Forest Research

Welsh Plant Health Surveillance Network

2025 review

Racheal Lee BSc (Hons) and Dr Matthew Watkins PhD

The Research Agency of the Forestry Commission

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Executive summary

Attacks on trees by invasive pests and pathogens, if left uncontrolled, can cause significant damage to the forestry industry across the UK, primarily the spruce and timber industries. However, the values at risk extend beyond the commercial woodland and forest industry, to include natural forests and urban trees. These resources are essential to a healthy, biodiverse environment, which in turn provides key ecosystem services and benefits to human health. Infestation by some pests, such as the emerald ash borer, can be fatal to trees and, once established, can cause significant harm to woodland biodiversity and ecosystems, as well as the timber industry.

This document is an annex to the Welsh Plant Health Surveillance Network 2022 review (Lee and Olivieri, 2023) and reports on the fourth year of the Welsh Plant Health Surveillance Network (WPHSN) activities undertaken on behalf of the Welsh Government. It describes a network of insect and spore traps placed at strategic woodland sites across Wales to monitor and record the presence/absence of invasive pests and pathogens which may negatively affect our trees, woodlands, and forests.

Data from the WPHSN is being used to inform the development of priority goals and policies relating to woodland management in Wales.

Details are given of the project objectives, key biological threats being monitored, trapping and analysis methodologies, and interim results from the 2025 trapping season. Finally, recommendations are made for 2026 and beyond.

Roles in the WPHSN team

Ariennir gan Lywodraeth Cymru
Funded by Welsh Government

Welsh Government

Funder of the Welsh Plant Health Surveillance Network

Racheal Lee BSc (Hons)

Forest Biologist and Project Lead/Biolegydd Coedwigaeth a Arweinydd Prosiect

Project manages and leads on the field and public engagement elements of the WPHSN and is based at the Talybont-on-Usk field station in Wales.

Dr Matthew Watkins PhD

Field Research Technician/Technegydd Ymchwil Maes

Research technician with a background in molecular biology. Carries out field support and laboratory-based work associated with the detection and identification of forest pathogens for the WPHSN project. Matt is based at the Talybont-on-Usk field station.

Tom Jenkins MBE, FICFor

Head of Forest Research Wales/Pennaeth Ymchwil Coedwigaeth yng Nghymru

Leads the Forest Research unit in Wales and is responsible for the management and growth of the Unit and the assessment of research opportunities within Wales.

Background

The objective of the Welsh Plant Health Surveillance Network (WPHSN) project is to monitor and gather data (presence/absence) on native and invasive pests and pathogens that can pose a threat to the health of trees across Wales. A network of insect and airborne particle traps has been deployed at sites deemed at high risk of invasion and colonisation. Biological samples are obtained and analysed by the WPHSN team using laboratory facilities at Swansea University. The data gathered will be used to build distribution maps of pests and pathogens, inclusive of their abundance, and will inform the development of priority goals and policies relating to woodland management in Wales. To ensure adequate coverage of the geographical area and the sharing of information and advice within the sector, the surveillance network includes sites managed by Natural Resources Wales (NRW) as well as privately managed estates through collaboration with sentinel sites and private landowners.

The commercial element of the forest industry in Wales depends heavily on the healthy planting, growth, and harvesting of one spruce species, Sitka spruce (*Picea sitchensis*). An outbreak affecting this tree species has the potential to cause the loss of business investments worth hundreds of millions of pounds, leading to negative consequences for nurseries, sawmills, timber transport companies, and other related industries dependent on the forestry sector. Other economically important, though relatively small, forest industry components, such as Christmas tree plantations (spruce and fir species), can also suffer serious damage.

Trees in the countryside and urban areas, including the many veteran trees, are an essential part of the landscape and national heritage, and are an invaluable support to human physical and mental wellbeing. All of these resources are directly exposed, and potentially vulnerable, to invasive pests and pathogens. These threats are increasing under the current pattern of climate change – where milder winters, wetter springs, and hotter, drier summers are likely to improve the survival rate of invasive pests and pathogens. These more frequently observed weather patterns simultaneously cause stress in trees, increasing their susceptibility to infection and disease.

The WPHSN project targets invasive organisms which have historically been detected in Wales, or which are likely to migrate to Wales with the warming climate. A summary of these organisms and the key threats they pose to tree health is provided in Table 1.

Project aims

I. To assess presence/absence and abundance of invasive tree pests and pathogens across Wales.

II. To build a 'real-time' map detailing where invasives are detected, which will act both as an early warning system and as a monitoring tool.

III. To promote and facilitate collaborative working with external agencies to grow the Network, whereby information and advice can be shared.

Table 1 Summary of the WPHSN project primary organisms and the key threats they pose to tree health

Organism	Threat to tree health
Insects	
Agrilus biguttatus	Weakens trees through the larvae's wood-boring activities and feeding from the vascular tissues on the bark. Possibly also contributes to the spread of acute oak decline by carrying the causative bacteria from affected trees to healthy trees.
Agrilus convexicollis	Feeds on dead and dying native ash trees (*Fraxinus excelsior*). Not detected in Wales to date. Further study required into the potential impact of this beetle in high numbers and its impact as a secondary pest on tree mortality.
Agrilus planipennis	Not believed to be present in the UK. Fatal to infected trees as the larvae live and feed on internal tissues of trees, preventing water and nutrient cycling.

Organism	Threat to tree health
Dendroctonus micans	Weakens trees by burrowing into the bark and creating egg chambers in the cambium for breeding. Larvae feed on internal woody tissue. Fatal in prolonged colonisations.
Hylobius abietis	Destructive to conifer seedlings and newly planted young conifer trees by girdling stems through feeding on the bark tissue.
Ips cembrae	Primarily attacks already compromised trees. Weakens trees further by boring tunnels through the bark to the phloem layer to create breeding chambers. Feeding larvae cause canopy dieback and needle defoliation. Vector of pathogenic fungi which can contribute to the death of the tree.
Ips typographus	Primarily attacks already compromised trees before colonising healthy trees. Tree death occurs as beetles bore into the tree, creating 'galleries' to serve as nuptial and feeding chambers. This destroys the inner tissues of the tree, preventing water and nutrient flow.
Monochamus alternatus	A vector for the pine wood nematode (PWN) which causes pine wilt disease (PWD) in conifers, especially pine species, and which can be fatal to trees.
Thaumetopoea processionea	Can be fatal to infected trees through voracious feeding on the leaves by the larvae (caterpillars), stripping the canopy bare and leaving the tree open to secondary infection and more susceptible to drought stress.
Pathogens	
Cryphonectria parasitica	A regulated pathogen of sweet chestnut (*Castanea sativa*). Fatal to infected trees by killing off cambium and woody tissue, inhibiting the flow of nutrients. Spores dispersed by wind and water. Not detected in Wales to date.
Curreya pithyophila – Cucurbidothis spp.	Infects Scots pine (*Pinus sylvestris*). Infests shoots and branches, with high levels of infestation leading to crown thinning and dieback. Not detected in Wales to date.
Dothistroma septosporum	Infects conifers, particularly pine (*Pinus* spp.). Causes premature needle defoliation resulting in loss of timber yield and, in severe cases, tree fatality.
Heterobasidion spp.	Infects conifers. Highly damaging to the timber industry. Causes decay in the lower part of the trunk and roots, weakening trees and killing them in some cases. Includes established (*H. annosum, H. abietinum*) as well as regulated species (*H. irregulare*, not reported in the UK).

Organism	Threat to tree health
Hymenoscyphus fraxineus	Infects ash (*Fraxinus* spp.). Spreads through the phloem and xylem layers, cutting off water and nutrient supplies to the tree and causing dieback. Trees can die as a result of the infection, or due to increased susceptibility to secondary pathogens.
Neonectria neomacrospora	Infects fir (*Abies* spp.). Weakens trees by causing cankers that kill off the phloem layer in branches, resulting in dieback. Excessive infection can lead to mortality.
Phytophthora pluvialis	A regulated pathogen. Weakens trees by causing needle loss, multiple resinous cankers, and shoot dieback. Several aspects of its biology (e.g. dispersal and host range in the UK) are not fully understood yet.
Phytophthora ramorum	A regulated pathogen of larch (*Larix* spp.) and other tree species. Induces mortality in infected larches by causing shoot wilting and withering, premature needle cast, and bleeding cankers on branches and stems. Spores are spread by wind, rain, and mechanical means (e.g. footfall, mammals, vehicles).
Rhizoctonia butinii	A relatively unknown and poorly investigated tree pathogenic fungus. It is known to infect spruces (*Picea* spp.), western hemlock (*Tsuga heterophylla*), and Douglas fir (*Pseudotsuga menziesii*), and can cause needle death by parasitising young shoots and needles. Normally occurring in twigs at ground level, it penetrates needles when air humidity is high, forming mycelial mats on the surface of the leaf tissue.
Thekopsora areolata	A rust fungus that infects spruce and cherry (*Picea* spp. and *Prunus* spp.) trees. It can reduce seed yield in spruce as infected cones produce infertile seeds and cause necrosis in leaf tissue in cherry trees. It relies on both tree species to complete its life cycle.
Xylella fastidiosa	A bacterial disease of plants which invades their water-conducting systems and, in so doing, restricts or blocks the movement of water and nutrients through the plant, with serious consequences, including death, for some host plants.

Detecting invasive organisms

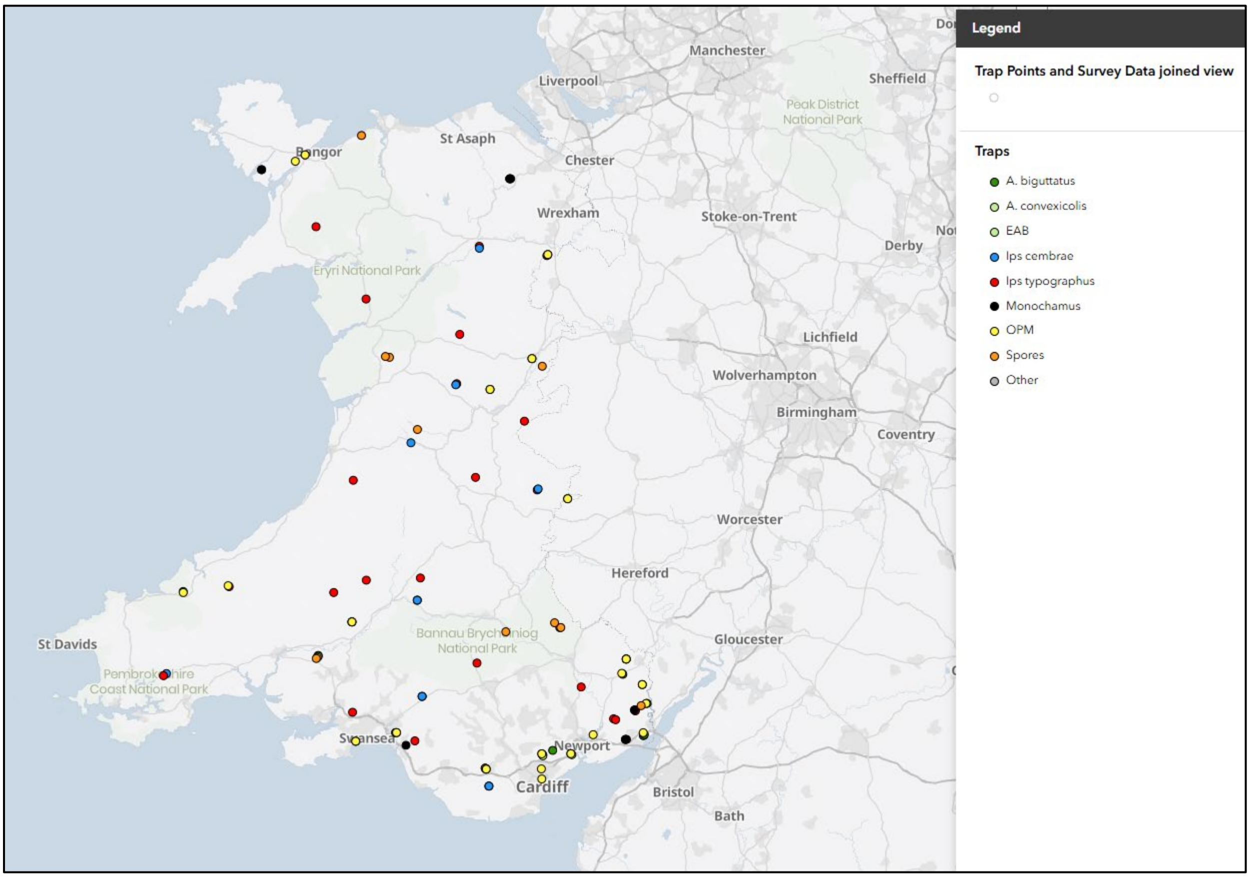
Methodology

Locations for the deployment of insect and airborne particle traps in 2025, and in previous years, were selected based on work led by Professor Hugh Evans and his forecast of potential establishment of *Ips typographus* from continental Europe (Evans, 2021). Sites deemed at higher risk of colonisation from migrating organisms were selected, including:

- at the Wales/England border
- along major transport corridors (*e.g.,* the M4 in South Wales and the A55 in North Wales)
- sites closely situated to industrial areas (*e.g.,* ports and sawmills)
- parks and gardens containing a wide variety of potential host tree species ('sentinel sites').

Site selection for surveillance in 2025 has been further informed by historical wind patterns (Inward *et al.*, 2024), in conjunction with sites that have been wind damaged as a result of Storms Darragh and Éowyn in December 2024 and January 2025 respectively (Figure 1).

Figure 1 WPHSN 2025 surveillance sites. A. = Agrilus; EAB = emerald ash borer; OPM = oak processionary moth



Traps

Insect traps

Three types of insect trap were used in the WPHSN project: cross-vane traps, bucket traps, and Lindgren multi-funnel traps. Each was deployed with a chemical lure comprising a synthetic cocktail mimicking the sexual pheromone emitted by females to attract a male for breeding. Depending on the target insect, traps were deployed either at head height or in the tree canopy.

Airborne particle traps

Burkard™ 7-day samplers and Agri Samplers™ Rotorod samplers were used; both operate with adhesive surfaces (sticky tapes and sticky rods respectively) to which airborne spores and particles adhere upon impact. It is these sticky surfaces that were analysed to establish what genetic material relating to fungal and bacterial organisms is present in an area.

Progress report

Insect monitoring

A target set in the Welsh Plant Health Surveillance Network 2023 review (Lee and Olivieri, 2024) was to incorporate surveillance for the emerging tree pests *Agrilus convexicollis* (a European jewel beetle associated with declining health in ash trees) and *Pseudips mexicanus* (Monterey pine engraver; a secondary pest of pine trees). Additionally, it was anticipated that there would be continued collaboration with the Wider Environment Monitoring (WEM) surveillance programme (an EU monitoring programme for the detection of *Ips typographus*).

Another target included a revision to the spore trapping network to focus surveillance efforts on specific fungal pathogens such as *Cryptostroma corticale* (sooty bark disease), *Curreya pithyophila* (affecting Scots pine), and *Diplodia corticola* (bot canker of oak). Additionally, we implemented a revision to the site selection process to cover a higher percentage of priority regions in Wales through the inclusion of surveillance along major road corridors, in industrial areas, and on storm damage sites.

A total of 57 sites were used for surveillance in 2025 (see Appendix C) in which 95 insect traps and 12 spore traps were deployed (Table 2); 10 insect traps for the detection of *Ips typographus* were allocated for use in the WEM programme as well as the WPHSN survey. Physical pheromone traps were not deployed for the detection of *P. mexicanus*; however, samples from other insect traps deployed in pine stands were screened for presence/absence, most specifically in southwest Wales following its detection in Ireland in December 2023.

Table 2 Summary of traps deployed in the WPHSN 2025

Trap	Number deployed
X-vane to detect *Ips typographus*	35
X-vane to detect *Ips cembrae*	13
Bucket to detect *Thaumetopoea processionea*	23
Multi-funnel to detect *Agrilus planipennis and A. convexicollis*	6
Multi-funnel to detect *Agrilus biguttatus*	13
Multi-funnel to detect *Monochamus alternatus*	5
Total insect traps	**95**
Burkard samplers to detect pathogenic spores	2
Rotor arm traps to detect pathogenic spores	10
Total airborne particle traps	**12**
Total number of traps deployed	**107**

Further to the interception of *Ips typographus* in May 2024 at a site in southeast Wales, no other detections of *Ips typographus* were made in traps across Wales in 2025. Furthermore, samples suggest an absence of *Thaumetopoea processionea* (oak processionary moth), *Agrilus planipennis* (emerald ash borer), *Agrilus convexicollis* (European jewel beetle), *Agrilus biguttatus* (two-spotted oak buprestid), *Monochamus alternatus* (Japanese pine sawyer beetle), and *Pseudips mexicanus* (Monterey pine engraver).

Detection for *Ips cembrae* during the 2025 survey season shows a presence at Bryn y Ysbyty, Cefn Arthen, Chepstow Park Wood, Coed Llewyn Celyn, Cynwyd Forest, Hensol Forest, Moel Famau, Radnor Forest, St Pierre Golf Club, Taliaris Forest, and Toch Wood (Figure 2). *Ips cembrae* was not detected in traps at Rheola Forest and Rhos Pant Mawr.

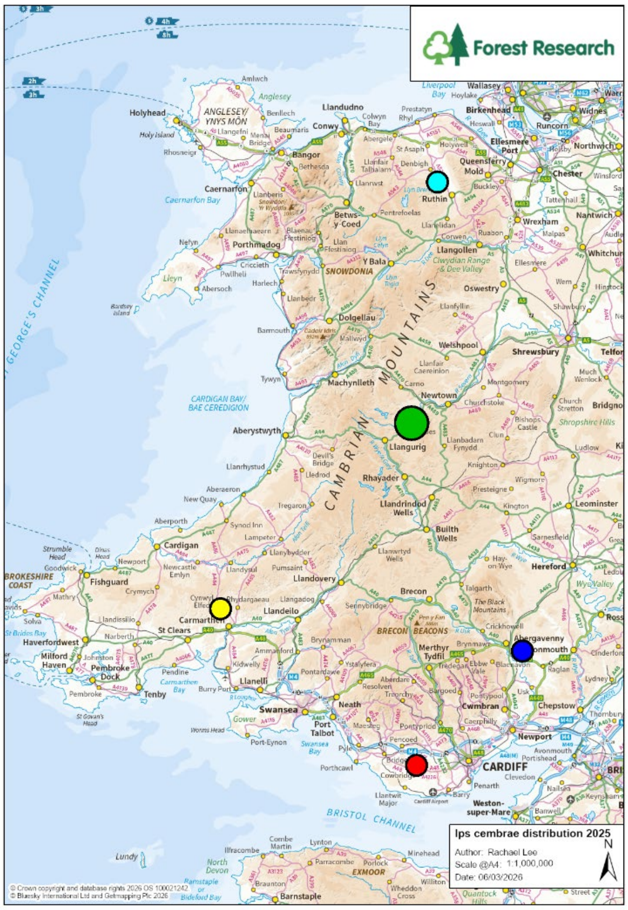
Figure 2 Map illustrating the presence of *Ips cembrae* (blue circles) in traps deployed in Welsh woodlands selected for the WPHSN 2025 programme

Of the 13 insect trap sites, *Ips cembrae* was detected at 11 locations in Wales. Data gathered in 2025 is being compared with data from surveys in 2022, 2023, and 2024, allowing population density and distribution patterns to be analysed and monitored for use in future surveillance planning.

The highest numbers of *Ips cembrae* (140 beetles) were caught in traps in Radnor Forest in mid-north Wales. Traps in southwest Wales, south-central Wales, southeast Wales, and northeast Wales caught fewer than 60 individuals at each location over the 2025 survey season (Figure 3).

Figure 3 Map illustrating population density (dot size) and distribution (dot position) of *Ips cembrae* detected in traps across Wales in 2025

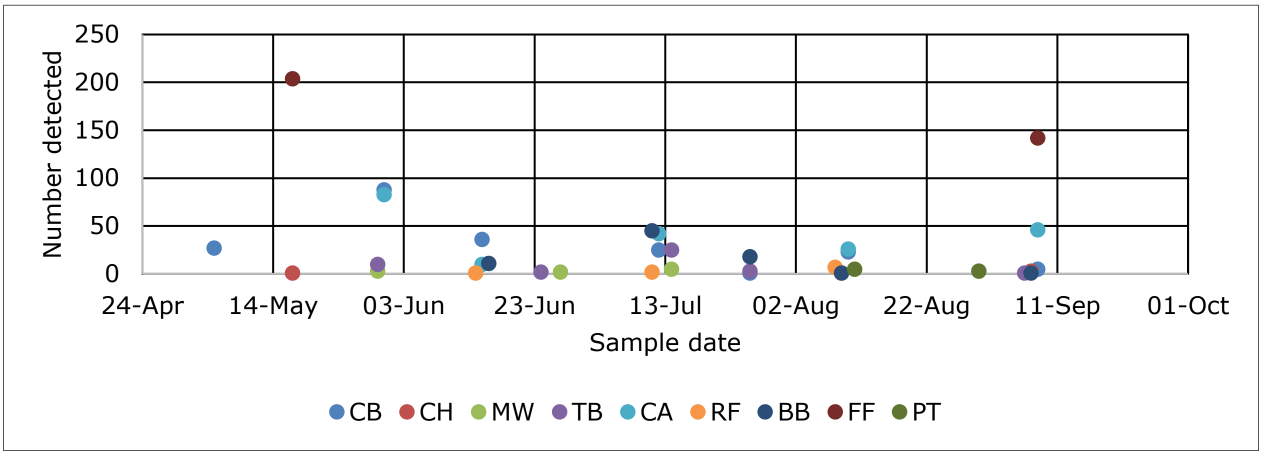
Region	Site	# *Ips cembrae*
Southwest	Cefn Arthen	52
	Taliaris Forest	1
	Toch Wood	1
	TOTAL	54
South central	Coed Llwyn-celyn	41
	Hensol Forest	12
	TOTAL	53
Southeast	Chepstow Park Wood	54
	St Pierre Golf Club	1
	TOTAL	55
Mid north	Radnor Forest	140
	Bryn y Ysbyty	2
	TOTAL	142
Northeast	Cynwyd Forest	5
	Moel Famau	49
	TOTAL	54



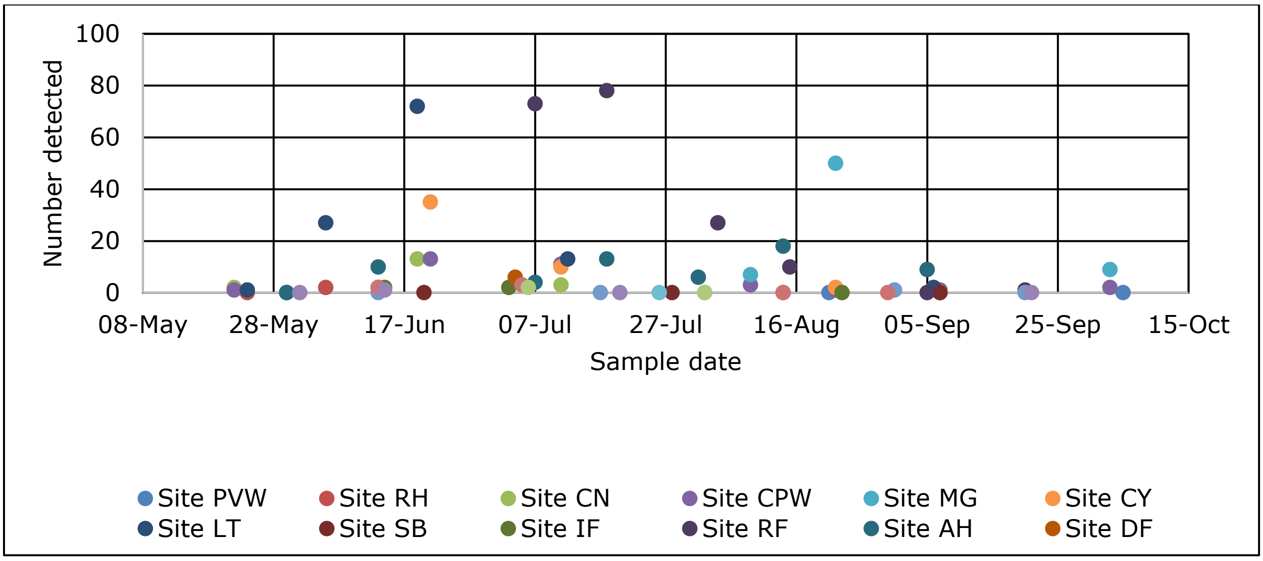
Numbers of *Ips cembrae* continue the downward pattern observed at Radnor Forest, where 140 were caught in 2025, 164 in 2024, and 277 in 2023. Interestingly, seasonal detections were noticeably different in 2025 compared with other years. Historically, higher numbers have been detected between May and July, with numbers decreasing mid-July to September, but, in 2025, the opposite can be seen: higher numbers detected in late July and late August with lower detections April to mid-July (Figure 4).

Figure 4 Graphs (a–d) illustrating a trend in detection of *Ips cembrae* in traps across Welsh woodlands 2022–2025 (site abbreviations are given in Appendix B)

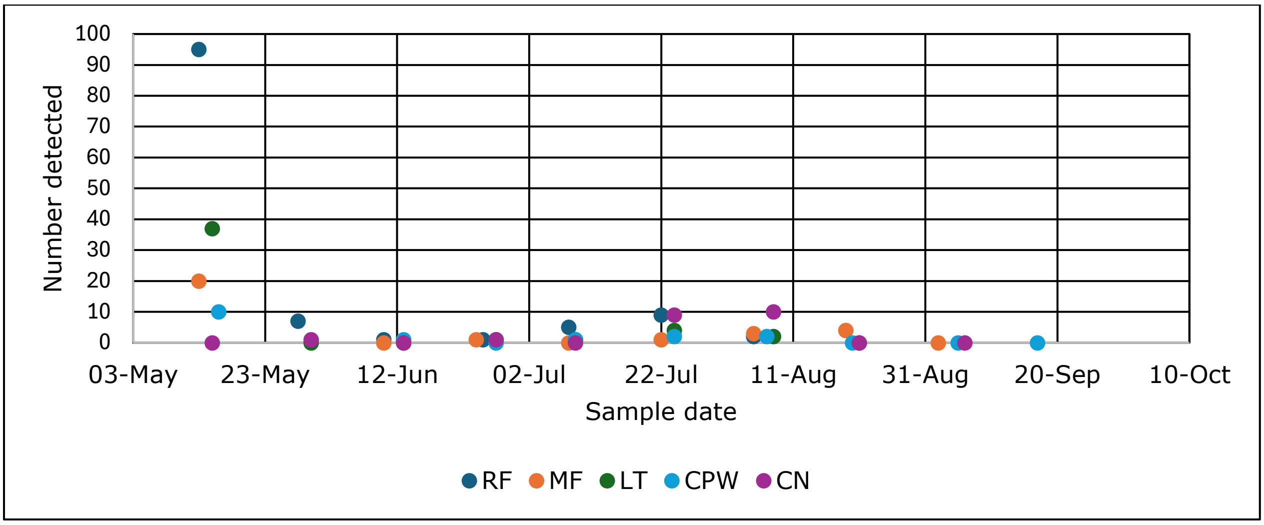
a) Presence of *Ips cembrae* in Welsh woodlands – 2022



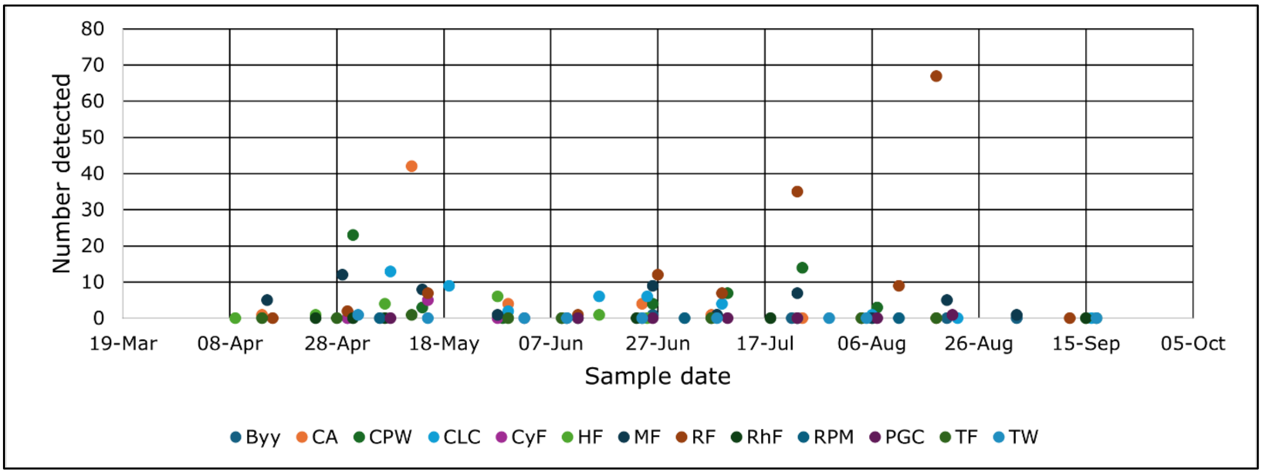
b) Presence of *Ips cembrae* in Welsh woodlands – 2023



c) Presence of *Ips cembrae* in Welsh woodlands – 2024



d) Presence of *Ips cembrae* in Welsh woodlands – 2025



While *Ips cembrae* is not a primary pest, it is prudent to continue with surveillance to monitor changes in its population density and distribution across Wales. This is particularly important following the detection of *Ips cembrae* in the previously pest-free area in Scotland.

Other insect species found in the samples taken from the traps, but not of concern, include:

- *Hylobius abietis* (large pine weevil)
- *Hylastes* species (crenulate bark beetle)

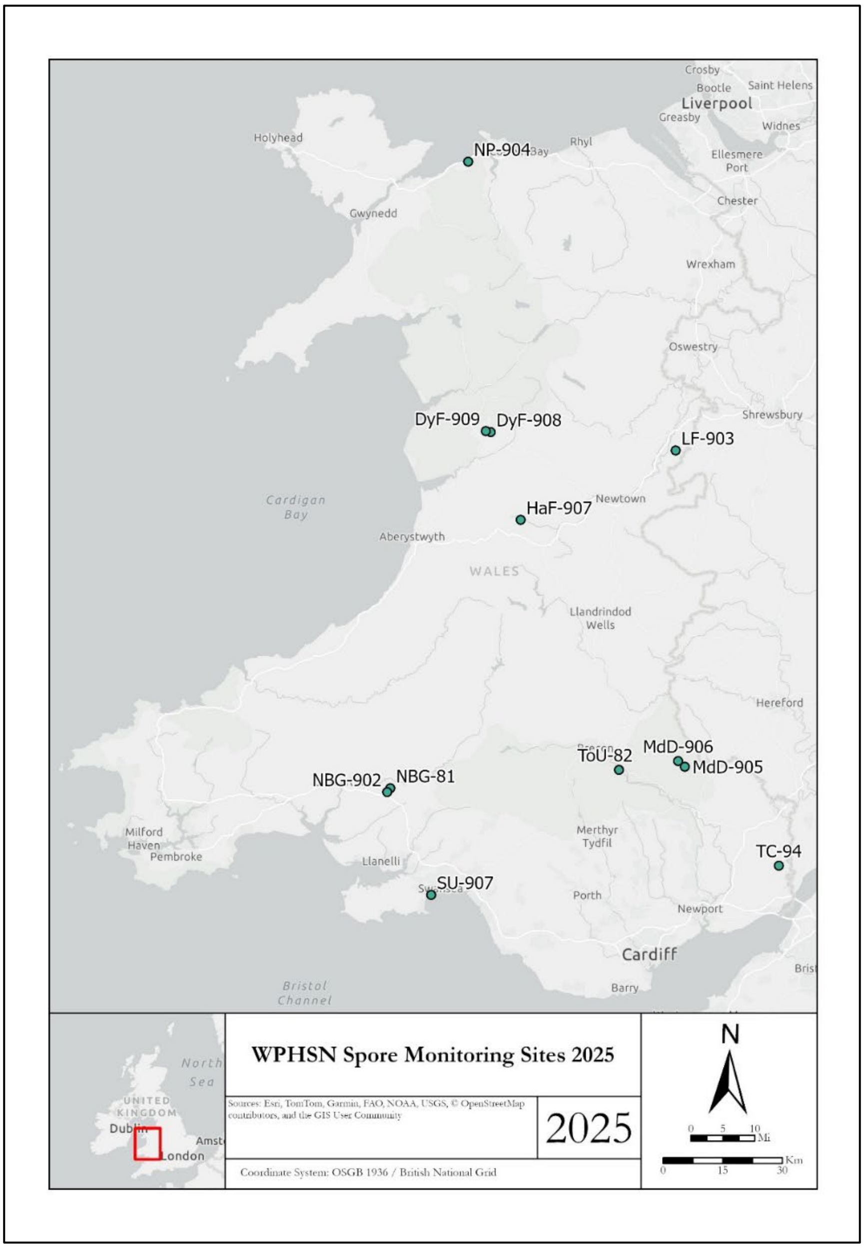
- *Platypus cylindrus* (oak pinhole borer; establishes in severely stressed trees, thus is a good indicator of poor tree health)
- *Pityogenes chalcographus* (six-toothed spruce bark beetle)
- *Pityogenes bidentatus* (two-toothed pine beetle)
- *Rhagium bifasciatum* (two-banded longhorn beetle)
- *Rhizophagus* species (predators of bark beetles)
- *Thanasimus latreille* (ant beetle; important predator of bark beetles and ambrosia beetles)
- *Trypodendron domesticum* (European hardwood ambrosia beetle)
- *Trypodendron lineatum* (striped ambrosia beetle)

A full list of insect species identified is given in Appendix A.

Airborne particle monitoring

Continuing to build on the previous years’ spore trapping analysis, the 2025 spore monitoring survey season grew from two monitoring sites used in 2024 (The Cot and Talybont-on-Usk) to 12 sites in 2025 by utilising two Burkard™ 7-day samplers and nine Agri Samplers™ Rotorod samplers; two Agri Samplers™ were doubled up for use across other sites. Figure 5 illustrates the 2025 spore monitoring site locations.

Figure 5 WPHSN 2025 spore surveillance sites



Key

NP	Noddfa Park
DyF	Dyfi Forest
LF	Leighton Forest
HaF	Hafren Forest
MdD	Mynydd Ddu
ToU	Talybont-on-Usk
TC	The Cott
SU	Swansea University
NBG	National Botanic Garden of Wales

For this year's monitoring and surveillance, a range of sites were chosen to encompass a variety of factors that may influence inoculum levels and, therefore, pathogen dynamics. Factors include tree species/age/composition, climatic conditions, altitude, and known locations of target pathogens. As a result, sites vary from botanical gardens to high-altitude commercial forestry, and to coastal sites with minimal tree cover (Figure 6 and Table 3). This deliberate variation should better our understanding of the conditions required for pathogens to become symptomatic or to reach ‘outbreak’ status.

Figure 6 Altitude of each spore trap indicated in metres above sea level. Orange boxes indicate Burkard™ 7-day samplers; blue boxes indicate Agri Samplers™ Rotorod sampler; NBGW=National Botanic Garden of Wales.

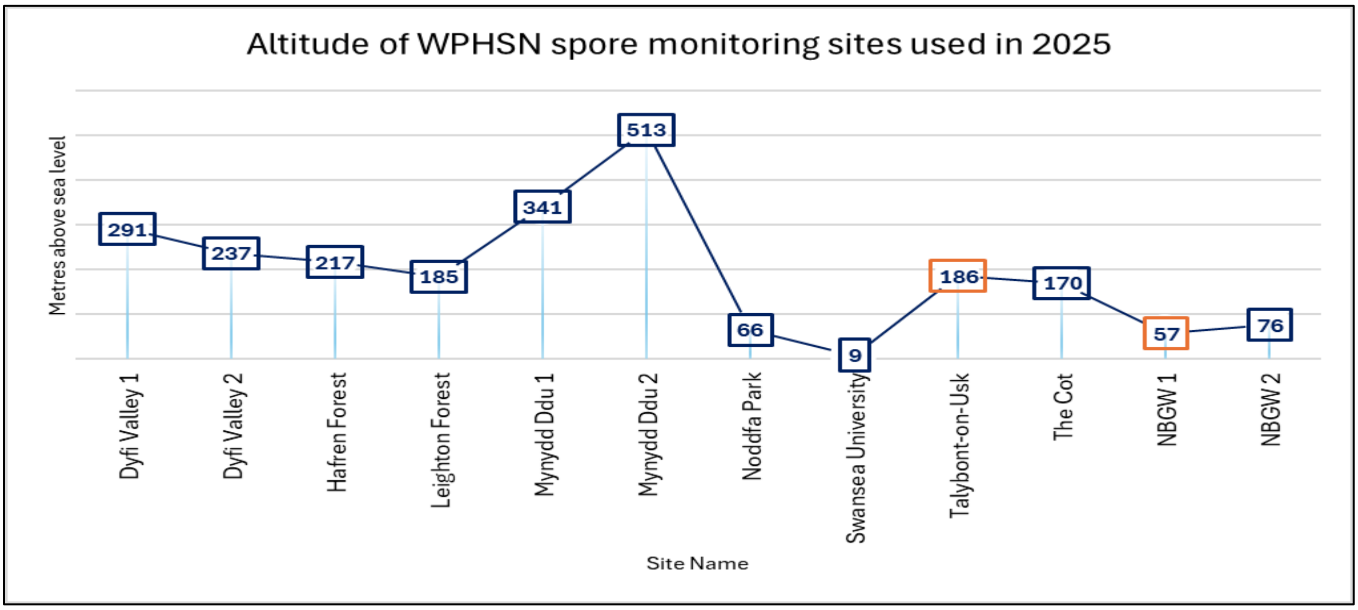


Table 3 Summary of the 2025 WPHSN spore monitoring sites, including site name, location, altitude, and tree species composition

Site name	Trap type	Grid reference	Altitude (a.s.l)	Dominant species
DyF-908	Rotorod	SH 78198 08410	291 m	*Quercus robur*, *Betula* spp., *Salix* spp., *Larix kaempferi*, *Picea sitchensis*, *Picea abies*, *Sorbus* spp.
DyF-909	Rotorod	SH 76927 08698	237 m	*Eucalyptus* spp., *Betula* spp., *Quercus petraea*, *Sorbus* spp., *Pseudotsuga menziesii*, *Picea sitchensis*, *Picea abies*, *Alnus glutinosa*, *Cryptomeria japonica*
HaF-907	Rotorod	SN 686 856	217 m	*Picea sitchensis*, *Betula pendula*, *Quercus petraea*, *Pinus sylvestris*, *Salix* spp., *Larix × marschlinsii*, *Sorbus* spp.
LF-903	Rotorod	SJ 24748 03768	185 m	*Sequoia sempervirens*
MdD-905	Rotorod	SO 27005 24113	341 m	*Picea sitchensis*, *Picea abies*, *Pseudotsuga menziesii*, *Tilia cordata*, *Corylus avellana*,

Site name	Trap type	Grid reference	Altitude (a.s.l)	Dominant species
				Abies grandis, *Betula* spp., *Cryptomeria japonica*
MdD-906	Rotorod	SO 254 250	513 m	*Tsuga heterophylla*, *Picea sitchensis*, *Picea abies*, *Betula* spp.
NP-904	Rotorod	SH 72491 76497	66 m	*Sequoia sempervirens*, *Quercus* spp., *Castanea sativa*, *Acer pseudoplatanus*
SU-907	Rotorod	SS 63200 91899	9 m	*Quercus ilex*, *Quercus robur*, *Fagus* spp., *Pinus* spp., *Taxus* spp., *Prunus* spp., *Betula* spp., *Araucaria araucana*
TOU-B2	Burkard 7-day Sampler	SO 1048 2338	186 m	*Populus nigra*, *Fraxinus excelsior*, *Sequoia* spp., *Fagus sylvatica*, *Picea* spp.
TOU-907	Rotorod	SO 1048 2338	186 m	*Populus nigra*, *Fraxinus excelsior*, *Sequoia* spp., *Fagus sylvatica*, *Picea* spp.
TC-901	Rotorod	ST 50726 99243	170 m	*Abies procera*, *Picea abies*, *Betula pendula*, *Fraxinus excelsior*
NBG-B1	Burkard 7-day Sampler	SN 52898 18706	57 m	*Abies* spp., *Alnus* spp., *Corylus avellana*, *Fagus sylvatica*, *Fraxinus excelsior*, *Ilex aquifolium*, *Pinus* spp., *Quercus* spp.
NBG-902	Rotorod	SN 52142 17758	76 m	*Taxus baccata*, *Tilia cordata*, *Acer* spp., *Araucaria Araucana*, *Betula* spp., *Cotoneaster* spp., *Cupressus gigantea*, *Pinus* spp., *Quercus* spp., *Rhododendron* spp., *Sorbus* spp.

The increased number of airborne particle monitoring stations deployed across Wales in 2025, coupled with a research-led approach to site selection, highlights the completion of the forecast objectives set out in the 2024 report and has resulted in the most comprehensive level of airborne pathogen surveillance on the WPHSN to date. We aim to continue to develop this aspect of the project to not only provide widespread surveillance, but also to begin to answer specific research questions associated with fungal and bacterial pathogen dynamics within Wales. Figure 7 shows the two types of air samplers used.

Figure 7 Air samplers used for 2025 spore surveillance: a) Agri Samplers™ Rotorod sampler; b) Burkard™ 7-day sampler

a)

b)

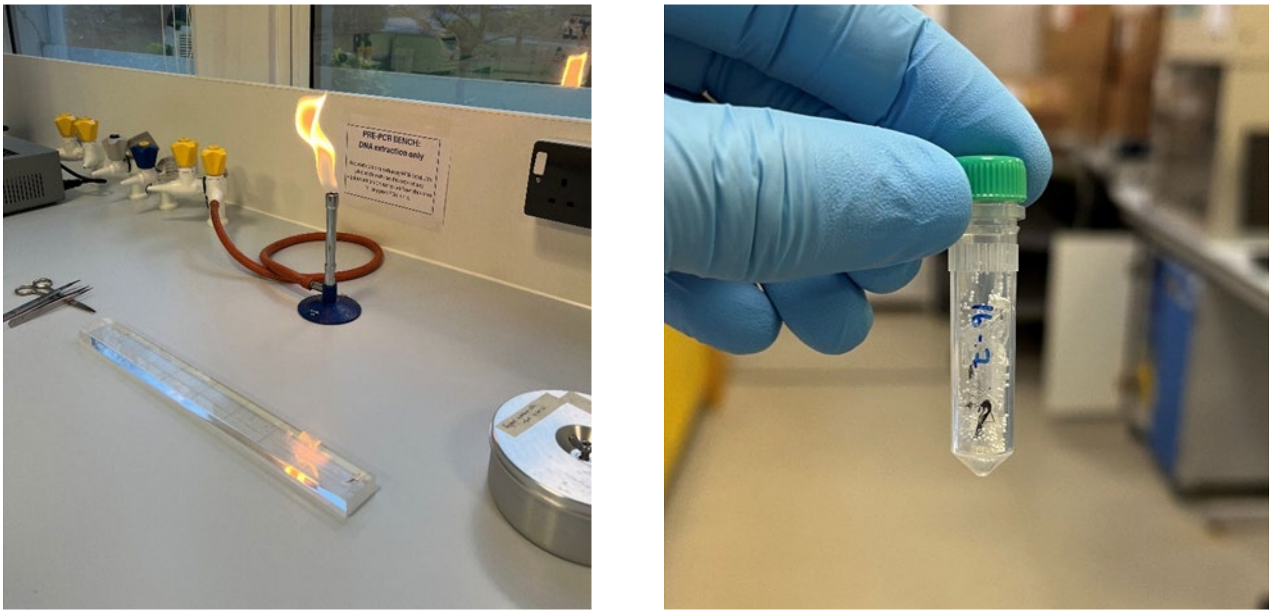
A total of 212 samples were obtained between May and December 2025 and these are being analysed via a combination of DNA metabarcoding and PCR/qPCR methods to provide data on the abundance and distribution of pathogenic and non-pathogenic fungal spores across Wales. A detailed analysis of this will be provided in a follow up report in mid-2026. The results will provide a unique insight into the status of known airborne pathogens across Wales, allowing the early detection of the migration of these pathogens into new habitats, and the identification of new/novel pathogens. Data collected on non-pathogenic fungi may also provide a valuable insight into the biodiversity of these sites and deepen our understanding of fungal interactions.

Materials, methods, and preliminary results

Samples collected via the Burkard™ 7-day samplers were first divided into seven evenly split subsamples (cut using a template; Figure 8) to provide seven 24-hour periods of data. The tape was also cut longitudinally to provide two replicates. Agri Samplers™ Rotorod samplers were deployed for 48 hours and were not subsampled. Instead, DNA was extracted from both rods to provide one sample representative of a single 48-hour period. Each spore trap was also accompanied by a Tinytag data logger to allow the analysis of the interaction between climatic conditions and spore dynamics.

Figure 8 a) Subsampling of Burkard™ 7-day sampler into 1-day samples which were b) placed into homogenisation tubes for DNA extraction.

a) b)



DNA was extracted using a Machery-Nagel™ Plant II Kit using a hybrid method of Chandelier *et al.* (2021) and Zajc *et al*. (2022). This hybrid method includes an additional preparatory step using CTAB buffer as a method of removing the petroleum jelly (used to coat the Burkard™ tape and Rotorod rods to allow airborne material to adhere), ensuring it would not interfere with DNA retrieval and downstream applications. Success of the DNA extraction was validated by gel electrophoresis and the presence of a band at the expected amplicon length. ITS-1-F and ITS-4 primer sets were chosen to produce 500–1000 base pair amplicons, depending on species (Table 4). Some notable targets are outlined in Table 5.

Table 4 Summary of primers and Illumina overhangs used to prepare samples for metabarcoding

Primer	Sequence (5'–3')
ITS-1-F Forward	CTT GGT CAT TTA GAG GAA GTA A
ITS-4 Reverse	TCC TCC GCT TAT TGA TAT GC
Illumina overhang F	TCG TCG GCA GCG TCA GAT GTG TAT AAG AGA CAGxxx
Illumina overhang R	GTC TCG TGG GCT CGG AGA TGT GTA TAA GAG ACA Gxxx

Table 5 Summary of key targets for WPHSN airborne monitoring

Target species	Common name
Armillaria spp.	honey fungus
Cronartium quercuum	pine/oak gall rust
*Cryphonectria parasitica**	sweet chestnut blight
Cucurbidothis spp.	Scots pine fungus
Dothistroma septosporum	Dothistroma needle blight
Heterobasidion spp.	conifer root and butt rot
Neonectria neomacrospora	canker of fir
Phytophthora spp.*	water moulds
Rhizoctonia spp.	web blight
*Valsa oxystoma**	-
Xylella fastidiosa	-

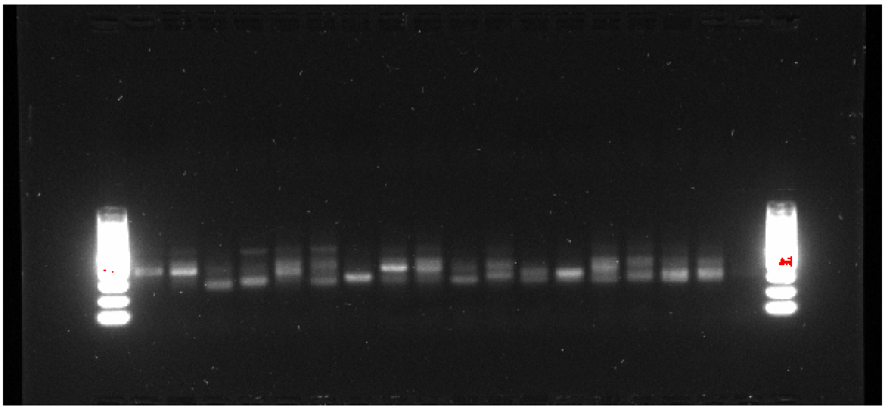
*These species are not detected using the protocol outlined above and will instead be analysed via qPCR.

DNA quality and suitability for sequencing was validated by running a cross-section of extracts via PCR using the primer pair (ITS-1-F-Forward and ITS-4 Reverse) outlined above and visualised via gel electrophoresis. For every batch of 12 samples extracted, 6 were randomly selected to be run as 25 ul reactions (1X Platinum II

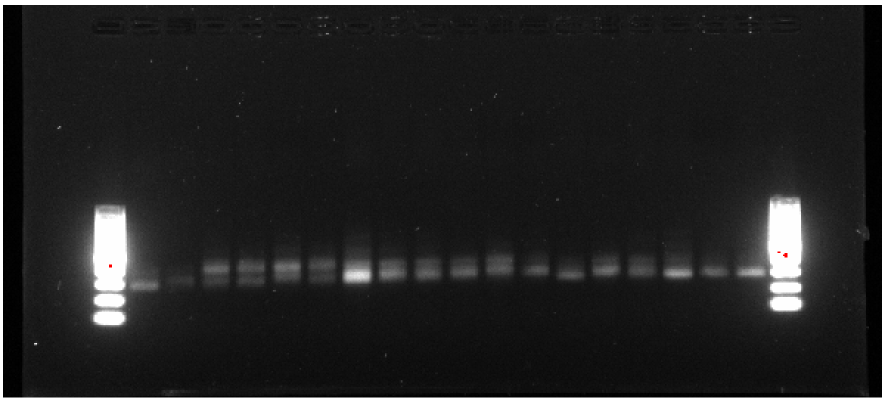
Taq Polymerase, 200 nM FP, 200 nM RP, 5 ul DNA template) for the following conditions: 95 °C for 3 minutes, followed by 40 cycles of 95 °C for 30 seconds, 55 °C for 30 seconds, and 72 °C for 30 seconds, followed by 72 °C for 5 minutes. Amplicons were run on a 2% agarose:TAE gel using 6X Loading Dye and 5 ul DNA template and run at 90 V for 60 minutes. Most samples contained multiple amplicons of varying lengths, which is expected as this region is highly variable in fungi. Extraction blanks contained no amplification (Figure 9).

Figure 9 DNA quality and suitability was checked via 2% gel electrophoresis from a) a random subset of Agri Samplers™ Rotorod sampler samples and b) a random subset of Burkard™ 7-day sampler samples

a)



b)



Due to the publication date of this report, we are unable to present the full set of results for this method of analysis; these will instead be published in a mid-year report. However, from the work conducted thus far, it is possible to confirm the presence of usable fungal DNA across the subsamples taken during the survey period. The next step will be to prepare the library of samples for sequencing via the Illumina miSeq platform (Illumina, 2013; Chandelier *et al.,* 2021) and results analysed by both internal Forest Research bioinformatics pipelines and FungiSearch_V2 (Chandelier *et al.,* 2025).

Collaboration

Sentinel sites

Collaboration with the sentinel site network continued into 2025 and is set to continue with the same sites coming on board for 2026 (Table 6). Feedback is consistent with previous years, in that all site managers maintain their interest and enthusiasm and wish to continue their collaboration for the foreseeable future.

Table 6 Development of the sentinel site network and private landowners collaborating with the WPHSN project: 2022–2026

Sentinel sites	2022	2023	2024	2025	2026
Forest plantations across Wales (NRW)	•	•	•	•	•
National Botanic Garden of Wales, Carmarthen	•	•	•	•	•
Cardiff Golf Club, Cardiff	•	•	•	•	•
Powis Castle, Welshpool (National Trust)	•	•	•	•	•
Plas Newydd, Anglesey (National Trust)	•	•	•	•	•
Loggerheads Country Park, Llanferres	•	•	•		
Treborth Botanic Gardens, Bangor		•	•	•	•
Penllergare Valley Woods, Swansea		•	•		•
Bute Park, Cardiff		•	•		
Landmarc, Brecon		•			•
Llyn Parc Mawr, Anglesey			•	•	•
Pengelli Forest, Pembrokeshire (Wildlife Trust of South and West Wales)			•	•	•
Celtic Manor, Newport			•	•	•

Sentinel sites	2022	2023	2024	2025	2026
Forest plantations across Wales (NRW)	•	•	•	•	•
Leighton Estate, Welshpool (Royal Forestry Society)			•	•	•
Chirk Castle, Chirk (National Trust)			•	•	•
Roath Park, Cardiff				•	•
St Pierre Golf Club, Chepstow				•	•
Tredegar House, Newport (National Trust)				•	•
Gregynog Hall, Newtown				•	•
Total number of sites per year	**6**	**10**	**14**	**15**	**17**
Private landowners					
Dingestow Court, Monmouthshire			•	•	•
Taliaris Forest, Llandeilo			•	•	•

Forestry colleagues

Working relationships with senior project leads and research scientists at Forest Research and Forestry Commission Forest Services have continued into 2026 since the inception of the project in 2022. Shared data, such as site information, trapping locations, sporulation patterns, and emergence and flight patterns of beetles and moths all help to optimise the trapping network in Welsh woodlands. Additionally, support from Forest Research entomologists provides independent verification of insect identification from samples obtained during the survey season.

Multiple collaborations with insect surveillance projects will continue in 2026. The Forest Trapping Network (a national and Forest Research-led insect surveillance project) will work in tandem again with the WPHSN to ensure adequate coverage across Wales and to prevent duplication of sites used for monitoring. The WPHSN will continue to support the Wider Environment Monitoring programme for the presence/absence of *Ips typographus*, providing both surveillance for Wales and data returnable to the EU.

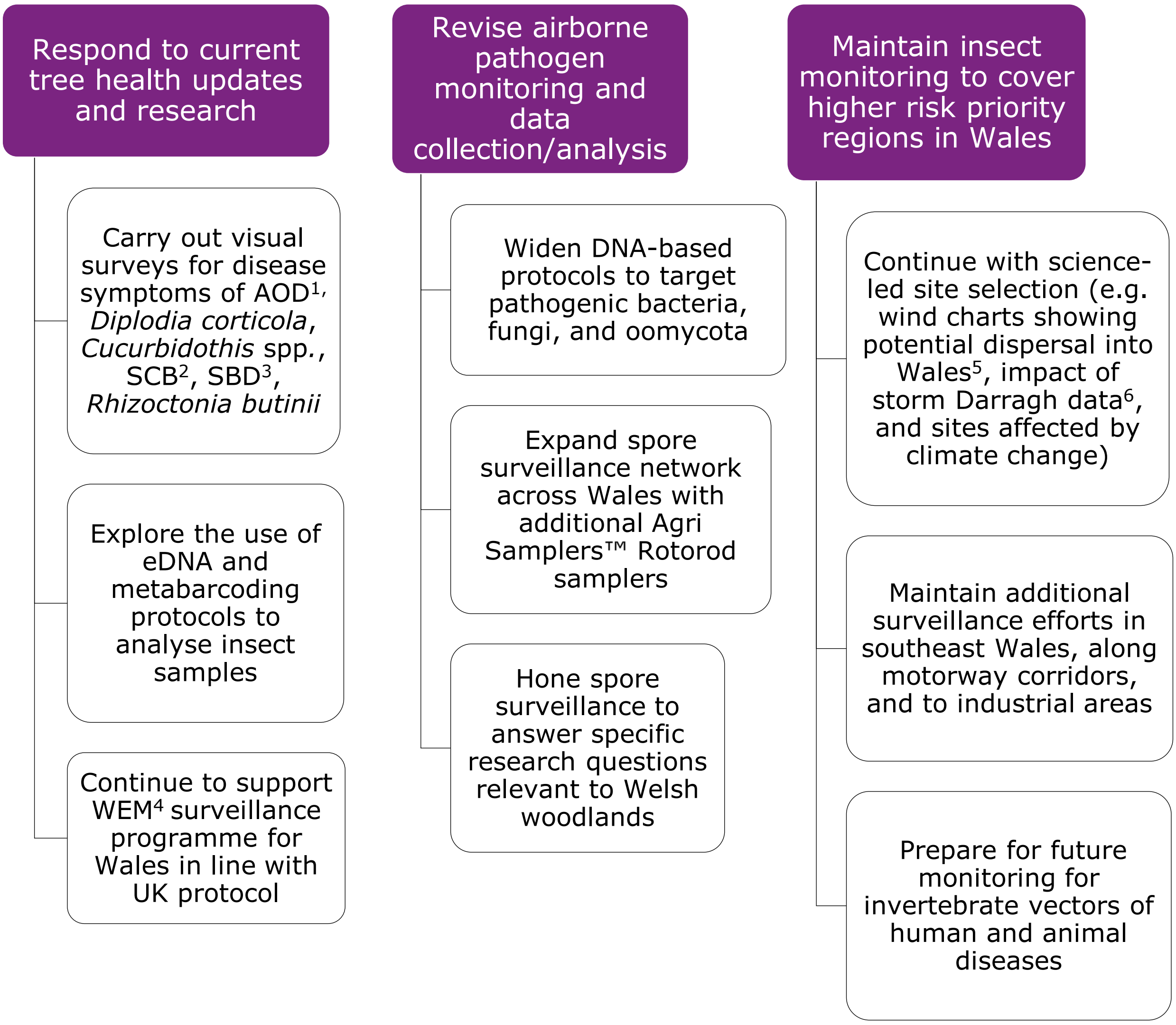
External colleagues

Our collaboration with the Genomics for Animal and Plant Disease Consortium (GAP-DC) came to a close in 2025, but spore surveillance to safeguard the health of plants continued, as described in Airborne particle monitoring. Notwithstanding this, the WPHSN was able to establish a collaboration with the Department of Biosciences at Swansea University via Dr Tamsyn Uren Webster. This facilitated the DNA-based analysis of the airborne sampling aspect of the project and has enabled it to be carried out in Wales for the first time. We hope to continue this highly productive collaboration to increase our capacity to keep sample analysis within Wales; increase the research focus of the WPHSN in Wales; and potentially develop Wales-centric undergraduate, postgraduate, and PhD projects.

WPHSN 2026 – forecast and targets

The current WPHSN funding from the Welsh Government enables the project to continue the surveillance and monitoring for invasive pests and pathogens until 31 March 2027, including ongoing collaboration with the sentinel site network and private landowners, and for essential fieldwork support through the appointment of a dedicated Fieldwork Technician.

Figure 10 Objectives for 2026



[1]AOD – Acute oak decline
[2]SCB – Sweet chestnut blight
[3]SBD – Sooty bark disease
[4]WEM – Wider Environment Monitoring surveillance for *Ips typographus*
[5]Inward *et al.* (2024)
[6]NRW GIS files

Refine surveillance network

Sites selected for 2026 surveillance will mirror those of 2025 (Figure 1). Once again, sites in southeast Wales will be prioritised because of the dispersal projections described by Inward *et al.* (2024) and following the interception of *Ips typographus* in Monmouthshire in 2024. Similar methods can also be applied for the surveillance of other invasive insect species to ensure the surveillance programme remains as effective as possible.

A total of 30 pheromone traps will be deployed in Welsh woodlands for the monitoring and detection of *Ips typographus* between 01 April and 30 September 2026, serviced fortnightly. Primary sample analysis for *Ips typographus* will take place in the field at the time of sample collection to ensure early detection.

Additionally, the WPHSN will again carry out surveillance on behalf of the WEM scheme for the early detection of *Ips typographus*.

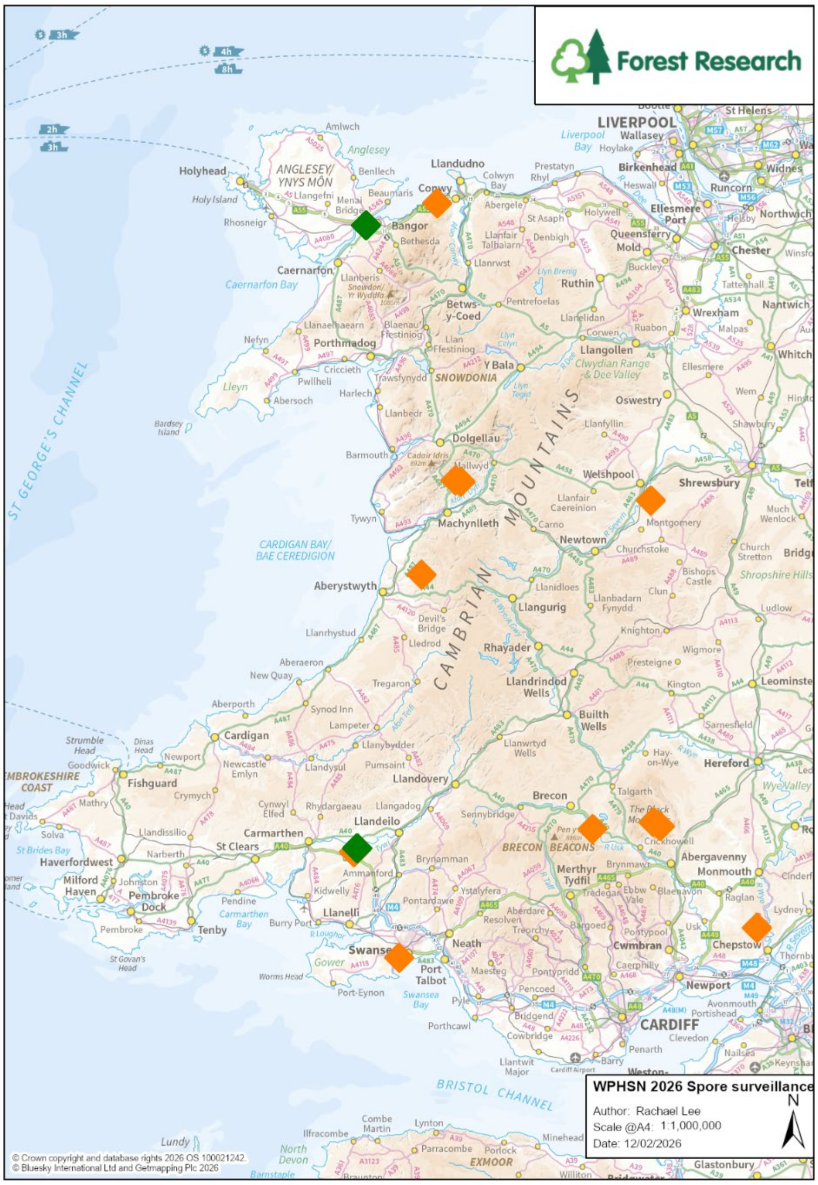
Monitoring absence/presence of other invasive pests and pathogens across Wales will take place between April and December 2026 and will include insect/spore trap deployment and routine servicing for:

- *Ips cembrae* (large larch bark beetle)
- The jewel beetles *Agrilus planipennis* (emerald ash borer), *A. biguttatus* (two-spotted oak buprestid), and *A. convexicollis*
- *Thaumetopoea processionea* (oak processionary moth)
- *Monochamus alternatus* (Japanese pine sawyer beetle)
- *Cryphonectria parastica* (sweet chestnut blight)
- *Cucurbidothis* spp. (formerly *Curreya pithyophila*) (Scots pine fungus)
- *Heterobasidion* species (conifer root and butt rot fungus)
- *Neonectria neomacrospora* (canker of fir)
- *Phytophthora* species (water moulds)
- *Rhizoctonia butinii* (web blight).

Visual surveys will also be carried out (in areas of insect surveillance) for the detection and monitoring of acute oak decline disease, *Diplodia corticola* (bot canker of oak), the fungus *Cucurbidothis* spp. (previously known as *Curreya pithyophila*), sooty bark disease, and sweet chestnut blight.

A wider network of spore traps is planned for the 2026 monitoring season through the deployment of additional air samplers across Wales (Figure 11). Furthermore, the performance of different spore collection instruments, such as the Cyclone sampler, will be tested with a view to optimising spore capture for DNA extraction. Sampling is scheduled to take place monthly between May and December 2026.

Figure 11 Map illustrating planned locations for air samplers. Orange rhombi indicate sites which will host a Rotorod air sampler; green rhombi will host a Burkard air sampler.



Cultivate stakeholder engagement

Engaging with stakeholders is key to the success of the WPHSN. Figure 12 outlines how this can be done and what the aims of engagement with different types of stakeholders are.

Figure 12 Flowchart detailing planned steps in cultivating stakeholder engagement

1. Continue to partake in networking and public engagement activities, as well as knowledge sharing events to raise the profile of the work of the WPHSN project and raise awareness of plant health issues, pests, and pathogens
2. Nurture working relationships with external colleagues in furtherance of data sharing and project collaboration to widen the scope of the WPHSN
3. Cultivate collaborations with sentinel sites and private landowners to ensure needs of both parties are met and support the work of the WPHSN project

Recommendations

The appointment of Dr Matthew Watkins as Field Research Technician in April 2025 has supported the project’s expansion by enabling an increase in monitoring sites and establishing a facility for Wales-based spore sample analysis. Because of his previous experience and training, Matthew’s role has since evolved to encompass both cutting-edge laboratory analysis and fieldwork. To sustain improvements in monitoring and sample analysis through 2027, the appointment of a dedicated Field Research Technician should be considered as Matthew’s position continues to develop into a field pathology role.

Site selection for the detection and monitoring of *Ips typographus* in 2026 will continue to be determined based on assessments of wind damage on the Welsh Government Woodland Estate as a result of Storms Darragh and Éowyn in 2024 and 2025 respectively, as well as on those sites deemed at high risk of an outbreak based on their geographical location in conjunction with the pattern of likely wind plume events from continental Europe.

Air sampler site selection for the 2026 spore surveillance will be informed using results from the 2025 spore sample analysis and can be used to facilitate research around the distribution of pathogenic fungal species and their impact on tree health (*e.g.,* resilience to wind damage and drought in extreme weather events).

The WPHSN project has the potential to carry out a pilot surveillance programme for larval and adult arthropod vectors of human and animal disease (*e.g., Aedes* species) via deployment of traps in suitable habitats across Wales. Furthermore, data collected can be analysed through taxonomic identification and DNA-based methods to record species, abundance, and distribution of the target vectors.

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Appendix A: Results from biological samples collected from insect traps deployed in Welsh woodlands in 2025

Organism	Organism	Organism
Adarrus ocellaris	*Morellida* species	*Taphrorychus villifrons*
Amblyjoppa proteus	*Malthinus seriepunctatus*	*Thanasimus latreille*
Anobium species	*Monotoma* species	*Tomicus minor*
Aphididae species	*Nebria brevicollis*	*Tomicus piniperda*
Apis mellifera	*Nicrophorus vespilloides*	*Trypodendron domesticum*
Asemum striatum	*Notiophilus* species	*Trypodendron lineatum*
Baeocrara variolosa	*Panorpidae* species	*Trypodendron signatum*
Bombus terrestris	*Parasitoid hymenoptera*	*Vespa crabro*
Cantharis rustica	*Pediacus depressus*	*Vespula vulgaris*
Carabus problematicus	*Pediacus dermestoides*	*Vincenzellus ruficollis*
Crypturgus subcribrosus	*Pentatoma* species	*Weevil* species
Dryocetes alni	*Pityogenes bidentatus*	*Xyleborus* species
Dryocetes autographus	*Pityogenes calcographus*	*Taphrorychus villifrons*
Dryocetes villosus	*Pityophthorus lichtensteinii*	*Thanasimus latreille*
Elateridae species	*Platyderus depressus*	*Tomicus minor*
Ephemeroptera species	*Platypus cylindrus*	*Tomicus piniperda*
Formica rufa	*Polygraphus poligraphus*	*Trypodendron domesticum*
Grammoptera abdominalis	*Ptilinus pectinicornis*	*Trypodendron lineatum*
Grammoptera ruficornis	*Rhagium bifasciatum*	*Trypodendron signatum*
Grammoptera ustulata	*Rhizophagus depressus*	*Vespa crabro*
Halyzia sedecimguttata	*Rhizophagus ferrugineus*	*Vespula vulgaris*

Organism	Organism	Organism
Hylastes species	*Rutpela maculata*	*Vincenzellus ruficollis*
Hylurgops palliatus	*Salpingus planirostris*	*Weevil* species
Hylesinus toranio	*Salpingus ruficollis*	*Xyleborus* species
Hylesinus varius	*Scarabaeidae* species	
Hylobius abietis	*Scolytus* species	
Hymenoptera species	*Scraptiidae* species	
Ichneumonid species	*Serica brunnea*	
Leiopus species	*Sircidae* species	
Lymantria monacha	*Staphylinidae* species	
	Symphyta species	

Appendix B: Site abbreviations relating to Figure 4

Figure 4a site abbreviations (2022)

CB	Cwmcarn Forest, Cwmbran
CH	Fedw Wood, Chepstow
MW	Manor Wood, The Narth
TB	Talybont-on-Usk
CA	Coed Mawr, Caerphilly
RF	Radnor Fishpools, near Presteigne
BB	Mynydd Ddu, Black Mountains
FF	Fforest Fawr, Caerphilly
PT	Mynydd Margam, Port Talbot

Figure 4b site abbreviations (2023)

PVW	Penllergare Valley Woods
RH	Rheola
CN	Cwmcarn
CPW	Chepstow Park Wood
MG	Manson's Grove
CY	Cwmyoy Wood
LT	Llantrisant Forest
SB	Sennybridge
IF	Irfon Forest
RF	Radnor Forest
AH	Abbeycwmhir
DF	Dyfnant Forest

Figure 4c site abbreviations (2024)

RF	Radnor Forest, Presteigne
MF	Moel Famau
LT	Llantrisant Forest, Llantrisant
CPW	Chepstow Park Wood, Devauden
CN	Cwmcarn Forest, Cwmbran

Figure 4d site abbreviations (2025)

Byy	Bryn y Ysbyty
CA	Cefn Arthen
CPW	Chepstow Park Wood
CLC	Coed Llewyn Celyn
CyF	Cynwyd Forest
HF	Hensol Forest
MF	Moel Famau
RF	Radnor Forest
RhF	Rheola Forest
RPM	Rhos Pant Mawr
PGC	Saint Pierre Golf Club
TF	Taliaris Forest
TW	Toch Wood

Appendix C: Trap index

Site name	Site grid reference	Pest/pathogen
Allt Ceiliog	SN 26556 30382	*Ips typographus*
Banc Bronffen	SN 68455 41003	*Ips typographus*
Banc Cwmllechwedd	SN6582471396	*Ips typographus*
Beacon Hill	SO 51375 05818	*Ips typographus*
Beddgelert Forest	SH 57467 49179	*Ips typographus*
Brechfa Forest	SN 58347 37690	*Ips typographus*
Bryn yr ysbyty	SN 98443 99703	*Ips typographus*
Cefn Arthen	SN 83758 34187	*Ips typographus*
Chepstow Park Wood	ST48571 97924	*Ips typographus*
Chirk Castle	SJ 27460 37477	*Ips typographus*
Coed Cwmgolog	SO 18623 87495	*Ips typographus*
Coed Llwyn-celyn	ST 19804 85910	*Ips typographus*
Coed Taff	SO 01212 14232	*Ips typographus*
Coed Trecastle	ST 02348 82193	*Ips typographus*
Coed y Brenin	SH 71672 26424	*Ips typographus*
Crychan Forest	SN 84905 40860	*Ips typographus*
Cwmsymlog	SO 03124 70758	*Ips typographus*
Cynwd Forest	SJ 06854 41169	*Ips typographus*
Dyfnant Forest	SH 99955 14606	*Ips typographus*
Hensol Forest	ST0323776812	*Ips typographus*
Moel Famau	SJ 17257 61498	*Ips typographus*
Mynydd Ddu	SO 26958 23991	*Ips typographus*
Mynydd Margam	SS 81420 91432	*Ips typographus*
Newborough Forest	SH 41435 67054	*Ips typographus*
Penllergaer Forest	SN 62731 00903	*Ips typographus*
Picklewood	SN 0546214449	*Ips typographus*
Radnor Forest	SO 21673 66414	*Ips typographus*
Rheola Forest	SN 84121 04765	*Ips typographus*

Site name	Site grid reference	Pest/pathogen
Slade Wood	ST 45524 89214	*Ips typographus*
Slade Wood	ST4593889304	*Ips typographus*
Taliaris Forest	SN 63634 28453	*Ips typographus*
The Hendre	SO 46678 13858	*Ips typographus*
Wentwood	ST 42200 95590	*Ips typographus*
Wenwood	ST 42763 95403	*Ips typographus*
Wern Fawr	SO 32501 05907	*Ips typographus*
Bryn yr ysbyty	SN 98103 99242	*Ips cembrae*
Cefn Arthen	SN 83728 34196	*Ips cembrae*
Chepstow Park Wood	ST 48739 98308	*Ips cembrae*
Coed Llwyn-celyn	ST 20056 85651	*Ips cembrae*
Cynwd Forest	SJ 07045 40719	*Ips cembrae*
Hensol Forest	ST 03443 76724	*Ips cembrae*
Moel Famau	SJ 17138 61410	*Ips cembrae*
Radnor Forest	SO 21978 66599	*Ips cembrae*
Rheola Forest	SN 84080 04808	*Ips cembrae*
Rhos Pant-mawr	SN8385682218	*Ips cembrae*
St Pierre Golf Club	ST 50984 90227	*Ips cembrae*
Taliaris Forest	SN 63639 28412	*Ips cembrae*
Toch Wood	SN0630314945	*Ips cembrae*
Briton Ferry	SS 75420 94239	*A. biguttatus*
Chirk Castle	SJ 27701 37933	*A. biguttatus*
Coed Llwyn-celyn	ST2004285408	*A. biguttatus*
Coed Trecastle	ST 02521 82145	*A. biguttatus*
Dingestow Court	SO 45377 09286	*A. biguttatus*
Gregynog	SO 08631 97609	*A. biguttatus*
Nash Wood	SO 30929 63395	*A. biguttatus*
Pengelli Forest	SN 12344 39571	*A. biguttatus*

Site name	Site grid reference	Pest/pathogen
Powis Castle	SJ 21617 06246	*A. biguttatus*
St Pierre Golf Club	ST 51357 90546	*A. biguttatus*
The Hendre	SO 46649 13839	*A. biguttatus*
Tintern Abbey	ST 52490 99929	*A. biguttatus*
Tredegar House	ST 28545 85566	*A. biguttatus*
Briton Ferry	SS 75640 94213	*A. convexicolis*
National Botanical Gardens of Wales	SN 52761 18159	*A. convexicolis*
Coed Llwyn-celyn	ST 20081 85392	*Agrilus planipennis*
Coed Trecastle	ST 02370 82243	*Agrilus planipennis*
Treborth Botanic Gardens	SH 55009 71088	*Agrilus planipennis*
Tredegar House	ST 28998 85446	*Agrilus planipennis*
Chepstow Park Wood	ST 48433 98252	*Monochamus alternatus*
Moel Famau	SJ 17101 61412	*Monochamus alternatus*
Mynydd Emroch	SS 78410 90119	*Monochamus alternatus*
Newborough Forest	SH 41397 67128	*Monochamus alternatus*
Slade Wood	ST 45490 89285	*Monochamus alternatus*
Allt Ceiliog	SN 26275 40830	*Thaumetopoea processionea*
Beacon Hill	SO 51270 05733	*Thaumetopoea processionea*
Briton Ferry	SS 75718 94196	*Thaumetopoea processionea*
Cardiff Golf Club	ST 19488 81446	*Thaumetopoea processionea*
Celtic Manor	ST 35658 91206	*Thaumetopoea processionea*
Chirk Castle	SJ 27725 37942	*Thaumetopoea processionea*
Coed Llwyn-celyn	ST 19946 85801	*Thaumetopoea processionea*

Site name	Site grid reference	Pest/pathogen
Coed Trecastle	ST 02815 81934	*Thaumetopoea processionea*
Dingestow Court	SO 45289 09349	*Thaumetopoea processionea*
Gregynog	SO 08597 97570	*Thaumetopoea processionea*
Nash Wood	SO 30929 63395	*Thaumetopoea processionea*
National Botanical Gardens of Wales	SN 52419 18054	*Thaumetopoea processionea*
Pengelli Forest	SN 12423 39536	*Thaumetopoea processionea*
Plas Newydd	SH 51969 69469	*Thaumetopoea processionea*
Powis Castle	SJ 21688 06292	*Thaumetopoea processionea*
Roath Park	ST 19441 78135	*Thaumetopoea processionea*
St Pierre Golf Club	ST 51074 91101	*Thaumetopoea processionea*
Swansea University	SS 63184 91895	*Thaumetopoea processionea*
Taliaris Forest	SN 63586 28425	*Thaumetopoea processionea*
The Hendre	SO 46604 13819	*Thaumetopoea processionea*
Tintern Abbey	SO 52344 00035	*Thaumetopoea processionea*
Treborth Botanic Gardens	SH 55134 71144	*Thaumetopoea processionea*
Tredegar House	ST 28654 85452	*Thaumetopoea processionea*
National Botanical Gardens of Wales	SN 52898 18706	Airborne spores
Talybont-on-Usk field station	SO 1048 2338	Airborne spores

Site name	Site grid reference	Pest/pathogen
Dyfi Forest	SH 78198 08410	Airborne spores
Dyfi Forest	SH 76927 08698	Airborne spores
Hafren Forest	SN 85751 86287	Airborne spores
Leighton Forest	SJ 24748 03768	Airborne spores
Mynydd Ddu	SO 27005 24113	Airborne spores
Mynydd Ddu	SO 25388 25550	Airborne spores
National Botanical Gardens of Wales	SN 52142 17758	Airborne spores
Noddfa Park	SH 72491 76497	Airborne spores
Swansea University	SS 63200 91899	Airborne spores
The Cott	ST 50726 99243	Airborne spores

Appendix D: Glossary

Acute oak decline (AOD)	AOD is a disease caused by multiple agents (especially bacteria) which can severely affect native oak species.
Agrilus biguttatus	Two-spotted oak buprestid beetle: a native bark boring 'jewel' beetle which mostly lives in *Quercus* species (oak trees).
Agrilus convexicollis	A jewel beetle that has no common name: a non-native pest of dying and dead *Fraxinus* species (ash trees).
Agrilus planipennis	Emerald ash borer beetle (EAB): an exotic beetle pest of *Fraxinus* species (ash trees). Not currently detected in the United Kingdom.
Assay	An investigative procedure to quantitively and/or qualitatively assess the composition of a sample.
Biological sample	A 'living' specimen; that which contains cells of an animal, plant, or other living organisms.
Canker	Disease symptom, in which tree bark is killed and appears discoloured and/or sunken and/or cracked.
Cryphonectria parasitica	Sweet chestnut blight: a fungal pathogen of the *Castanea* genus (sweet chestnut trees).
Cucurbidothis spp.	A fungal pathogen of *Pinus sylvestris* (Scots pine) (previously known as *Curreya pithyophila*).
Dendroctonus micans	Great spruce bark beetle: a non-native beetle pest of *Picea* and *Pinus* species (spruce and pine trees).
Dieback	Disease symptom, in which a shoot/stem begins to die from the tip of its leaves backwards.
DNA	Deoxyribonucleic acid: the chemical carrying the genetic information enabling organisms to grow and function. This information, and therefore the DNA that carries it, is unique to every single living species.
Ecosystem services	The benefits that the natural environment provides to human life. These include natural pollination, clean air, extreme weather mitigation, and human wellbeing.
Forest Trapping Network (FTN)	A UK-wide insect surveillance programme targeting quarantine and priority species.
GAPDC2 Project	Genomics for Animal and Plant Disease Consortium: a conglomerate of six different organisations with a primary focus to advance genomic surveillance approaches for terrestrial and aquatic animal and plant pathogens to improve disease management strategies.

Heterobasidion species	Conifer root and butt rot: a fungal pathogen of conifer trees.
Hylobius abietis	Large pine weevil: a beetle pest of many species of young trees, particularly in restocking areas.
Hymenoscyphus fraxineus	Ash dieback: a fungal pathogen of *Fraxinus* species (ash trees). Previously known as Chalara dieback of ash.
Invasive organism	A non-native organism, the presence of which will cause, or is likely to cause, harm to an area into which it is introduced.
Ips cembrae	Large larch bark beetle: a non-native beetle pest of *Larix* species (larch trees).
Ips typographus	Larger eight-toothed European spruce bark beetle: a non-native beetle pest primarily of *Picea abies* (Norway spruce trees).
Metabarcoding	DNA-based method used to simultaneously identify many organisms within an individual biological sample.
Molecular assay	A DNA-based assay. Molecular assays can be used to detect a pathogen in a biological sample by detecting their specific DNA, providing a qualitative (presence/absence) or quantitative (amount) assessment of the target organism.
Monochamus alternatus	Japanese pine sawyer beetle: a non-native longhorn beetle which acts as a vector for the pine wood nematode – a pest of conifers, especially pine trees.
Multi vial cyclone sampler	Air sampler for the collection of airborne particles.
Neonectria neomacrospora	Neonectria canker of fir: a fungal pathogen of *Abies* species (true fir trees). It causes severe cankers, crown dieback, and, eventually, tree death.
Pathogen	A microorganism that can cause disease.
Phloem	Transport tissue in plants. The innermost layer of tree bark, it transports the nutrients made during photosynthesis to the rest of the plant.
Phytophthora pluvialis	Fungus-like pathogen of softwood (coniferous) trees.
Phytophthora ramorum	Fungus-like pathogen affecting many plants, including softwood (coniferous) and hardwood (broadleaved) trees.
Pine wood nematode (PWN)	A microscopic worm-like organism which poses a serious threat to the health of pine trees.
Pseudips mexicanus	Monterey pine engraver: a non-native beetle pest of *Pinus* species (pine trees).

Real-time PCR	Real-time polymerase chain reaction: a molecular assay enabling detection and quantification of a specific DNA in a biological sample. Used to assess presence/absence, and in some cases amount, of a specific organism.
Rhizoctonia butinii	A fungal pathogen of *Picea* species (spruce trees), *Tsuga heterophylla* (western hemlock) and *Pseudotsuga menziesii* (Douglas fir).
Sentinel site	An area of land, such as a botanic garden or arboretum, being monitored for the presence/absence of harmful organisms in that geographical area.
Spore	The reproductive structure of a fungus or fungal-like organism. Spores can be spread by water splashes, air currents, or vectored by other organisms (e.g. insects).
Shotgun metagenomics	DNA-based method used to simultaneously identify many organisms within an individual biological sample; it differs from metabarcoding because it allows the analysis of all DNA present in a sample, rather than targeting a specific sequence (i.e. the barcode). Shotgun metagenomics requires considerably higher amount of starting DNA sample compared to metabarcoding.
Thaumetopoea processionea	Oak processionary moth (OPM): a non-native insect pest of *Quercus* species (oak trees).
Thekopsora areolata	Cherry spruce rust: a rust fungus which conducts its life cycle in stages over different host species, infecting the cones of *Picea* (spruce) species and the leaves of *Prunus* (cherry) species.
Wider Environment Monitoring (WEM)	An insect surveillance project spanning England, Scotland, and Wales which monitors the presence of invasive species, such as *Ips typographus*.
Welsh Plant Health Surveillance Network (WPHSN)	A Welsh Government plant health initiative.
Xylem	Transport tissue in plants. Situated internally to the phloem in shoots and stems, it transports water, as well as some nutrients, from roots to leaves.
Xyllela fastidiosa	A bacterial disease of plants: it invades their water-conducting systems, and in so doing, it restricts or blocks the movement of water and nutrients through the plant, with serious consequences, including death, for some host plants.

Alice Holt Lodge
Farnham
Surrey, GU10 4LH, UK
Tel: **0300 067 5600**

Northern Research Station
Roslin
Midlothian, EH25 9SY, UK
Tel: **0300 067 5900**

Forest Research in Wales
Talybont Research Office
Cefn Gethiniog
Talybont-on-Usk
Brecon
Powys, LD3 7YN, UK
Tel: **0300 067 5709**

info@forestresearch.gov.uk
www.forestresearch.gov.uk

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