

Scoping the risk of bulk aggregate (topsoil, sand, gravel, stone, wood chips) movement into and within Scotland

Project Final Report



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1 Executive summary

1.1 Background

Plant pests and diseases are inadvertently moved around the globe on or in plants and plant products (Spence, et al., 2020). These biosecurity risks are mitigated by the Plant Health Authorities through the processes that have been put in place to help to prevent pest incursions, e.g., plant passporting, phytosanitary certificates, special requirements, border inspections and in-country inspections. However, due to the absence of plant material and perceived low risk, some bulk aggregates (e.g., sand, gravel and crushed rock) are not currently covered within the plant health regulations and therefore may pose a risk.

This scoping study therefore aimed to understand the scale of the importation of bulk aggregates into Great Britain (GB) and their movement within Scotland. In addition to sand, gravel and crushed rock (so called primary aggregates), this study also considered the production and movement of topsoil and bark chips in Scotland.

1.1.1 Methods

- This project engaged with the building, quarrying, forestry and landscaping sectors to understand how bulk aggregates are produced and moved into and within Scotland.
- An evidence review was conducted to clarify bulk aggregate provenance and movement from the literature.
- Import data for some of the bulk aggregates in question was examined.
- Laboratory experiments were conducted on samples of bulk aggregate materials to ascertain the presence of any pests.

1.1.2 Results and recommendations

Achieving widespread stakeholder engagement during this study was a significant challenge. It soon became clear that the sectors with whom we engaged did not consider biosecurity as an issue for their business/organisation. Contamination was a major consideration (e.g., asbestos, plastics, etc.) but we found no evidence that plant diseases had been considered.

In addition, it was challenging to understand the provenance of some of the bulk aggregates because the sectors in question are largely unregulated. In some instances, there are voluntary industry standards, such as the British Standard for topsoil (BS 3882:2015), however, such standards are voluntary and not all suppliers will be signed up. In addition, BS 3882:2015 does not require any heat treatment to remove pathogens, it is more focussed on the quality of the product (e.g., contaminants have been removed) (NRM, 2021).

Soil from third countries (i.e., those outside of the EU) is not permitted to be imported into GB or Northern Ireland. However, soil is permitted to be moved within the EU (including into the UK) because plants for planting may be grown and moved with compost which contains soil (e.g., plants in a potting media with soil included, and soil composed composts). Therefore, if there was a blanket prohibition of soil imports, this would have a significant negative impact on plant imports. However, there was no evidence reported from stakeholders or other sources of the widespread importation of soil into GB, but topsoil for sale in Scotland may have originated from other parts of GB.

Most of the primary bulk aggregates (sand, gravel and crushed rock) used in Scotland originate from within the country (e.g., 3.74 Mt of sand and gravel, and 17.04 Mt of crushed rock were produced in Scotland in 2019) (Mankelow, et al., 2023). The plant health risks associated with this material is thought to be low (Litterick, et al., 2024). This study did find live pathogens to be present, but this could have been due to the storage of the materials at the destination site

or other factors. Many more samples would have to be tested before robust conclusions could be drawn.

The UK imports significant amounts of sand from 49 countries (1.2Mt with a value of £86 million between 1st January 2022 and 30th June 2024; HMRC, 2024). The biosecurity risks of sand are thought to be low, but studies have found *Pseudomonas* spp. in beach sand during studies of the human health implications. This genus of bacteria is not only associated with zoonotic diseases in humans and diseases of animals but are also associated with a number of serious plant diseases (e.g., horse chestnut bleeding canker caused by *Pseudomonas syringae* pathovar *aesculi*). Further research is therefore required to understand the plant health risks posed by sand and any measures required to ensure that pathogens are removed or not present in the first instance.

One of the areas investigated by this study was the biosecurity risk associated with the building of roads and paths within forests and woodlands (e.g., for timber extraction or for recreational activities) and in the natural environment. We found that in Scotland, there is sufficient material within quarries across the forest estate to enable forest roads and paths to be built with material of a known provenance within a short distance of the activity (usually less than 100 miles) (Pers. Comm. Scottish Forestry, Woodland Trust). The risks of the introduction and spread of a forestry pest during this activity is therefore very low (except where crossing boundaries of outbreak areas).

From a plant health and biosecurity aspect, the bulk aggregate product giving rise to most concern was bark chips. The disease risk from bark chips is high (Kopinga, et al., 2010). Many studies have found that disease-causing organisms can move from infected bark chips onto nearby plants (Koski & Jacobi, 2004; Panesar, et al., 1994; Foreman, et al., 2002). This sector is unregulated in the UK, and it is very difficult to establish the provenance of some of the material for sale. The more responsible suppliers reported that their products were UK-sourced and FSC certified, but they did not carry out any treatment processes to reduce or remove plant pests. There are also more informal ways of obtaining bark chips (e.g., from online marketplaces) which could be very high risk.

Wood chips are also imported into the UK from 39 countries (appendix a), totalling 62,165 tonnes between 1st January 2022 and 30th June 2024, with a value of £21m (HMRC, 2024). This is concerning because there are currently 72 pests which have “bark” listed as an introduction pathway on the UK Plant Health Risk Register (Defra, 2024a). This includes seven species of damaging jewel beetles (*Agrilus* spp.), 12 species of longhorn beetles (*Monochamus* spp.) and many fungal pathogens (e.g., *Cronartium* spp.). Bark would have to be declared to the Plant Health Authorities before landing so that it can be inspected. However, many of the pests that may be present will not be visible with the naked eye.

This study identified six oomycete species in bark chips sourced from Scottish suppliers. Most notably, *Phytophthora bilorbang* was recovered by baiting with rhododendron leaves.

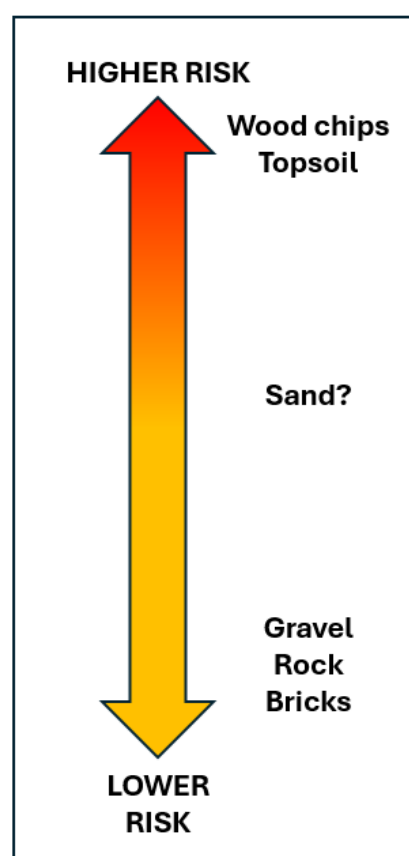


Figure 1: The biosecurity risks associated with each bulk aggregate. ? = unknown.

Regarded as a species of inundated soil and rivers, it has been found in streams in Oregon, USA (Reeser, et al., 2011) and is the causal agent of decline in a number of woody hosts, including Olea root rot in Italy (Santilli, et al, 2020). However, although pointing to potential risks, many more samples would have to be tested before firm conclusions could be drawn.

We can potentially learn from international standards, particularly the Import Health Standard (IHS) for Soil, Rock, Sand, Clay, and Water which was introduced in New Zealand to address the biosecurity risks posed by these bulk aggregates (New Zealand Government, 2024). This Standard describes the conditions that must be met by the exporting country or importer to receive a permit to import (such as heat-treatments). This dramatically reduces the risk of the import of the kinds of organisms identified in this study, as well as insect pests and weed seeds (including potential invasive and non-native species).

Recommendations:

- Further attempts should be made to engage with the various organisations and businesses involved in the production and movement of bulk aggregates to raise awareness of the potential plant health issues associated with these products. This is particularly important for the topsoil and bark chip sectors because their products are high risk from a plant health perspective.
- The British Standard for topsoil (BS 3882:2015) should be updated to include treatments which lower the risk of the product containing pests and pathogens. In addition, a more rigorous application of the standard to make it obligatory would raise the standard of the product and lower the plant health risks.
- There are currently no restrictions on the import of soil from the EU, the Plant Health Authorities should consider a prohibition to avoid the movement of pests into GB within soil.
- The Plant Health Authorities should consider carrying out Pest Risk Analyses on bulk aggregate pathways so that they can be included in the UKPHRR. This would lead to a better understanding of the trade networks involved and enable stakeholders to carry out more accurate biosecurity risk assessments.
- Sand is a major commodity which is known to contain pathogens associated with human health issues. Further investigation on the ability of sand to contain plant pathogens and enable their movement should be initiated.
- An industry standard for bark products is urgently needed to ensure that this commodity is treated in some way to remove pests (e.g., heat treated). This should be a requirement for all producers because it is clear from this and other studies that plant pathogens can be present in bark products which will be applied during landscaping projects. This represents a significant biosecurity risk to Scotland's natural and managed environments.

2 Background

The trade in plants and plant products is global (Hulme, 2009). As a result, plant pests and pathogens can sometimes be inadvertently moved into new regions and spread within regions, in or on a range of commodities (Brasier, 2008; Eyre, et al., 2013; Potter & Urquhart, 2017). For example, on plants for planting, within timber, and in products made of wood.

For this reason, these pathways are regularly assessed for the risk of pest and pathogen movement by the Plant Health Authorities in the form of Pest Risk Analyses (PRAs). Once produced, these PRAs can be used to inform the risk status of a pest or pathogen (where data are available), for example, on the UK Plant Health Risk Register (UKPHRR) (Defra, 2024a), where pest risk scores are given to particular pest species based on the level of risk posed (Defra, 2021). This then allows businesses and organisations to assess the plant health risks related to the products being moved.

However, bulk materials such as stone and sand, are often not considered as pathways for pest and pathogen movement and are not currently captured within the UKPHRR (i.e., there is no pathway in the data for “stone”, “sand”, “bricks”, etc. so no pests are currently recorded for these pathways). It is, however, conceivable that damaging species can move via these pathways, particularly if they are successful at living outside plants for a period of time, so called “hitchhikers” in invasive species terminology (e.g., McCarthy, et al., 2022).

An example of such a species is Asian longhorn beetle (ALB; *Anoplophora glabripennis*). This species was inadvertently imported into Kent, England, in 2012 within the wood of pallets that held ornamental stone (Defra, 2016). Despite being from more tropical climes, it was able to survive in the wider environment in Southern England, a concerning development due to the damage that this pest can do to broadleaf trees. The infested pallets went unnoticed for some time, and the beetles emerged and entered nearby woods and gardens. Fortunately, the adult beetles are very distinctive, and they were soon reported in the area by the public. The Plant Health Authorities then initiated a significant response to successfully eradicate the pest. However, this proved to be an expensive exercise with the removal of 2166 host plants and remains a salutary lesson in the impact that a hitchhiking species can have (Straw, et al., 2016).

In addition to sand and stone, this study investigated wood chips. This is a specific biosecurity risk which is important to understand due to the frequent movement of wood chips into and around the country, and its common use in many contexts. Wood and bark products have previously been described as having an elevated biosecurity risk due to contamination with plant pathogens at source, during transit or storage (Litterick et al., 2024). Bark is mentioned in the UKPHRR as a pest pathway for 72 pests (as of August 2024).

This study also examines topsoil as a commodity which is not specifically named as a pathway in the UKPHRR but is captured as a pathway for 238 pests as either “soil/growing media” or “Plants for planting (with soil)” (as of August 2024).

It can be challenging for an organisation or business to assess the biosecurity risk from products such as topsoil, decorative bark, stone and sand. This means that the plant related biosecurity risks to Scotland posed by these materials are currently unclear. To address this information gap, this report, a) reviews the literature related to the plant health risks posed by bulk aggregates, b) examines the data for bulk aggregate imports, c) presents findings from lab-based pathogen detection work, and d) suggests actions which could lower the biosecurity risk posed by these commodities.

3 Materials and methods

3.1 *Engaging with stakeholders*

Generally speaking, the bulk aggregates investigated in this study fall within three areas:

- building materials – sand, blocks and bricks
- landscaping materials – stones, sand, rocks and wood chips
- materials used in the natural environment – stone and sand for building roads and paths (e.g., forestry roads and trails).

Therefore, relevant organisations were contacted by email to provide a member of staff with knowledge in these areas for an interview with the aim of gaining a better understanding of bulk aggregate production, movement and spread within Scotland. Interviews were conducted on Teams. To encourage engagement, potential interviewees were reassured that all comments would not be linked to individual businesses, organisations or employees.

Organisations contacted included:

Building materials:

- The Federation of Master Builders
- The National Federation of Builders
- Build UK
- Mineral Products Association
- Institute of quarrying (cross sectoral)

Landscaping materials:

- British Association of Landscape Industries (BALI)
- Horticultural Trades Association (HTA)

Path/track laying:

- Forestry and Land Scotland
- Woodland Trust
- NatureScot
- Cairngorms NP

In addition to online interviews, a visit to a bulk aggregate event took place so that conversations could be initiated directly with those involved with bulk aggregate materials. This event was Hillhead 2024, Buxton, Derbyshire, which had 599 exhibitors (<https://www.hillhead.com/>) and we engaged with 14 exhibitors from various areas of the sector.

3.2 Import data

Data related to the movement of bulk aggregates into GB are managed by HMRC. We engaged with their team to obtain the data related to the most relevant commodity codes for the bulk aggregate products being investigated:

Table 1 - Bulk aggregate commodity codes used to obtain import data

Bulk aggregate	Commodity codes and brief descriptions
Sand	<p>25051000 - Silica sands and quartz sands, whether or not coloured.</p> <p>25059000 - Natural sands of all kinds, whether or not coloured.</p>
Rocks and stones	<p>25161100 - Granite, crude or roughly trimmed.</p> <p>25161200 - Granite, merely cut, by sawing or otherwise, into blocks or slabs of a square or rectangular shape.</p> <p>25162000 - Sandstone, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a square or rectangular shape.</p> <p>25169000 - Porphyry, basalt and other monumental or building stone, whether or not roughly trimmed.</p> <p>68010000 - Setts, curbstones and flagstones, of natural stone.</p> <p>68022900 - Monumental or building stone and articles thereof, simply cut or sawn, with a flat or even surface.</p> <p>68029910 - Monumental or building stone, in any form, polished, decorated or otherwise worked, but not carved.</p> <p>68029990 - Monumental or building stone, natural (excl. calcareous stone, granite and slate), in various forms.</p>
Building blocks and bricks	<p>68101190 - Building blocks and bricks of cement, concrete or artificial stone, whether or not reinforced.</p> <p>69041000 - Building bricks (excl. those of siliceous fossil meals or similar siliceous earths, and refractory bricks).</p> <p>70169040 - Blocks and bricks, of a kind used for building or construction purposes.</p>
Wood chips	<p>44012100 - Coniferous wood in chips or particles (excl. those of a kind used principally for dyeing or tanning purposes).</p> <p>44012210 - Wood in chips or particles, of eucalyptus.</p> <p>44012290 - Wood in chips or particles (excl. those of a kind used principally for dyeing or tanning purposes).</p>

3.3 Testing Bulk Aggregate Materials for the Presence of Oomycete Pathogens

Testing was carried out by Forest Research, Northern Research Station, Roslin, Midlothian, EH25 9SY (FR-NRS). The experiments were conducted blind, i.e., the provenance of the materials was not known to the testing lab. This also ensured the confidentiality of the suppliers of any material tested.

3.3.1 Samples

Twelve samples of aggregate materials were obtained, representing four groups of aggregate material (see Figure 1 & Table 2). Samples RBGE 1-3 were a gravel aggregate of the type used in potting (pea gravel); 4-6 were a larger quarry stone aggregate, commonly known as ‘Type 1’; 7-9, small particulate aggregate as used in path foundations, also known as sub-base, and samples 10-12 were a wood chip used for topping paths, planted areas and general landscaping.

3.3.2 Leaf baiting

Each aggregate sample was weighed in duplicate (~300g) into plastic containers e.g. RBGE 1.1 and RBGE 1.2, enabling incubation of each type at two temperatures. For the woody bark mix this weight was reduced due to the density of the material and containers were filled to the equivalent depths of the three gravel aggregate groups. All containers were filled with sterile distilled water to a depth of 1cm above the aggregate (~500 ml).



Figure 2: Aggregate sub-groups in bait containers. Left to right, gravel aggregate (RBGE1-3), quarry stone ‘Type 1’ (RBGE 4-6), path sub-base (RBGE 7-9) and woody bark mix (RBGE10-12).

Table 2: Baiting set-up including aggregate type, incubation temperature and leaf bait composition (different leaf types were used to ensure the best chance of infection, i.e., R (Rhododendron), Bi (Birch), Be (Beech), H (Holly), H(d) (Holly disc), R(d) (Rhododendron disc). RT = room temperature (19-21°C).

							Bait Composition					
Sample ID	Replicate	Location	Sample Description	Intake Date	Bait start	Incubation °C	R	Bi	Be	H	H(d)	R(d)
RBGE 01	RBGE 01.1	RBGE	Small gravel	07/17/24	07/18/24	25	3	1	1	0	1	5
RBGE 01	RBGE 01.2	RBGE	Small gravel, plant material present	07/17/24	07/18/24	RT	3	1	1	0	1	0
RBGE 02	RBGE 02.1	RBGE	Small gravel, plant material present	07/17/24	07/18/24	25	3	1	1	0	4	8
RBGE 02	RBGE 02.2	RBGE	Small gravel	07/17/24	07/18/24	RT	3	1	1	0	1	0
RBGE 03	RBGE 03.1	RBGE	Small gravel	07/17/24	07/18/24	25	3	1	1	0	4	8
RBGE 03	RBGE 03.2	RBGE	Small gravel	07/17/24	07/18/24	RT	3	1	1	0	3	10
RBGE 04	RBGE 04.1	RBGE	Large quarry stone (Type 1)	07/17/24	07/18/24	25	3	1	1	0	1	5
RBGE 04	RBGE 04.2	RBGE	Large quarry stone (Type 1)	07/17/24	07/18/24	RT	3	1	1	0	1	5
RBGE 05	RBGE 05.1	RBGE	Large quarry stone (Type 1)	07/17/24	07/18/24	25	3	1	1	0	1	4
RBGE 05	RBGE 05.2	RBGE	Large quarry stone (Type 1)	07/17/24	07/18/24	RT	3	1	1	0	1	5
RBGE 06	RBGE 06.1	RBGE	Large quarry stone (Type 1)	07/17/24	07/18/24	25	3	1	1	0	3	12
RBGE 06	RBGE 06.2	RBGE	Large quarry stone (Type 1)	07/17/24	07/18/24	RT	3	1	1	0	3	4
RBGE 07	RBGE 07.1	RBGE	Path sub-base gravel	07/17/24	07/18/24	25	3	2	1	0	1	0
RBGE 07	RBGE 07.2	RBGE	Path sub-base gravel	07/17/24	07/18/24	RT	3	1	1	1	0	0
RBGE 08	RBGE 08.1	RBGE	Path sub-base gravel	07/17/24	07/18/24	25	3	1	1	0	2	4
RBGE 08	RBGE 08.2	RBGE	Path sub-base gravel	07/17/24	07/18/24	RT	4	1	1	0	1	0
RBGE 09	RBGE 09.1	RBGE	Path sub-base gravel	07/17/24	07/18/24	25	3	1	1	0	3	8
RBGE 09	RBGE 09.2	RBGE	Path sub-base gravel	07/17/24	07/18/24	RT	3	1	1	1	0	0
RBGE 10	RBGE 10.1	RBGE	Woody bark mix	07/17/24	07/18/24	25	3	1	1	0	1	0
RBGE 10	RBGE 10.2	RBGE	Woody bark mix	07/17/24	07/18/24	RT	3	1	1	0	1	0
RBGE 11	RBGE 11.1	RBGE	Woody bark mix	07/17/24	07/18/24	25	3	1	1	0	1	0
RBGE 11	RBGE 11.2	RBGE	Woody bark mix	07/17/24	07/18/24	RT	3	1	1	0	1	3
RBGE 12	RBGE 12.1	RBGE	Woody bark mix	07/17/24	07/18/24	25	3	1	1	0	3	10
RBGE 12	RBGE 12.2	RBGE	Woody bark mix	07/17/24	07/18/24	RT	3	1	1	0	1	0
RBGE BL	Control 1	NRS	Lab blank RT		07/18/24	25	3	1	1	0	3	0

							Bait Composition					
Sample ID	Replicate	Location	Sample Description	Intake Date	Bait start	Incubation °C	R	Bi	Be	H	H(d)	R(d)
	Control 2	NRS	Lab blank RT		07/18/24	25	3	1	1	0	3	0
	Control 3	NRS	Lab blank RT		07/18/24	25	3	1	1	0	3	0
RBGE BL	Control 4	NRS	Lab blank 25C		07/18/24	RT	3	1	1	0	3	0
	Control 5	NRS	Lab blank 25C		07/18/24	RT	3	1	1	0	3	0
	Control 6	NRS	Lab blank 25C		07/18/24	RT	3	1	1	0	3	0

Intact and healthy leaves showing no signs of damage or existing lesions were chosen from various plant species around the grounds of FR-NRS. Bait leaves included *Rhododendron ponticum*, *Fagus sylvatica*, *Betula* spp. and *Ilex aquifolium*. Leaves were washed with sterilised distilled water (SDW) and floated with the abaxial surface in contact with the water. At least one leaf of each plant species was placed in every box with *Rhododendron* used for the majority of baits (Figure 2). A cork borer (size 8) was used to create discs of *Ilex* as their spiked shape prevented them from floating flat on the surface. Discs of *rhododendron* were also used to fill small gaps on the water surface to ensure a high coverage of the surface. Negative controls (RBGE BI) were set up using containers of 500ml of sterile distilled water and representative leaf baits. All containers were then covered loosely with a lid to allow air flow.



Figure 3: Leaf distribution in bait containers across aggregate sub-groups.

Samples were organised into a Randomised Complete Block Design (RCBD) on trays, each tray containing one of each aggregate sample and a control. Setting up duplicate trays enabled incubation at two temperatures, 15 °C and 19-21 °C (room temperature - RT).

3.3.3 Isolation from lesions

All bait containers were monitored daily for the presence of lesions. Figure 3 shows some examples of lesions from which isolation into culture was attempted using aseptic techniques in a laminar flow cabinet. Material was cut from the living green edge of the lesion using a sterile scalpel and transferred to a selective Synthetic Mucor Agar (SMA) media plate, labelled according to sample ID, temperature, date and bait material e.g. RBGE11.1_25_290724_R_1. Plates were limited to isolates from a single lesion to prevent cross-contamination and all isolation plates were sealed using cling film and incubated at 15 °C. Gaps left in the bait containers when leaves were removed were filled with fresh *rhododendron* leaves.

Primary isolations showing *Phytophthora*-like growth on SMA (aseptate, slow-growing, structured branching of hyphae, sometimes coraloid) were sub-cultured onto fresh SMA to obtain a single pure culture. A further subculture was sometimes necessary to obtain single cultures from mixed colonies. Once a single isolated growth was obtained the isolate was sub-cultured onto V8 agar prior to DNA extraction.

3.3.4 DNA extraction

Under a laminar flow hood, a small amount of mycelium was transferred from V8 to 20 µl of Sodium hydroxide (NaOH, 25mM) by scraping cultures with a pipette tip. Samples were digested for 15 minutes at 100 °C and 5 minutes at 4 °C using a thermal cycler and 20 µl Tris-HCl (40mM) was added. In total 32 plates of Oomycetes, including putative *Phytophthoras*, were harvested for DNA extraction (Table 2). A positive control consisting of *Phytophthora ramorum* mycelium and a negative control were included.

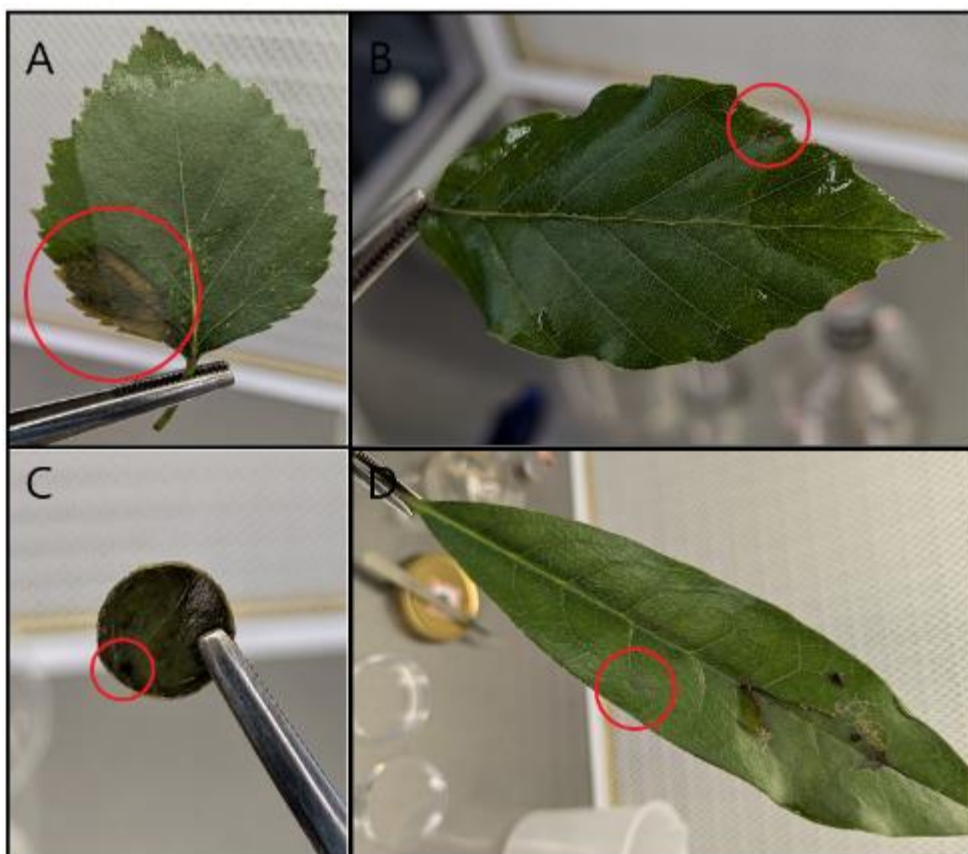


Figure 4: Examples of lesion isolations from bait containers. A) *Betula* leaf with light brown lesion near base of leaf. B) *Fagus sylvatica* showing small lesion on leaf edge. C) *Rhododendron* disc showing a small dark spot near disc edge. D) *Rhododendron* leaf with pale lesion (red circle) and other large lesions.

3.3.5 PCR amplification and identification by sequencing of ITS rDNA

Digested samples were centrifuged to pellet excess mycelium. In a PCR cabinet, 2µl of each sample was transferred to 0.2ml PCR tubes containing a PCR amplification mix (14µl PCR grade water, 20µl One-taq Quick-load Taq 2X Master mix, 2µl each ITS6 forward and ITS4 reverse primers). PCR thermal cycling consisted of lid 105°C, initial denaturation 94 °C for 2 minutes followed by 35 cycles of denaturation 94 °C for 30 seconds, annealing 55 °C for 30 seconds, elongation 72 °C for 45 seconds, and a final elongation of 72 °C 10 minutes.

Five microlitres of PCR product was loaded onto a 1% TAE agar gel containing gel red as a visual check for amplification. A 100bp ladder was loaded to check for fragment size and the tank was run at 100V for 40 minutes. Gel results were used to confirm amplification of the correct amplicon size. Samples were stored at 20 °C.

PCR amplicons were cleaned using Zymo research Clean & Concentrate-25™ prior to Sanger sequencing at the James Hutton Institute. DNA chromatograms were viewed and edited using Sequencer v. 5.4.6. Sequences were identified using NCBI blastn at 99-100% match to voucher, type or taxonomic specimens.

4 Results

4.1 Evidence review

4.1.1 Import data

Scotland produces a significant amount of bulk materials within its borders. However, bulk aggregates are still imported into the UK, and while a country breakdown is not possible it is conceivable that these materials will also be destined for Scotland. Therefore, HMRC were requested to provide import data for the materials in question. These data are available from 1st January 2022 (i.e., it has only been required to be collected since the UK left the EU). Due to the timing of this project and the reporting cycles, the 2024 data only includes 6 months data from 1st January to 30th June 2024 (HMRC, 2024).

In order to analyse the data, commodity codes were combined into the categories of “sand”, “rocks and stones”, “building blocks and bricks”, and “wood chips” (see table 1, section 3.2).

4.1.1.1 Sand

Over the 30 months represented in the data, over a million tonnes of sand was imported into the UK with an overall value of over £86 million (Table 3).

Table 3 – Imports of sand into the UK (HMRC, 2024).

Year	Total import (tonnes)	Value (£)
2022	556,927	£38,836,064
2023	429,524	£30,967,736
2024 (6 months data)	190,531	£16,355,631
Total (Jan 22 – Jun 24)	1,176,984	£86,159,431

The sand was imported from 49 countries (full list in appendix a), the top 10 of which are shown in Figure 5.

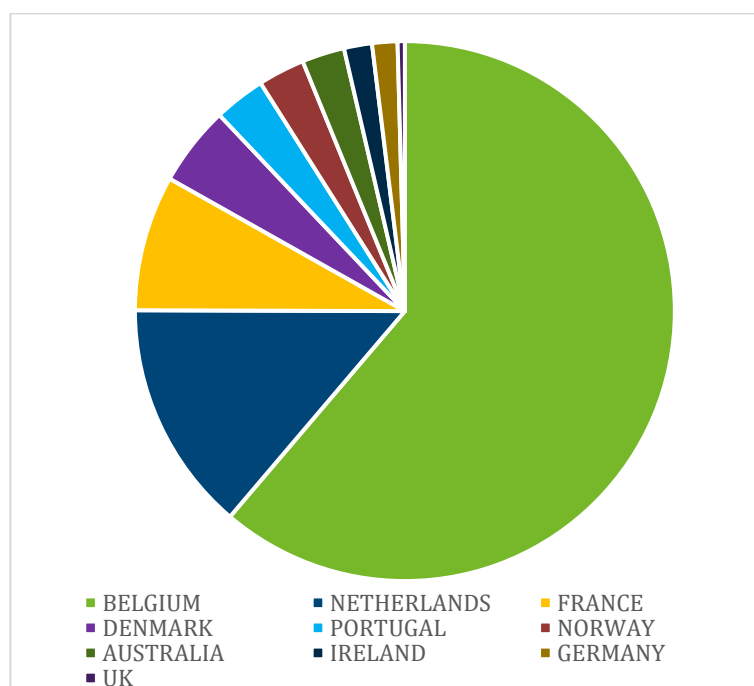


Figure 5 – Top 10 countries from where sand was imported into the UK by weight (HMRC, 2024).

4.1.1.2 Rocks and stone

More than 12 million tonnes of rocks and stones were imported during the period studied with a value of over £659 million (Table 4).

Table 4 – Imports of rocks and stone into the UK (HMRC, 2024)

Year	Total import (tonnes)	Value (£)
2022	5094192	£313,585,663
2023	4724077	£225,866,394
2024 (6 months data)	2410040	£119,954,053
Total (Jan 22 – Jun 24)	12,228,310	£659,406,110

Rocks and stone were imported from 78 countries (appendix a), the top 6 are shown in Figure 6.

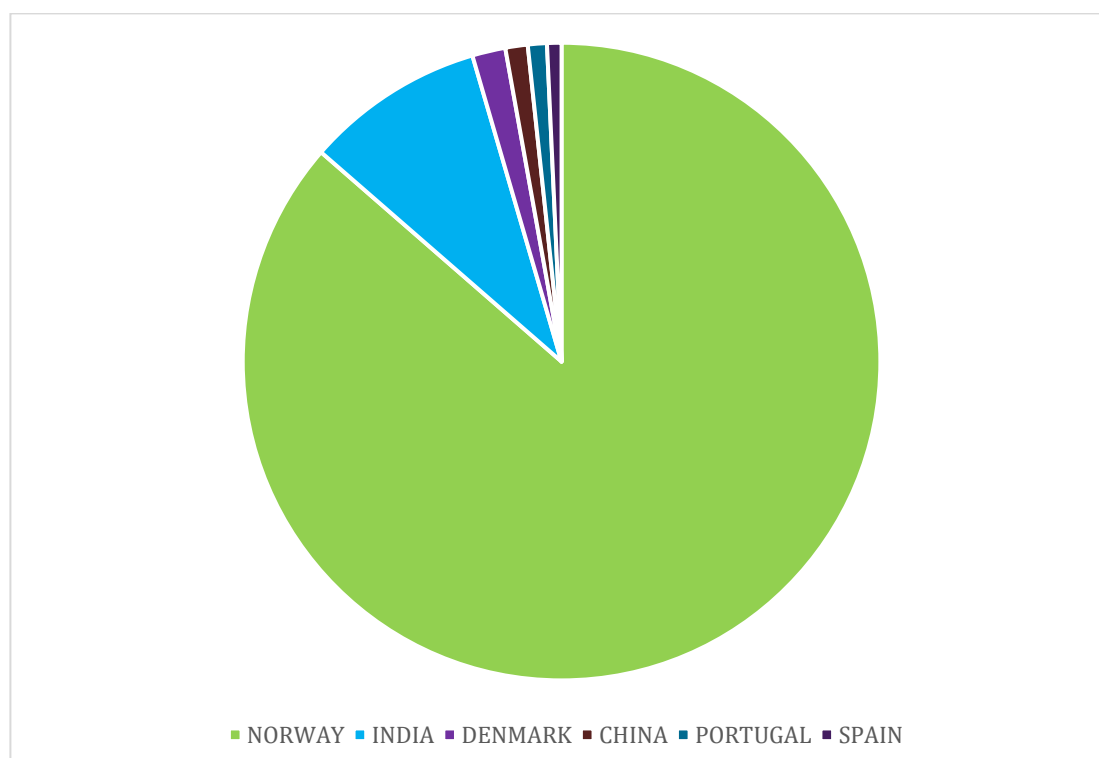


Figure 6 – Top 6 countries from where rocks and stone were imported into the UK by weight (HMRC, 2024).

4.1.1.3 Building blocks and bricks

Almost 3 million tonnes of building blocks and bricks were imported with a value of almost £668 million (Table 5).

Table 5 – Imports of building blocks and bricks (HMRC, 2024).

Year	Total import (tonnes)	Value (£)
2022	1532166	£322,725,534
2023	857515	£224,034,728
2024 (6 months data)	399849	£120,938,724
Total (Jan 22 – Jun 24)	2,789,532	£667,698,986

Building blocks and bricks originated from 39 countries (appendix a), the top 12 are shown in figure 7.

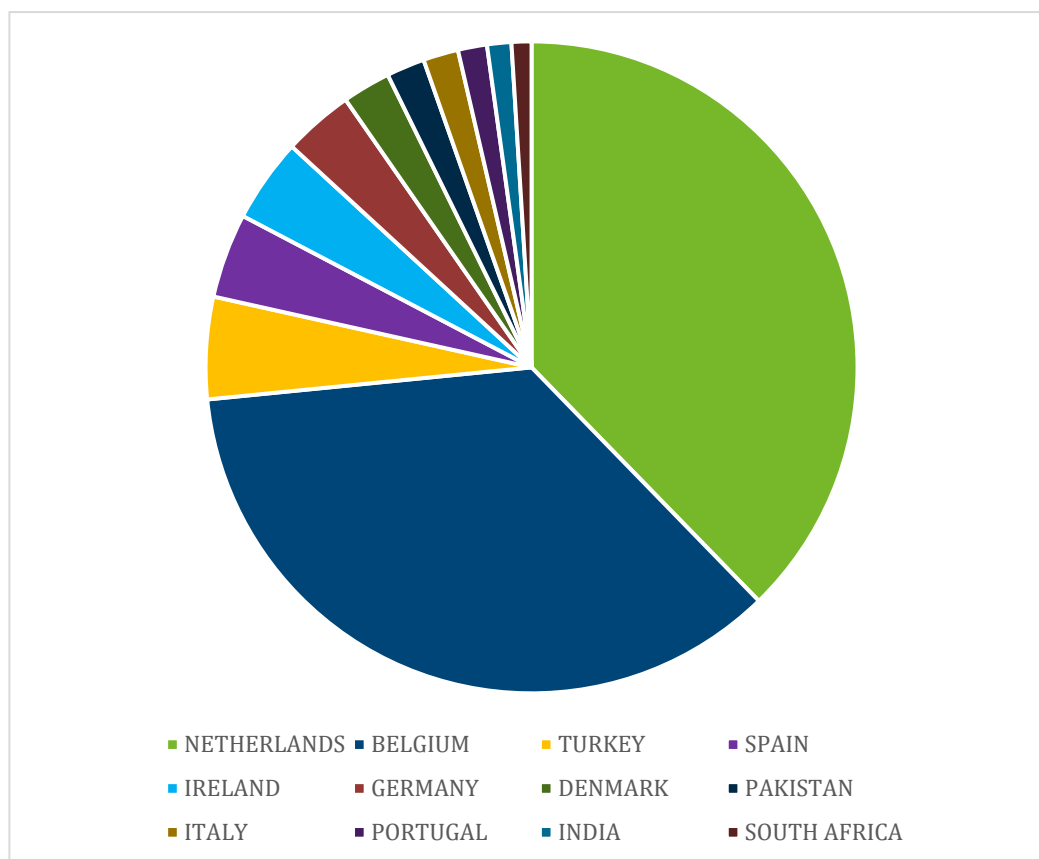


Figure 7 – Top 12 countries from where building blocks and bricks were imported into the UK by weight (HMRC, 2024).

4.1.1.4 Wood chips

More than 60 thousand tonnes of wood chips were imported over the 30-month data period with a value of almost £21 million (Table 6).

Table 6 – Imports of wood chips into the UK (HMRC, 2024)

Year	Total import (tonnes)	Value (£)
2022	24,941.19	£8,470,740
2023	25,908.68	£8,478,619
2024 (6 months data)	11,314.76	£3,955,201
Total (Jan 22 – Jun 24)	62,164.63	£20,904,560

This commodity originated from 39 countries (appendix a), the top 14 are shown in Figure 8.

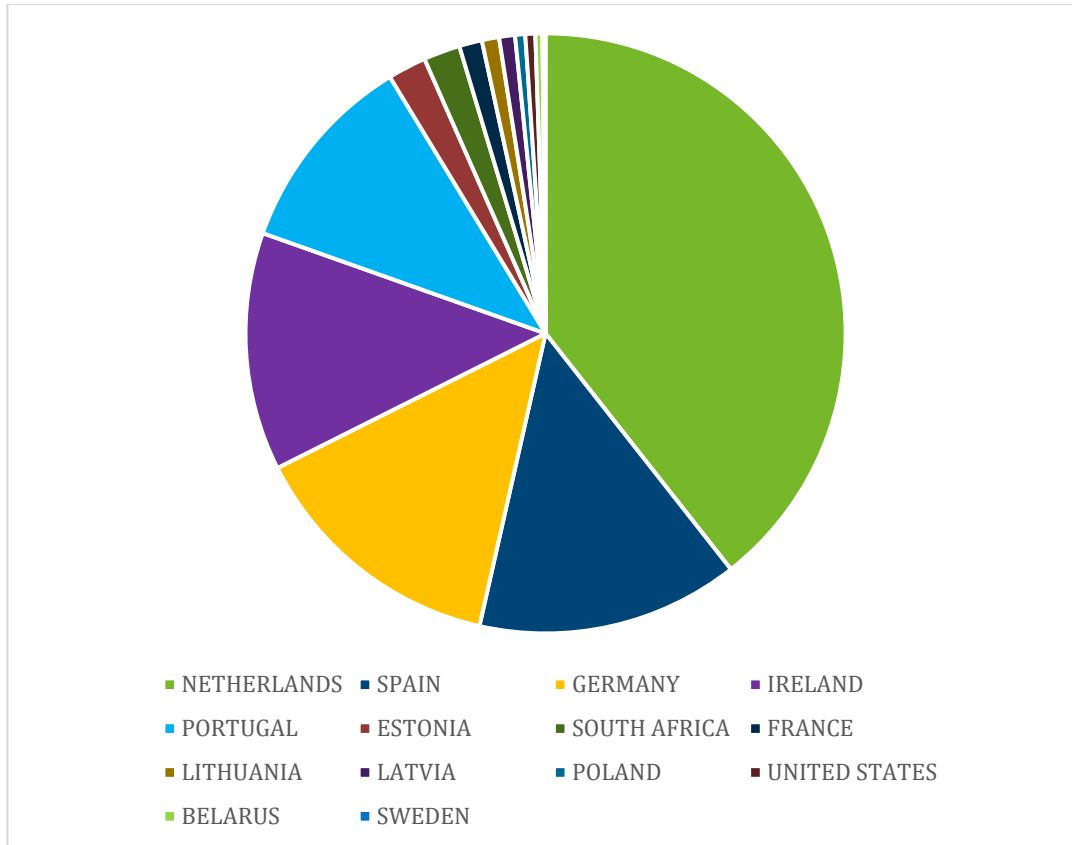


Figure 8 – Top 14 countries from where wood chip was imported into the UK by weight (HMRC, 2024).

4.1.2 Aggregate Minerals Survey for Scotland

The British Geological Survey (BGS) conduct a mineral survey of Scotland on a regular basis on behalf of the Scottish Government. The current version, the 2019 Aggregate Minerals Survey for Scotland, was published in September 2023 (Mankelow, et al., 2023).

The information in the report is collected from aggregates producers (reserves, sales and sales by destination) and Planning Authorities (planning permissions), and covers sales, consumption, and permitted reserves of primary aggregates.

In this latest version, data were obtained for 131 quarries, of which 22 were inactive in 2019, although worked in the past, and two sites which had yet to be worked. Of the 107 active quarries surveyed, 66 were for crushed rock and 41 for sand and gravel. According to BGS records, there were 237 active aggregates quarries in Scotland in 2019. Therefore, the response rate for the survey by active quarries was only 45%. This report therefore is not a complete picture of bulk aggregate production and movement in Scotland, but it is the most accurate data currently available.

Total sales of primary aggregates (sand, gravel and crushed rock) produced in Scotland were over 21 million tonnes in 2019, comprising 3.74 Mt (18%) of sand and gravel, and 17.04 Mt (82%) of crushed rock. Of the crushed rock types, igneous rock is the most important source of primary aggregate in Scotland (79%) (Figure 9).

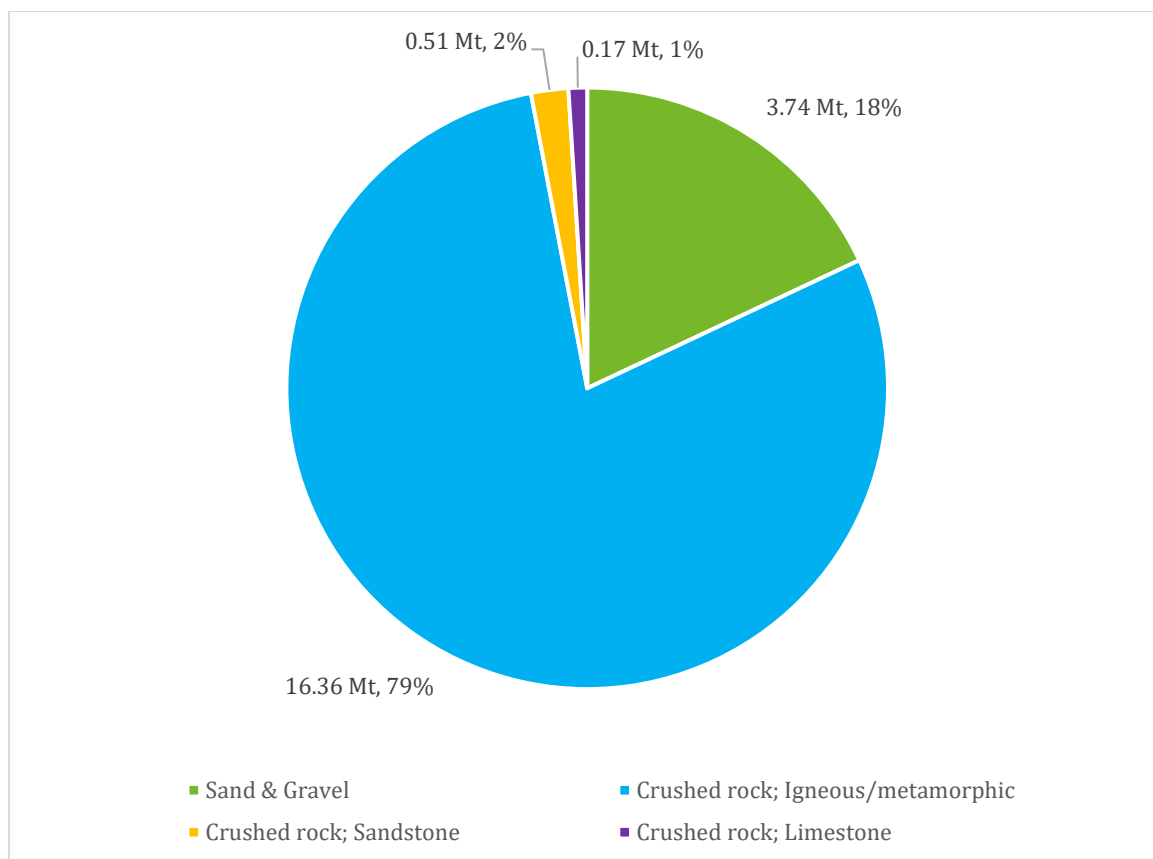


Figure 9 – Total sales of primary aggregates produced in Scotland by weight (20.78 Mt total)

The Highland region of Scotland is the largest producer of bulk aggregates (crushed rock, sand and gravel), responsible for 36% of total primary land-won aggregates sales (7.5 Mt), and West Central Scotland was the second largest source (4.5 Mt, 22%) (Figure 10). The amounts of the types of aggregate produced in these regions differs significantly, with Highland accounting for the largest volume of crushed rock aggregate sales (7.2 Mt, 42%), followed by West Central Scotland (3.5 Mt, 20%). This reflects where the large quarries are located in Scotland (e.g., the large coastal quarry at Glensanda in Highlands region).

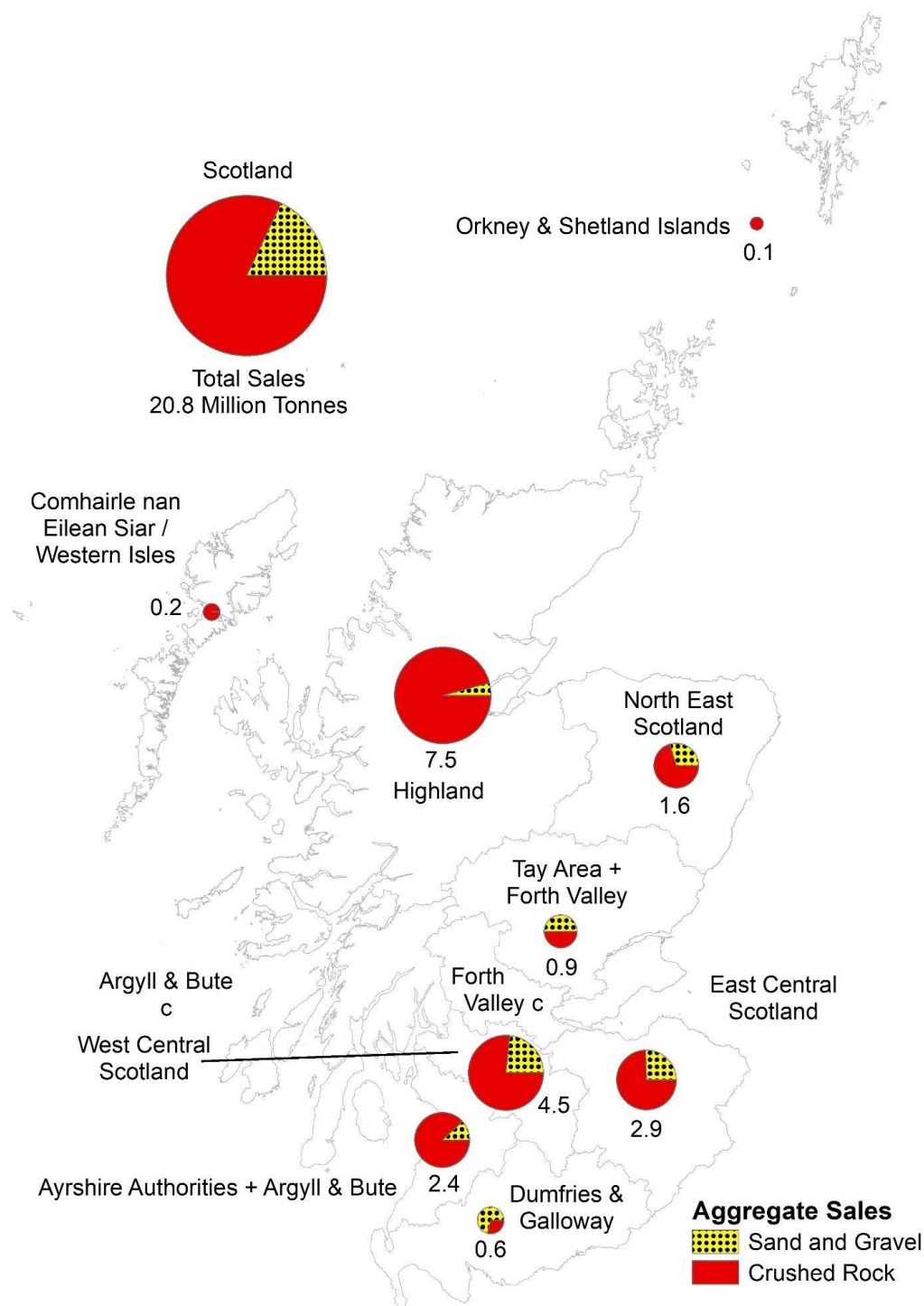


Figure 10 – Sales of sand and gravel and crushed rock for primary aggregates, 2019. Mankelow, et al., 2023.

In terms of the use of the primary aggregates captured in the mineral survey, the Central and Southern regions of Scotland are the largest consumers (Figure 11; West Central Scotland 5.1 Mt, East Central Scotland 2.6 Mt). The survey also states that a small proportion of primary aggregates are imported from England and Wales (0.08 Mt) which are not included in these figures.

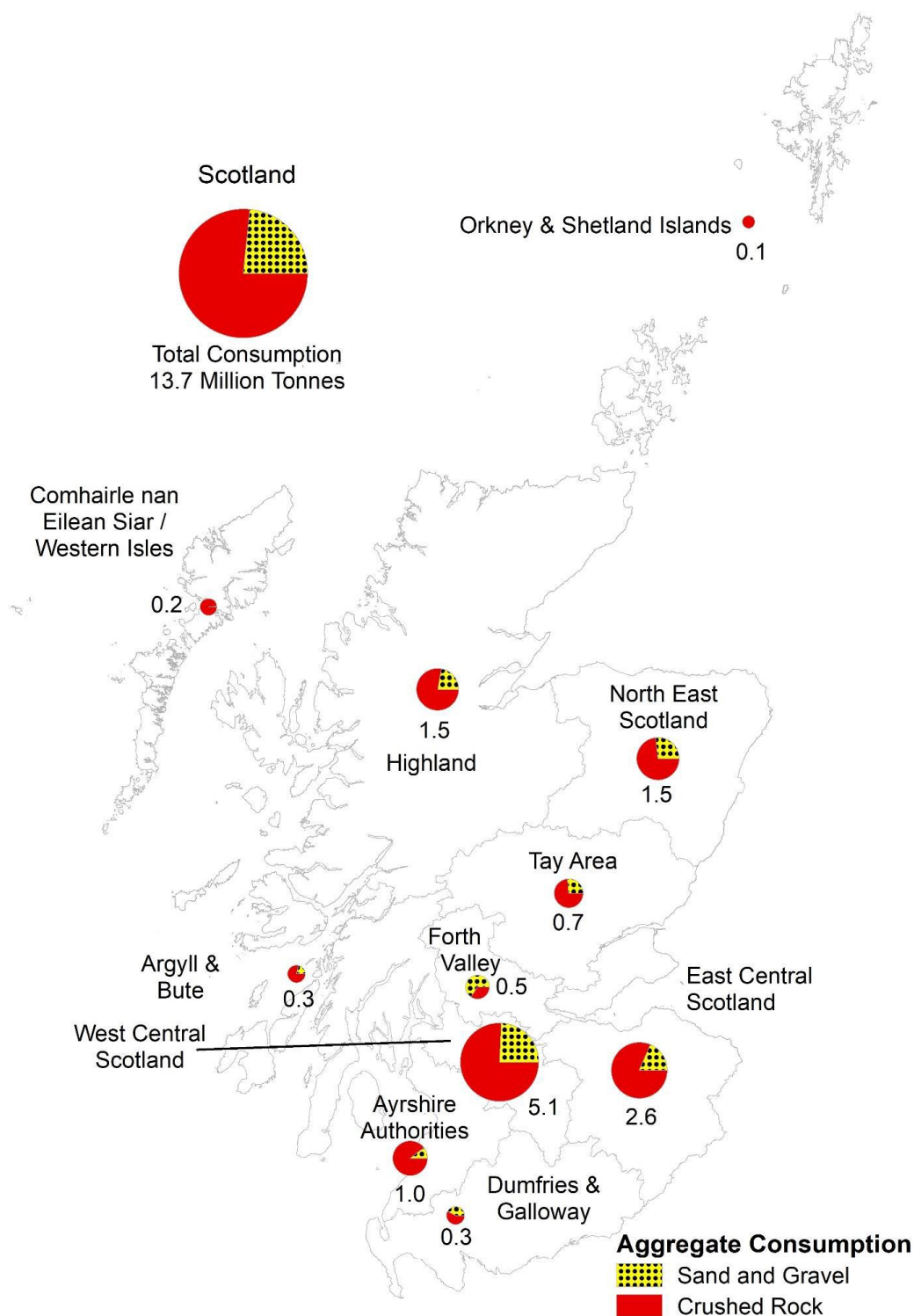


Figure 11 – Consumption of sand and gravel and crushed rock for primary aggregates, 2019. Mankelow, et al., 2023.

These primary aggregates are moved throughout Scotland as shown in Figures 12 and 13. It is not always possible for quarry operators to be sure of where their products will be sold, e.g., where customers and retailers collect their aggregates directly from the quarry, but the data shown are a good representation of how these primary products are distributed after quarrying.

Proportionally, the movement of sand and gravel were around one fifth the level of crushed rock. The leading exporter of crushed rock is the Highland region (85%; 6.1 Mt), and the leading exporter of sand and gravel was East Central Scotland (0.35 Mt), principally to the Forth Valley.

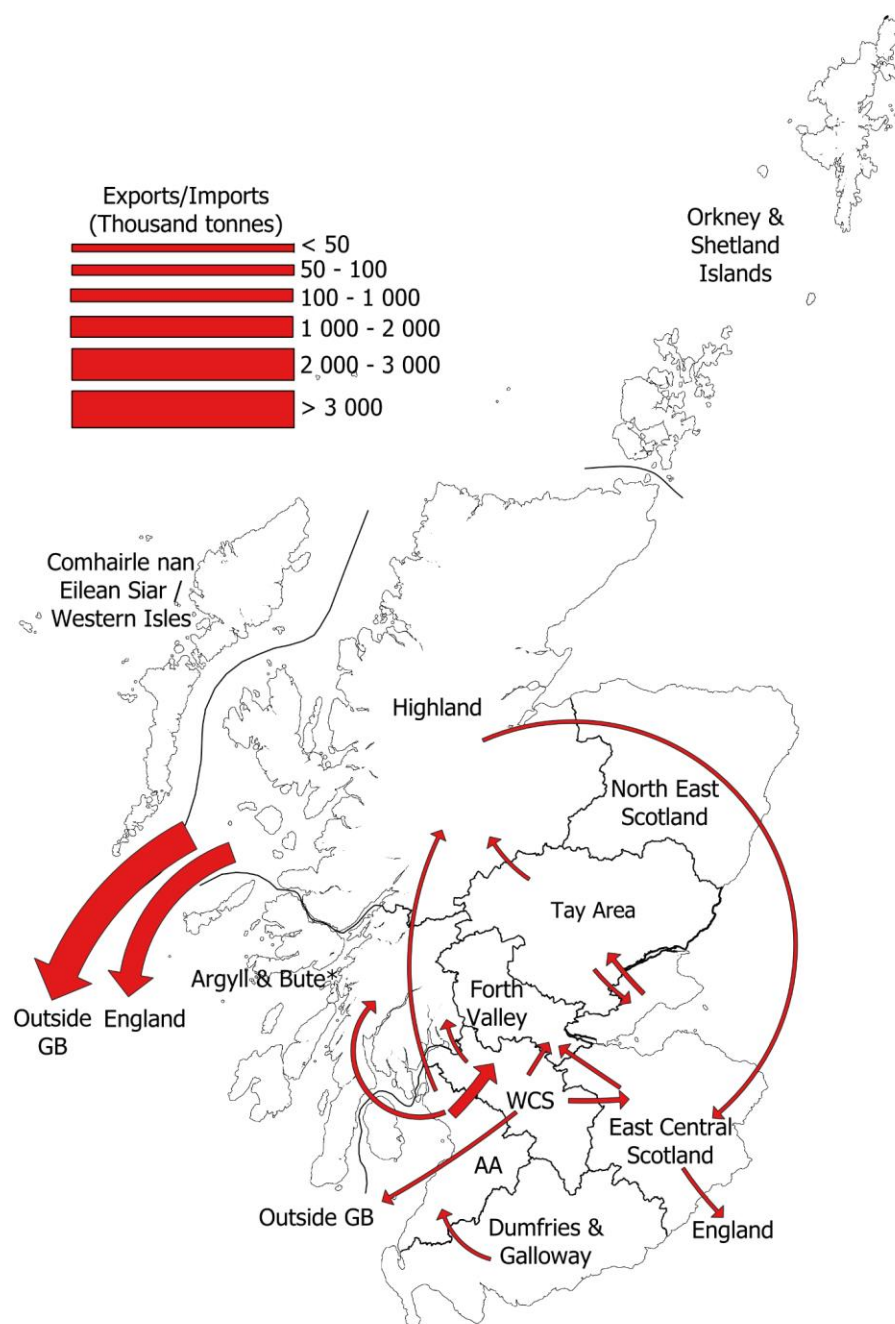
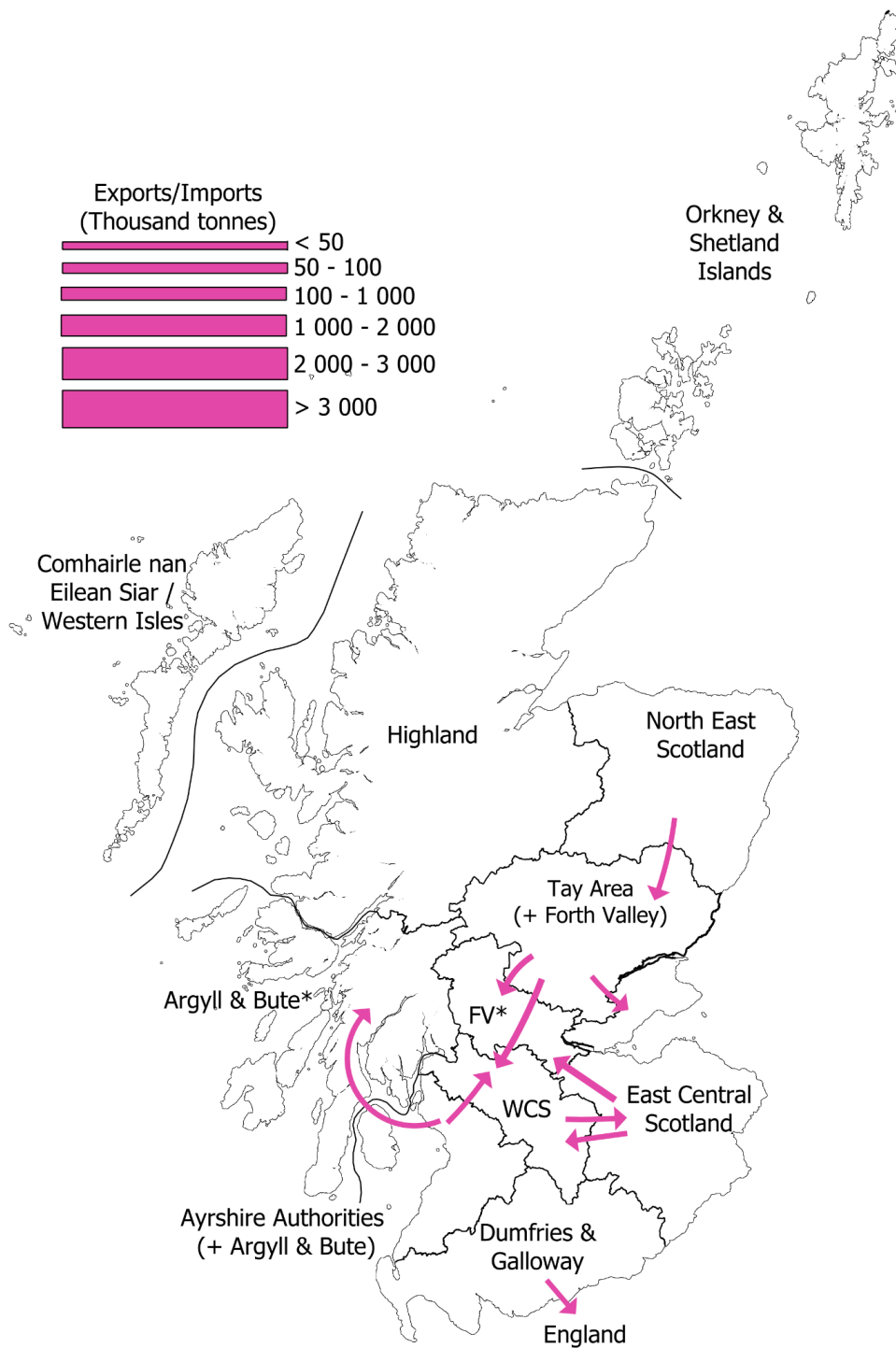


Figure 12 – Crushed rock inter-regional flows of primary aggregates, 2019. Mankelaw, et al., 2023.



*Figure 13 – Sand and gravel inter-regional flows of primary aggregates, 2019.
Mankelow, et al., 2023.*

Most primary bulk aggregates are moved by road (68%) with the exception of the Highland region which moves crushed rock by water (due to the large coastal quarry at Glensanda) (Mankelow, et al., 2023).

4.1.3 International movement of Sand

Globally, sand is the most-consumed natural resource besides water (Torres, et al., 2021). The global sand market was worth £1.9B (\$2.33B) in 2022 (OEC, 2022). As mentioned in 4.1.2, Scotland produces a significant amount of sand within its borders. The bulk of silica sand production is based on Carboniferous sandstones in central Scotland (e.g., Hullerhill, North Ayrshire) and high purity silica sands of Upper Cretaceous age is mined at the Lochaline Mine on the Morvern peninsula of the Isle of Mull (Historic Environment Scotland, 2024).

However, the sand used for building, landscaping and adding to composts is more angular in shape and is required to be mined or dredged from water sources around the world (Torres, et al., 2021).

As the data in section 4.1.1.1 shows, the UK imports significant amounts of sand (1.2Mt with a value of £86 million). Figure 14 shows the top 20 sand exporting countries in 2022 (OEC, 2022), the UK imports the majority of the sand used from Belgium (Figure 4).

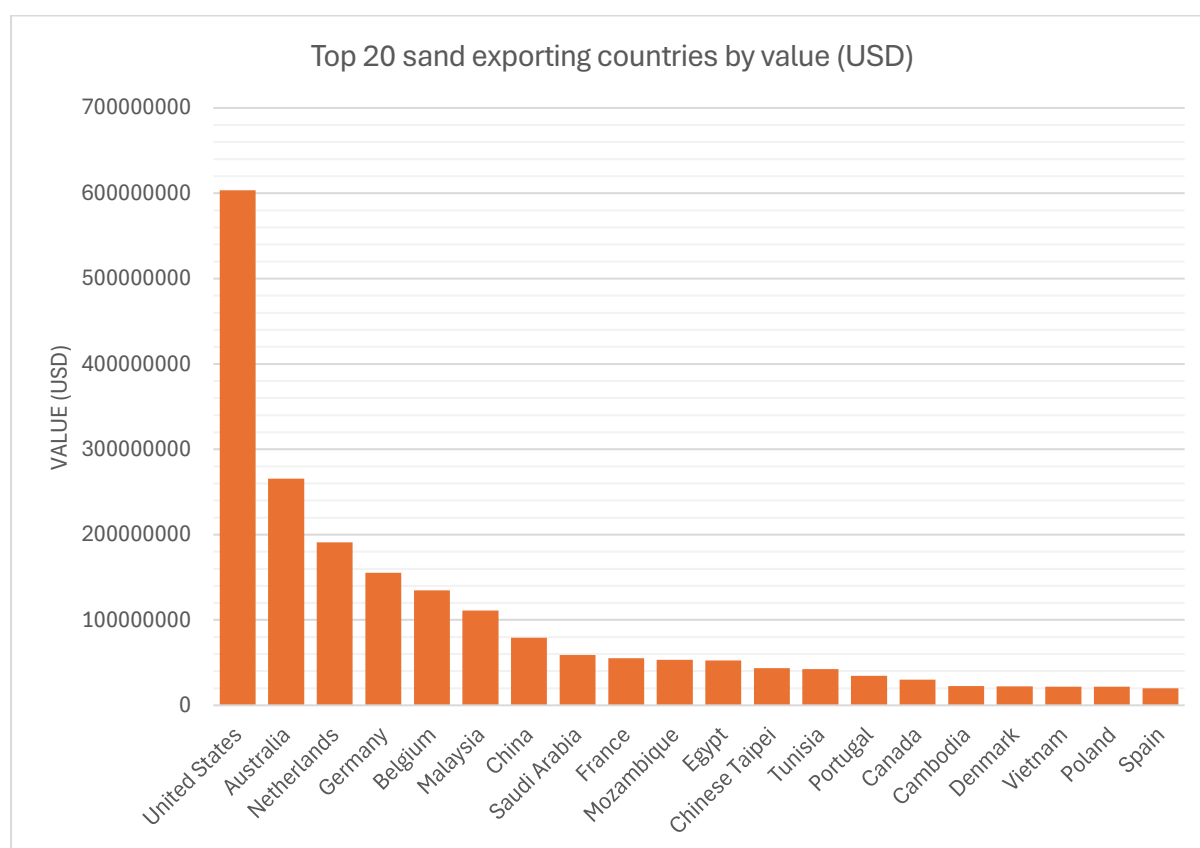


Figure 14 – Top 20 sand exporting countries in 2022 (OEC, 2022).

This study could not identify any literature which investigated the plant health implications of sand movement. However, in 2012, an expert group held a workshop on the public health implications of sand, the so-called “Microareias 2012” workshop (Sabino, et al., 2014). Evidence was presented that pathogens associated with human health conditions were present in sand (e.g., bacteria such as *Pseudomonas* spp., *Salmonella* spp., *Shigella* spp., *Campylobacter jejuni*, *Staphylococcus aureus*, *Vibrio parahaemolyticus*; fungi such as *Candida* spp. and dermatophytic fungi; and parasitic nematodes and viruses (adenovirus, norovirus, enterovirus) (Stewart, et al., 2008). It is therefore conceivable that if sand can harbour pathogens associated with human health, it could also harbour plant pathogens.

Due to the risks to public health, the workshop recommended that:

- beach sand should be screened for a variety of pathogens harmful to human health, and sand monitoring should then be initiated alongside regular water monitoring
- sampling and analysis protocols should be standardized to allow proper comparisons among beach locations
- further studies are needed to estimate human health risk with exposure to contaminated beach sand. Much of the manuscript is focused on research specific to Portugal, but similar results have been found elsewhere, and the findings have worldwide implications

4.1.4 Topsoil

When engaging with the topsoil supply sector, they were keen to point out that responsible suppliers adhered to the British Standard for topsoil, BS 3882:2015. This Standard has evolved from an original 1994 version which specified three grades of topsoil (economy, general purpose and premium), to the 2007 edition which describes two grades (multipurpose and specific purpose). This was required to improve the quality of topsoil because the economy grade in the original Standard was usually poor-quality sub-soil rather than topsoil.

A further update occurred in 2015 which clarified the two-grade approach, a multipurpose grade, intended as a general quality topsoil for most landscaping applications, and “specific purpose” grade which is for projects which need topsoil with specific properties (e.g., acidic soil, calcareous soil or low fertility).

In order to be BS 3882:2015 certified, topsoil must have passed certain requirements. These include specific parameters of fertility, soil structure and classification, as well as the soil being free from contamination. In addition, the requirements set out steps to be taken to avoid erosion from areas where topsoil has been removed (NRM, 2021).

However, BS 3882:2015 is a voluntary quality standard and suppliers are not obliged to be certified. There will be many topsoil suppliers that are not. As far as plant health risks are concerned, BS 3882:2015 does not require any heat-treatment, or other sterilisation techniques, to remove plant pests or pathogens.

Understanding the provenance and movement of topsoil in Scotland is very difficult due to the unregulated nature of the sector. Stakeholders reported that most of the topsoil for sale in Scotland is produced via the removal of the top layer(s) of soil prior to building work taking place (brownfield as well as greenfield sites). The suppliers of high-quality topsoil stated that their product was from virgin, greenfield sites, where the top layer of soil is excavated before other work takes place. The topsoil is also usually screened to keep some stones for structure but remove larger stones and other material (about 14mm was regularly mentioned).

Another area of topsoil supply is as a byproduct of agricultural processes. For example, approximately 200,000 tonnes of soil is recovered annually from sugar beet growing. The sugar beet is washed as part of its processing, these washings are captured and stored in settlement lagoons. The soil is then excavated from these lagoons and dried over a two-year period before it is blended and sold as topsoil.

However, potentially poor-quality topsoil can be purchased from online marketplaces with unknown provenance which is not only a quality issue but also a plant health concern. This activity avoids standards and regulations.

The International Plant Protection Convention (IPPC) governs international standards which are published in the form of International Standards for Phytosanitary Measures (ISPM) standards. ISPM 40 is concerned with the *international movement of growing media in*

association with plants for planting which also captures soil (FAO, 2017). ISPM 40 gives the Plant Health Authorities in GB advice on which measures may be used to address the risk posed by soil movement.

For import, soil is captured as a risk to plant health within current plant health regulations (EUR2019/2072¹; Annex 7, point 1) because it can contain pests and disease-causing organisms which cannot be seen with the naked eye. This prohibits soil from non-EU 3rd countries. In order to allow for the import of plants from the EU, soil is allowed to be moved into GB because there may be soil associated with plants (e.g., plants in a potting media with soil included, and soil composed composts). Therefore, if there was a blanket prohibition of soil imports, this would have a significant negative impact on the movement of plants for planting. The Plant Health Authorities would need to be notified if soil was imported from the EU so that it could be inspected. Defra is currently reviewing the status of EU soil imports into the UK as part of its regular pest risk assessment process (Pers. Comm., SASA).

There was no evidence reported from stakeholders of the widespread importation of soil into GB, but topsoil for sale in Scotland may have originated from other parts of GB.

Due to the regulations described above, the UKPHRR captures soil within the “Pathway” data as “soil/growing media”. There are 199 pests associated with this pathway (appendix b), including *Ceratocystis platani*, a serious pathogen of plane trees, 13 species of *Phytophthora* pathogens, and 2 species of *Epitrix* (potato flea beetle). In addition, the UKPHRR lists a further 39 pests under “Plants for planting (with soil)” within the “Pathway assessed for Entry to UK” data (appendix b) (Defra, 2024).

In 2015, the European Commission asked the European Food Safety Authority (EFSA) to investigate the plant health risks posed by EU import of soil or growing media. This report, prepared by the EFSA Panel on Plant Health (PLH Panel), reviewed 207 scientific publications to identify and rate the effectiveness of options that could reduce the risk of entry of pests via the import of soil and growing media (EFSA, 2015). The Panel found that the ‘prohibition of import’ was the only phytosanitary measure with a very high effectiveness and a low uncertainty. However, as explained above, this would be very difficult to implement because plants that are traded across borders may be potted in soil, and there may be products which will have soil as a component (e.g., compost).

4.1.5 Wood chips

There is no HMRC commodity code specific to isolated bark (e.g., bark chips). As an approximation, the data in this report uses commodity codes for wood chips (coniferous and broadleaves) which can conceivably be used for a wide range of applications, some outdoors. The product tested in section 3.3 is a widely available product used in ornamental landscaping as a mulch, which is intended to conserve soil moisture, reduce weeds and maintain a more consistent soil temperature. These chips are often derived as a by-product during forestry operations from trees which have been felled but could also be from other waste wood products such as pallets. It may or may not contain bark.

The disease risk from wood chips is high (Kopinga, et al., 2010). Many studies have found that disease-causing organisms can move from infected chips onto nearby plants (Koski & Jacobi, 2004; Panesar, et al., 1994; Foreman, et al., 2002). For example, wood pieces infected with the fungal pathogen *Thyronectria austroamericana*, which causes canker in honey locust (*Gleditsia triacanthos*) trees, have been shown to remain a source of inoculum for 143 weeks (Koski & Jacobi, 2004). Therefore, placing chips from an infected, previously felled tree, would greatly increase the risk of healthy honey locust trees becoming infected.

¹ EUR2019/2072; <https://www.legislation.gov.uk/eur/2019/2072>

Kopinga, et al. (2010), found that chipping alone cannot eliminate fungal (and fungal-like) organisms, pathogenic bacteria or nematodes. Chipping can reduce the risk of the spread of Asian longhorn beetle and emerald ash borer if chips are below 2.5cm (although some pre-pupae of emerald ash borer could potentially survive this). Further treatments, such as heat-treatment, are required to lower the risk of the survival and spread of plant pests and diseases (Kopinga, et al., 2010).

Due to the known plant health risks posed by bark, this product is captured as a pathway within plant health regulations (International Standard for Phytosanitary Measures 39 (ISPM 39) – International movement of wood (FAO, 2017a)). The UKPHRR (Defra, 2024a) contains 72 pests which have “bark” as a pathway, i.e., they can potentially be introduced or spread within bark (appendix b). This includes 7 species of damaging jewel beetles (*Agrilus* spp.), 12 species of longhorn beetles (*Monochamus* spp.) and many fungal pathogens (e.g., *Cronartium* spp.).

The current import regulations (introduced in January 2024) assign risk categorisations to plants, plant products, wood and wood products (Defra, 2024b). The bark of certain tree species is considered a high-risk commodity, some examples are provided in Table 7.

Table 7 – Examples of high risk hosts of bark (Defra, 2024b)

High Risk	
Group	Commodity
Bark of	<i>Castanea</i> spp. Conifers (Pinales) <i>Fraxinus</i> spp. <i>Juglans</i> spp. <i>Pterocarya</i> spp. <i>Ulmus davidiana</i>

As a result, bark from these species are subject to certain phytosanitary conditions, set out in [Phytosanitary Conditions Regulation](#) (PCR) Annex 6 (PART C – 2) and Annex 7 (PART A 109-142). Pre-notification to plant health authorities is also required so that the consignment can be inspected if appropriate (Defra, 2024b).

We talked to six bark chip suppliers in Scotland. They described their products as UK-sourced and sustainable (i.e., they were an FSC-certified product) “mixed conifer bark” with a white wood (trunk) content of between 20 and 30% by volume and free from chemical contamination.

FSC (The Forest Stewardship Council) certification of bark ensures that the product comes from FSC-certified forests which are managed to strict environmental, social and economic standards (FSC, 2024). Integrated pest management (IPM) is embedded in the FSC principles, however, bark products are not required to be treated before sale (e.g., heat treated). Other elements such as storage of bark chips in the medium-long term are not covered, which can mean that piles of bark chips could build up on sites before their sale.

In addition, there is no industry standard for bark chip supply, it is therefore very difficult for a buyer to ascertain how the product has been treated before purchasing. Provenance of a bark product can be ascertained if the product is sourced from a responsible supplier. However, it is difficult to gain data on the quantity of bark chips being moved around Scotland and wider GB. These factors therefore indicate that bark chips are a significant plant health risk, not only to landscaping but also forestry and the wider environment.

4.1.6 Forest roads and paths

One of the plant health risks this study sought to clarify, was whether the material used to build forest roads for forestry operations (e.g., timber extraction) posed a risk of the introduction and spread of a tree pest or pathogen. Additionally, could building recreational paths within woodlands introduce plant health risks?

We spoke to stakeholders in the forestry and woodland sectors (e.g., Scottish Forestry, Woodland Trust) to understand this further. Recycled material (e.g., aggregates from demolished buildings) was not generally used for forestry applications due to the potential presence of contaminants such as asbestos. There is currently no industry standard for the products used for forest road/path building.

In Scotland in particular, there are quarries within, or close by, most forest blocks and therefore freshly quarried material is in plentiful supply. There are currently approximately 900 so called ‘borrow pits’ on the Public Forest Estate (Pers. Comm. Scottish Forestry). This means that quarried material for road/path building travels short distances in Scotland, typically less than 100 miles.

This suggests that the plant health risks from building forest roads and woodland paths is very low [except where moving across boundaries where a pest is known to be present].

4.1.7 Building blocks and bricks

The UK imported 2.8 Mt of building blocks and bricks between 1st January 2022 and the 30th June 2024 with a value of £667m. This study could not identify any research which investigated the phytosanitary status of bricks and building blocks. Given that these materials go through an industrial process during production it is assumed that they are very low risk.

However, as these materials move across borders it is conceivable that they may contain hitchhiking species of pests in spaces within them (or on the pallets that they are on – as per Asian Longhorn Beetle mentioned earlier).

4.1.8 International examples of standards for bulk aggregates

4.1.8.1 International Standards for Phytosanitary Measures

International Standards for Phytosanitary Measures are standards adopted by the Commission on Phytosanitary Measures (CPM), which is the governing body of the International Plant Protection Convention (IPPC). As of April 2024, there were 46 adopted ISPMs (ISPM 30 is being revoked), 33 Diagnostic Protocols and 46 Phytosanitary Treatments (IPPC, 2024).

ISPM 40: International movement of growing media in association with plants for planting (IPPC, 2021), captures a number of bulk aggregate materials relevant to this study in terms of their addition as a component of growing media. These are sand, gravel, soil and wood chips. This standard sets out the requirements that should be met for these aggregates as part of growing media, however, there are no specific ISPMs for the commodities themselves (i.e., wood chip, sand, rock or soil). Without this international framework for the development of such standards, it would be challenging for a National Plant Protection Organisation to create an import standard for such commodities.

4.1.8.2 New Zealand

Despite there being no internationally agreed ISPMs for bulk aggregates, New Zealand have identified a risk from such materials and have introduced their own standard: an Import Health Standard (IHS) for Soil, Rock, Sand, Clay, and Water (New Zealand Government,

2024). This Standard describes the conditions that must be met by the exporting country or importer to receive a permit to import. In addition to declarations containing the details of the consignment (e.g., provenance of the material), the details of the treatment that has been carried out on the material must be declared (Table 8).

Table 8 – Treatments required under the IHS for Soil, Rock, Sand, Clay, and Water (New Zealand Government, 2024).

Treatment	Specific requirements
Boiling	Heat to 100°C for a minimum of 1 minute
Filtration	<ul style="list-style-type: none"> • Filtration down to 0.1 µm • Avoid filter overload by using progressive filtration where appropriate. • The residue must then be securely destroyed, re-exported or treated with one of the following options: <ul style="list-style-type: none"> ○ Chemical treatment in accordance with this Table 1; or ○ Irradiation treatment in accordance with this Table 1
Chemical	<ul style="list-style-type: none"> • Add calcium hypochlorite at 20 mg/L. • The water must be agitated for 1 minute and then left to sit for 30 minutes. <p>OR:</p> <ul style="list-style-type: none"> ▪ Add mercuric chloride at 7 mg/L (100uL of saturated mercuric chloride per 1L of water sample). <p>OR</p> <ul style="list-style-type: none"> ▪ Preserve in Lugol's iodine, minimum 1% concentration for at least 48 hours
Irradiation	<ul style="list-style-type: none"> • When used for soil, the soil must be loosely packed and spread no thicker than 10 cm. • Irradiation at 50 kGy
Moist heat	<ul style="list-style-type: none"> • When used for soil, the soil must be loosely packed and spread no thicker than 10 cm. • Heat treat at a minimum of 40% humidity, to <ul style="list-style-type: none"> ○ 100°C for 25 minutes; or ○ 85°C for 15 hours.

Treatment	Specific requirements
Dry heat	<ul style="list-style-type: none"> • When used for soil, the soil must be loosely packed and spread no thicker than 10 cm. • Dry heat treat to minimum of <ul style="list-style-type: none"> ○ 110°C for 16 hours; or ○ 121°C for 2 hours; or ○ 154°C for 30 minutes; or ○ 193°C for 4 minutes; or ○ 221°C for 2 minutes
Autoclave	<ul style="list-style-type: none"> • When used for soil, the soil must be loosely packed and spread no thicker than 10 cm. • Autoclave at 100 kPa 121°C for 30 minutes
Cleaning	<ul style="list-style-type: none"> • Manually remove all visible plant material, animal material and soil. • It may be necessary to use clean tools and/or water. • Any removed organic material must then be disposed of as quarantine waste or re-exported.

The approach taken by New Zealand shows that it is possible to introduce a country-specific standard should a plant health risk be identified.

4.2 Laboratory testing of samples

Live oomycete cultures were obtained from all aggregate types tested, including one species of *Phytophthora*, several *Pythium* species, two *Phytophthora* and *Globisporangium* species, and one *Elongisporangium* species (Table 9).

4.2.1 Bark chip

Clade 6b *Phytophthora bilorbang* was detected in bark chip (intended as a horticultural top dressing) by baiting with rhododendron at room temperature (19-21 °C). *Phytophthora bilorbang* is the causal agent of decline in a number of woody hosts, including Olea root rot in Italy (Santilli, et al, 2020). In Sardinia, *P. bilorbang* was isolated from 25% of soil samples around *Juniperus phoeniceae* exhibiting severe dieback, and from *Pistacia lentiscus*. *P. bilorbang* soil inoculation of *J. phoeniceae* gave rise to reduced root length, leading to the death of ~38% of seedlings (Scanu, et al., 2015). The species was formally described and named in 2012 when the pathogen was identified as the agent responsible for blackberry decline in Australia (Aghighi, et al., 2012). Regarded as a species of inundated soil and rivers, it has been found in streams in Oregon, USA (Reeser, at al., 2011) and was first recorded in soil around several tree species in N.E. France (Hansen E. & Delatour C., 1999).

In the UK, DNA of *P. bilorbang* was first detected by metabarcoding in 13 out of 17 nurseries sampled between 2016-2022. Although found predominantly in water samples, *P. bilorbang* was also less frequently associated with root samples (Green et al, 2024). Live *P. bilorbang* was also recovered by baiting stream water collected from a nursery in Scotland with

rhododendron leaves (Schiffer-Forsyth, et al, 2023). More recent detections of DNA in environmental soil and water samples in England and Wales (Defra Green, et al, 2025, submitted) suggest that *P. bilorbang* may be widespread in the UK.

Phytophythium littorale was also obtained as a live culture from the bark. This species was reported as a novel pathogen causing root and collar rot of oriental plane trees in Turkey (Dervis, et al., 2020), a root rot of apple in Turkey (Mert, et al., 2020), as well as root and crown rot of rhododendron in China (Li, et al., 2021) and almond root and crown rot in Iran (Javadi and Sharifnabi, 2016).

Shafizadeh and Kavanagh (2005) described *Elongisporangium undulatum* (formerly *Pythium undulatum*) as a virulent root rot pathogen of *Abies procera*, *Picea sitchensis*, *Picea abies* and *Pinus contorta* in Ireland. The pathogen was the cause of pine and spruce seedling damping-off in Finnish nurseries (Lilja et al, 1992) and also reduced growth and biomass of Norway Spruce seedlings in Switzerland (Tellenback & Sieber, 2012). It has been noted as a pathogen of forest oaks in several European countries (Jung, 1996) and of *Abies* and *Pseudotsuga* in Germany (Weber, et al, 2004). It has also been previously identified by baiting bark samples in other studies (Green, et al, 2023) and more recently by baiting stream water in Scotland (Green, et al., 2024).

Also identified were *Phytophthium citrinum*, which has been associated with soil-root samples in declining oak stands in Poland (Jankowiak, et al., 2014), and *Pythium sterilum* which has been the cause of root rot of blueberry in the US (Miles, et al., 2011).

4.2.2 Path sub-base gravel

Pythium dissotocum/coloratum (couldn't be separated based on the sequence data) have both previously been described in the UK (CABI, 2021; CABI, 2004). *Pythium dissotocum* has a broad host range, including food crops, woody hosts and ornamentals. *Pythium dissotocum* had a huge impact on hydroponic, commercially grown spinach in China, destroying 60 percent of the production in 2016 (Huo, et al., 2020). Another case of spread in a hydroponic growth system was reported from the USA, where *P. dissotocum* caused root rot of lettuce (McGhee, et al., 2018). *Pythium coloratum* was the cause of a cauliflower root rot in China (Song, et al, 2019) and causes carrot cavity spot. This group have previously baited *Pythium dissotocum* from a peat-free industry mix and from a sample of chopped bark (Pers. Comm. D. Frederickson Matika).

4.2.3 Large quarry stone

Very few species were detected on larger pieces of stone. *Pythium acanthicum* was identified, the literature suggests that this species is a mycoparasite of several fungi (Ali-Shtayeh, 1999). In addition, there is some evidence that *P. acanthicum* can be highly pathogenic to germinating seeds and seedling roots of tomato (Robertson, 1973).

Globisporangium rostratifringens was also detected. There is no information currently available for this species, but the genus *Globisporangium* are known as soil-inhabiting oomycetes with a worldwide distribution (Tojo, et al., 2021). Some species of the genus are known as important plant pathogens (Hu, 2023).

4.2.4 Gravel

Pythium torulosum was identified within these samples. This species is known to cause severe corn wilt and root rot in NE China (Tang, 2020), and a seed and seedling disease of soybean in the US (Clevinger, et al., 2012).

Globisporangium heterothallicum has a broad host range as a damping-off pathogen of alfalfa, soybean, spinach, corn, pepper and guayule (Hu, 2023).

Table 9 – Isolates identified by Sanger sequencing according to aggregate, incubation temperature & bait. RT refers to room temperature (19-21oC).

Primary Isolation ID	Aggregate ID	Aggregate Type	Incubation (°C)	Bait species	Harvest ID	Sequence ID & Match (%)
RBGE1.1_25_240724_H(d)_1	RBGE 1	Small gravel	25	Holly disc	H7/ H8	<i>Globisporangium rostratifingens</i> , 99.5
RBGE2.1_25_240724_Be_2	RBGE 2	Small gravel	25	Beech	H16/ H17	<i>Globisporangium heterothallicum</i> , 99.6
RBGE2.1_25_240724_H(d)_1	RBGE 2	Small gravel	25	Holly disc	H19/ H20	<i>Globisporangium heterothallicum</i> , 99.8
RBGE3.1_25_240724_Bi_2	RBGE 3	Small gravel	25	Birch	H18	<i>Pythium torulosum</i> , 100
RBGE4.1_25_230724_R(d)_1	RBGE 4	Large quarry stone (Type 1)	25	Rhododendron disc	H11	<i>Pythium</i> sp. 8 KVS-2023, 99
RBGE4.2_RT_310724_Bi_2	RBGE 4	Large quarry stone (Type 1)	RT	Birch	H21	<i>Pythium acanthicum</i> , 100
RBGE5.2_RT_240724_Be_1	RBGE 5	Large quarry stone (Type 1)	RT	Beech	H22/ H23/ H24/ H27/ H28	<i>Globisporangium rostratifingens</i> , 99
RBGE6.1_25_230724_Bi_1	RBGE 6	Large quarry stone (Type 1)	25	Birch	H3	<i>Pythium coloratum/ dissotocum</i> , 100
RBGE8.1_25_240724_H(d)_1	RBGE 8	Path sub-base gravel	25	Holly disc	H2	<i>Pythium coloratum/ dissotocum</i> , 100
RBGE10.2_RT_310724_R_1	RBGE 10	Woody bark mix	RT	Rhododendron	H12/ H13	<i>Phytopythium littorale</i> , 99
					H/14	<i>Pythium sterilum</i> , 99.6
RBGE11.1_25_240724_R_1	RBGE 11	Woody bark mix	25	Rhododendron	H5/ H6/ H25/ H26	<i>Phytopythium littorale</i> , 100
RBGE11.2_RT_240724_R(d)_1	RBGE 11	Woody bark mix	RT	Rhododendron disc	H29/ H30/ H31/ H32	<i>Phytophthora bilorbang</i> , 100
RBGE12.1_25_290724_R_1	RBGE 12	Woody bark mix	25	Rhododendron	H4	<i>Phytopythium citrinum</i> , 100
RBGE12.1_25_310724_R_1	RBGE 12	Woody bark mix	25	Rhododendron	H9	<i>Elongisporangium undulatum</i> , 99.8

5 Discussion and recommendations

Stakeholder engagement and awareness

Achieving widespread stakeholder engagement during this study was a significant challenge. It soon became clear that those working in quarrying and the movement of bulk aggregates did not consider biosecurity. Contamination was a major consideration by those recycling building material (e.g., asbestos, plastics, etc.) but plant diseases were not considered as important.

Soil

There is a voluntary industry standard for topsoil (BS 3882:2015) which ensures that it is of a certain quality (NRM, 2021). However, not all suppliers will be signed up, and the standard does not require any heat treatment to remove pathogens. The standard is more focussed on removing contaminants and other quality issues. Understanding the provenance and movement of topsoil in Scotland is very difficult due to the unregulated nature of the sector, this therefore represents a biosecurity risk. In addition, potentially poor-quality topsoil can be purchased from online marketplaces with unknown provenance which is not only a quality issue but also a plant health concern. This activity is under the radar as far as standards and regulations are concerned.

Soil from third countries (i.e., those outside of the EU) is not permitted to be imported into GB or Northern Ireland. However, soil is permitted to be moved within the EU (including GB) because plants for planting may be grown and moved with compost which contains soil (e.g., plants in a potting media with soil included, and soil composed composts). Therefore, if there was a blanket prohibition of soil imports, this would have a significant negative impact on plant imports. This is captured in ISPM 40 “international movement of growing media in association with plants for planting” (FAO, 2017). The UKPHRR currently lists 238 pests associated with the pathways “soil/growing media” and “Plants for planting (with soil)” (appendix b). This includes *Ceratocystis platani*, a serious pathogen of plane trees, 13 species of *Phytophthora* pathogens, and 2 species of *Epitrix* (potato flea beetle).

The UK Plant Health Authorities would need to be notified if soil was imported from the EU so that it could be inspected. Defra is currently reviewing the status of EU soil imports into the UK as part of its regular pest risk assessment process (Pers. Comm., SASA). There was no evidence reported from stakeholders or other sources of the widespread importation of soil into GB, but topsoil for sale in Scotland may have originated from other parts of GB.

In 2015, the European Food Safety Authority (EFSA) investigated the plant health risks posed by EU imports of soil and growing media. After reviewing 207 scientific publications they concluded that the ‘prohibition of import’ was the only phytosanitary measure with a very high effectiveness and a low uncertainty (EFSA, 2015). However, as explained above, this would be very difficult to implement because plants that are traded across borders may be potted in soil, and there may be products which will have soil as a component (e.g., compost). However, working with industry to further develop BS 3882:2015 to include treatments that would reduce pest risks would be a significant step forward.

Bulk aggregates

Most of the primary bulk aggregates (sand, gravel and crushed rock) used in Scotland originate from within the country (e.g., 3.74 Mt of sand and gravel, and 17.04 Mt of crushed rock were produced in Scotland in 2019) (Mankelov, et al., 2023). The plant health risks associated with this material is thought to be low (Litterick, et al., 2024). However, this study found live pathogens to be present in the small number of samples tested. Many more samples would have to be tested before conclusions could be drawn on the biosecurity status of these materials.

The sand quarried in Scotland is a high-quality product, building sand and sand which may be used for landscaping purposes is mostly imported (HMRC, 2024). In fact, sand is one of the most traded commodities globally, which means that it is constantly being moved internationally (OEC, 2022). The UK imports significant amounts of sand from 49 countries (full list in appendix a) (1.2Mt with a value of £86 million between 1st January 2022 and 30th June 2024; HMRC, 2024).

Beach sands have been screened to understand the implications for public health (e.g., Sabino, et al., 2014), but this project could not identify any literature which examined the plant health risks associated with sand. Stewart et al. (2008) found *Pseudomonas* spp. in sand during a study of human health implications of sand, however, this genus of bacteria is not just the cause of zoonotic diseases but are also associated with a number of serious plant diseases (e.g., horse chestnut bleeding canker caused by *Pseudomonas syringae* pathovar *aesculi*). Further research is therefore required to understand the plant health risks posed by sand and the measures that are required to ensure that pathogens are removed or not present.

Aggregates in the natural environment

One of the areas investigated by this study was the biosecurity risks associated with the building of roads and paths within forests and woodlands (e.g., for timber extraction or for recreational activities). We found that in Scotland, there is sufficient material within quarries across the forest estate to enable forest roads and paths to be built with material of a known provenance within a short distance of the activity (usually less than 100 miles) (Pers. Comm. Scottish Forestry, Woodland Trust). The risks of the introduction and spread of a forestry pest during this activity is therefore very low [except where moving across a boundary where a pest is present].

Wood chips

There is no HMRC commodity code specific to isolated bark (e.g., bark chips). As an approximation, the data in this report uses commodity codes for wood chips (coniferous and broadleaves) which can conceivably be used for a wide range of applications, some outdoors. Wood chips are imported into the UK from 39 countries (appendix a), totalling 62,165 tonnes between 1st January 2022 and 30th June 2024, with a value of £21m (HMRC, 2024).

The product tested in section 3.3 is a widely available product used in ornamental landscaping as a mulch, which is intended to conserve soil moisture, reduce weeds and maintain a more consistent soil temperature. These chips are often derived as a by-product during forestry operations from trees which have been felled but could also be from other waste wood products such as pallets. It may or may not contain bark.

From a plant health and biosecurity aspect, wood chips are the most concerning bulk aggregate product investigated during this study. The disease risk from wood chips is high, especially if any bark remains (Kopinga, et al., 2010). Many studies have found that disease-causing organisms can move from infected wood chips onto nearby plants (Koski & Jacobi, 2004; Panesar, et al., 1994; Foreman, et al., 2002). This sector is unregulated in the UK, and it is very difficult to establish the provenance of some of the material for sale. The more responsible suppliers reported that their products were UK-sourced and FSC certified, but no processes to reduce or remove plant pests were reported. Other elements of production are also not covered by FSC, for example the storage of wood chips in the medium-long term, which can mean that piles could build up on sites before their sale. This may allow any pests present to proliferate if conditions are suitable.

The concern associated with wood and bark chips is reflected in the UKPHRR which currently lists 72 pests under the introduction pathway of “bark” (Defra, 2024a) (appendix b). This includes 7 species of damaging jewel beetles (*Agilus* spp.), 12 species of longhorn beetles (*Monochamus* spp.) and many fungal pathogens (e.g., *Cronartium* spp.). Bark would have to

be declared to the Plant Health Authorities before landing so that it can be inspected, however many of the pathogens that may be present will not be visible with the naked eye. The data did not make it possible to compare the amount of wood chips imported compared to domestically produced because no data on domestic production is gathered. This has an important bearing on risk assessment because there is a higher risk from the introduction of a new pest from imported wood chips whereas the risk is from spread with domestic chips.

This study identified 6 oomycete species in the bark chip products sourced from Scottish suppliers. Most notably, *Phytophthora bilorbang* was recovered by baiting with rhododendron leaves. Regarded as a species of inundated soil and rivers, it has been found in streams in Oregon, USA (Reeser, et al., 2011) and was first recorded in soil around several tree species in N.E. France (Hansen E. & Delatour C., 1999). This species was formally described and named in 2012 when the pathogen was identified as the agent responsible for blackberry decline in Australia (Aghighi, et al., 2012). *Phytophthora bilorbang* is also the causal agent of decline in a number of woody hosts, including *Olea* root rot in Italy (Santilli, et al, 2020).

In the UK, DNA of *P. bilorbang* was first detected by metabarcoding in 13 out of 17 nurseries sampled between 2016-2022. Although found predominantly in water samples, *P. bilorbang* was also less frequently associated with root samples (Green et al, 2024). Live *P. bilorbang* was also recovered by baiting stream water collected from a nursery in Scotland with rhododendron leaves (Schiffer-Forsyth, et al, 2023). More recent detections of DNA in environmental soil and water samples in England and Wales (Defra Green, et al, 2025, submitted) suggest that *P. bilorbang* may be widespread in the UK.

In addition, *Phytophythium littorale* was obtained as a live culture from the bark, as was *Phytophythium citrinum*. The findings of potentially damaging oomycete species in bark chips sourced from Scotland raise obvious plant health concerns. These findings indicate that bark chips are potentially a significant plant health risk, not only to landscaping but also forestry and the wider environment. However, many more samples would have to be tested before conclusions could be drawn.

International comparisons

We can potentially learn from international standards, particularly the Import Health Standard (IHS) for Soil, Rock, Sand, Clay, and Water which was introduced in New Zealand to address the biosecurity risks posed by these bulk aggregates (New Zealand Government, 2024). This Standard describes the conditions that must be met by the exporting country or importer to receive a permit to import (such as heat-treatments). This dramatically reduces the risk of the import of the kinds of organisms identified in this study, as well as insect pests and weed seeds.

5.1 Conclusions

This report includes data showing that large proportions of wood chips are imported into the country each year and that domestic supply chains are opaque. There are no requirements in place for the pre-treatment of this material to reduce pests in-country or before landing. This is a biosecurity concern given the pathogens identified in bark material during the testing carried out during this study. We therefore conclude that wood chips pose the highest biosecurity risk of those studied here. Further research is required into this sector to provide clarity on the provenance of wood chips so that accurate pest risk analyses can be conducted. This is particularly important to protect the forestry industry and wider natural landscape.

Topsoil is often produced in a professional manner under a British Standard (BS 3882:2015). However, this standard does not include any treatments to remove plant pests and/or pathogens. There is also topsoil for sale on online trading sites which has an unknown provenance. We therefore conclude that topsoil is a biosecurity high-risk product which needs to be pest risk assessed to better understand the plant health risks to the natural environment.

We conclude that sand is a medium biosecurity risk but with a low confidence. This is because significant amounts of sand are imported each year from many countries across the globe. Disease-causing pathogens have been found in sand, but these were human health issues, no study has been conducted on the plant health risks posed by sand (to the best of our knowledge). It is therefore difficult to fully understand the plant health risks posed by sand. We conclude that stone, rocks and gravel are of low plant health risk due to significant quarrying within Scotland and the short distances this material travels.

Similarly, bricks and building blocks are considered to be of low biosecurity risk because these materials go through an industrial process during production. However, the UK imports significant quantities of building materials (2.8 Mt of building blocks and bricks between 1st January 2022 and the 30th June 2024), it is therefore conceivable that as these commodities move across borders, they could harbour hitchhiking species of pests on or within spaces in them (or on the pallets that they are on).

5.2 Recommendations

- Further attempts should be made to engage with the various organisations involved in the production and movement of bulk aggregates to raise awareness of the potential plant health issues associated with these products. This is particularly important for the topsoil and wood chip sectors because their products are high risk from a plant health perspective.
- The British Standard for topsoil (BS 3882:2015) should be updated to include treatments which lower the risk of the product containing pests and pathogens. In addition, a more rigorous application of the standard to make it obligatory would raise the standard of the product and lower the plant health risks.
- There are currently no restrictions on the import of soil from the EU, the Plant Health Authorities should consider a prohibition to avoid the movement of pests into GB within soil.
- The Plant Health Authorities should consider carrying out Pest Risk Analyses on bulk aggregate pathways so that they can be included in the UKPHRR. This would lead to a better understanding of the trade networks involved and enable stakeholders to carry out more accurate biosecurity risk assessments.
- Sand is a major commodity which is known to contain pathogens associated with human health issues, further investigation on the ability of sand to contain plant pathogens and enable their movement should be initiated.
- An industry standard for wood chip and other bark products is urgently needed to ensure that this commodity is treated in some way to remove pests (e.g., heat treated). This should be a requirement for all producers because it is clear from this and other studies that plant pathogens in particular are present in products which will be applied during landscaping projects. This represents a significant biosecurity risk to plant health in Scotland.

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7 Appendix A

The countries of origin of the bulk aggregates investigated during this study. Data provided by HMRC. Data covers 30 months from 1st January 2022 to 30th June 2024.

Sand:

Country of Origin	Weight (tonnes)
BELGIUM	713626.04
NETHERLANDS	161237.57
FRANCE	94550.42
DENMARK	55739.64
PORTUGAL	35880.50
NORWAY	32635.36
AUSTRALIA	29739.66
IRELAND	19561.83
GERMANY	17675.36
UK	5044.71
UNITED STATES	3261.03
CHINA	2403.35
FAROE ISLANDS	2257.70
ITALY	1171.69
SPAIN	665.53
POLAND	459.54
JAPAN	337.01
BRAZIL	138.61
SOUTH AFRICA	113.91
TURKEY	73.46
SWEDEN	71.31
SLOVENIA	63.78
AUSTRIA	57.79
CANADA	53.58
ROMANIA	34.01
SWITZERLAND	27.44
MOROCCO	24.51
ISRAEL	19.58
QATAR	12.18
INDIA	6.11
CZECHIA	6.00
UAE	5.10
SINGAPORE	4.24
SERBIA	4.00
IVORY COAST	3.20
CYPRUS	2.95
GEORGIA	2.84
CROATIA	2.50
BAHAMAS	2.47
FINLAND	2.20

ANGOLA	2.01
SRI LANKA	1.26
HONG KONG	0.88
SENEGAL	0.52
TUNISIA	0.38
SLOVAKIA	0.17
MEXICO	0.13
PAKISTAN	0.08
THAILAND	0.07

Rocks and stone:

Country of Origin	Weight (tonnes)
NORWAY	10479235.30
INDIA	1101920.57
DENMARK	204320.21
CHINA	137302.39
PORTUGAL	116907.90
SPAIN	88671.82
EGYPT	19420.13
BELGIUM	15560.98
ITALY	10378.21
FRANCE	7712.35
NETHERLANDS	6943.76
TURKEY	6767.12
BRAZIL	6422.27
UK	6090.68
UAE	4411.82
VIETNAM	4278.35
MOROCCO	4028.84
IRELAND	1578.00
GERMANY	1079.04
INDONESIA	1008.59
POLAND	688.51
HONG KONG	399.16
ISRAEL	339.33
FINLAND	294.31
UNITED STATES	253.77
TUNISIA	206.69
TAIWAN	202.37
SOUTH AFRICA	158.01
SWITZERLAND	154.26
GREECE	137.69
NAMIBIA	135.00
PAKISTAN	132.78
SWEDEN	120.79
IRAN	115.17

BULGARIA	103.21
OMAN	99.27
SOUTH KOREA	95.92
BANGLADESH	89.51
MALTA	81.15
ROMANIA	61.92
MEXICO	50.19
JORDAN	46.82
CZECHIA	42.74
MALAYSIA	35.88
ESTONIA	35.40
SRI LANKA	28.21
AUSTRIA	24.25
OCC PALEST TERR	22.60
MOLDOVA	20.00
ANGOLA	14.61
ALBANIA	12.33
SERBIA	11.12
HUNGARY	7.71
AUSTRALIA	7.36
JAPAN	6.41
LEBANON	5.90
SINGAPORE	4.84
SLOVAKIA	4.71
PERU	4.62
LITHUANIA	4.54
THAILAND	3.15
CANADA	3.14
ZIMBABWE	1.60
BOSNIA & HERZ.	1.50
RUSSIA	0.70
CAMBODIA	0.54
SLOVENIA	0.37
ICELAND	0.36
ARMENIA	0.33
TANZANIA	0.22
KENYA	0.20
NEW ZEALAND	0.17
NEPAL	0.16
MADAGASCAR	0.15
PHILIPPINES	0.12
LUXEMBOURG	0.10
AFGHANISTAN	0.07
DOMINICAN REP	0.03

Building blocks and bricks:

Country of Origin	Weight (tonnes)
NETHERLANDS	1040473.50
BELGIUM	985223.89
TURKEY	139586.13
SPAIN	115816.46
IRELAND	114765.34
GERMANY	96291.35
DENMARK	65938.39
PAKISTAN	52377.13
ITALY	48103.63
PORTUGAL	39762.81
INDIA	33139.70
SOUTH AFRICA	27220.52
FRANCE	17252.31
CHINA	5249.90
UK	2292.84
BELARUS	2011.90
UNITED STATES	1238.34
CZECHIA	885.68
LATVIA	608.52
POLAND	410.39
NICARAGUA	149.61
SWEDEN	126.64
VIETNAM	123.17
BULGARIA	99.18
LITHUANIA	91.19
THAILAND	76.68
AUSTRALIA	42.08
BANGLADESH	35.40
MOROCCO	29.93
ANDORRA	27.66
HONG KONG	25.35
IRAN	17.45
GREECE	15.39
ESTONIA	11.25
SWITZERLAND	5.27
AUSTRIA	4.36
CANADA	2.51
SLOVAKIA	0.75
MALTA	0.02

Wood chips:

Country of Origin	Woodchip (tonnes)
NETHERLANDS	24391.01
SPAIN	8753.59
GERMANY	8703.36
IRELAND	7941.20
PORTUGAL	6744.08
ESTONIA	1282.56
SOUTH AFRICA	1219.75
FRANCE	761.26
LITHUANIA	575.04
LATVIA	529.55
POLAND	337.88
UNITED STATES	332.45
BELARUS	232.94
SWEDEN	103.46
UKRAINE	28.98
GHANA	28.00
RUSSIA	25.96
NAMIBIA	23.09
CANADA	22.59
MALI	21.61
GABON	21.50
FINLAND	18.21
CHINA	15.62
CZECHIA	14.19
BRAZIL	11.16
MEXICO	10.04
INDIA	5.04
NORWAY	3.19
ROMANIA	2.42
DENMARK	1.73
NEW ZEALAND	1.60
UK	1.04
ITALY	0.28
HONG KONG	0.24
JAPAN	0.04

8 Appendix B

Pests on the UK Plant Health Risk Register which list a bulk aggregate material investigated in this study within the “pathways” field of the data (downloaded August 2024).

Soil (as the pathway “Soil/growing medium”):

Pest Name	Pathways
<i>Ceratocystis platani</i>	water; Hitchhiking; Agricultural machinery; Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Wood packaging material
<i>Thaumetopoea pityocampa</i>	vehicles/containers; Soil/growing medium; Natural spread; Wood and wood products; Plants for planting (except seeds bulbs and tubers)
<i>Plasmopara halstedii</i>	Soil/growing medium; Seeds
<i>Aphelenchoides besseyi</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Seeds
Beet necrotic yellow vein benyvirus	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Seeds
<i>Xanthomonas vesicatoria</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Seeds
<i>Phytophthora ramorum</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark
<i>Asproparthenis punctiventris</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Epicauta adspersa</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Epicauta atomaria</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Epicauta luctifera</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Epicauta monachica</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Epicauta pilme</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Epicauta pluvialis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Epicauta willei</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Xiphinema chambersi</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Meloidogyne ethiopica</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Agricultural machinery; Potato bags; Bulbs or tubers
<i>Heterodera elachista</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Agricultural machinery
<i>Agrypnus variabilis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Aloephagus myersi</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Aphis nerii</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Cactodera cacti</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Conoderus exsul</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)

<i>Exomala orientalis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Haplaxius crudus</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Helicotylenchus dihystra</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Heterodera fici</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Heterodera glycines</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Hoplolaimus spp.</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Margarodes prieskaensis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Margarodes vitis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Margarodes vredendalensis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Meloidogyne incognita</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Paratrachodorus minor</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Paratylenchus tenuicaudatus</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Phymatotrichopsis omnivora</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Phytophthora austrocedri</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Phytophthora kernoviae</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Phytophthora lateralis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Phytophthora pinifolia</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Phytophthora polonica</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Phytophthora pseudosyringae</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Phytophthora rubi</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Pseudomonas cannabina pv. alisalensis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Psilenchus spp.</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Punctodera chalcensis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Radopholus similis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Satsuma dwarf virus</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Simo hirticornis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Strobilomyia viaria</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Thecodiplosis japonensis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Tylenchorhynchus crassicaudatus</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)

<i>Tylenchorhynchus leviterminalis</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Tylenchulus semipenetrans</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xanthomonas axonopodis</i> pv. <i>poinsetticola</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema bakeri</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema brasiliense</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema brevicolle</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema bricolense</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema californicum</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema elongatum</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema inaequale</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema incognitum</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema insigne</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema intermedium</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema pachtaicum</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema rivesi</i> (European populations)	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema rivesi</i> (non-European populations)	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema tarjanense</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema thornei</i>	Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Leucinodes orbonalis</i>	Soil/growing medium; Passengers; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Dendrolimus pini</i>	Soil/growing medium; Natural spread; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood
<i>Lissorhoptrus oryzophilus</i>	Soil/growing medium; Hitchhiking; Plants for planting (except seeds bulbs and tubers)
<i>Listroderes costirostris</i>	Soil/growing medium; Hitchhiking; Plants for planting (except seeds bulbs and tubers)
<i>Listroderes delaiguei</i>	Soil/growing medium; Hitchhiking; Plants for planting (except seeds bulbs and tubers)
<i>Gonipterus scutellatus</i>	Soil/growing medium; Hitchhiking; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers)
<i>Naupactus leucoloma</i>	Soil/growing medium; Hitchhiking; Bulbs or tubers
<i>Diabrotica barberi</i>	Soil/growing medium; Hitchhiking
<i>Diabrotica speciosa</i>	Soil/growing medium; Hitchhiking

<i>Diabrotica undecimpunctata howardi</i>	Soil/growing medium; Hitchhiking
<i>Limoniuss californicus</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Nacobbuss aberrans sensu lato</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers
<i>Anastrepha fraterculus species complex</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Anastrepha ludens</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Anastrepha obliqua</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Anastrepha suspensa</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Bactrocera dorsalis species complex</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Bactrocera tsuneonis</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Ceratitis capitata</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Ceratitis cosyra</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Ceratitis rosa</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Conotrachelus nenuphar</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Keiferia lycopersicella</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Psylliodes punctifrons</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Rhagoletis cingulata</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Rhagoletis completa</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Rhagoletis fausta</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Rhagoletis indifferens</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Rhagoletis mendax</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Rhagoletis pomonella</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Rhagoletis ribicola</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Rhagoletis suavis</i>	Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Achyra rantalis</i>	Soil/growing medium; Fruits or vegetables; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers)
<i>Acleris gloveranus</i>	Soil/growing medium; Fruits or vegetables; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers)

<i>Carposina sasakii</i>	Soil/growing medium; Fruits or vegetables; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers)
<i>Meloidogyne fallax</i>	Soil/growing medium; Fruits or vegetables; Bulbs or tubers; Plants for planting (except seeds bulbs and tubers); Plant waste
<i>Meloidogyne chitwoodi</i>	Soil/growing medium; Fruits or vegetables; Bulbs or tubers; Plants for planting (except seeds bulbs and tubers)
<i>Delia sanctijacobi</i>	Soil/growing medium; Fruits or vegetables; Bulbs or tubers
<i>Epitrix cucumeris</i>	Soil/growing medium; Fruits or vegetables; Bulbs or tubers
<i>Epitrix tuberis</i>	Soil/growing medium; Fruits or vegetables; Bulbs or tubers
<i>Globodera pallida</i> European Strains	Soil/growing medium; Fruits or vegetables; Bulbs or tubers
<i>Globodera pallida</i> Non-European Strains	Soil/growing medium; Fruits or vegetables; Bulbs or tubers
<i>Globodera rostochiensis</i> European Strains	Soil/growing medium; Fruits or vegetables; Bulbs or tubers
<i>Globodera rostochiensis</i> Non-European Strains	Soil/growing medium; Fruits or vegetables; Bulbs or tubers
<i>Melanotus communis</i>	Soil/growing medium; Fruits or vegetables; Bulbs or tubers
<i>Synchytrium endobioticum</i>	Soil/growing medium; Fruits or vegetables; Bulbs or tubers
<i>Bactrocera carambolae</i>	Soil/growing medium; Fruits or vegetables
<i>Bactrocera caryae</i>	Soil/growing medium; Fruits or vegetables
<i>Bactrocera kandiensis</i>	Soil/growing medium; Fruits or vegetables
<i>Bactrocera minax</i>	Soil/growing medium; Fruits or vegetables
<i>Bactrocera occipitalis</i>	Soil/growing medium; Fruits or vegetables
<i>Bactrocera tryoni</i>	Soil/growing medium; Fruits or vegetables
<i>Bactrocera zonata</i>	Soil/growing medium; Fruits or vegetables
<i>Ceratitidis quinaria</i>	Soil/growing medium; Fruits or vegetables
<i>Dacus ciliatus</i>	Soil/growing medium; Fruits or vegetables
<i>Elatichrosis castanea</i>	Soil/growing medium; Fruits or vegetables
<i>Heteronychus arator</i>	Soil/growing medium; Fruits or vegetables
<i>Liriomyza brassicae</i>	Soil/growing medium; Fruits or vegetables
<i>Myiopardalis pardalina</i>	Soil/growing medium; Fruits or vegetables
<i>Neoceratitis cyanescens</i>	Soil/growing medium; Fruits or vegetables
<i>Pratylenchus mediterraneus</i>	Soil/growing medium; Fruits or vegetables
<i>Zeugodacus cucurbitae</i>	Soil/growing medium; Fruits or vegetables
<i>Diabrotica signficata</i>	Soil/growing medium; Cut flowers or branches; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)

<i>Strauzia longipennis</i>	Soil/growing medium; Cut flowers or branches; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Diabrotica balteata</i>	Soil/growing medium; Cut flowers or branches; Fruits or vegetables
<i>Colaspis chlorites</i>	Soil/growing medium; Bulbs or tubers
<i>Omophlus lepturoides</i>	Soil/growing medium; Bulbs or tubers
<i>Scutellonema unum</i>	Soil/growing medium; Bulbs or tubers
<i>Wiseana cervinata</i>	Soil/growing medium; Bulbs or tubers
<i>Wiseana despecta</i>	Soil/growing medium; Bulbs or tubers
<i>Wiseana jacosa</i>	Soil/growing medium; Bulbs or tubers
<i>Wiseana signata</i>	Soil/growing medium; Bulbs or tubers
<i>Wiseana umbraculata</i>	Soil/growing medium; Bulbs or tubers
<i>Tylenchorhynchus claytoni</i>	Soil/growing medium
<i>Xanthomonas fuscans</i> subsp. <i>fuscans</i>	Seeds; Soil/growing medium
<i>Xanthomonas translucens</i> pv. <i>translucens</i>	Seeds; Soil/growing medium
<i>Diaporthe caulivora</i>	Seeds; Plants for planting (except seeds bulbs and tubers); Soil/growing medium; Agricultural machinery
<i>Meloidogyne luci</i>	Potato bags; vehicles/containers; Agricultural machinery; Soil/growing medium; Bulbs or tubers; Plants for planting (except seeds bulbs and tubers)
<i>Tecia solanivora</i>	Potato bags; Soil/growing medium; Fruits or vegetables; Bulbs or tubers
<i>Pectobacterium aroidearum</i>	Potato bags; Agricultural machinery; Soil/growing medium; Cut flowers or branches; Fruits or vegetables; Stored plant products; Bulbs or tubers; Plants for planting (except seeds bulbs and tubers)
<i>Phytophthora alni</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium; Natural spread
<i>Bitylenchus aerolatus</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Fusarium oxysporum</i> f. sp. <i>cubense</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Globodera tabacum</i> sensu lato	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Grapevine fanleaf virus</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Lilioceris merdigera</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Meloidogyne arenaria</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Meloidogyne javanica</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Meloidogyne mali</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Phytophthora acerina</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium

<i>Phytophthora bisheria</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Phytophthora pluvialis</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Rhizoctonia fragariae</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Thaumetopoea piniivora</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Xiphinema americanum sensu stricto</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Xiphinema diversicaudatum</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Xiphinema index</i>	Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Fusarium oxysporum f. sp. lactucae</i>	Plants for planting (except seeds bulbs and tubers); Fruits or vegetables; Soil/growing medium; Seeds; Agricultural machinery
<i>Meloidogyne enterolobii</i>	Plants for planting (except seeds bulbs and tubers); Fruits or vegetables; Soil/growing medium
<i>Rotylenchulus macrosoma</i>	Plants for planting (except seeds bulbs and tubers); Fruits or vegetables; Soil/growing medium
<i>Phytophthora siskiyouensis</i>	Plants for planting (except seeds bulbs and tubers); Cut flowers or branches; Soil/growing medium; Non-squared wood
<i>Enigmadiplosis agapanthi</i>	Plants for planting (except seeds bulbs and tubers); Cut flowers or branches; Soil/growing medium
<i>Paropsisterna selmani</i>	Plants for planting (except seeds bulbs and tubers); Cut flowers or branches; Soil/growing medium
<i>Gonipterus gibberus</i>	Plants for planting (except seeds bulbs and tubers); Cut flowers or branches; Hitchhiking; Soil/growing medium
<i>Pratylenchus scribneri</i>	Plants for planting (except seeds bulbs and tubers); Bulbs or tubers; Soil/growing medium; Fruits or vegetables
<i>Scutellonema bradys</i>	Plants for planting (except seeds bulbs and tubers); Bulbs or tubers; Soil/growing medium; Fruits or vegetables
<i>Trichodorus cedarus</i>	Plants for planting (except seeds bulbs and tubers); Agricultural machinery; Plant waste; Soil/growing medium
<i>Anthonomus quadrigibbus</i>	Plant waste; Soil/growing medium; Fruits or vegetables
<i>Popillia japonica</i>	Passengers; Soil/growing medium; Hitchhiking; Plants for planting (except seeds bulbs and tubers)
<i>Neoleucinodes elegantalis</i>	Passengers; Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Helicoverpa zea</i>	Passengers; Soil/growing medium; Fruits or vegetables; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers)
Arabis mosaic virus	nematodes; Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Seeds
Raspberry ringspot virus	nematodes; Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Atrichonotus taeniatus</i>	Hitchhiking; Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Seeds
<i>Pantomorus viridis</i>	Hitchhiking; Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Phlyctinus callosus</i>	Hitchhiking; Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers); Bulbs or tubers

<i>Naupactus xanthographus</i>	Hitchhiking; Soil/growing medium; Fruits or vegetables; Plants for planting (except seeds bulbs and tubers)
<i>Diabrotica undecimpunctata</i>	Hitchhiking; Soil/growing medium
<i>Bactrocera pyrifoliae</i>	Fruits or vegetables; Soil/growing medium
<i>Gymnandrosoma aurantianum</i>	Fruits or vegetables; Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Rhagoletis cerasi</i>	Fruits or vegetables; Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Heliothis virescens</i>	Fruits or vegetables; leaves; Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Natural spread
<i>Contarinia jongi</i>	Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Globodera ellingtonae</i>	Bulbs or tubers; Plants for planting (except seeds bulbs and tubers); Soil/growing medium; Fruits or vegetables
<i>Ditylenchus destructor</i>	Bulbs or tubers; Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Pratylenchus brachyurus</i>	Bulbs or tubers; Plants for planting (except seeds bulbs and tubers); Soil/growing medium
<i>Phomopsis phaseoli</i>	Agricultural machinery; Soil/growing medium; Plants for planting (except seeds bulbs and tubers); Seeds
<i>Meloidogyne graminicola</i>	Agricultural machinery; Soil/growing medium; Bulbs or tubers; Plants for planting (except seeds bulbs and tubers)
<i>Scutellonema brachyurus</i>	Agricultural machinery; Soil/growing medium; Bulbs or tubers; Plants for planting (except seeds bulbs and tubers)

Soil (as the pathway assessed for entry to UK “Plants for planting (with soil):

Pest Name	Pathway Assessed for Entry to UK
<i>Aonidiella orientalis</i>	Plants for planting (with soil)
Blueberry shock virus	Plants for planting (with soil); Plants for planting (except seeds bulbs and tubers)
<i>Cerroneuroterus lanuginosus</i>	Plants for planting (with soil); Plants for planting (except seeds bulbs and tubers)
<i>Ennomos subsignaria</i>	Plants for planting (with soil); Firewood
<i>Eotetranychus sexmaculatus</i>	Plants for planting (with soil); Plants for planting (except seeds bulbs and tubers); Fruits or vegetables
<i>Fusarium oxysporum f. sp. lactucae</i>	Plants for planting (with soil)
<i>Gnomoniopsis idaeicola</i>	Plants for planting (with soil)
<i>Helicotylenchus dihystera</i>	Plants for planting (with soil)
<i>Hoplolaimus spp.</i>	Plants for planting (with soil)
<i>Meloidogyne arenaria</i>	Plants for planting (with soil); Soil/growing medium; Plants for planting (except seeds bulbs and tubers)
<i>Meloidogyne ethiopica</i>	Plants for planting (with soil); Bulbs or tubers
<i>Meloidogyne graminicola</i>	Plants for planting (with soil)
<i>Meloidogyne luci</i>	Bulbs or tubers; Plants for planting (with soil)
<i>Otiorhynchus meridionalis</i>	Plants for planting (with soil)
<i>Paratrachodoros minor</i>	Plants for planting (with soil)
<i>Psilenchus spp.</i>	Plants for planting (with soil)

<i>Punctodera chalcoensis</i>	Plants for planting (with soil)
<i>Scutellonema brachyurus</i>	Plants for planting (with soil)
<i>Tylenchorhynchus leviterminalis</i>	Plants for planting (with soil)
<i>Tylenchulus semipenetrans</i>	Plants for planting (with soil)
<i>Xiphinema americanum sensu stricto</i>	Plants for planting (with soil)
<i>Xiphinema bakeri</i>	Plants for planting (with soil)
<i>Xiphinema brasiliense</i>	Plants for planting (with soil)
<i>Xiphinema brevicolle</i>	Plants for planting (with soil)
<i>Xiphinema bricolense</i>	Plants for planting (with soil)
<i>Xiphinema californicum</i>	Plants for planting (with soil)
<i>Xiphinema chambersi</i>	Plants for planting (with soil)
<i>Xiphinema diversicaudatum</i>	Plants for planting (with soil)
<i>Xiphinema elongatum</i>	Plants for planting (with soil)
<i>Xiphinema inaequale</i>	Plants for planting (with soil)
<i>Xiphinema incognitum</i>	Plants for planting (with soil)
<i>Xiphinema index</i>	Plants for planting (with soil)
<i>Xiphinema insigne</i>	Plants for planting (with soil)
<i>Xiphinema intermedium</i>	Plants for planting (with soil)
<i>Xiphinema pachtaicum</i>	Plants for planting (with soil); Plants for planting (except seeds bulbs and tubers)
<i>Xiphinema rivesi</i> (European populations)	Plants for planting (with soil)
<i>Xiphinema rivesi</i> (non-European populations)	Plants for planting (with soil)
<i>Xiphinema tarjanense</i>	Plants for planting (with soil)
<i>Xiphinema thornei</i>	Plants for planting (with soil)

Wood chip:

Pest Name	Pathways
<i>Agrilus hastulifer</i>	Bark; Non-squared wood; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers)
<i>Dendroctonus simplex</i>	Bark; Non-squared wood; Wood packaging material
<i>Scolytus ventralis</i>	Bark; Non-squared wood; Wood packaging material
<i>Hylesinus striatus</i>	Bark; Non-squared wood; Wood packaging material; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers)
<i>Hylesinus cholodkovskyi</i>	Bark; Non-squared wood; Wood packaging material; Firewood
<i>Heterobasidion occidentale</i>	Bark; Non-squared wood; Wood packaging material; Plants for planting (except seeds bulbs and tubers)
<i>Hylesinus eos</i>	Bark; Plants for planting (except seeds bulbs and tubers); Cut flowers or branches
<i>Dinoderus minutus</i>	Cut Bamboo Canes; Hitchhiking; Plant parts and plant products;; Wood and wood products;; Wood packaging material; Bark
<i>Xylosandrus germanus</i>	Cut flowers or branches; Bark; Non-squared wood; Squared wood; Wood packaging material; Plants for planting (except seeds bulbs and tubers); Natural spread
<i>Malacosoma parallela</i>	Cut flowers or branches; Bark; Plants for planting (except seeds bulbs and tubers)
<i>Malacosoma americanum</i>	Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Bark
<i>Malacosoma disstria</i>	Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Bark
<i>Chionaspis pinifoliae</i>	Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood
<i>Atropellis pinicola</i>	Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark; Woodchip
<i>Atropellis piniphila</i>	Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Non-squared wood; Woodchip; Bark
<i>Fusarium circinatum</i>	Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Seeds; Bark; Non-squared wood; Squared wood; Woodchip
<i>Entoleuca mammata</i>	Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Wood packaging material; Bark; Non-squared wood
<i>Agrilus granulatus subsp. liragus</i>	Firewood; Bark; Non-squared wood; Wood packaging material
<i>Chrysobothris femorata</i>	Firewood; Hitchhiking; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood; Squared wood; Wood packaging material
<i>Lonsdalea quercina</i>	Firewood; insect vectors; leaves; Roundwood of oak with bark present; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood; Woodchip; Seeds
<i>Ennomos subsignaria</i>	Firewood; leaves; Roundwood of oak with bark present; Hitchhiking; Bark; Non-squared wood
<i>Agrilus granulatus</i>	Firewood; Non-squared wood; Wood packaging material; Bark; Woodchip
<i>Orgyia leucostigma</i>	Firewood; packing cases; Roundwood of oak with bark present; vehicles/containers; Agricultural machinery; Hitchhiking; Cut flowers

	or branches; Bark; Wood packaging material; Woodchip; Plants for planting (except seeds bulbs and tubers)
<i>Agrilus planipennis</i>	Firewood; Plants for planting (except seeds bulbs and tubers); Wood and wood products; Squared wood; Non-squared wood; Wood packaging material; Bark
<i>Melittomma sericeum</i>	Firewood; Roundwood of oak with bark present; Bark; Non-squared wood; Squared wood; Wood packaging material
<i>Lambdina fiscellaria</i>	Firewood; Roundwood of oak with bark present; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood
<i>Phellinus spiculosus</i>	Firewood; Roundwood of oak with bark present; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood; Squared wood; Wood packaging material
<i>Lamprodila festiva</i>	Firewood; vehicles/containers; Hitchhiking; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood
<i>Hypothenemus seriatus</i>	Fruits or vegetables; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood
<i>Dendrolimus superans</i>	Hitchhiking; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood
<i>Dendrolimus sibiricus</i>	Hitchhiking; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark
<i>Monochamus sartor</i>	Hitchhiking; Manufactured plant products; Plants for planting (except seeds bulbs and tubers); Bark; Squared wood; Non-squared wood; Wood packaging material
<i>Monochamus scutellatus</i>	Manufactured plant products; Hitchhiking; Plants for planting (except seeds bulbs and tubers); Non-squared wood; Wood packaging material; Bark; Squared wood
<i>Monochamus galloprovincialis</i>	Manufactured plant products; Hitchhiking; Plants for planting (except seeds bulbs and tubers); Wood packaging material; Bark; Squared wood; Non-squared wood
<i>Monochamus nitens</i>	Manufactured plant products; Hitchhiking; Plants for planting (except seeds bulbs and tubers); Wood packaging material; Bark; Squared wood; Non-squared wood
<i>Monochamus urossovii</i>	Manufactured plant products; Non-squared wood; Squared wood; Wood packaging material; Bark; Plants for planting (except seeds bulbs and tubers)
<i>Monochamus notatus</i>	Manufactured plant products; Plants for planting (except seeds bulbs and tubers); Bark; Squared wood; Non-squared wood; Wood packaging material
<i>Monochamus alternatus</i>	Manufactured plant products; Plants for planting (except seeds bulbs and tubers); Non-squared wood; Wood packaging material; Bark; Squared wood
<i>Monochamus carolinensis</i>	Manufactured plant products; Plants for planting (except seeds bulbs and tubers); Non-squared wood; Wood packaging material; Bark; Squared wood
<i>Monochamus maculosus</i>	Manufactured plant products; Plants for planting (except seeds bulbs and tubers); Wood packaging material; Bark; Squared wood; Non-squared wood
<i>Monochamus marmorator</i>	Manufactured plant products; Plants for planting (except seeds bulbs and tubers); Wood packaging material; Bark; Squared wood; Non-squared wood
<i>Monochamus obtusus</i>	Manufactured plant products; Plants for planting (except seeds bulbs and tubers); Wood packaging material; Bark; Squared wood; Non-squared wood

<i>Monochamus titillator</i>	Manufactured plant products; Plants for planting (except seeds bulbs and tubers); Wood packaging material; Bark; Squared wood; Non-squared wood
<i>Ophiostoma novo-ulmi</i>	Natural spread; Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark
<i>Saperda tridentata</i>	Non-squared wood; Bark
<i>Hylesinus laticollis</i>	Non-squared wood; Bark; Wood packaging material
<i>Heterobasidion insulare species complex</i>	Non-squared wood; Bark; Wood packaging material; Plants for planting (except seeds bulbs and tubers)
<i>Pseudips mexicanus</i>	Non-squared wood; Wood packaging material; Bark
<i>Atropellis apiculata</i>	Non-squared wood; Woodchip; Bark
<i>Stereonychus fraxini</i>	Plants for planting (except seeds bulbs and tubers); Bark
<i>Cryphonectria parasitica</i>	Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood
<i>Cronartium comptoniae</i>	Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood; Cut flowers or branches
<i>Platypus apicalis</i>	Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood; Squared wood
<i>Agrilus ater</i>	Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood; Wood packaging material
<i>Hypothenemus eruditus</i>	Plants for planting (except seeds bulbs and tubers); Bark; Wood packaging material; Manufactured plant products
<i>Cronartium quercuum f. sp. fusiforme</i>	Plants for planting (except seeds bulbs and tubers); Cut flowers or branches; Bark; Non-squared wood
<i>Dryocoetes himalayensis</i>	Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark
<i>Hypocryphalus scabricollis</i>	Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark
<i>Agrilus auroguttatus</i>	Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark; Firewood
<i>Coniferiporia sulphurascens</i>	Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark; Wood packaging material
<i>Dendroctonus mesoamericanus</i>	Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark; Wood packaging material
<i>Heterobasidion abietinum</i>	Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark; Wood packaging material
<i>Xylosandrus compactus</i>	Plants for planting (except seeds bulbs and tubers); Non-squared wood; Bark; Wood packaging material; Cut flowers or branches; Hitchhiking
<i>Coniferiporia weirii</i>	Plants for planting (except seeds bulbs and tubers); Non-squared wood; Wood packaging material; Bark
<i>Heterobasidion parviporum</i>	Plants for planting (except seeds bulbs and tubers); Non-squared wood; Wood packaging material; Bark
<i>Dendroctonus jeffreyi</i>	Plants for planting (except seeds bulbs and tubers); Wood packaging material; Non-squared wood; Bark
<i>Ips subelongatus</i>	Plants for planting (except seeds bulbs and tubers); Wood packaging material; Non-squared wood; Bark

<i>Phellinus everhartii</i>	Roundwood of oak with bark present; Firewood; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood; Squared wood; Wood packaging material
<i>Dendrolimus pini</i>	Soil/growing medium; Natural spread; Cut flowers or branches; Plants for planting (except seeds bulbs and tubers); Bark; Non-squared wood
<i>Dendroctonus valens</i>	Wood packaging material; Cut flowers or branches; Non-squared wood; Plants for planting (except seeds bulbs and tubers); Woodchip; Squared wood; Bark
<i>Scolytus morawitzi</i>	Wood packaging material; Non-squared wood; Plants for planting (except seeds bulbs and tubers); Squared wood; Bark; Hitchhiking
<i>Agrilus fleischeri</i>	Wood packaging material; Plants for planting (except seeds bulbs and tubers); Woodchip; Non-squared wood; Bark

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