Department for Environment Food & Rural Affairs

Rapid Pest Risk Analysis (PRA) for:

Diaprepes abbreviatus

February 2024

Summary and conclusions of the rapid PRA

Diaprepes abbreviatus (*Citrus* root weevil) is a major pest of *Citrus*, root vegetables, ornamentals, and other commercial crops in the Caribbean and a few of the most southern states of the USA where it was unintentionally introduced. This weevil has recently been found in Madeira and the Canary Islands and is established in one tropical indoor site in the UK. During a commodity risk assessment of *Ligustrum* spp. (privet) from the UK conducted by EFSA (European Food Safety Authority), this pest was short listed as a possible pest of concern. An EFSA pest categorisation concluded that *D. abbreviatus* satisfies all the criteria to be regarded as a potential EU quarantine pest. An assessment is required to indicate whether this pest could establish elsewhere in the UK and whether statutory action is required.

This rapid PRA shows:

Diaprepes abbreviatus does not pose a risk to plants in outdoor environments in the UK. This weevil has only established outdoors in tropical and subtropical parts of the world. It does pose a risk to glasshouses with tropical and subtropical temperatures, particularly those with plants growing in the ground, as eradicating the pest would be more challenging than with containerised plants.

Risk of entry

This assessment rates the likelihood of *D. abbreviatus* entering the UK on plants for planting as **unlikely** with **high confidence**. All other pathways were rated as **very unlikely** with **high confidence.**

Risk of establishment

UK air and soil temperatures are too low to support the development of *D. abbreviatus* outdoors. The risk of *D. abbreviatus* establishing outdoors was therefore rated as **very unlikely** with **high confidence**.

As *D. abbreviatus* is a known pest of potted ornamental plants and has established at one indoor site in the UK, the likelihood of this pest establishing in glasshouses with tropical/subtropical temperature regimes is rated as **likely** with **medium confidence**. The risk rating was not scored higher because of the assumption that incursions would be noticed relatively early by importers quarantining plants before introducing them to their principal glasshouses/collections, and that incursions in glasshouses with containerised plants would be relatively straightforward to eradicate.

Economic, environmental and social impact

As tropical and subtropical glasshouses are the only environments in which this pest is expected to be able to establish in the UK, the potential economic impact of *D. abbreviatus* was rated as **very small** with **high confidence**. Environmental and social impacts were not rated.

Endangered area

This pest is not expected to establish outdoors in the PRA area, neither is it expected to result in economically important losses on a national scale in areas where it could establish (in tropical/sub-tropical glasshouses). There is, therefore, no endangered area.

Risk management options

The most likely pathway for this pest to enter the country was considered to be plants for planting. There are already many measures on plants for planting, some of which have been tightened since *D. abbreviatus* was introduced to the tropical glasshouse in the UK. Importers may wish to source plants that have been grown under a physical barrier and/or plants that are bare rooted. Quarantining plants before introducing them to main glasshouses/collections will also help reduce the risk of introducing this pest. There are a few entomopathogenic nematode products available on the UK market that could be used against *D. abbreviatus.*

Key uncertainties and topics that would benefit from further investigation.

No uncertainties were found that warrant further investigation.

Images of the pest

	
Adult *Diaprepes abbreviatus* By Keith Weller, USDA, Bugwood.org	Root damage caused by *D. abbreviatus* (plant unknown) By Florida Division of Plant Industry, Florida Department of Agriculture and Consumer Services, 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 EPPO) and the PRA scheme (UK or EPPO) to be used.

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

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

Diaprepes abbreviatus only poses a risk to ornamental plants grown in tropical and subtropical glasshouses in the UK. Statutory action would therefore be inappropriate.

Yes Statutory action		No Statutory action	✓

Stage 1: Initiation

1. What is the name of the pest?

Diaprepes abbreviatus (Linnaeus, 1758)

Coleoptera: Curculionidae

Synonyms: *Curculio abbreviatus, Diaprepes spengleri, Diaprepes festivus, Diaprepes irregularis, Diaprepes quadrilineatus, Exophthalmus abbreviatus*

Common names: *Citrus* weevil; *Citrus* root weevil; sugarcane rootstalk borer weevil; *Diaprepes* root weevil

This species has several colour varieties which has resulted in many varietal names and synonyms (Woodruff, 1985) (Fig. 1).

Fig. 1 Colour and pattern diversity of the wing cases of adult *Diaprepes abbreviatus* © C. Malumphy

2. What initiated this rapid PRA?

This pest is known to be present in England at one tropical indoor site – the rainforest biome at the Eden project, Cornwall. During a commodity risk assessment of *Ligustrum* spp. (privet) from the UK conducted by EFSA (European Food Safety Authority), this pest was short listed as a possible pest of concern (EFSA PLH Panel, 2022). An assessment is required to indicate whether this pest could establish elsewhere in the UK and whether statutory action is required.

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 plant health legislation, and in the lists of EPPO[1]?

This pest is not listed in regulations that apply to Great Britain (Phytosanitary Conditions Regulation (retained regulation (EU) 2019/2072)[2]).

As of January 2024, this pest is not listed in regulations that apply to Northern Ireland (EU legislation (2019/2072 and 2016/2031)[3]).

Diaprepes abbreviatus is not on the EPPO alert lists.

An EFSA pest categorisation concluded that *D. abbreviatus* satisfies all the criteria to be regarded as a potential EU quarantine pest (EFSA PLH Panel, 2023).

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

This weevil is native to the Caribbean Islands and has been introduced to southern parts of the USA, Madeira (Portugal), the Island of Gran Canaria (Spain), and the Eden project in Cornwall, UK (EPPO GD, 2023) (Table 1).

In the USA, *D. abbreviatus* was first discovered in Florida in 1964. It is thought to have arrived on imported ornamental plants from Puerto Rico (Knapp *et al.*, 2001). There was an effort to eradicate the pest, but the weevil was rediscovered in 1968 (Cherry *et al.*, 2011). In 2000, *D. abbreviatus* was found in Texas and in 2005, it was found in California. The pest is suspected to have spread to California in or on potted *Citrus* or ornamentals from Florida (CISR, No Date).

Diaprepes abbreviatus was first detected in Gran Canaria in 2014. There has been a total of eleven outbreaks, nine of which have been eradicated. The remaining two are under eradication (EPPO GD, 2023). In Madeira, *D. abbreviatus* was first discovered in 2018 by Andrade & Stüben (2020) who suggest that it could have travelled through the same channels as passengers from Gran Canaria.

[1] https://www.eppo.int/ACTIVITIES/quarantine_activities

[2] https://www.legislation.gov.uk/eur/2019/2072

[3] The latest consolidated version can be accessed on the left-hand side of https://eur-lex.europa.eu/eli/reg_impl/2019/2072/oj

Table 1: Distribution of *Diaprepes abbreviatus*	
North America:	USA: California; Florida; Louisiana; Texas
Central America:	Barbados, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Lucia, St Kitts-Nevis, St Vincent and the Grenadines, Trinidad and Tobago, Virgin Islands (British), Virgin Islands (US)
South America:	
Europe:	Portugal: Madeira, Spain: Gran Canaria, UK: one glasshouse in England
Africa:	
Asia:	
Oceania:	

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

There have been several UK interceptions of this pest over the last few decades. As the interceptions have been made over a large time span, the sources of data (interception databases) have changed and so the details are patchy but are summarised here:

- four interceptions in the 1980s on bananas from the Caribbean
- two interceptions in the 1990s associated with imported plants (one recorded as *Musa*; no host recorded on the other)
- one dead adult in 2023 found in the mulch layer of a *Ficus* sp. (an ornamental fig tree) inside a hospital atrium that had been imported from the Netherlands a few months earlier.

It was first discovered at the Eden project (Cornwall, southwestern England) circa 2002. In 2004, the population was large enough to be considered a serious pest and control measures were taken to manage the population (C. Malumphy, pers. comms.). For several years now, weevil numbers have been thought to have been low based on few adults being observed and no plants being damaged enough to warrant them being discarded (Eden project, pers. comms., December 2023). Although the adults are relatively large and colourful, they are nocturnal and hide during the day, so they can be overlooked. No control measures are being applied. Until a site visit by the PHSI (Plant Health and Seed

Inspectorate) in October 2023 found that this pest was still present (confirmed by DNA sequencing), the last specimen to be sent in was in 2014.

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?

This is a very polyphagous weevil. In a review of hosts from 1996, there were a recorded 270 plant species from 59 families '*associated*' with this pest, and 40 plant species from 20 families associated with larval feeding (Simpson *et al.*, 1996). The plant associations were collated from scientific literature, plant inspection records and personal field observations, and were one or a combination of the following observations: plants from which adults were collected, plants upon which the adults were observed feeding, plants from which larvae were collected, and plants upon which *D. abbreviatus* eggs were laid.

Confirmed true hosts ('*those that support egg deposition to adult*') included: *Arachis hypogaea* L. (peanut), *Citrus* spp., *Dracaena draco* (L.) L. (dragon tree), *Eugenia uniflora* L. (Surinam cherry), *Ipomoea batatas* (L.) Lam. (sweet potato), *Saccharum officinarum* L. (sugarcane), *Sorghum* spp. and *Zea mays* L. (sweetcorn) (Simpson *et al.*, 1996).

Larval feeding was recorded on: *Capsicum annum* L. (peppers), *Cyperus* spp., '*Juniperus conferta* L.' probably = *Juniperus rigida* var. *conferta* (Parl.) Patschke (shore juniper), *Juniperus virginiana* L. (Eastern red cedar), *Phaseolus vulgaris* L. (common bean), *Solanum melongena* L. (aubergine), and other species of low importance or used as ornamental plants in the UK.

In field nurseries in southern Florida, *Conocarpus erectus* L. (green buttonwood), *Phoenix roebelenii* O'Brien (dwarf date palm), and *Quercus virginiana* Mill. (Southern live oak) are commonly grown together and known to support the larval and adult stages of this pest. Serious root injury has been observed on field-grown *Q. virginiana* (Diaz *et al.*, 2006). Also in Florida, *D. abbreviatus* is an occasional root pest of plasticulture *Fragaria* x *ananassa* (Duchesne ex Weston) Duchesne ex Rozier (strawberry) - where strawberries are grown in rows of mounded soil covered in plastic to extend the growing season (Renkema *et al.*, 2021).

Larval feeding on potato (*Solanum tuberosum* L.) is reported (Grafton-Cardwell *et al.*, 2004). *Diaprepes abbreviatus* also laid eggs on this host in no choice and multiple choice oviposition tests (Mannion *et al.*, 2003), and *D. abbreviatus* larvae were used in a trial recording the response of *Steinernema diaprepesi* (Steinernematidae) (an entomopathogenic nematode) to potato plants subject to root herbivory (Hassani-Kakhki *et al.*, 2020).

Host plants recorded in Gran Canaria include *Brachychiton* sp., *Citrus* sp., *Coccoloba uvifera* L., *Codiaeum variegatum* (L.) A.Juss., *Corynocarpus laevigatus* 'variegata' J.R.Forst. & G.Forst.(recorded as *Corynocarpus variegate*), *Hybiscus* sp., *Lagunaria*

patersonia (Andrews) G.Don (recorded as *Lagunaria patersonii*), *Markhamia lutea* (Benth.) K.Schum., *Morus alba* L., *Schefflera* sp., *Schinus terebinthifolius*, *Syzygium aqueum* (Burm.f.) Alston, *Tipuana tipu* (Benth.) Kuntze and *Vitis* sp. (EFSA PLH Panel, 2023).

The only reference to *Ligustrum* spp. as hosts was found in Mannion *et al.* (2003) where, in a survey of ornamental nurseries, one plant '*Ligustrum* sp.' was found with 'feeding damage'. In the survey methods section of the paper, the authors state that each plant selected was inspected for five minutes and that the presence of adults, feeding damage and egg masses was recorded. This suggests that the feeding damage recorded was from adult weevils (rather than larvae which attack the roots and would require a longer inspection time). In insecticide trials for the control of *D. abbreviatus*, phytotoxicity tests have been carried out on various plants including *Ligustrum* spp. which suggests that it might be known as a host, but the information has not been published (Collins, 1977).

To summarise, the hosts recorded in the literature which are of most concern to the UK are potato, sweetcorn, pepper, aubergine, common bean, strawberry, juniper and oak. This pest is very polyphagous and could potentially feed on many hosts of importance to the UK. Its distribution, however, is tropical and subtropical and therefore its main hosts are limited to plant species growing in these regions.

8. Summary of pest biology and/or lifecycle

Lifecycle: Adult weevils live for approximately four months and will feed on leaf edges, leaving irregular semi-circular notches which causes little economic damage. Only rarely do adults feed on fruit (most commonly *Carica papaya* (papaya) and young *Citrus*), again doing little economic damage (Jetter & Godfrey, 2009 references therein). Eggs are generally laid in clusters of 25 to 250 between mature leaf surfaces held together by an adhesive produced by the female. Eggs can also be laid on a single leaf, by folding parts of the leaf to cover the egg mass. A single female may lay as many as 5,000 eggs in total (Knapp *et al.*, 2001). Once hatched, larvae drop to the ground, burrow into the soil, and begin to feed on fibrous roots, moving to larger roots as they mature. Young larvae cannot burrow into dry soil (Grafton-Cardwell *et al.*, 2004). After a period of feeding which can last several months to over a year (depending on environmental temperature), larvae pupate in the soil from which adult weevils will emerge (Knapp *et al.*, 2001). It is the larval stage which causes the most significant economic losses, and can be difficult to detect as the above ground parts of plants may not show any symptoms until root feeding is extensive (Jetter & Godfrey, 2009). In a research article, it is stated that larger larvae may girdle the crown of the host plant (Jetter & Godfrey, 2009), it is presumed that in this instance, 'crown' is the basal part of a perennial plant (e.g. grass or strawberry) rather than the crown of a tree. Young trees may be killed by larval feeding, and mature trees will decline rapidly, resulting in yield reductions and a greater chance that they will be uprooted in strong winds (Jetter & Godfrey, 2009 references therein). Root damage also provides openings for the entry of pathogens such as *Phytophthora* spp. (fungus-like oomycetes) causing root rot. The pupal stage lasts between two to four weeks, and teneral adults may remain in the pupal chamber for a month or more before emerging (CDFA, No Date). Adult

weevils will not emerge from soil that is dry and compacted. Irrigation or rainfall promotes adult emergence (McCoy *et al.*, 2003 cited in Grafton-Cardwell *et al*., 2004). On containerised plants, the lifecycle is much the same with larvae feeding on the roots within pots.

Adult emergence and voltinism: The large variations in the time it takes larvae to develop can result in overlapping generations. In Florida, adult weevils emerge from the soil throughout the year, though there appears to be two peak emergence periods in spring and autumn (Knapp *et al.*, 2000). In southern California, Bates *et al.* (2015) observed no second peak during a four year study, concluding that the weevil is univoltine in southern California's climate which is cooler in comparison to Florida.

9. 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?

The main pathway of *D. abbreviatus* spread to new areas has been on plants for planting. This assessment rates the likelihood of *D. abbreviatus* entering the UK on plants for planting as **unlikely** with **high confidence**. Natural dispersal from the one established population indoors in the UK was also rated as **unlikely** with **high confidence**. All other pathways are rated as **very unlikely** with **high confidence.**

Plants for planting:

There is a proven history of the immature stages of this pest being intercepted on plants for planting (CABI, 2021 and references therein). Interceptions have been made between Caribbean Islands (Haiti to Puerto Rico), the Caribbean to the USA (Puerto Rico to Florida), and between US states. Between 1974 and 2003, more than 20 interceptions were made by California on plant material from Florida and Puerto Rico (Grafton-Cardwell 2005 cited in Lapointe, 2007). As well as the eggs being on the leaves of plants and the larval and pupal stages being associated with the roots, Grafton-Cardwell *et al.* (2004) mention that *D. abbreviatus* has been intercepted in truck trailers, and in the cargo holds of aircraft – presumably these are adult weevils that have moved from or been shaken off plants.

Plants for planting would have been the pathway on which this pest was introduced to the Eden project site in England circa 2000. Apart from a project in 2023, the movement of living plants from the rainforest biome does not occur. The one-off movement of plants in 2023 was for a temporary outdoor show garden. The plants were thoroughly inspected by Eden project staff and either bare rooted and washed so that they were free of soil before being potted and grown on in a nursery building, or cuttings or seeds were taken. The plants destined for the show garden were then inspected by PHSI.

Trade volumes in imported plants for planting from the distribution of *D. abbreviatus* are very small. There was no recorded trade from the Caribbean Islands in the last five years. Table 2. shows the trade in plants for planting from the United States. Trade in hosts from the United States where this pest is present will only be a proportion of the values presented as it has a limited distribution within this country. Included in the table are values for indoor ornamental plants (intended for direct retail) which are likely to end up in environments with limited or no other hosts available to transfer to.

Table 2. Last five years of imported plants for planting from the USA (kg)

CN8 code and description	2018	2019	2020	2021	2022	Mean
06023000 Rhododendrons & azaleas*	0	0	0	0	22,320	4464
06029030 Vegetable & strawberry plants	0	0	0	562	0	112
06029045 Outdoor rooted cuttings & young plants**	923	1247	17	53	0	448
06029050 Live outdoor plants***	26	356	1309	570	818	616
06029070 Indoor rooted cuttings & young plants****	103	165	23	208	0	100
06029091 Indoor flowering plants with buds or flowers****	0	0	0	34	107	28
06029099 Live indoor plants & cacti*****	10	25	0	0	53	18
Grand Total	**18,581**	**1793**	**1349**	**17,280**	**32,280**	**14,257**

Source: HMRC data
***** grafted or not
****** of trees, shrubs & bushes (excl. fruit, nut & forest trees)
******* incl. their roots (excl. bulbs, tubers, tuberous roots, corms, crowns and rhizomes, incl. chicory plants & roots, unrooted cuttings, slips, rhododendrons, azaleas, roses, mushroom spawn, pineapple plants, vegetable & strawberry plants, trees, shrubs & bushes)
******** (excl. cacti)
********* (excl. rooted cuttings, young plants and flowering plants with buds or flowers)

As soil is prohibited from the United States and the Caribbean (for GB and NI) and excess amounts of permittable growing medium would be heavy and expensive to export, many of the imported plants for planting would be bare rooted or shipped with the minimum amount of medium – reducing the likelihood of larvae and pupae being associated with the plants.

Growing media must consist entirely of peat or fibre of *Cocos nucifera* L. or meet certain requirements which reduce the likelihood of larvae and pupae being associated with plants e.g., be subject to effective fumigation or heat treatment or an effective systems approach (for GB and NI).

Trees and shrubs must have been grown in a nursery, be free from plant debris, flowers and fruit, and have been inspected prior to export. Deciduous trees and shrubs must also be dormant and free from leaves (reducing the likelihood of being infested with *D. abbreviatus* eggs and adults) (for GB and NI).

Not including samples from the Eden project, there have only been three interceptions of this pest in the UK associated with plants for planting since the early 1990s (section 6).

There have been no reports of interceptions made by other EU member states on any commodity (Europhyt 1993-2020).

Diaprepes abbreviatus is very polyphagous, so if the pest arrived on plants for planting into a glasshouse or outdoor environment, it is likely there would be other suitable hosts for it to transfer to. However, imports of plants for planting from infested countries are limited and measures have been tightened since the pest was introduced to the Eden project circa 2000. The likelihood of *D. abbreviatus* entering the UK on plants for planting is therefore rated as **unlikely** with **high confidence**.

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

Cut flowers and parts of plants:

Not many of the listed hosts or plants listed as those that *D. abbreviatus* will lay eggs on (Simpson *et al.*, 1996) are plants traditionally traded for the cut flower market, floristry or decoration. *Diaprepes abbreviatus* is very polyphagous, however, and does attack conifers, broadleaved trees, grasses, palms and members of the Compositae (daisy family) and Liliaceae (lily family) for example. Eggs could therefore potentially enter the UK on this pathway, but without soil and roots for the emerging neonate larvae to move to, the pathway is a dead end. Trade in cut flowers or parts of plants from the pest's distribution headed for outdoor environments will be negligible. This pathway is therefore rated as **very unlikely** with **high confidence**.

Cut flowers and parts of plants	Very unlikely	☑	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely ☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐			

Plant produce:

The larvae of *D. abbreviatus* inhabit the soil and feed on the outside of roots, so are therefore not going to be associated with root vegetables. Rarely adults feed on fruit - most commonly papaya and young *Citrus* (Jetter & Godfrey, 2009 references therein), and eggs are laid on mature leaves or between mature leaves. *Citrus* fruit will be harvested when mature not 'young', the fruit will also be packed and transported or vice versa prior to export at which point the adults might fly or drop from the produce (like many weevils, adult initial reaction to disturbance is to feign death and drop (Grafton-Cardwell *et al.*, 2004)). Most leaves will also be removed prior to export. There seems, however, a very small chance that adults and eggs could be associated with *Citrus*, papaya and other host

fruit. *Citrus* is one of the main crops attacked by this pest in the USA and *Citrus* fruit and leaves have been deregulated for GB (Annex 11 C: Phytosanitary Conditions Regulation (retained regulation (EU) 2019/2072 as amended)) (for NI they remain regulated). Trade in *Citrus* and papaya from the distribution area of *D. abbreviatus* is relatively low though still significant (Table 3).

Table 3. Last five years of imported host fruits from the top three exporting countries and countries within the distribution of *D. abbreviatus* (Tonnes)*

CN code & country	2018	2019	2020	2021	2022	Mean
0805 Citrus fruit, fresh or dried						
Spain	236,943	271,630	264,783	238,465	288,597	260,084
South Africa	176,132	159,505	197,550	195,230	200,786	185,841
Egypt	73,922	74,063	58,187	66,189	62,569	66,986
United States	964	1056	730	708	455	783
Jamaica	476	77	0	4	25	117
Antigua:Barbuda	0	174	113	0	0	57
Dominican Rep	21	0	0	0	0	4
08072000 Fresh pawpaws "papayas"						
Brazil	5599	5104	4166	4668	4241	4756
Netherlands	335	1477	76	66	21	395
Spain	100	31	58	295	474	192
Jamaica	541	223	11	0	0	155
Dominican Rep	86	3	11	7	0	21
Grenada	2	0	0	0	0	0
08039010 Bananas, fresh (excl. plantains)						
Colombia	285,258	282,087	272,068	261,340	242,187	268,588
Costa Rica	201,393	224,380	238,787	246,854	215,476	225,378
Dominican Rep	139,388	133,890	125,725	93,122	72,361	112,897
St Lucia	9155	6447	3812	1460	541	4283
Dominica	187	17	0	0	0	41
United States	31	0	0	0	59	18

*Countries in grey are not within the distribution of *Diaprepes abbreviatus*

Trade in bananas from the Domincan Republic and St Lucia is large, though it appears to be declining (Table 3). Four interceptions of this pest were made by GB on bananas from the Caribbean in the 1980s. There have not been any interceptions since. There have been no interceptions reported by other EU member states on any commodity (Europhyt 1993-2020). Bananas have been deregulated by GB (Annex 11 C: Phytosanitary Conditions Regulation (retained regulation (EU) 2019/2072 as amended) and the EU.

Though eggs might be associated with leaves still left on fruit, these leaves will eventually be discarded, and any neonate larvae would struggle to find suitable soil substrate or hosts to transfer to. For adults associated with fruit consignments, their best chance of transferring to suitable hosts would be on consignments headed straight for outdoor markets. Many of these will be in urban settings with a restricted number and range of plants in the immediate environment. Establishment outdoors is considered very unlikely

(section 11). For these reasons, the pathway of plant produce is rated as **very unlikely** with **high confidence**.

Plant produce	Very unlikely	✓	Unlikely		Moderately likely		Likely		Very likely	
Confidence	High Confidence	✓	Medium Confidence		Low Confidence				

Hitchhiking/contaminating pest:

Grafton-Cardwell *et al.* (2004) mention that *D. abbreviatus* has been intercepted in truck trailers, and in the cargo holds of aircraft. And that the human movement of farm equipment greatly increases the rate at which this pest can disperse within an area. Larvae and pupae could be associated with soil on agricultural machinery and vehicles, but there is a requirement for imported used agricultural machinery or vehicles to have been cleaned and be free from soil and plant debris (GB and EU). The chances of adult weevils remaining with agricultural machinery and vehicles that are washed/ loaded/ transported/ and potentially reloaded seem slim. If any did enter the UK on this pathway, they would need to be mated females (or there would need to be enough individuals to allow mating) and females would still need to locate a suitable host on which to lay eggs. For these reasons, this pathway has been rated as **very unlikely** with **high confidence**.

For hitchhiking on visitors from the Eden project, see the below section on natural dispersal.

Hitchhiking	Very unlikely	✓	Unlikely		Moderately likely		Likely		Very likely	
Confidence	High Confidence	✓	Medium Confidence		Low Confidence				

Dispersal from the established indoor UK population:

Adults are reported not to fly far from the spot where they emerge from the soil – estimated to be less than 300 m (Weissling *et al.*, 1998;CDFA, No Date).

Natural dispersal from the rainforest biome of the Eden project, where this pest is established, might be possible. Adults could potentially escape through vents which are netted for the purpose of excluding birds (but not insects) or as a hitchhiker on visitors and their belongings. The two entrances to the biome (visitor and staff) are closed and sealed unless in use. The visitor entrance is automatic and is within a ‘link’ building which has a restaurant area and links the rainforest and Mediterranean biome. Therefore, for a weevil to escape via the doors, it would need to first escape through the rainforest biome entrance and then the link building entrance. The staff entrance door to the rainforest biome is manually operated and leads to a staff area. The outer access doors to this area are on spring closers and are always kept shut. This is a much less likely means of

escape. The weevil has never been found outside of the rainforest biome. Plant debris, pruning debris and (very infrequently) dead plants are removed from the biome to be composted in an outdoor area onsite. Pruned material is inspected as it is cut, it is then shaken and dropped, which reduced the chance of adults being associated with the material (Eden project, pers. comms., December 2023). The climate surrounding this site (and the outdoor climate of the UK) is unsuitable for the establishment of this pest (section 11), so in the event of adults escaping, it is very unlikely that a population could establish outdoors.

The Eden project is also situated in a steep-sided disused clay quarry (Fig. 2). The quarry is 60 to 80 m deep. Whether the adult weevil would fly to such a height is uncertain but seems improbable. Approximately 350 m to the north of the rainforest biome and outside of the quarry, is a nursery owned by the Eden project (Fig. 2). To infest plants in this nursery, a gravid female/several weevils would need to escape the rainforest biome, fly to a considerable height and distance, and then find a way into the protected nursery. This also seems improbable. This nursery supplies the Eden project's online shop with plants. Currently these plants are not sold outside of the UK.

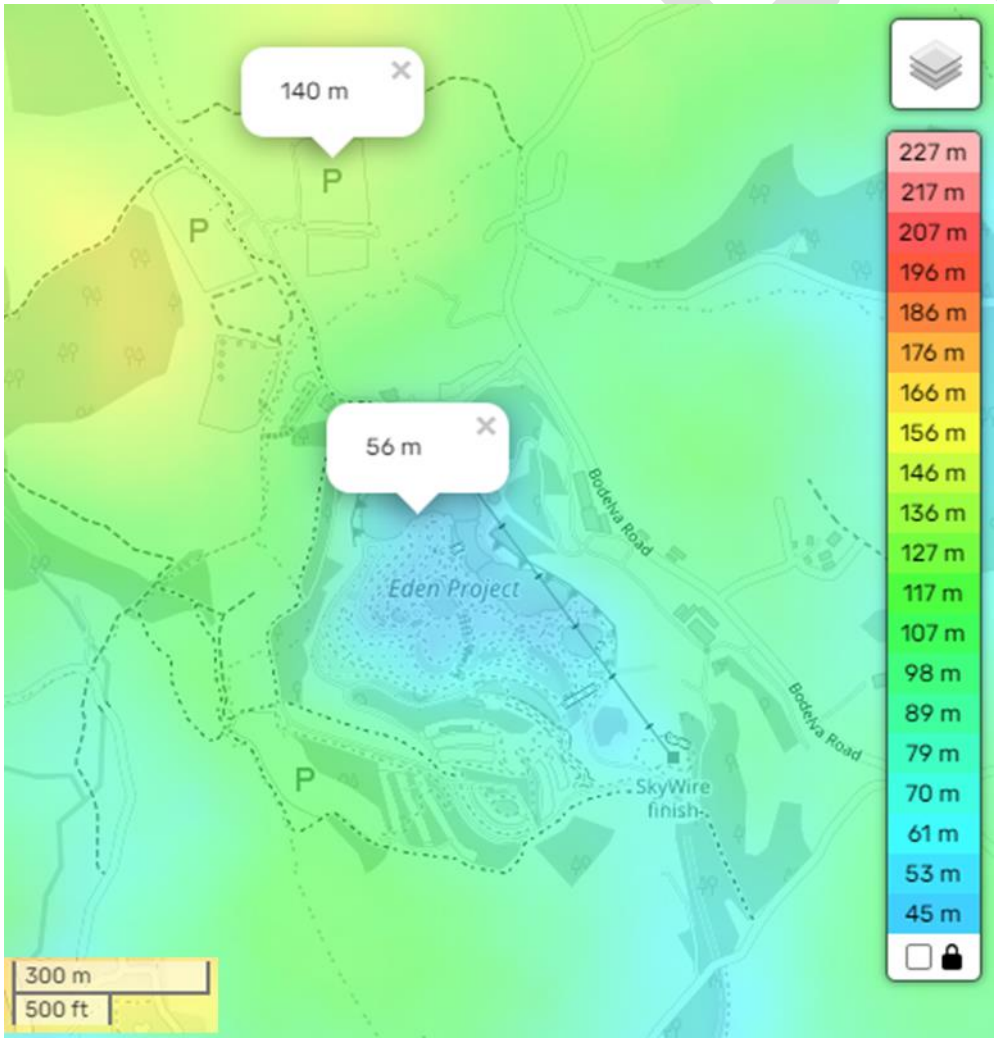

Fig. 2 Topographic map of the Eden project and surrounding areas. The nursery and rainforest biome are shown at approx. 140 m and 56 m respectively. Source: OpenStreetMap https://www.openstreetmap.org/copyright

The likelihood of this pest dispersing from the current established population in England (adults escaping the Eden project's rainforest biome and transferring to a suitable new environment) is considered **very unlikely** with **high confidence**.

Dispersal from UK population	Very unlikely	☑	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely ☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐			

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

This pest does not require a vector.

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

Establishment outdoors:

UK air and soil temperatures are too low to support the development of *D. abbreviatus*.

Diaprepes abbreviatus temperature parameters:

In laboratory experiments, Lapointe *et al.* (2007) found the egg and pupal stages of *D. abbreviatus* to be the most sensitive to low temperatures. At a constant 12°C, it took an average of 4 days for 95% mortality of eggs; at a constant 6°C, it took an average of 15 days for 95% mortality of larvae (eleven day old at start of treatment); and at a constant 9°C, it took an average of 12.5 days for 100% mortality of pupae (though there were only three replicates per treatment hence a mortality curve could not be fitted, and mortality was defined as dead pupae or deformed teneral adults resulting from the surviving pupae).

There are only a few areas of the UK where average winter soil temperatures are above 6°C (Fig. 3). Even taking account of climate change, the sustained cold temperatures would very likely be inhospitable for the larval and pupal stages of *D. abbreviatus.*

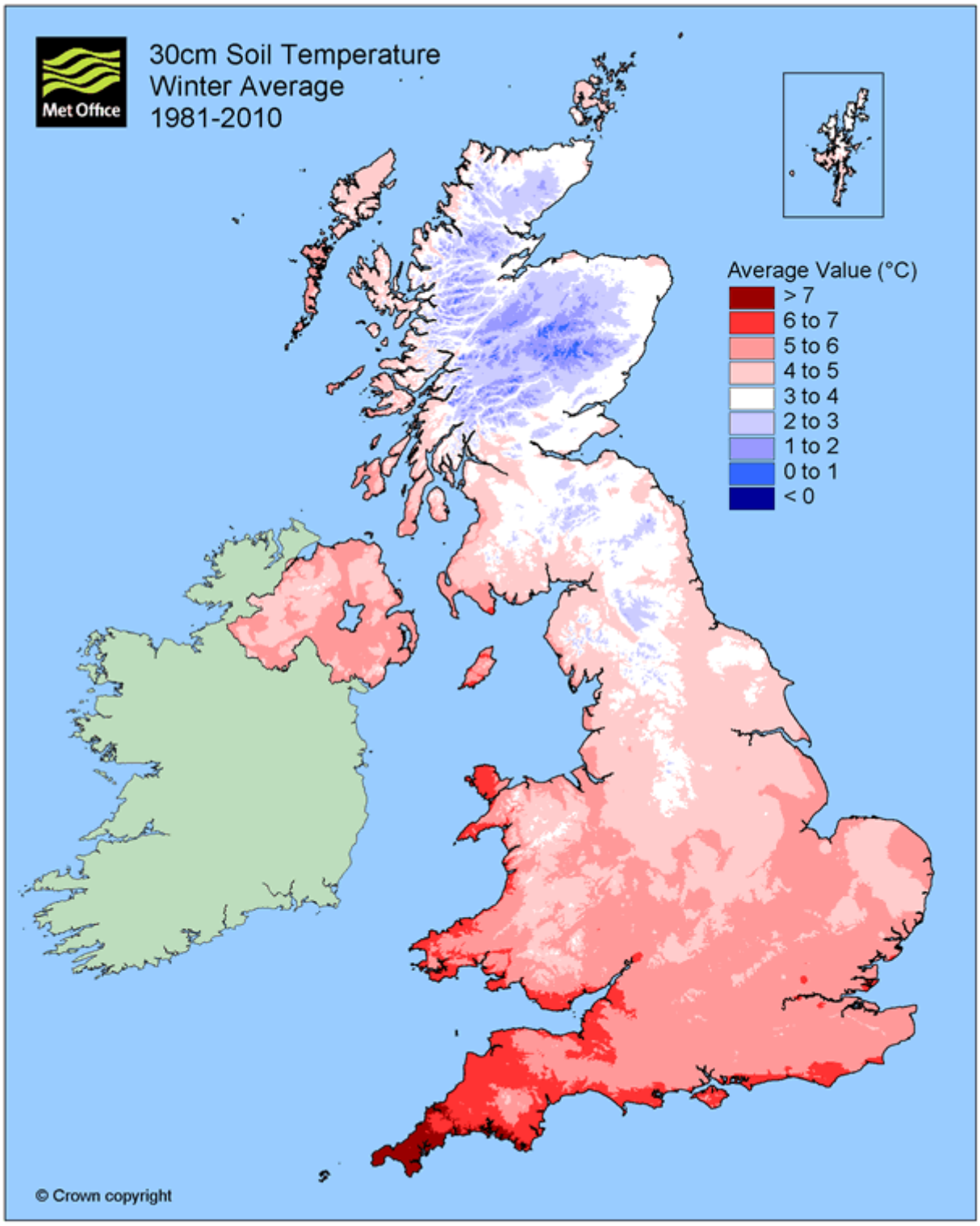

Fig. 3 Map showing the average (1981-2010) winter temperature of soil at a depth of 30 cm across the UK. Source: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages

In other experiments, Lapointe (2001) estimated that the lower developmental threshold temperature (LDT, the temperature below which no development occurs) for eggs was 12°C. A sum of degree days (DD) required by the egg stage was not given, but can be calculated using his linear model to give 111 DD (accumulated DD are a measure of time and temperature required by poikilothermic organisms to complete a lifecycle or stage – it

is a thermal constant that can be used to model development). The LDT for neonate larvae was estimated to be 15°C by (Lapointe, 2000). His reasoning being that at 12°C mortality was over 90% during the experiment, whereas at 15°C, mortality was 56%. The lowest estimate for the required sum of degree days was 1226 DD.

Even if eggs were laid in the spring when UK air temperatures rise above 12°C, the larval stage would not accumulate enough DD to complete development by spring the next year (Fig. 4).

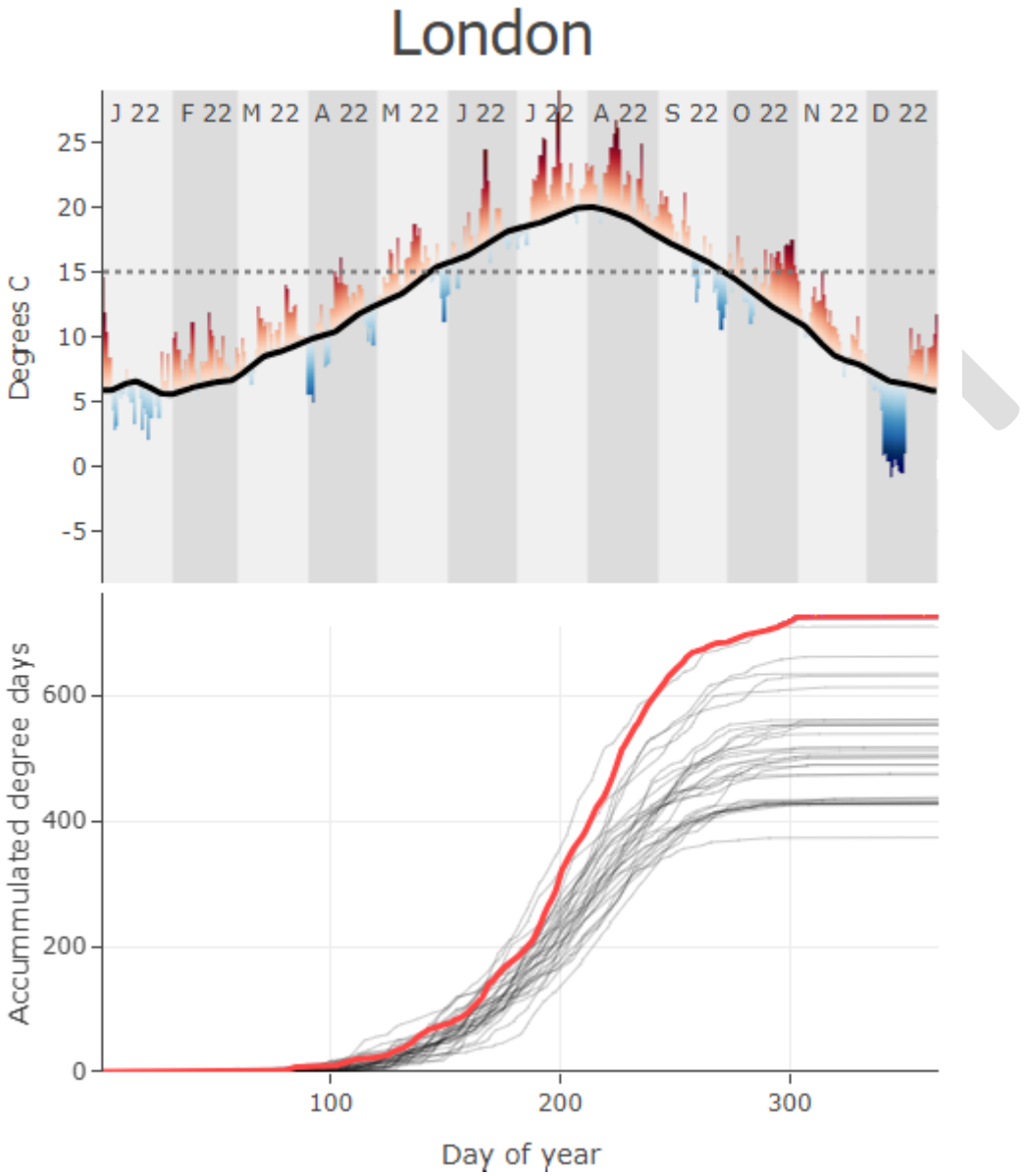

Fig. 4 Top graph shows the recorded air temperatures for London (one of the warmest parts of the UK) during 2022 (the warmest year on record). The dotted line at 15°C is the lower developmental threshold temperature (LDT) for the larval stage of *D. abbreviatus* (only June, July, August and September had mean temperatures above the LDT). Bottom graph shows the degree days that would have been accumulated (red line = in London in the year of 2022, grey lines = degree day accumulations for different years in London) had the larval stage commenced development on the 1st of January and its environmental temperature been equal to air temperature – the larval stage would be developing below ground where temperatures would be buffered in comparison to air

temperature. Even so, the accumulated degree days are nowhere near the required 1226 DD. Graphs adapted from https://www.metoffice.gov.uk/hadobs/biosecurity_uk_hist/

Since 2007 when Lapointe *et al.* (2007) used climate mapping to estimate the northerly limits of *D. abbreviatus* in Florida, Texas and California, the pest has been reported in Louisiana (2009), but in no other states further north. A pest ratings assessment dated 2013 for California states that *D. abbreviatus* has established a widespread distribution in coastal areas of southern California (San Diego, Orange, and Los Angeles Counties). It has not, however, fully established in the agricultural production areas of San Diego, Riverside, and Imperial counties.

Given the abundance of host plants in more northerly US states, it appears that low temperatures are indeed a limiting environmental variable for this tropical pest. The risk of *D. abbreviatus* establishing outdoors is therefore rated as **very unlikely** with **high confidence**.

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

Establishment under protection:

This pest has already established in the UK in the established, large and naturalistic rainforest biome of the Eden project in Cornwall, England. No statutory eradication measures have ever been implemented. Some of the plants in this biome are very large and planted into the ground. The benefits from eradicating this pest at this site are not considered to outweigh the cost. Some of the control measures adopted have been biocontrol agents (nematode species) (Treseder *et al.*, 2011), and have not eradicated the population (though eradication may not have been the aim).

Were this pest to be introduced to glasshouses of containerised plants or circumstances where the plants affected were of lower value and could be destroyed, the pest could be more easily eradicated. Martin *et al.* (2009) found that flooding potted green buttonwood plants (a flood-tolerant ornamental) was very effective at killing *D. abbreviatus* larvae. Therefore, the destruction of plants or use of pesticides may not be the only means of eradicating this pest from glasshouses.

Crops such as tomatoes, peppers and cucumbers grown under protection in the UK are not at risk from this pest as the vast majority are grown hydroponically (with very few exceptions grown in soil outdoors or under protection). Crops grown under temporary protection (polytunnels etc) are also not expected to be at risk as winter soil temperatures seem to be lethal for the larval and pupal stages.

As *D. abbreviatus* is a known pest of potted ornamental plants, and ornamentals imported from the pest's distribution would be tropical/subtropical plants headed for glasshouses (if not being sold for direct retail), the likelihood of this pest establishing in glasshouses with tropical/subtropical temperature regimes is rated as **likely** with **medium confidence**. The risk rating is not scored higher because of the assumption that incursions would be noticed relatively early by growers who may already be alert to *Otiorhynchus sulcatus* (vine weevil). *Otiorhynchus sulcatus* is a native temperate and subtropical pest which can reproduce parthenogenetically. Sources of *O. sulcatus* infestation include adults moving to container beds from the surrounding environment (Buxton, 2003). As *D. abbreviatus* could not establish outdoors in the UK, should it establish in a glasshouse it is not expected to be a pest as significant as *O. sulcatus*, though glasshouse to glasshouse spread could occur with traded plants. It is also assumed that importers of tropical plants with large nurseries/collections quarantine such plants before introducing them to the main glasshouses. And it is worth noting that apart from the Eden project, no other introductions of *D. abbreviatus* to glasshouses are known.

Under Protection (tropical / sub-tropical glasshouses)	Very unlikely	☐	Unlikely	☐	Moderately likely	☐	Likely	☑	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			

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

Diaprepes abbreviatus adults are reported to fly less than 300 m from where they emerge, furthermore the adults tend to stay on whichever host plant they first encounter (Weissling *et al.*, 1998;CDFA, No Date), and its expansion in Florida is attributed to the movement of infested plants in trade and by individuals rather than its ability to fly (Knapp *et al.*, 2000;Jetter & Godfrey, 2009).

Apart from a project in 2023, the movement of living plants from the rainforest biome of the Eden project does not occur. The one-off movement of plants in 2023 was for a temporary outdoor show garden. The plants were thoroughly inspected by Eden project staff and either bare rooted and washed so that they were free of soil before being potted and grown on in a nursery building, or cuttings or seeds were taken. The plants destined for the show garden were then inspected by PHSI.

As this pest is very unlikely to establish outdoors and is only expected to establish within tropical/subtropical glasshouses, spread would be a relatively rare event between these

glasshouses which are limited in number in the UK. Natural spread is therefore not scored and spread with trade is scored as very slowly with high confidence.

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

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

In the Caribbean, this weevil is a significant pest of sugarcane, *Citrus* and other commercial crops. It is also a common pest of ornamental plants in public and private gardens (C. Malumphy, pers. comm.). In central and southern Florida, where it was introduced, it is a major pest of *Citrus*, ornamental and root crops (Knapp *et al.*, 2001;Diaz *et al.*, 2006). In Florida, it was estimated that this pest caused 70 million dollars' worth of damage annually (estimate published in a continuously updated factsheet circa 2002, Weissling *et al*. 1998 cited in Diaz *et al*., 2006). Another undated estimate of 75 - 100 million dollars' worth of damage to commercial *Citrus* production in the Caribbean and Florida was found in McCoy & Duncan (No Date). In a cost benefit analysis of IPM strategies for *Citrus* in Florida, Muraro (2000) estimates that % yield reduction in a 'no control' scenario is 40%. Economic impacts are therefore rated as **very large** with **high confidence** for the pest's existing distribution.

No reports of environmental damage were found. Given this pest appears to be very polyphagous and given the chemical controls used against the pest and the reported secondary infections of *Phytophthora* spp., it is assumed that the direct and indirect environmental impacts of *D. abbreviatus* are significant, but without any data, this impact has not been rated. No reports on the social impacts of this pest were found, therefore social impacts have also not been rated.

Impacts	Very small		Small		Medium		Large		Very large	✓
Confidence	High Confidence	✓	Medium Confidence		Low Confidence					

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

Tropical and subtropical glasshouses are the only environments in which this pest is predicted to be able to establish in the UK. As these types of glasshouses are limited in number in the UK, the potential economic loss nationally is low. Losses to individual glasshouses could be moderate if this pest is not discovered quickly and if the plants within the glasshouse are of high value.

The current population of *D. abbreviatus* at the Eden project is not under any control and numbers are thought to be low based on few adults being observed and no plants being damaged enough to warrant them being discarded (Eden project, pers. comms., December 2023).

The potential economic impact of *D. abbreviatus* to the UK is rated as **very small** with **high confidence**.

Neither potential environmental nor potential social impacts in the UK could be rated. Impacts in the wider environment are not expected as this pest can only establish in tropical/sub-tropical glasshouses in the UK. Social impacts cannot be scored separately from economic impacts, as tropical glasshouses open to the public will take measures (at an economic cost) to ensure the site remains attractive to paying visitors.

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

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

There are no reported pathogens vectored by *D. abbreviatus*, though root damage caused by feeding larvae does increase the incidence of *Phytophthora* spp. infections (Knapp *et al.*, 2000).

16. What is the area endangered by the pest?

This pest is not expected to establish outdoors in the PRA area, neither is it expected to result in economically important losses on a national scale where it could establish (in tropical/sub-tropical glasshouses). There is, therefore, no endangered area.

Stage 3: Pest Risk Management

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

Excluding the pest: The most likely source of new introductions of this pest is imported plants for planting. Sourcing plants from areas outside the geographical distribution of this

pest; plants grown under a physical barrier; plants that are dormant (if applicable) and/or bare rooted are the most effective ways of reducing the risk of importing this pest. Growers could also help protect their stocks or collections by keeping new containerised plants in quarantine for as long as practically possible. The soil dwelling stage (larva and pupa) of this pest can last roughly a year, so if it is not too impractical, an inspection of the plant roots as well as the leaves could be carried out before plants are introduced to the main glasshouse/collection.

Pest eradication or control: No sources of detailed information on the eradication or control of *D. abbreviatus* in glasshouses were found. McCoy & Duncan (No Date) describe some of the control methods used in Florida's *Citrus* orchards and nurseries including cultural, chemical and biological controls, though many of these will not be permitted for use in the UK or would be inappropriate for indoor use. Martin *et al.* (2009) found that flooding potted green buttonwood plants (a flood-tolerant ornamental) was very effective at killing *D. abbreviatus* larvae. *Heterorhabditis bacteriophora* (Heterorhabditidae), an entomopathogenic nematode used against vine weevils, has been used on *D. abbreviatus* and is available in the UK under licence. The Eden project have also used *Heterorhabditis megidis* and *Steinernema kraussei* (Steinernematidae) to control *D. abbreviatus* in the past (Treseder *et al.*, 2011). Other products that are available for use in commercial horticulture against *Otiorhynchus sulcatus* (vine weevil) are *Steinernema feltiae*, pyrethrins garlic and *Metarhizium anisopliae* (an ascomycete) soil incorporations.

If the glasshouse is an ornamental production site where crop breaks are possible, this pest will be easier to eradicate than in botanical collections where plants may be long established in permanent beds and the continuity of displays is important.

Exporting: There are EU measures in place for plants for planting of *Ligustrum delavayanum* and *L. japonicum* originating from the UK (Implementing regulation - 2023/446 - EN - EUR-Lex (europa.eu)). The *Ligustrum* genus is listed as a high risk host and as such is prohibited from entering the EU from the UK unless the following requirements are met. The plants are *Ligustrum delavayanum* or *Ligustrum japonicum*; may be up to 20 years old; are planted in growing medium (not soil); have a maximum diameter of 18 cm at the base of the stem; are free from *Diaprepes abbreviatus*; the site of production has been found free from *D. abbreviatus* during official inspections; the plants have been inspected according to the measures described; and the Phytosanitary Certificate includes an official Additional Declaration.

Management at the Eden project: Apart from a project in 2023, the movement of living plants from the rainforest biome of the Eden project does not occur. The one-off movement of plants in 2023 was for a temporary outdoor show garden. The plants were thoroughly inspected by Eden project staff and either bare rooted and washed so that they were free of soil before being potted and grown on in a nursery building, or cuttings or seeds were taken. The plants destined for the show garden were then inspected by PHSI.

Plant debris, pruning debris and (very infrequently) dead plants are removed from the biome to be composted in an outdoor area onsite. Pruned material is inspected as it is cut,

it is then shaken and dropped, which reduced the chance of adults being associated with the material (Eden project, pers. comms., December 2023).

The Eden project is situated in a steep-sided disused clay quarry (Fig. 2). The quarry is 60 to 80 m deep. Whether the adult weevil would fly to such a height is uncertain but seems improbable. Approximately 350 m to the north of the rainforest biome and outside of the quarry, is a nursery owned by the Eden project (Fig. 2). To infest plants in this nursery, a gravid female/several weevils would need to escape the rainforest biome, fly to a considerable height and distance, and then find a way into the protected nursery. This also seems improbable. This nursery supplies the Eden project's online shop with plants. Currently these plants are not sold outside of GB. *Ligustrum* is not grown on site; neither in the garden nor for sale in the plant shop.

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This publication is available via the UK Plant Health Information portal https://planthealthportal.defra.gov.uk/

This PRA has been undertaken following IPPC International Standards for Phytosanitary Measures (ISPMs 2 and 11) and it provides technical evidence relating to the risk assessment and risk management of this pest.

This PRA has been undertaken taking into account the environmental principles laid out in the Environment Act 2021. Of particular relevance are:

The prevention principle, which means that any policy on action taken, or not taken should aim to prevent environmental harm.

The precautionary principle, which assists the decision-making process where there is a lack of scientific certainty.

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