Go to 3.29** **If no, go to 3.10**	No	

3.10. Is the pathway being considered contaminated machinery or means of transport? **If yes, possible measures: cleaning or disinfection of machinery/vehicles**	Yes	Used forestry machinery coming from countries where *D. pini* is present should be free of soil and plant debris which could harbour the pest in its egg, larval or pupal cocoon stages.
3.11. If the pest is a plant, is it the commodity itself? **If yes, go to 3.29,** **If no (the pest is not a plant or the pest is a plant but is not the commodity itself), go to 3.12**		
3.12. Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest? **if appropriate, list the measures and identify their efficacy against the pest of concern, Go to 3.13**	No	The pine-tree lappet moth is not a regulated pest within the EU and, therefore, there are no existing phytosanitary measures against this or any similar pests that would prevent introduction.
3.13. Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import? **If yes, possible measure: visual inspection, go to 3.14**	No	Visual examination of plants for planting for the presence of larvae and pupal cocoons during the growing season should reveal the presence of infestation. However, eggs would be more difficult to see and potentially missed. Any indication of infestation in the immediate vicinity of the place of production would also serve to warn of possible contamination. During the dormant season the presence of larvae would be impossible to detect visually. Consequently the periods during egg production and larval dormancy would make it difficult to detect infestation visually on plants for planting.
3.14. Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)? **If yes, possible measure: specified testing, go to 3.15**	No	
3.15. Can the pest be reliably detected during post-entry quarantine? **If yes, possible measure: import under special licence/permit and post-entry quarantine, go to 3.16**	Yes	Post entry quarantine would have to be of variable duration depending on time of importation. Importation during the period October to April would need to ensure that no plants for planting were released prior to spring activity of larvae commencing (late April) and importation in period May to September should be quarantined during the period *D. pini* is in the egg stage (July-August).

3.16. Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)? **If yes, possible measure: specified treatment, go to 3.17**	No	Insecticides could be applied to the foliage of the plant at selected times during the main activity periods, avoiding periods when eggs and pupal cocoons might be present. This would effectively control the larvae. However, it is unlikely that such insecticide applications would completely eradicate larvae over-wintering in the soil.
3.17. Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment? (This question is not relevant for pest plants) **If yes, possible measure: removal of parts of plants from the consignment, go to 3.18**	No	Eggs, larvae and pupal cocoons can occur on almost any part of the plant and so it would not be possible to remove plant parts and prevent importation.
3.18. Can infestation of the consignment be reliably prevented by handling and packing methods? **If yes, possible measure: specific handling/packing methods, go to 3.19**	No	Live plants, other than those originating in Belarus, Moldova, Russia, Turkey, Ukraine, or any country outside Europe other than Egypt, Israel, Libya, Morocco or Tunisia (countries from where the import of soil and growing medium is prohibited) are normally moved with root balls and soil, although in the dormant season bare-rooted, chilled plants could be moved. The latter route would reduce risks considerably if movement was restricted to the dormant season. There is no measure related to handling and packing methods that could be used for plants with soil.
3.19. Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice? **If yes, possible measure: import under special licence/permit and specified restrictions, go to 3.20**	No	Not for this pathway

3.20. Can infestation of the commodity be reliably prevented by treatment of the crop? **If yes, possible measure: specified treatment and/or period of treatment, go to 3.21**	Yes	Insecticide treatment of the plants at the time of adult flight could act as a preventative measure. However, there are no data to support this approach and it would require verification. Routine application of a contact or systemic insecticide to trees could also be an option but, again, this would need to be tested and would not be a measure of choice because of the difficulty of ensuring adequate coverage and efficacy. The location of place of plant production would also be need to be separated from natural pine forest/woodland to ensure no larvae were able to gain access to the planting medium for over-wintering.
3.21. Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants) **If yes, possible measure: consignment should be composed of specified cultivars, go to 3.22**	No	There is no current evidence to suggest that there might be any value in favouring certain cultivars, as *D .pini* exhibits a limited degree of polyphagy, feeding on a number of different tree genera.
3.22. Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)? **If yes, possible measure: specified growing conditions, go to 3.23**	Yes	Protected indoor greenhouse conditions throughout the production cycle with a sterilised growing medium may be sufficient to ensure that the chances of infestation are kept to a minimum.
3.23. Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages? **If yes, possible measure: specified age of plant, growth stage or time of year of harvest, go to 3.24**	No	Plants for planting could have live stages of the moth at any time of the year. The nature of trade in this pathway tends to favour the dormant season when the larval stage is present in the soil and hence this is also the time when it is most difficult to spot the moth.
3.24. Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)? **If yes, possible measure: certification scheme, go to 3.25**	Yes	It is conceivable that a rigorous regime of inspection in both the vicinity (to detect moth populations on standing trees) and, especially, in the place of production could allow a clean plant regime to be developed. It would also be important to ensure a sterilised growing medium as part of this certification process.

3.25. Is the pest of very low capacity for natural spread? **If yes, possible measures: pest freedom of the crop, or pest-free place of production or pest-free area, Go to 3.28** **If no, go to 3.26**	No	
3.26. Is the pest of low to medium capacity for natural spread? **If yes, possible measures: pest-free place of production or pest free area, Go to 3.28** **If no, go to 3.27**	Yes	Females of the moth are not regarded as strong fliers and thus pest-free areas or place of production and a defined immediate vicinity options may be appropriate.
3.27. The pest is of medium to high capacity for natural spread **Possible measure: pest-free area, go to 3.28**	No	
3.28. Can pest freedom of the crop, place of production or an area be reliably guaranteed? **If no, possible measure identified in questions 3.25-3.27 would not be suitable, go to 3.29**	No	The ability of the females to fly a low number of kilometres, which constitutes a low to medium capacity for natural spread, would still make it difficult to guarantee that an outdoor place of production or area would be free of the pest. The degree of rigour of inspection of the crop plants for export combined with knowledge of the population growth stages of the pest in the immediate vicinity (up to 1 km) should allow targeted inspections which would be related to known cycles of the pest. Clearly, the risk of infestation of nursery stock increases with the size of the moth population in local forests and woodlands. Consequently, a combination of survey techniques (pheromone traps, light traps, visual surveys) would be necessary, in and around a nursery, to give confidence that the inspection regime had not missed infestations of plants designated for export to the PRA area.

3.29. Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts? **If yes, possible measures: internal surveillance and/or eradication campaign, go to 3.30**	Yes	Surveillance and eradication is a possibility, but cannot be guaranteed. It would require detection of pioneer populations of the moth, a delimiting survey and localised eradication action, particularly application of suitable insecticides to eliminate larval populations. This would require early concerted action and be demanding of resources.
3.30. Have any measures been identified during the present analysis that will reduce the risk of introduction of the pest? List them. **If yes, go to 3.31** **If no, go to 3.38**	Yes	Production of plants indoors in sterile growing conditions or ensuring nursery inspection of plants for export in relation to insect lifecycle combined with a rigorous monitoring regime for the area surrounding the place of production and sterile growth medium.
3.31. Does each of the individual measures identified reduce the risk to an acceptable level? **If yes, go to 3.34** **If no, go to 3.32**	Yes	Production of plants indoors in sterile growing conditions.
3.32. For those measures that do not reduce the risk to an acceptable level, can two or more measures be combined to reduce the risk to an acceptable level? **If yes, go to 3.34** **If no, go to 3.33**		
3.33. If the only measures available reduce the risk but not down to an acceptable level, such measures may still be applied, as they may at least delay the introduction or spread of the pest. In this case, a combination of phytosanitary measures at or before export and internal measures (see question 3.29) should be considered. **Go to 3.34**		

3.34. Estimate to what extent the measures (or combination of measures) being considered interfere with trade. **Go to 3.35**	High	These measures are likely to interfere with international trade. All measures of growing under controlled conditions and monitoring of environment around the production area would be likely to have a significant effect on production costs. Plants could be re-potted in sterile media prior to despatch in the plants' dormant season.
3.35. Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences. **Go to 3.36**	Low	The measures are generally considered to be high cost and there has been no formal cost-benefit analysis. However, the fact that infestations of pine looper moth (a native moth with impacts on tree growth and increased vulnerability to other pests) have been treated with aerially applied insecticides in the past, indicates that moths with similar damage characteristics would also justify action. This would especially be the case following early detection when the likelihood of eradication is still high.
3.36. Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences? **If yes, For pathway-initiated analysis, go to 3.39** **For pest-initiated analysis, go to 3.38** **If no, go to 3.37**	No	
3.37. Envisage prohibiting the pathway **For pathway-initiated analysis, go to 3.43 (or 3.39),** **For pest-initiated analysis go to 3.38**		
3.38. Have all major pathways been analyzed (for a pest-initiated analysis)? **If yes, go to 3.41,** **If no, Go to 3.1 to analyze the next major pathway**	Yes	

3.39. Have all the pests been analyzed (for a pathway-initiated analysis)? **If yes, go to 3.40,** **If no, go to 3.1 (to analyze next pest)**		
3.40. For a pathway-initiated analysis, compare the measures appropriate for all the pests identified for the pathway that would qualify as quarantine pests, and select only those that provide phytosanitary security against all the pests. **Go to 3.41**		
3.41. Consider the relative importance of the pathways identified in the conclusion to the entry section of the pest risk assessment **Go to 3.42**		
3.42. All the measures or combination of measures identified as being appropriate for each pathway or for the commodity can be considered for inclusion in phytosanitary regulations in order to offer a choice of different measures to trading partners. **Go to 3.43**		

3.43. In addition to the measure(s) selected to be applied by the exporting country, a phytosanitary certificate (PC) may be required for certain commodities. The PC is an attestation by the exporting country that the requirements of the importing country have been fulfilled. In certain circumstances, an additional declaration on the PC may be needed (see EPPO Standard PM 1/1(2): Use of phytosanitary certificates) **Go to 3.44**		
3.44. If there are no measures that reduce the risk for a pathway, or if the only effective measures unduly interfere with international trade (e.g. prohibition), are not cost-effective or have undesirable social or environmental consequences, the conclusion of the pest risk management stage may be that introduction cannot be prevented. In the case of pest with a high natural spread capacity, regional communication and collaboration is important.		
Conclusion of Pest Risk Management. **Summarize the conclusions of the Pest Risk Management stage. List all potential management options and indicate their effectiveness. Uncertainties should be identified.**		Pest Risk Management for *Dendrolimus pini* depends very much on early detection of small populations of the moth. In the context of the current PRA, the aim is to detect and eradicate or at the very least monitor and control what appears to be a pioneer population of the moth and this is feasible as it still appears to be localised at the present time. Measures to reduce further incursions have also been identified and these are based principally on managing the plants for planting pathway through place of production freedom and rigorous inspection, potentially linked to specific post-landing quarantine procedures. These approaches should be effective in eliminating or controlling the infestation already present in the PRA area and in minimising the likelihood of further introductions. The level of uncertainty is dependent on the quality of survey and inspection and, provided these are rigorous, there should be high likelihood of successful application of the measures.

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