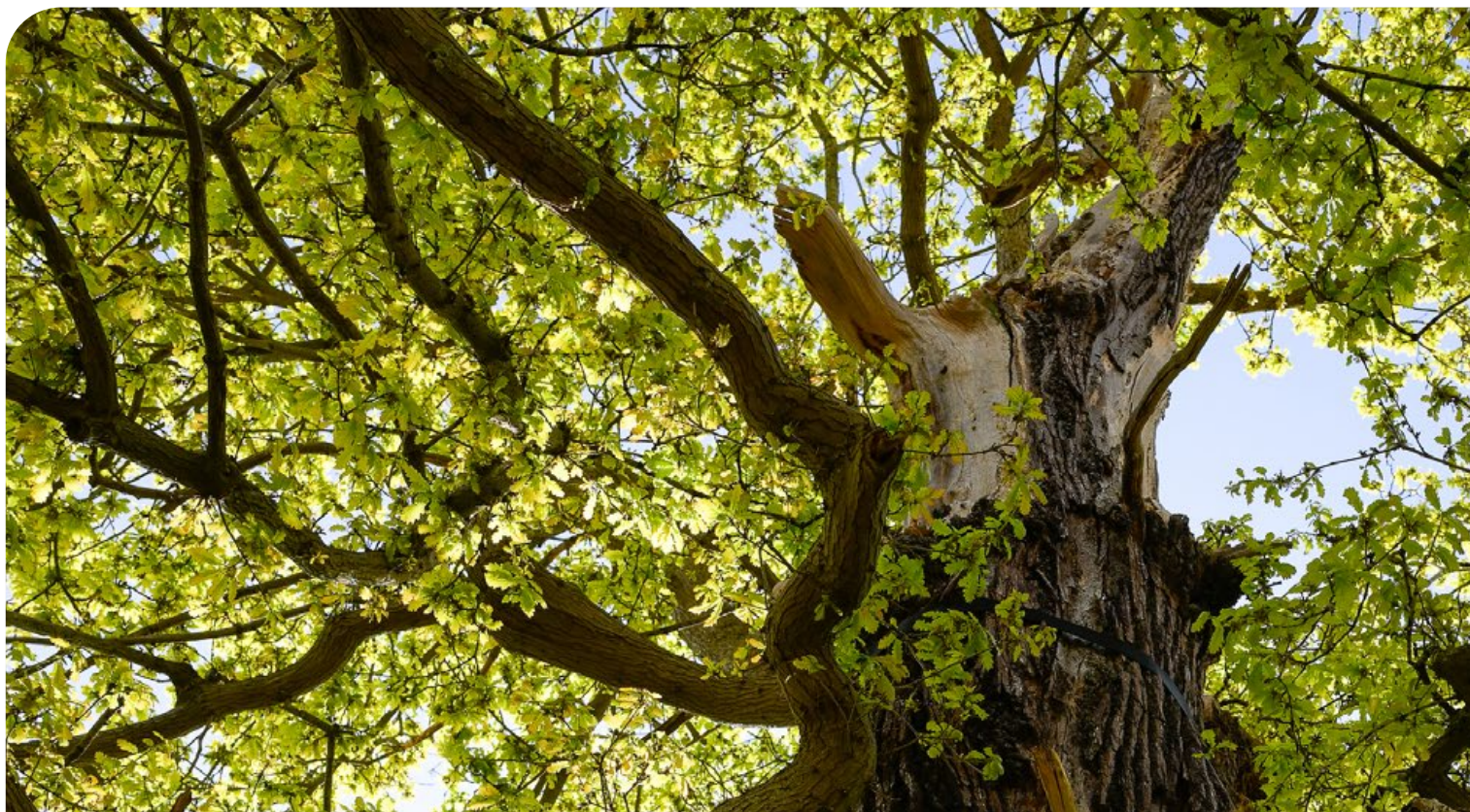
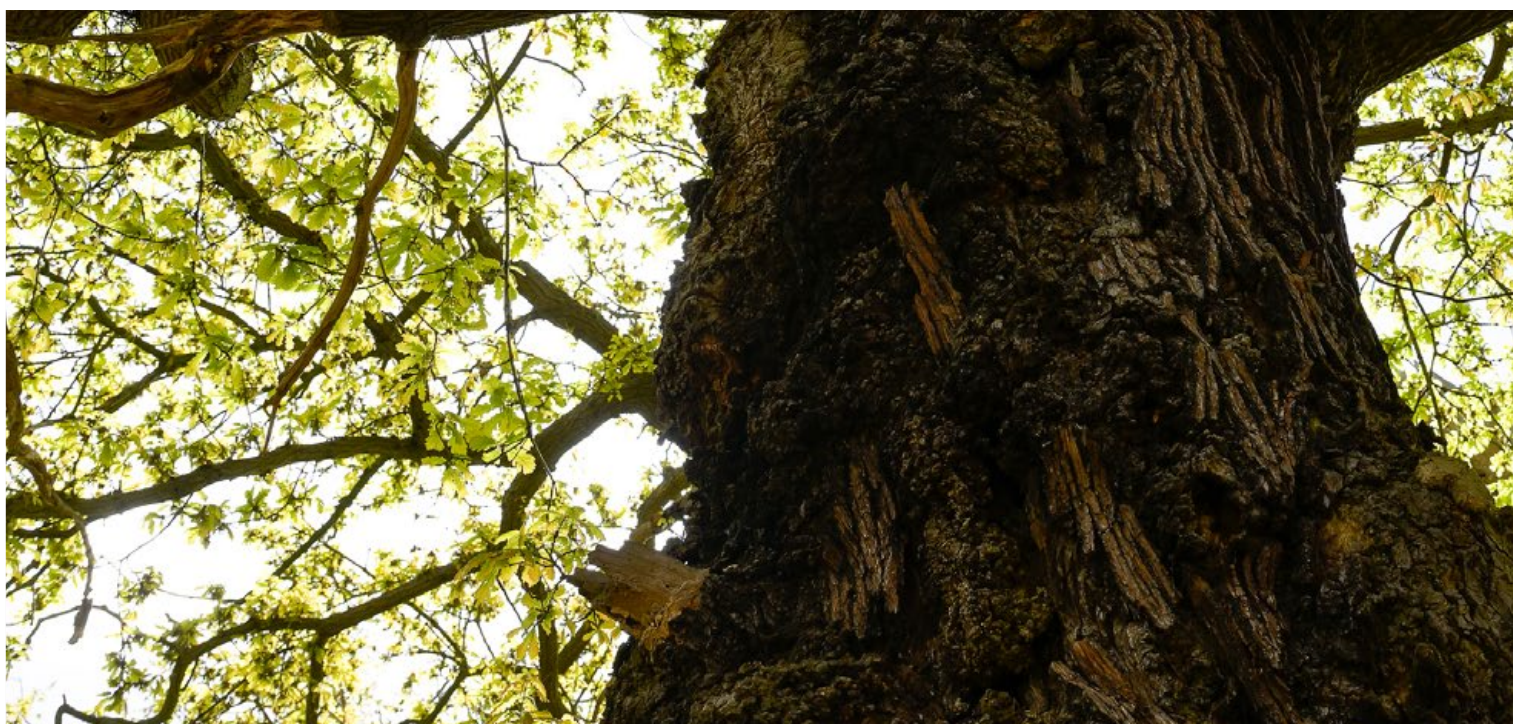




Welsh Plant Health Surveillance Network



2025 Review

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Racheal Lee BSc (Hons)
and Dr Matthew Watkins PhD



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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

Welsh Government

Funder of the Welsh Plant Health Surveillance Network



Ariennir gan
Lywodraeth Cymru
Funded by
Welsh Government

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. Delivers field-based support and associated sample analysis for the detection and identification of forest pests. Racheal 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 in Wales.



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

- To assess presence/absence and abundance of invasive tree pests and pathogens across Wales.
- 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.
- 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	
<i>Agrilus biguttatus</i>	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.
<i>Agrilus convexicollis</i>	Feeds on dead and dying native ash trees (<i>Fraxinus excelsior</i>). 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.
<i>Agrilus planipennis</i>	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.
<i>Dendroctonus micans</i>	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.
<i>Hylobius abietis</i>	Destructive to conifer seedlings and newly planted young conifer trees by girdling stems through feeding on the bark tissue.

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

Organism	Threat to tree health
<i>Ips cembrae</i>	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.
<i>Ips typographus</i>	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.
<i>Monochamus alternatus</i>	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.
<i>Thaumetopoea processionea</i>	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	
<i>Cryphonectria parasitica</i>	A regulated pathogen of sweet chestnut (<i>Castanea sativa</i>). 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.
<i>Curreya pithyophila</i> – <i>Cucurbitodthis</i> spp.	Infects Scots pine (<i>Pinus sylvestris</i>). Infects shoots and branches, with high levels of infestation leading to crown thinning and dieback. Not detected in Wales to date.
<i>Dothistroma septosporum</i>	Infects conifers, particularly pine (<i>Pinus</i> spp.). Causes premature needle defoliation resulting in loss of timber yield and, in severe cases, tree fatality.
<i>Heterobasidion</i> 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 (<i>H. annosum</i> , <i>H. abietinum</i>) as well as regulated species (<i>H. irregulare</i> , not reported in the UK).
<i>Hymenoscyphus fraxineus</i>	Infects ash (<i>Fraxinus</i> 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.
<i>Neonectria neomacrospora</i>	Infects fir (<i>Abies</i> spp.). Weakens trees by causing cankers that kill off the phloem layer in branches, resulting in dieback. Excessive infection can lead to mortality.
<i>Phytophthora pluvialis</i>	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.
<i>Phytophthora ramorum</i>	A regulated pathogen of larch (<i>Larix</i> 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).
<i>Rhizoctonia butinii</i>	A relatively unknown and poorly investigated tree pathogenic fungus. It is known to infect spruces (<i>Picea</i> spp.), western hemlock (<i>Tsuga heterophylla</i>), and Douglas fir (<i>Pseudotsuga menziesii</i>), 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.
<i>Thekopsora areolata</i>	A rust fungus that infects spruce and cherry (<i>Picea</i> spp. and <i>Prunus</i> 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.
<i>Xylella fastidiosa</i>	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).

Traps

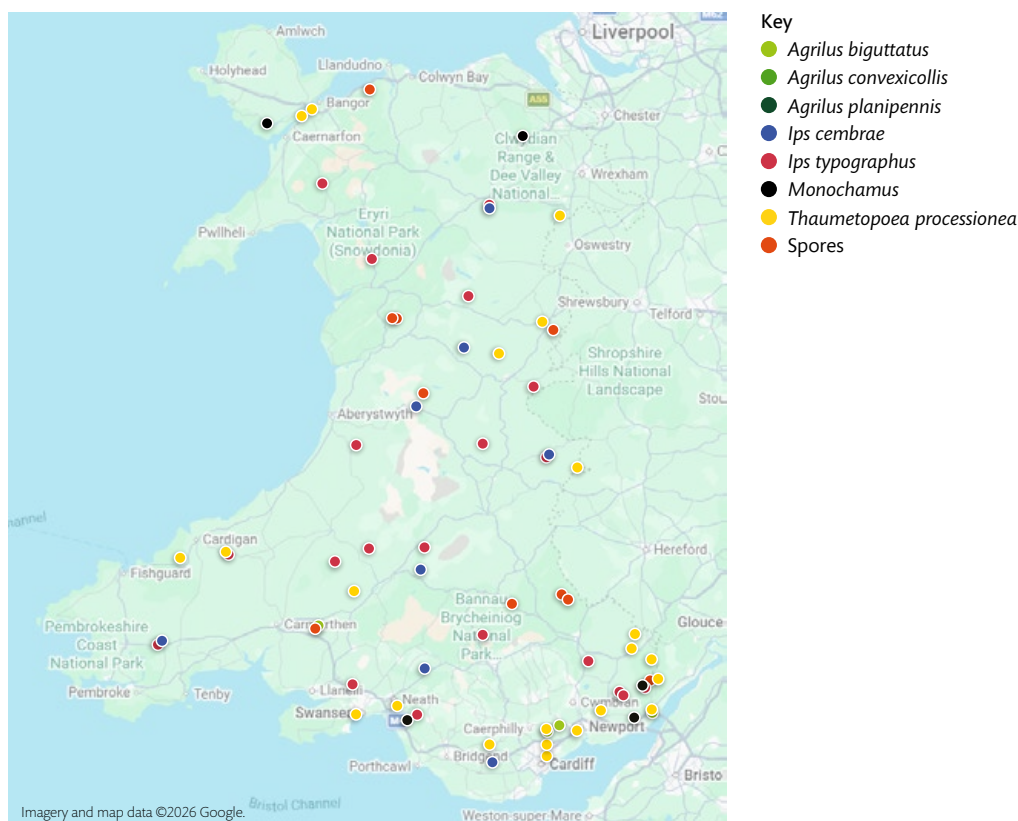
Insect traps

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.

Figure 1 WPHSN 2025 surveillance sites.



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 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.

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 Llwyn 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 or Rhos Pant Mawr.

Of the 13 insect trap sites, *Ips cembrae* was detected at 11 locations in Wales. Data gathered in 2025 is being

Table 2 Summary of traps deployed in the WPHSN 2025.

Trap	No. deployed
X-vane to detect <i>Ips typographus</i>	35
X-vane to detect <i>Ips cembrae</i>	13
Bucket to detect <i>Thaumetopoea processionea</i>	23
Multi-funnel to detect <i>Agrilus planipennis</i> and <i>A. convexicollis</i>	6
Multi-funnel to detect <i>Agrilus biguttatus</i>	13
Multi-funnel to detect <i>Monochamus alternatus</i>	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

Figure 2 Presence of *Ips cembrae* in traps deployed in Welsh woodlands selected for the WPHSN 2025 programme.

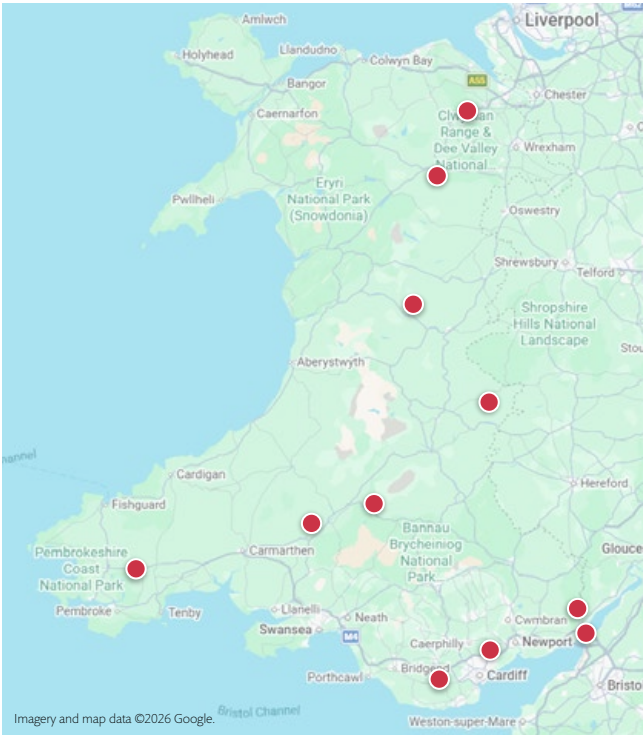
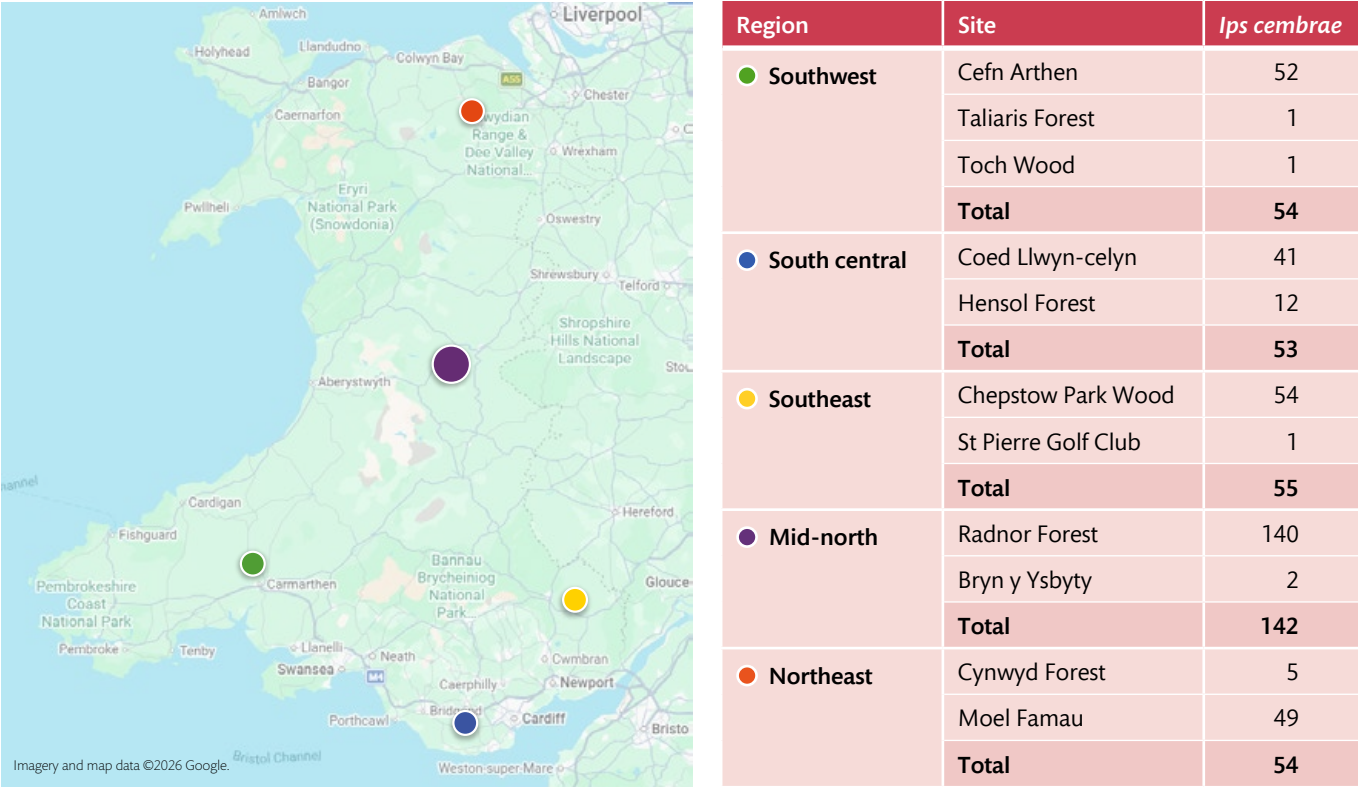


Figure 3 Population density (dot size) and distribution (dot position) of *Ips cembrae* detected in traps across Wales in 2025.



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).

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).

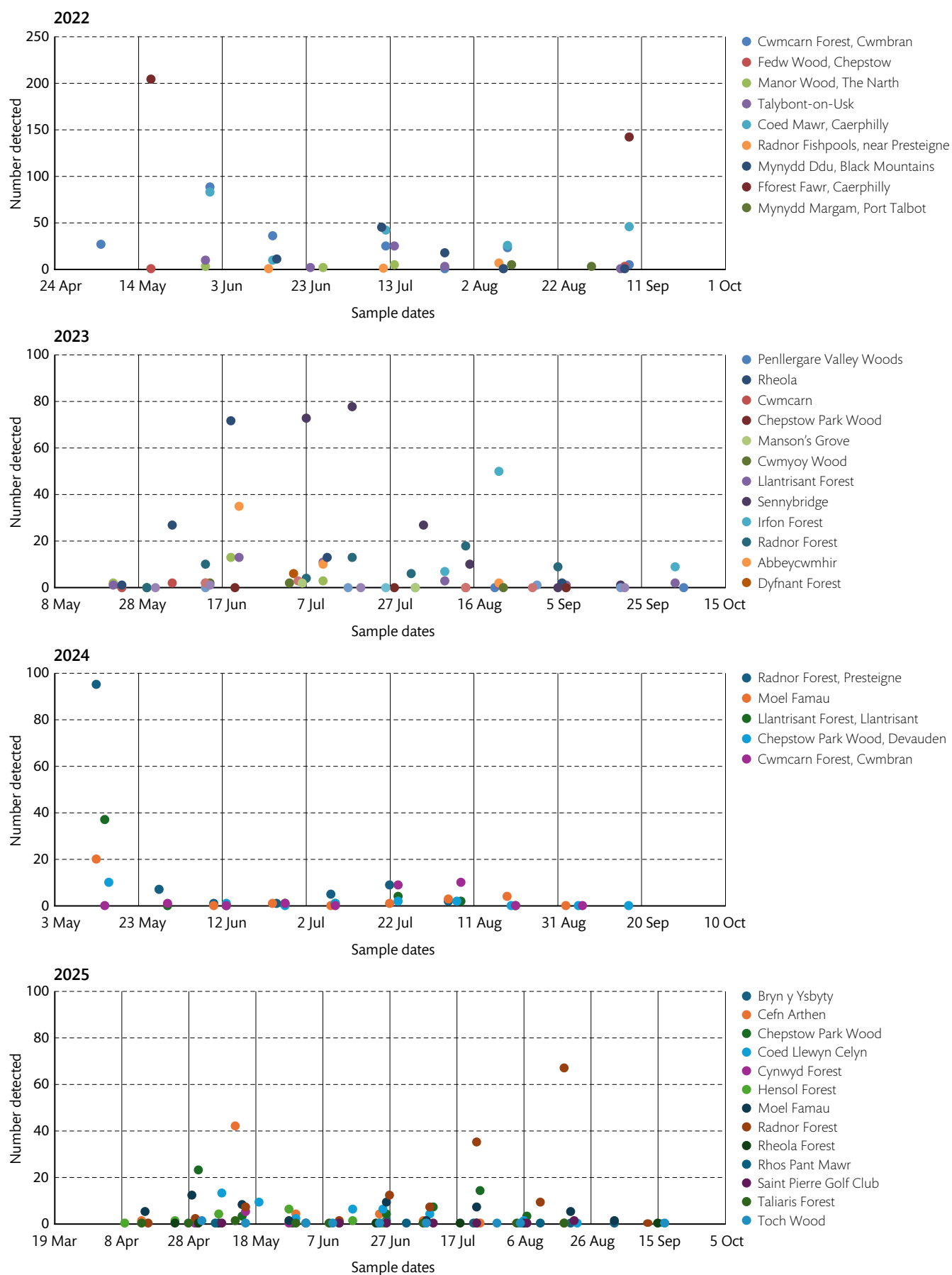
While *Ips cembrae* is not a primary pest, it is prudent to continue with surveillance to monitor changes in its population density and distribution across Wales. This is particularly important following the detection of *Ips cembrae* in the previously pest-free area in Scotland.

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 the appendix.

Figure 4 Trend in detection of *Ips cembrae* in traps across Welsh woodlands 2022–2025.

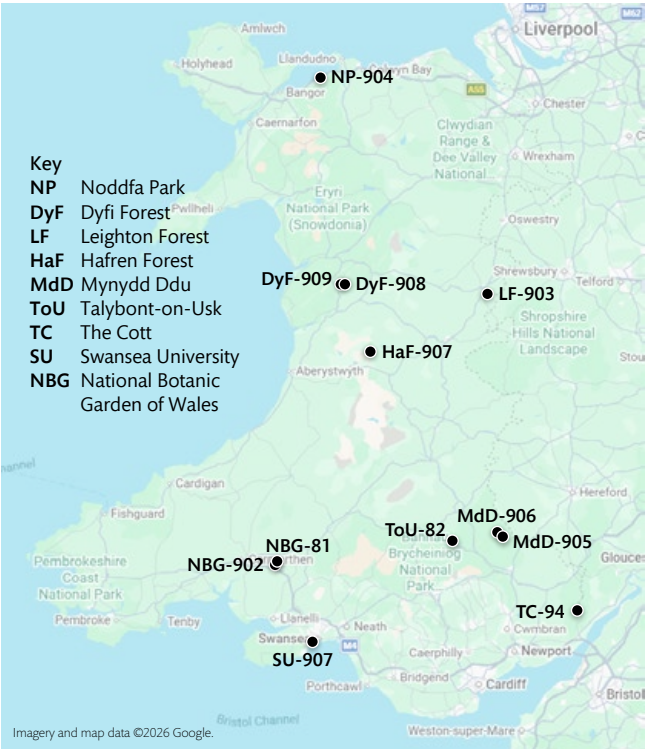


Airborne particle monitoring

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.

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.

Figure 5 WPHSN 2025 spore surveillance sites.



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.

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.

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 late 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.

Figure 6 Altitude of each spore trap indicated in metres above sea level. NBGW = National Botanic Garden of Wales.

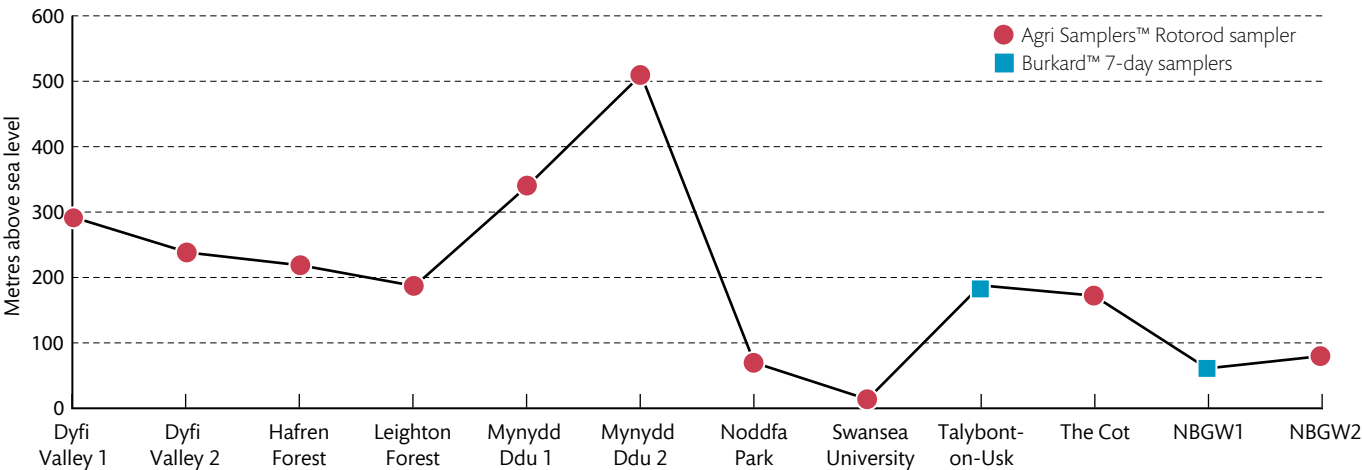


Table 3 Summary of the 2025 WPHSN spore monitoring sites, including site name, location, altitude, and tree species composition.

Site name	Trap type	Location	Altitude (a.s.l)	Dominant species
DyF-908	Rotorod	Corris	291 m	<i>Quercus robur</i> , <i>Betula</i> spp., <i>Salix</i> spp., <i>Larix kaempferi</i> , <i>Picea sitchensis</i> , <i>Picea abies</i> , <i>Sorbus</i> spp.
DyF-909	Rotorod	Corris	237 m	<i>Eucalyptus</i> spp., <i>Betula</i> spp., <i>Quercus petraea</i> , <i>Sorbus</i> spp., <i>Pseudotsuga menziesii</i> , <i>Picea sitchensis</i> , <i>Picea abies</i> , <i>Alnus glutinosa</i> , <i>Cryptomeria japonica</i>
HaF-907	Rotorod	Hafren	217 m	<i>Picea sitchensis</i> , <i>Betula pendula</i> , <i>Quercus petraea</i> , <i>Pinus sylvestris</i> , <i>Salix</i> spp., <i>Larix × marschlinsii</i> , <i>Sorbus</i> spp.
LF-903	Rotorod	Welshpool	185 m	<i>Sequoia sempervirens</i>
MdD-905	Rotorod	Brecon Beacons	341 m	<i>Picea sitchensis</i> , <i>Picea abies</i> , <i>Pseudotsuga menziesii</i> , <i>Tilia cordata</i> , <i>Corylus avellana</i> , <i>Abies grandis</i> , <i>Betula</i> spp., <i>Cryptomeria japonica</i>
MdD-906	Rotorod	Brecon Beacons	513 m	<i>Tsuga heterophylla</i> , <i>Picea sitchensis</i> , <i>Picea abies</i> , <i>Betula</i> spp.
NP-904	Rotorod	Penmaenmawr	66 m	<i>Sequoia sempervirens</i> , <i>Quercus</i> spp., <i>Castanea sativa</i> , <i>Acer pseudoplatanus</i>
SU-907	Rotorod	Swansea	9 m	<i>Quercus ilex</i> , <i>Quercus robur</i> , <i>Fagus</i> spp., <i>Pinus</i> spp., <i>Taxus</i> spp., <i>Prunus</i> spp., <i>Betula</i> spp., <i>Araucaria araucana</i>
TOU-B2	Burkard 7-day Sampler	Brecon Beacons	186 m	<i>Populus nigra</i> , <i>Fraxinus excelsior</i> , <i>Sequoia</i> spp., <i>Fagus sylvatica</i> , <i>Picea</i> spp.
TOU-907	Rotorod	Brecon Beacons	186 m	<i>Populus nigra</i> , <i>Fraxinus excelsior</i> , <i>Sequoia</i> spp., <i>Fagus sylvatica</i> , <i>Picea</i> spp.
TC-901	Rotorod	Monmouth	170 m	<i>Abies procera</i> , <i>Picea abies</i> , <i>Betula pendula</i> , <i>Fraxinus excelsior</i>
NBG-B1	Burkard 7-day Sampler	Camarthen	57 m	<i>Abies</i> spp., <i>Alnus</i> spp., <i>Corylus avellana</i> , <i>Fagus sylvatica</i> , <i>Fraxinus excelsior</i> , <i>Ilex aquifolium</i> , <i>Pinus</i> spp., <i>Quercus</i> spp.
NBG-902	Rotorod	Camarthen	76 m	<i>Taxus baccata</i> , <i>Tilia cordata</i> , <i>Acer</i> spp., <i>Araucaria Araucana</i> , <i>Betula</i> spp., <i>Cotoneaster</i> spp., <i>Cupressus gigantea</i> , <i>Pinus</i> spp., <i>Quercus</i> spp., <i>Rhododendron</i> spp., <i>Sorbus</i> spp.

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



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.

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.

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.

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

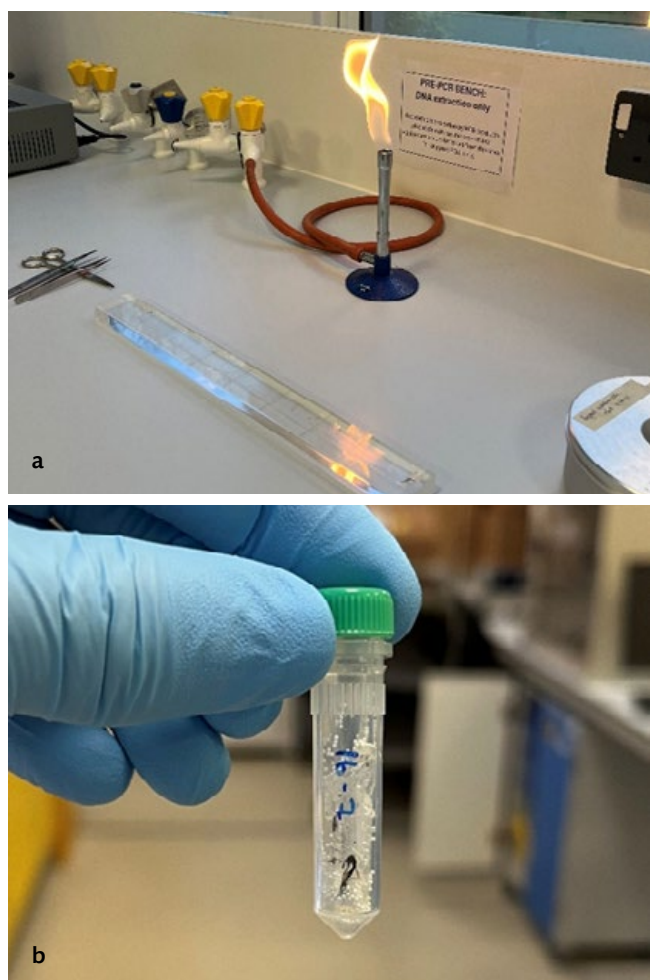


Table 4 Summary of primers and Illumina overhangs used to prepare samples for metabarcoding.

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
<i>Armillaria</i> spp.	honey fungus
<i>Cronartium quercuum</i>	pine/oak gall rust
<i>Cryphonectria parasitica</i> *	sweet chestnut blight
<i>Cucurbitodthis</i> spp.	Scots pine fungus
<i>Dothistroma septosporum</i>	Dothistroma needle blight
<i>Heterobasidion</i> spp.	conifer root and butt rot
<i>Neonectria neomacrospora</i>	canker of fir
<i>Phytophthora</i> spp.*	water moulds
<i>Rhizoctonia</i> spp.	web blight
<i>Valsa oxystoma</i> *	–
<i>Xylella fastidiosa</i>	–

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

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).

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 separate report in late 2026. 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.

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, 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 the section '[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.

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.

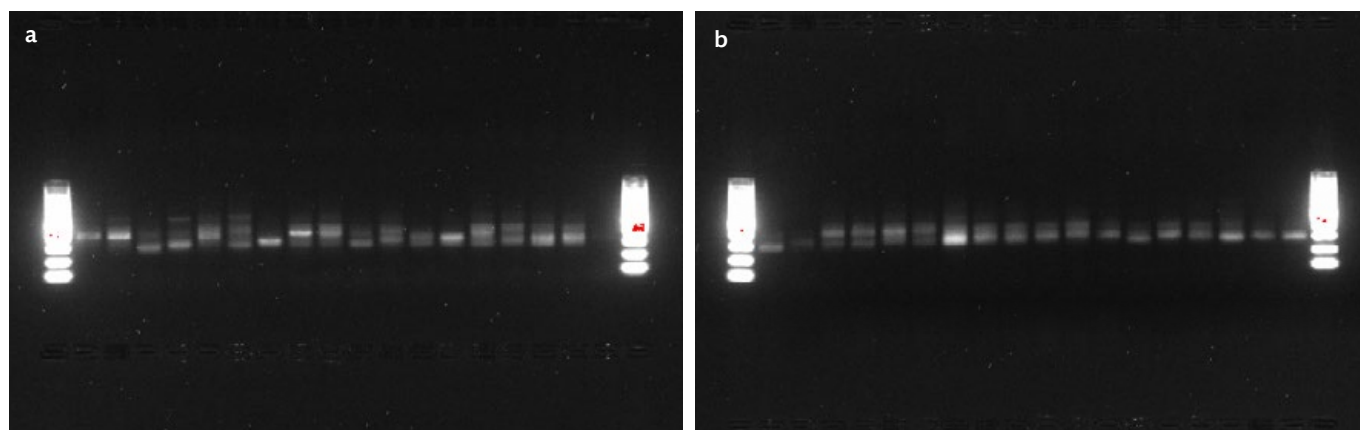


Table 6 Development of the sentinel site network and private landowners collaborating with the WPHSN project: 2022–2026.

<i>Sentinel sites</i>	<i>2022</i>	<i>2023</i>	<i>2024</i>	<i>2025</i>	<i>2026</i>
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			•	•	•
Forest plantations across Wales (NRW)	•	•	•	•	•
Leighton Estate, Welshpool (Royal Forestry Society)			•	•	•
Chirk Castle, Chirk (National Trust)			•	•	•
Roath Park, Cardiff				•	•
St Pierre Golf Club, Chepstow				•	•
Tredeggar 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			•	•	•

WPHSN 2026 – forecast and targets

The current WPHSN funding from the Welsh Government enables the project to continue the surveillance and monitoring of 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.

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 1 April and 30 September 2026, serviced fortnightly. Primary sample analysis for

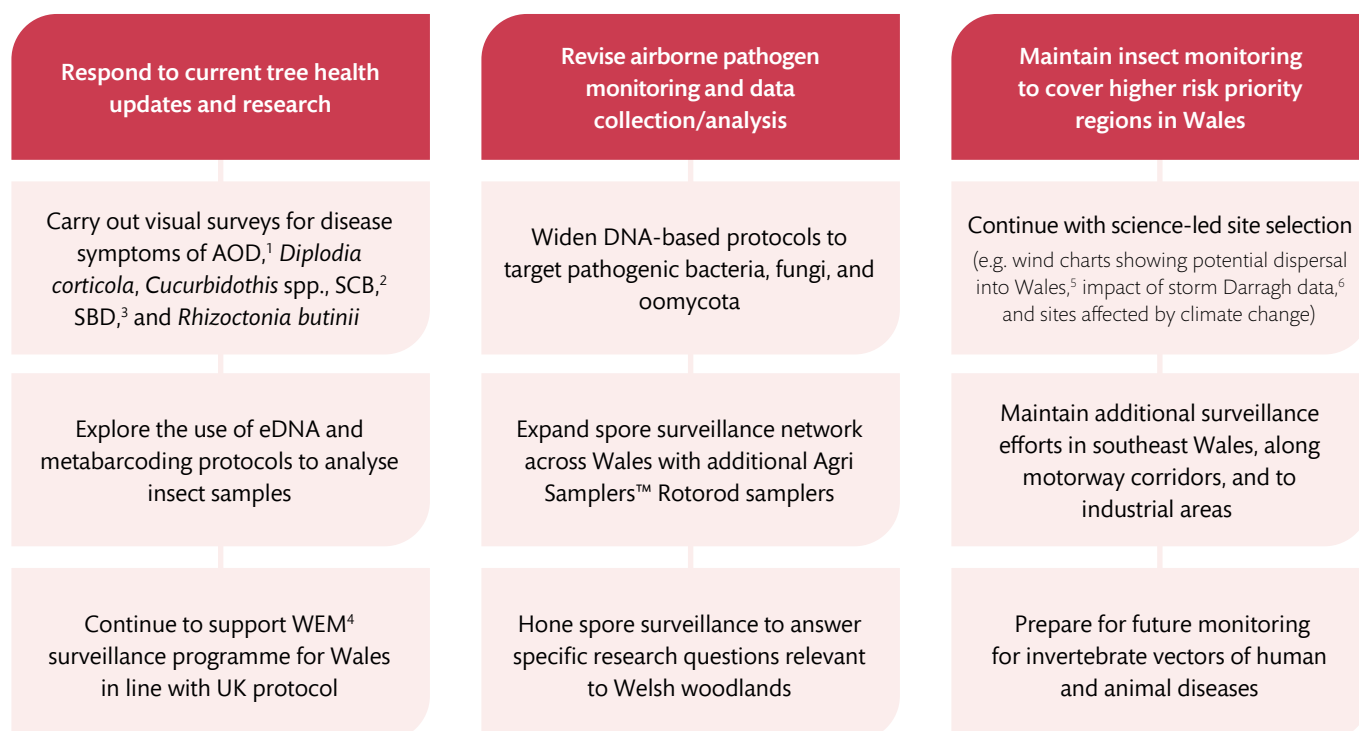
Ips typographus will take place in the field at the time of sample collection to ensure early detection.

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)
- *Cucurbitodthis* 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).

Figure 10 Objectives for 2026.

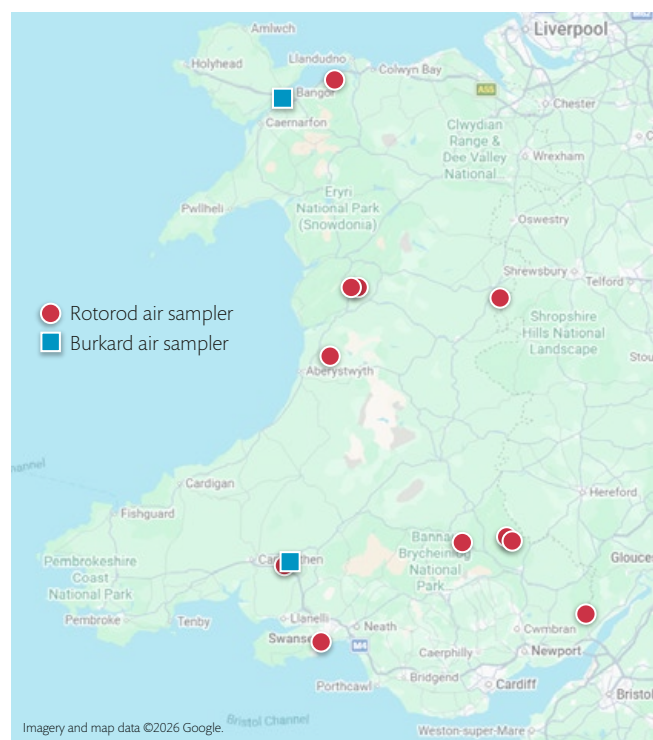


1. AOD – Acute oak decline, 2. SCB – Sweet chestnut blight, 3. SBD – Sooty bark disease, 4. WEM – Wider Environment Monitoring surveillance for *Ips typographus*, 5. Inward *et al.* (2024), 6. NRW GIS files.

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 *Cucurbitodthis* 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 Planned locations for air samplers.



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 Planned steps in cultivating stakeholder engagement.

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

Nurture working relationships with external colleagues in furtherance of data sharing and project collaboration to widen the scope of the WPHSN

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

<i>Adarrus ocellaris</i>	<i>Hylobius abietis</i>	<i>Rhizophagus ferrugineus</i>
<i>Amblyjoppa proteus</i>	<i>Hymenoptera</i> species	<i>Rutpela maculata</i>
<i>Anobium</i> species	<i>Ichneumonid</i> species	<i>Salpingus planirostris</i>
<i>Aphididae</i> species	<i>Leiopus</i> species	<i>Salpingus ruficollis</i>
<i>Apis mellifera</i>	<i>Lymantria monacha</i>	<i>Scarabaeidae</i> species
<i>Asemum striatum</i>	<i>Morellia</i> species	<i>Scolytus</i> species
<i>Baeocrara variolosa</i>	<i>Malthinus seriepunctatus</i>	<i>Scraptiidae</i> species
<i>Bombus terrestris</i>	<i>Monotoma</i> species	<i>Serica brunnea</i>
<i>Cantharis rustica</i>	<i>Nebria brevicollis</i>	<i>Siricidae</i> species
<i>Carabus problematicus</i>	<i>Nicrophorus vespilloides</i>	<i>Staphylinidae</i> species
<i>Crypturgus subcribrosus</i>	<i>Notiophilus</i> species	<i>Symphyta</i> species
<i>Dryocetes alni</i>	<i>Panorpidae</i> species	<i>Taphrorychus villifrons</i>
<i>Dryocetes autographus</i>	<i>Parasitoid hymenoptera</i>	<i>Thanasimus latreille</i>
<i>Dryocetes villosus</i>	<i>Pediacus depressus</i>	<i>Tomicus minor</i>
<i>Elateridae</i> species	<i>Pediacus dermestoides</i>	<i>Tomicus piniperda</i>
<i>Ephemeroptera</i> species	<i>Pentatoma</i> species	<i>Trypodendron domesticum</i>
<i>Formica rufa</i>	<i>Pityogenes bidentatus</i>	<i>Trypodendron lineatum</i>
<i>Grammoptera abdominalis</i>	<i>Pityogenes calcographus</i>	<i>Trypodendron signatum</i>
<i>Grammoptera ruficornis</i>	<i>Pityophthorus lichtensteinii</i>	<i>Vespa crabro</i>
<i>Grammoptera ustulata</i>	<i>Platyderus depressus</i>	<i>Vespula vulgaris</i>
<i>Halyzia sedecimguttata</i>	<i>Platypus cylindrus</i>	<i>Vincenzellus ruficollis</i>
<i>Hylastes</i> species	<i>Polygraphus poligraphus</i>	<i>Weevil</i> species
<i>Hylurgops palliatus</i>	<i>Ptilinus pectinicornis</i>	<i>Xyleborus</i> species
<i>Hylesinus toranio</i>	<i>Rhagium bifasciatum</i>	
<i>Hylesinus varius</i>	<i>Rhizophagus depressus</i>	

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 quantitatively 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).

***Cucurbitodthis* 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 a 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.

Xylella 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.

This document is an annex to the Welsh Plant Health Surveillance Network 2022 review 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.