Department
for Environment
Food & Rural Affairs

Rapid Pest Risk Analysis (PRA) for: *Tetropium fuscum*

January 2017

Summary and conclusions of the rapid PRA

This rapid PRA shows that *T. fuscum* prefers to attack already stressed *Picea* (spruce) trees, but in Canada and to a limited extent in Europe, infestation has led to the death of trees that may otherwise have recovered. This pest had few previous records in Great Britain and recent surveillance has revealed several sites in Scotland where there are breeding populations. The likelihood is that the pest is more widely established in Great Britain than is currently known.

Risk of entry

Entry is considered likely on timber imported from the EU, and moderately likely on wood packaging material. Entry via cut Christmas trees or natural spread is considered very unlikely.

Risk of establishment

Tetropium fuscum is already present in Great Britain and established in parts of Scotland, and establishment across the whole of the UK is very likely as climate is suitable and hosts are abundant.

Economic, environmental and social impact

It is generally a secondary pest in Europe; *T. fuscum* appears to be more aggressive in Canada, though still preferentially attacks already stressed pines. Attacks on fully healthy North American species are possible, but with a greatly reduced survival rate for the pest. All findings in Great Britain to date have been in association with cut timber/logs or in one case a tree already in a state of serious decline.

It is likely that this wood-boring pest would accelerate the degradation of fallen conifer timber in situations where it is left for more than one year before processing. Associated blue stain fungi may reduce wood marketability and for some fungal species hasten the death of the tree. Economic impacts are rated as small based on current evidence, with low confidence to acknowledge these possibilities.

Environmental and social impacts are rated as very small with high confidence.

Endangered area

Plantations of *Picea* and *Pinus* which are damaged or under stress will be more susceptible to attacks that have economic consequences.

Risk management options

Good silviculture practice to reduce the risk of damage and to avoid biotic and abiotic stress of spruce and other conifers will reduce the impacts of *T. fuscum*. Prompt clearance of fallen timber and the avoidance of delays to the processing of harvested material will reduce potential losses to the value of timber.

Key uncertainties and topics that would benefit from further investigation

It is uncertain how widespread *T. fuscum* is in the UK. The pest has also not been recorded to date in Ireland, but may be present at low levels due to difficulties in its detection. *Tetropium fuscum* may have been present in the UK for decades, and there are no recorded impacts in Great Britain to date. Another uncertainty is if this pest may cause cumulative impacts on stands of *P. sitchensis* which are stressed by other factors, such as wind-damage or defoliation by the green spruce aphid, or on stressed stands of pine, such as those suffering defoliation by *Dothistroma* and other needle blights.

Images of the pest

Adult *Tetropium fuscum*. Adults are 8 – 18mm long. Image credit: Steven Valley, Oregon Department of Agriculture, Bugwood.org

Is there a need for a detailed PRA or for a more detailed analysis of particular sections of the PRA? If yes, select the PRA area (UK or EU) and the PRA scheme (UK or EPPO) to be used.

No	✓				
Yes		PRA area: UK or EU		PRA scheme: UK or EPPO	

Given the information assembled within the time scale required, is statutory action considered appropriate / justified?

Tetriopium fuscum is established parts of Scotland, potentially having been present for several decades, and has not been recorded causing any impacts in Great Britain. Based on available evidence statutory action in Great Britain is not appropriate. Survey work has not detected the pest to date in Northern Ireland; further targeted surveys are planned for 2018.

Yes Statutory action		No Statutory action		✓	

Stage 1: Initiation

1. What is the name of the pest?

Tetropium fuscum (Fabricius, 1787) (Coleoptera: Cerambycidae), brown spruce longhorn beetle

2. What initiated this rapid PRA?

In December 2014 a report was published of a finding of *T. fuscum* in the wider environment in the UK – in a wood in South Wiltshire (Wright 2014). This record did not appear to be in association with an imported commodity, indicating possible establishment, though later research indicated a saw mill close to the woodlands. *Tetropium fuscum* was added to the UK Plant Health Risk Register in March 2015 and given a priority for PRA to assess the potential impacts of this species establishing in the UK. A draft PRA was completed in summer 2015 – a key uncertainty identified was the status of the pest in the UK, and it was decided to carry out further surveillance before producing a final version of the PRA. Surveillance was carried out in Scotland in 2015 and 2016 and populations were confirmed as breeding in several locations. The PRA has now been updated accordingly.

3. What is the PRA area?

The PRA area is the United Kingdom of Great Britain and Northern Ireland.

Stage 2: Risk Assessment

4. What is the pest's status in the EC Plant Health Directive (Council Directive 2000/29/EC[1]) and in the lists of EPPO[2]?

The pest is not listed in the EC Plant Health Directive and is not recommended for regulation as a quarantine pest by EPPO, nor is it on the EPPO Alert List.

5. What is the pest's current geographical distribution?

The distribution of *T. fuscum* is summarised in Table 1. The native range of *T. fuscum* is described as "widely distributed" in the north, central and south eastern parts of Continental Europe, across Siberia to Japan, but it is present in western Europe excluding Spain and Portugal (Bílý & Mehl 1989). It was first reported in Canada in 2000, but has been present since at least 1990 when previous captures at a park in 1990 were found to have been misidentified as the North America *T. cinnamopterum* (Smith & Hurley 2000). It is now established in central Nova Scotia, and, although there have been findings in traps in New Brunswick, follow up surveys indicate that it does not appear to be established there yet (CFIA 2014).

Table 1: Distribution of *Tetropium fuscum* taken from (CFIA 2014).	
North America:	Canada (Nova Scotia)
Central America:	No records
South America:	No records
Europe:	Austria, Belarus, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Lithuania, Moldova, Montenegro, Netherlands, Norway, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Sweden, Switzerland, Ukraine, United Kingdom
Africa:	No records
Asia:	Japan, Kazakhstan, Turkey
Oceania:	No records

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0029:20100113:EN:PDF

[2] https://www.eppo.int/QUARANTINE/quarantine.htm

6. Is the pest established or transient, or suspected to be established/transient in the UK/PRA Area?

As discussed in section 2, an adult *T. fuscum* was detected in the wider environment in the UK in South Wiltshire (Wright 2014). A second specimen was collected in a trap in the neighbouring county of Hampshire during a Forestry Commission survey in June 2015 (Inward, 2017). The status of the pest in England and Wales remains uncertain. It is possible that *T. fuscum* is only present with low abundance, leading to the possibility that further monitoring may not detect all small populations which may be present.

In June 2015, Defra became aware of further findings of the beetle in Rannoch forest in Scotland – a single adult, still within the pupal chamber, and half a dozen suspect larvae within a *Picea* log (Mendel 2015). Follow up surveys by Forestry Commission Scotland did not detect any further *T. fuscum* specimens, and the log pile where the *T. fuscum* was discovered was destroyed as a precaution (FC Scotland, *pers. comm.* 15.09.2015).

When the Rannoch Forest finding was published in December 2015, it contained a post script by Mendel, who had reviewed specimens from the Hunterian Zoology Museum in Glasgow, one of which proved to be a *T. fuscum* and had been collected in July 1986 'On Fir bark - Roslin, Midlothian'. This finding means that *T. fuscum* has potentially been breeding in the parts of the UK for 30 years or more.

In 2016, a single infested Norway spruce (*Picea abies*) was found near Stirling, Scotland, and the tree was destroyed (FC Scotland, personal communication, 29.6.2016). Two out of three lure traps set up in Spuce woodland within 5km of this finding returned adult beetles of *T. fuscum.* Further surveys in 2016 with billet traps were carried out in 63 plots across Scotland and *T. fuscum* was confirmed from three sites – one east of Stirling and two south east of Inverness – the known distribution in Scotland appears to be from the central belt to north of the Cairngorms, but the species was not commonly detected (FC Scotland, unpublished data). The first results from the 2017 Scottish survey have confirmed one specimen of *T. fuscum* from near Kincardine in southern Fife (N. Mainprize, Forestry Commission, *pers. comm.* 8.12.2017). Processing of samples is ongoing, and it is possible that additional specimens may be detected.

Northern Ireland has not detected *T. fuscum* to date. A forest insect survey in 2017 did not find the pest (S. McIntyre, DAERA, *pers. comm*. 15.01.2018). There are future plans to conduct another survey in 2018, targeted specifically at *T. fuscum*.

There are also very early records of *T. fuscum* in the UK. However, synonyms of *T. gabrieli* (which is established in the UK) include *Tetropium fuscum* sensu auctt. Brit. non (Fabricius, 1787), and as a consequence it cannot be known which species is being referred to in those early publications, but it is most likely to be *T. gabrieli* since references to *T. fuscum* in the UK stop after 1907 when the differences between the two species were published (Crawshay 1907). Although the two species have different host preferences, with *T. fuscum* being largely found on spruce and *T. grabrieli* on larch, they will both occasionally breed in other conifers.

T. fuscum has been intercepted occasionally on imported spruce timber in the UK (Bílý & Mehl 1989), with a record of a beetle emerging from a Norway spruce log imported from Germany in 1974 (Anna Brown, *pers. comm.* 22/09/2015). There was also a finding of a single adult in a pheromone trap in Bonnyrigg, Edinburgh in 1986 – this finding was close to the port of Grangemouth (Anna Brown, *pers. comm.* 22/09/2015) and thus may have entered on commodities from the port rather than representing an established population. These interceptions do demonstrate the pest has had opportunities to enter the UK in the past.

In conclusion, *T. fuscum* is established in parts of Great Britain, with breeding populations confirmed at three locations in Scotland. No records on the island of Ireland could be found. The status of the pest in England and Wales is uncertain, as only two findings in the wider environment, each of single individuals, have been recorded to date. It is very probable the pest is present at low levels and undetected, especially given many of the life stages are cryptic (e.g. inside wood) and adults tend to be most active at night.

7. What are the pest's natural and experimental host plants; of these, which are of economic and/or environmental importance in the UK/PRA area?

Hosts of *T. fuscum* have been listed as listed as: *Abies alba* (silver fir), *Picea abies* (Norway spruce), *Picea glauca* (white spruce), *Picea mariana* (black spruce), *Picea oreintalis* (Oriental spruce), *Picea pungens* (blue spruce) *Picea rubens* (red spruce), *Picea sitchensis* (Sitka spruce), and *Pinus sylvestris* (Scots pine) (Alkan & Eroğlu 2001, Norma *et al.* 2010).

In Poland the preferred hosts are *Picea abies* and *Pinus sylvestris* (Jankowiak & Kolařík 2010) and in Scandinavia species of *Picea* and *Pinus* are listed as the main hosts (Bílý & Mehl 1989). In Canada, only reproduction in *Picea* species has been recorded, with *Picea rubens* being the preferred host (Sweeney & Smith 2002), and the legitimacy of references to attacks on other hosts has been questioned (CFIA 2014). But there are recent records of *Pinus sylvestris* as a host (Korczyński *et al.* 2007), so at least this species in addition to *Picea* appears to be suitable as a reproductive host.

No recent records of *Abies alba* as a host could be found, except a reference to a larva being 'probably from *Abies*' (Švacha & Danilevsky 1986), so there is uncertainty about the suitability of this species as a host. As stated in section 6, a *T. fuscum* was collected from "fir" in Scotland, but this may refer to a species other than *Abies.* Some sources list larch (*Larix*) as a host (Benz & Zuber 1997), and in the laboratory eggs were laid on *L. laricina* (Sweeney & Smith 2002), but the suitability of larch as a host is questionable – in this experiment no adults emerged from the *L. laricina* billets (Jon Sweeney, personal communication, 29/09/2016).

In summary, *Picea* species appear to be strongly preferred as a host by *T. fuscum*, with more limited attacks reported on *P. sylvestris*. Though other conifers have been recorded

as hosts, breeding in these species is rarely reported and they are thus are very likely to be poor hosts for *T. fuscum*, and not endangered by the pest.

Pinus sylvestris is an important native species to the UK, a key constituent of the Caledonian forest. Various *Picea* species are grown for commercial forestry purposes, in particular *P. sitchensis* and *P. abies,* with the latter also grown as a Christmas tree species. Spruce species are also grown as ornamentals.

8. What pathways provide opportunities for the pest to enter and transfer to a suitable host and what is the likelihood of entering the UK/PRA area?

Entry requires adults to emerge from imported commodities and locate new hosts. Adults emerge in the summer and do not apparently feed (Lemay *et al.* 2010). Though natural spread potential is relatively low, as discussed below and in section 11, adults can fly in search of new hosts and on average flights of around 1 km in 24 hours were observed in flight mills (Sweeney *et al.* 2009). Lifespan of adults seems to vary depending on temperature – between 7 and 28 days has been observed in laboratory conditions (Juutinen 1955). Males release a pheromone to attract females (Lemay *et al.* 2010), which will aid individuals in locating each other. These facts have been taken into account when judging the pathways of entry below.

The pest is already established in parts of Scotland, and this section rates the likelihood of further introductions from the range of the pest.

Timber (Non-Squared wood and Squared Wood)

Eggs are laid in the bark, larvae bore into the inner bark and mature larvae may enter the sapwood to a depth of 2 to 4 cm, with pupation occurring in the bark or between the bark and sapwood layer (CFIA 2014). The commodity code for *Picea abies* also includes the doubtful host *Abies alba*. A search of Eurostat for imports to the UK from all EU countries showed that, on average, over the last five years, the UK imported over 14500 tonnes of *P. abies* and *A. alba* timber in the rough (roundwood, whether or not stripped of bark or sapwood) per annum (Eurostat data extracted 29.05.2015). It is not known what proportion is fir compared to the known host of spruce. There is also a significant import of other *Picea* and *Pinus* timbers, with *Pinus* at least occasionally acting as a host for *T. fuscum*. In addition hosts may enter the UK as coniferous firewood.

If timber (including firewood) originates from an area where *Ips duplicatus, I. typographus* or *I. amitinus* is known to occur (bark beetles with a wide distribution in Europe and for which the whole of the UK has Protected Zone status) then it must either be stripped of bark, come from a pest free area or have been subjected to kiln drying. These bark beetles all show a preference for spruce, the main host of *T. fuscum*. Northern Ireland has additional protected zones for *I. cembrae, I. sexdentatus* and *Dendroctonus micans* and any conifer wood entering Northern Ireland from areas where these pests are present will

also need to have been stripped of bark or kiln dried. Stripping of bark will reduce the number of viable life stages of *T. fuscum* associated with the wood. However, Juutinen, 1955 cautioned that in winter larvae will have bored into the wood and debarking alone will not be successful at preventing pupation. Kiln drying has been shown to be an effective treatment for *T. fuscum* in Canada (Mushrow *et al.* 2004).

Tetropium fuscum has been previously detected in the UK in association with imported timber. Where timber is stored or seasoned outside during summer months, it provides an opportunity for the beetles to emerge and transfer to suitable hosts. However, much of the host timber (including firewood) from Europe will be subject to phytosanitary treatments (stripped of bark or heat treated) to meet PZ requirements for *Ips* species, and these measures may be partially effective against *T. fuscum.* Entry on timber is rated as likely with medium confidence. It is uncertain how much of the host timber that is imported into the UK has been treated in a manner that reduces risk from *T. fuscum* such as by kiln drying, in comparison to being sourced from pest free areas for *Ips* species and thus untreated, but where *T. fuscum* may still be present and could become associated with the commodity.

Timber	Very unlikely	☐	Unlikely	☐	Moderately likely	☐	Likely	☑	Very likely	☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐				

Isolated Bark and Woodchips

Isolated bark and woodchips may harbour eggs, larvae and pupae and act as a pathway of entry. The UK does import coniferous woodchips from the EU and beyond but it is not known what proportion of these is made from *T. fuscum* host species. If these woodchips originate from an area where *Ips duplicatus, I. typographus* or *I. amitinus* is known to occur (bark beetles with a wide distribution in Europe and for which the UK has Protected Zone status), then the woodchips will either have to be produced from bark-free round wood (though larvae may still be present) or have undergone kiln drying, which would also act to reduce the risk of *T. fuscum* association.

Studies on wood chipping in Canada showed that no larvae survived a wood chipping process, though the size of the chips was not specified. However, all but one of the 2300 adult scolytids (which are smaller than *T. fuscum* adults and larvae) inserted into logs before chipping were killed as well (Allen *et al.* 2002). Sweeney *et al.* (2009) also concluded that bark has a much lower risk of carrying *T. fuscum* than round wood, with bark from de-barkers producing 0.15% of the *Tetropium* spp. of untreated logs (Sweeney *et al.* 2009).

Because debarking and wood chipping reduce the viability of the *T. fuscum* life stages associated with those commodities, and protected zone requirements mean kiln drying may also have occurred, entry on this pathway is rated as very unlikely with medium confidence.

Bark and Woodchips	Very unlikely	☑	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely	☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐				

Wood Packaging Material (WPM)

WPM that originates from outside of the EU must be compliant with ISPM 15 – a phytosanitary standard requiring debarking and heat treatment or fumigation of WPM to mitigate the risk of entry of pests on this pathway (IPPC 2011). In Canada, the heat treatment necessary to kill all life stages of *T. fuscum* has been shown to be less stringent than that required by ISPM15 (Mushrow *et al.* 2004). WPM is believed to have been the pathway of entry for *T. fuscum* into Canada, as the park in Halifax where it was first found is close to a large container port (O'Leary *et al.* 2003), though it is worth noting that the introduction of *T. fuscum* dates to before ISPM15 measures were introduced. There are also historical records of *T. fuscum* being intercepted on WPM of Norwegian origin in Canada (Humble & Allen 1999).

WPM that enters the UK from the EU does not have to meet ISPM15 requirements, however if made from conifer wood it must fit one of the following criteria due to the UK's Protected Zone status for several bark beetles (Forestry Commision 2015). WPM should either be:

- Bark free OR
- accompanied by a plant passport issued by a registered forestry trader in an EU Member State declaring that the wood with residual bark originated in an area known to be free of certain bark beetle species OR
- kiln dried (KD), marked with a KD mark, and accompanied by a plant passport issued by a registered forestry trader in an EU Member State.

The effectiveness of these measures is as discussed within the timber section: larvae can burrow into the sapwood and so may still be present on bark free WPM, though kiln drying should be effective. Entry on WPM is rated as moderately likely, with medium confidence: ISPM 15 is still applied to some EU origin material, and kiln drying is an effective measure against *T. fuscum.* Cases of non-compliance with the phytosanitary measures (both ISPM15 and on WPM of EU origin) also occur.

Wood Packaging Material	Very unlikely	☐	Unlikely	☐	Moderately likely	☑	Likely	☐	Very likely	☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐				

Cut Christmas Trees

Spruce, the preferred host of *T. fuscum*, is a popular Christmas tree species – along with firs. In 2014 the UK imported around 6000 tonnes of fresh Christmas trees (cut, rather than for planting, which is discussed in the section below) from the EU and Norway (Eurostat data extracted 29.5.2015), though this will include non-host species and trees originating in areas where *T. fuscum* is not found. *T. fuscum* overwinters in the larval stage and adults emerge in summer (Smith & Humble 2000). Thus it is larvae that would be the most likely life stage to enter on Christmas trees, and in order to complete their lifecycle the Christmas tree must not be discarded in a manner that would destroy the pest. Many Christmas trees in the UK are collected for recycling and chipped (recyclenow 2015), a process that is very likely to destroy the pest. However, Christmas trees discarded outside and whole could allow the pest to complete its lifecycle.

It is not certain how attractive Christmas trees would be as a host for *T. fuscum* – which appears to have a preference in Europe for mature and stressed trees. Juutinen, 1955 concluded from a review of the literature that "spruce longhorn beetles are only encountered in trees which are more than 50-60 years old". A study of thinned *Pinus sylvestris* in Poland of various ages only found *T. fuscum* infesting those between 21-40 years of age (Korczyński *et al.* 2007). Since vigorous trees are likely to be chosen for export, this also reduces the likelihood of entry on this pathway.

Given that many Christmas trees will be destroyed before the pest can complete its lifecycle, entry on this pathway is rated as very unlikely with high confidence.

Christmas Trees	Very unlikely	☑	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely ☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐			

Plants for Planting

Import of the known hosts of *T. fuscum* for planting is prohibited from outside of Europe.

Much of the *Picea* and *P. sylvestris* plantations for forestry purposes in the UK are grown from seed, which *T. fuscum* would not be associated with. Between 2002 and 2013, only two consignments of *Picea* plants were imported for forestry purposes (Forestry Commission 2013, unpublished data). However *Picea* is imported as plants for ornamental purposes, including outdoor plantings as living Christmas trees, and these numbers are not known.

As described in the Christmas tree pathway, the pest prefers older trees. These large, mature trees are occasionally traded, but less often and in smaller quantities than semi-mature trees and saplings. There is also no evidence that *T. fuscum* is a pest in nursery environments.

Because *T. fuscum* prefers mature trees that are much less likely to be moved in trade, and *T. fuscum* is not reported to be a pest of nursery trees, entry on plants for planting is rated as very unlikely with high confidence.

Plants for Planting	Very unlikely	☑	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely ☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐			

Natural Spread

Tetropium fuscum is widespread in Europe, including the Low Countries and France, but there is no evidence that the beetles undertake long distance flights. In studies where adults were places in flight mills, most adults flew on average 1km in 24 hours (Sweeney *et al.* 2009), far below the distance required to cross the channel. The pest is also not listed as present in the Republic of Ireland, so spread over the border into Northern Ireland is unlikely. New introductions of *T. fuscum* to the UK by means of natural spread is very unlikely with high confidence. Natural spread may be an important pathway for spread of *T. fuscum* within Great Britain, but this is not what is being assessed in this section of the PRA. See section 11 for a discussion of natural spread within Great Britain.

Natural Spread	Very unlikely	☑	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely ☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐			

9. If the pest needs a vector, is it present in the UK/PRA area?

This pest is a free living organism and no vector is required.

10. How likely is the pest to establish outdoors or under protection in the UK/PRA area?

The pest is already established in Great Britain, at least in Scotland.

Hosts of *T. fuscum* are abundant in the UK and all unthinned stands contain dead trees and can suffer from wind damge. The widespread distribution of the pest in northern and central Europe indicates it can adapt to a range of climates, and it is present in regions with a similar climate to the UK such as the Netherlands and Belgium. Though there are no specific data on the climatic requirements of the pest, based on the current distribution and the wide availability of hosts, establishment is rated as very likely with high

confidence. In all but the coldest regions, *T. fuscum* will complete its life cycle in one year (O'Leary *et al.* 2003), and it would be expected to have one generation per year in the UK.

The hosts are not usually grown under protection, and *T. fuscum* is not considered a pest of protected cultivation, so establishment under protection is rated as very unlikely with high confidence.

Outdoors	Very unlikely	☐	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely	☑
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐				

Under Protection	Very unlikely	☑	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely	☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐				

11. How quickly could the pest spread in the UK/PRA area?

The spread of *T. fuscum* since its introduction to Canada has been monitored. Upon discovery of the outbreak a containment area and buffer zone were set up, with measures in place to limit the movement of spruce wood material to prevent spread by man-made pathways. Over a twenty year period (the first ten without containment measures in place, when there may have been some spread by manmade pathways), *T. fuscum* spread around 80km – though the authors noted that removal of females due to monitoring with pheromone traps may have reduced the local populations (Rhainds *et al.* 2011). There is no evidence that *T. fuscum* will move long distances naturally, especially when suitable host plants are close by. Adults in flight mills flew on average 1km in 24 hours – though some flew greater distances and others did not fly at all (Sweeney *et al.* 2009). These results are from an artificial environment without hosts. Longhorn beetles do not generally disperse far from their natal sites. *Tetropium fuscum* has been regularly recorded re-infesting the same host, if suitable, year after year (Juutinen 1955, O'Leary *et al.* 2003), which will slow their rate of spread. Thus natural spread in Great Britain is rated as slowly, with high confidence. For Northern Ireland, where the pest is not known to be present, natural spread would not allow *T. fuscum* to arrive from Great Britain as it would not be capable of flying over the Irish Sea.

Without measures in place to limit spread in commodities such as timber, the pest could be transported to new areas by the movement of timber, though if timber is processed before adults emerge in the summer months this will reduce the risk of the pest transferring to new hosts. Spread with trade is rated as quickly, with medium confidence.

Natural Spread	Very slowly	☐	Slowly	☑	Moderate pace	☐	Quickly	☐	Very quickly	☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐				

With trade	Very slowly	☐	Slowly	☐	Moderate pace	☐	Quickly	☑	Very quickly ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			

12. What is the pest's economic, environmental and social impact within its existing distribution?

The behaviour of *T. fuscum* appears to differ between its native range in Europe and Canada, where it has been introduced. It has been reported that *T. fuscum* will be more damaging in Canada than it is in its native range, could cause widespread mortality of trees and threaten their use in forestry services, and have environmental and social impacts due to the importance of *P. rubens* (red spruce) to Nova Scotia, where it is the provincial tree (CFIA 2014). In Canada, the pest has proved particularly damaging to *P. rubens*, due to the larval feeding activity, with repeated infestations leading to the creation of extensive larval galleries that can girdle the stem (O'Leary *et al.* 2003).

Early reports indicated that *T. fuscum* was able to infest and kill apparently healthy trees. However, the O'Leary *et al.* (2003) study did note that *P. rubens* in Canada with a reduced growth rate and low vigour (for unknown reasons) were more susceptible to attack than more vigorous trees, however the infested trees were not weakened so much before attack that death was imminent. Later Canadian studies compared performance of *T. fuscum* on apparently healthy red spruce to those that had been artificially girdled. *Tetropium fuscum* performed significantly better on trees that had been girdled, with only a single adult emerging from the 30 healthy trees which had had eggs implanted in during the experiment, indicating that larvae are likely to die when the host's defences are uncompromised (Flaherty *et al.* 2013a). In the same study, examination of the lesion tissue caused by larval feeding showed it to be smaller in apparently healthy trees compared to stressed trees.

It has also been shown that females preferentially select stressed (girdled) red spruce trees over healthy ones, and when healthy trees were alighted on a significantly smaller number of eggs were laid (Flaherty *et al.* 2013b). So, even in its introduced range, evidence strongly suggests that trees with a lower health status are preferentially attacked and that vigorous trees do not make ideal hosts for *T. fuscum.*

In Europe *T. fuscum* is largely a secondary pest, albeit an important one in some regions. In Finland, *T. fuscum* was never the only cause of tree decline in studies – very commonly trees had already been attacked by defoliators, root rots or other stem pests before *T. fuscum* infestation began, however it was also stated that *T. fuscum* did sometimes attack and kill stressed trees that may otherwise have recovered (Juutinen 1955). Despite this, Juutinen stated that management measures for *T. fuscum* were unnecessary, "in view of the overall relatively minor importance of the spruce longhorn beetles". It was included in a list of European Cerambycidae considered to be damaging to trees, with the countries where damage has been recorded being Estonia and Romania (Lieutier 2004).

There are records from Europe of *T. fuscum* attacking North American species – in Finland it was recorded on blue spruce, *Picea pungens,* and the same paper also references findings in Sitka spruce in Germany – though states in that region *T. fuscum* preferred *Pinus*, and attack occurred only after trees have been weakened by *Dendroctonus micans* (Juutinen 1955). No records of significant impacts on exotic *Picea* species in Europe.

There are no apparent environmental or social impacts in the European range. Impacts in the current range are rated as medium, due to the increased impacts seen in the introduced range of Canada. However, in Europe, overall impacts would be rated as small.

Impacts	Very small	☐	Small	☐	Medium	☑	Large	☐	Very large	☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐				

13. What is the pest's potential to cause economic, environmental and social impacts in the UK/PRA area?

It is not known precisely why *T. fuscum* appears to be a more aggressive pest in Canada than in Europe, but it is not an uncommon situation, many pests are more damaging in their introduced range. Although this could be related to a lack of natural enemies, parasitoids have been observed in Canada (Sweeney *et al.* 2005a) and it might be due to increased susceptibility of the host genera grown in the invasive region.

The pest may have been present in Scotland for over 30 years, and to date no significant impacts have been recorded: findings have only been on cut logs or in one case, an already significantly stressed *P. abies* (FC Scotland, unpublished data). This strongly suggests that *T. fuscum* will have similar impacts in the UK as it does in continental Europe, where it is only reported as important in limited regions by killing already stressed trees. Many European parasitoids and natural enemies capable of infesting *T. fuscum* are likely to be present in the UK. The natural enemies of Cerambicidae in Europe have been reviewed including those that attack *T. fuscum* (Kenis & Hilszczanski 2004). This review states "The most important parasitoid of spruce *Tetropium* spp. is undoubtedly the braconid *Helconidea dentator*." This parasitoid wasp is known to occur in the UK and Ireland (Broad *et al.* 2012). Other major parasitoids listed by Kenis and Hilszanski (2004) are the ichneumon wasps *Rhimphoctona xoridiformis* and *Xorides brachylabis*, with the latter stated to be strong associated with the genus *Tetropium.* These two parasitoids are also known to occur in the UK (Broad 2012).

There is some uncertainty over the risk to the North American species, *P. sitchensis,* which is grown for forestry purposes in the UK. This species is not widely planted in the rest of Europe, and there is only a single old reference to *T. fuscum* attacking *P. sitchensis* could be found. It is very likely that it will be a suitable host for *T. fuscum,* but the level of impacts on this species is difficult to judge. As stated in section 12, evidence in Canada suggests that stressed trees are preferred and that performance of the pest is poor when

healthy trees are attacked – therefore there is potential that low vigour *P. sitchensis,* as well as other non-native spruce, could be impacted by this pest.

Another factor to take into account with potential impacts on *P. sitchensis* is the short rotation time these trees are grown on in the UK – with the typical rotation length for the UK described as 35-45 years (Moore 2011). As stated in section 8, in Europe *Picea* are generally not attacked until they are 50 – 60 years old, and the average age of attacked trees in Canada was over 80 (O'Leary *et al.* 2003). It is possible the average younger age of *P. sitchensis* forestry stands in the UK will help protect trees from attack from *T. fuscum*, but if they are stressed by other factors they may still be vulnerable.

Examples of stressed trees more susceptible to attack by *T. fuscum* include those suffering from 'heat stroke' leading to an increased susceptibility to *Armillaria* fungal infections (Schimitschek 1929), as well as attack by defoliators or other bark and stem pests (Juutinen 1955). Both drought and defoliation are suffered by *P. sitchensis* in the UK. In particular, spruce is defoliated by green spruce aphid, *Elatobium abietinum,* which leads to a reduction in vigour (Halldórsson *et al.* 2003, Straw *et al.* 2000, Straw *et al.* 2011). It is not known if these factors will reduce tree vigour enough to lead to large scale damaging attacks by *T. fuscum* on *P. sitchensis*. In addition, other factors related to upland spruce forestry could predispose trees to attack including the fact stands are often unthinned and suffer high rates of natural mortality and regular wind damage (John Morgan, Forestry Commission, *personal communication*).

Probably the best evidence in support of small impacts on *P. sitchensis* is the fact that the pest is present in areas where *P. sitchensis* is being grown, but no impacts have been noted and no live trees found to be infested. *Picea sitchensis* may be a host, but if it is, it is not apparently more susceptible than European species. It is worth noting there are no significant impacts reported on *P. sitchensis,* or any other species of *Picea*, in Denmark (Hans Peter Ravn, *pers. comm.* 30.09.2015), one of the other areas of Europe that grow *P. sitchensis* and where *T. fuscum* is native.

Economic impacts are rated as small, with low confidence; *T. fuscum* is largely a secondary pest in Europe, with it only being considered of economic importance in a limited part of its range. There have been no findings on healthy trees in the UK to date: in fact the only finding on a living tree was one that was already stressed by other diseases.

Confidence is low as it is uncertain if *P. sitchensis* stressed from defoliation by aphids or by other factors that affect upload spruce forestry may be more vulnerable to attack, though this phenomenon has not been recorded to date. Timber staining by associated fungi may also reduce wood marketability in some instances, but the impacts of this are uncertain, also contributing to the low confidence rating.

No species of *Picea* are native to the UK, though some *Picea* plantations are important habitats for UK native species. No significant impacts could be found on the native species *Pinus sylvestris*. Furthermore there are no apparent environmental impacts in Europe, so environmental impacts are rated as very small with medium confidence.

In some areas *Picea* may be planted in urban environments (gardens, public spaces) to act as Christmas trees in winter, or simply as ornamentals. However there is no evidence that *T. fuscum* is a pest on such ornamental trees in Europe. Many spruce plantations are used for recreation, and infestation of trees could cause them to become unsafe impacting on the use of forests for recreation. However, *T. fuscum* is not expected to act as a primary pest, attacking trees that are already stressed and may otherwise have become unsafe, and so social impacts are rated as very small with medium confidence.

Economic Impacts	Very small	☐	Small	☑	Medium	☐	Large	☐	Very large ☐
Confidence	High Confidence	☐	Medium Confidence	☐	Low Confidence	☑			
Environ - mental Impacts	Very small	☑	Small	☐	Medium	☐	Large	☐	Very large ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			
Social Impacts	Very small	☑	Small	☐	Medium	☐	Large	☐	Very large ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			

14. What is the pest's potential as a vector of plant pathogens?

Tetropium species are associated with blue-stain fungi, and those specifically isolated from the galleries of *T. fuscum* have been studied by Jankowiak *et al.* (2010) in Europe and Jacobs *et al.* (2002) in Canada. Table 2 summarises those fungi found in association with *T. fuscum* in these studies.

Table 2: Fungi associated with *T. fuscum*. The UK status is taken from the British Fungi Checklist (Kirk & Cooper 2015). Where the species is not known it is not possible to make conclusions about the UK status.

Table 2: Fungi associated with *T. fuscum*	UK Status
Graphium pseudormiticum	No records
Grosmannia cucullata	No records
Grosmannia penicillata	Present (listed as *Ophiostoma penicillatum*)
Grosmannia piceiperda	No records
Leptographium procerum	Present

Leptographium sp.	Unknown
Pesotum fragrans	No records
Pesotum spp.	Unknown
Ophiostoma minus	Present
O. piceae	Present
An unknown *Ophiostoma* sp.	Unknown
O. tetropii	No records

There are several fungal species in table 2 with no UK records. Blue stain fungi such as those listed in table 2 are usually associated with other *Tetropium* species and scolytids (bark beetles), some of which are already present in the UK. For example the majority of species associated with *T. fuscum* were also found from galleries caused by *T. castaneum*, a species present in the UK (Jankowiak & Kolařík 2010). Thus it is possible that these fungi are already present, but unrecorded.

Associated fungi can cause fungal staining of timber, reducing the quality of the wood. However no evidence could be found that these fungi are considered economically important in Europe because of their staining properties. Jankowiak *et al.* (2010) performed pathogenicity testing on 2 year old Norway spruce seedlings with several blue-stain fungi associated with *T. fuscum* and found that *Grosmannia penicillata*, *G. piceiperda, Ophiostoma minus, O. piceae* and *O. tetropii* all caused sapwood blue stain.

Staining is not conclusive of pathogenicity on plants, and not all of the blue-stain fungi associated with *T. fuscum* are pathogenic. For example *O. tetropii*, which is one of the most commonly isolated, has not been shown to be pathogenic in North America and is not considered economically important in Europe (Jacobs *et al.* 2002). Results from inoculation of two year old Norway spruce seedlings by Jankowiak *et al.* 2010 indicated that this species was not particularly pathogenic, though this was in contradiction to earlier publications which concluded that it was pathogenic (Sallé *et al.* 2005). Except for *G. piceiperda,* as discussed below, no reports of virulence could be found for the other species listed in Table 2 that are not recorded from the UK, and thus have potential to be introduced with *T. fuscum*.

Grosmannia piceiperda killed <33% of 2 year old Norway spruce seedlings when directly inoculated into the plants (Jankowiak & Kolařík 2010), and the authors state that this is similar to previously published findings referenced in the study. In a recent study, this species also killed one four year old seedling in a separate experiment, leading the authors to conclude that it showed some pathogenicity (Repe *et al.* 2015). Thus it can be concluded that *G. piceiperda* does show some pathogenicity towards *Picea*. This has been stated as a possible contributing factor to the mortality of *Picea* attacked by *Tetropium* species in Europe (Jankowiak *et al.* 2009).

Introductions of *T. fuscum* do have the potential to introduce new fungi to the UK, and some of these species have shown limited pathogenicity on trees. However these fungi

are not exclusively associated with *T. fuscum* and are often found in association with other *Tetropium* or scolytids that are present in the UK. As a consequence, they are likely to be introduced on additional pathways, and may already be present but are currently undetected.

15. What is the area endangered by the pest?

Areas of *Picea* and *Pinus* production where trees may be under stress from other pests or abiotic factors will be susceptible to attacks by *T. fuscum* that could hasten the death of the tree or reduce wood marketability.

Stage 3: Pest Risk Management

16. What are the risk management options for the UK/PRA area?

Exclusion, Eradication and Containment

Tetropium fuscum has already established in Great Britain, and prospects of preventing further introductions are poor. This is due to the large volume of trade in commodities known to act as a pathway of entry for *T. fuscum* from Europe, where the pest is widespread, native and not under official control, meaning the pest can continue to enter. It is not currently recorded on the island of Ireland, and so if Northern Ireland can demonstrate it is free of the pest, measures could be put in place to prevent its introduction; however it is possible that the pest is already present at low levels and undetected. Some survey work has been done, and more is planned, to determine if the pest is present in Northern Ireland.

There are several effective traps for *T. fuscum* – beetles are attracted to billet logs, and also deliberately girdled trees. There are highly effective pheromone traps that have been developed for *T. fuscum* (Sweeney *et al.* 2007, Sweeney *et al.* 2011b), which could be used to monitor for the pest in areas where its establishment is uncertain.

Control of local infestations may be achievable in some areas if detected early, but would require the removal of all infested trees plus additional hosts within a buffer zone, which is likely to cause greater impacts than the pest itself. Given studies on the spread of the pest, this buffer zone may be larger than those used for other longhorn species such as *Anoplophora glabripennis*. Many stages of the pest's life cycle are cryptic and would be difficult to detect, thus early detection of outbreaks is unlikely.

Containment measures, such as preventing the movement of potentially infested wood products out of the outbreak area, appear to have prevented long distance spread and introduction to new regions in Canada. However such measures would not be as effective

in the UK, unless measures were also taken to prevent introduction to new sites on imports.

Non-Statutory controls

Since stressed trees are preferred hosts, good silviculture practice will reduce the impacts of this pest – Juutinen, 1955 stated *"In general, only preventive measures are practicable for their control. The best way of controlling spruce longhorn beetles is improving the sanitation of the forest and maintaining it".*

There is ongoing work in Canada on biological control, including the entomopathogenic fungus *Beauveria bassiana* (Sweeney *et al.* 2005b), which is present in the UK. Population suppression has also been trialled using pheromone-mediated mating disruption (Sweeney *et al.* 2011a) and mass trapping using traps that attract both males and females (Sweeney *et al.* 2011b).

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