Chapter 5

Plant pest surveillance and diagnostics

Farmer and researchers. Image courtesy of CSIRO

Plant pest surveillance and diagnostics

Despite having excellent pre-border and border biosecurity systems in place there is always a chance that exotic pests can enter and become established in Australia. A unique and highly effective post-border biosecurity system exists to provide additional protection from exotic pests. Plant pest surveillance and diagnostics are critical components of this system.

Surveillance covers activities that detect and record the presence or absence of plant pests, while diagnostics is used to precisely identify a plant pest.

The information derived from surveillance and diagnostics provides the basis on which decisions about the status of pest presence, absence and distribution are made. This underpins the profitability, productivity and sustainability of Australia's plant industries and helps protect our landscapes and natural environment from plant pests.

Surveillance is carried out around the country by state governments, the Australian Government and plant industries, with increasing support from the community, and aims to:

- find new incursions or outbreaks before they spread too far to be eradicated or contained
- gather the 'evidence of absence' data needed to show overseas trading partners that Australia is free from pests of particular concern
- monitor the amount or distribution of pests at a national, regional or property level.

Diagnostic services, are primarily provided by governments, universities and research organisations, and are coordinated via a national network to support the definitive identification of pest species, types and strains to:

- provide information to ensure appropriate response to an incursion is undertaken
- support pest management
- provide evidence of pest status (pest presence or absence).

Plant pest surveillance

Information on the presence or absence of plant pests is highly valuable because it underpins many aspects of the biosecurity system. An effective surveillance system enables early detection of plant pests and diseases, supports pest freedom claims and facilitates market access. Activities within the plant biosecurity surveillance system work together to achieve five key objectives.

Early warning – Shows where new biosecurity measures are required to prevent the arrival or spread of a plant pest, with surveillance along high-risk pathways being a priority.

Early detection – Finding a new pest or outbreak early, before it has a chance to spread and become widely established.

Plant pest status – Data confirming that pests are absent from growing areas demonstrates to other countries that they can safely import Australian produce without receiving pests and help to justify our import conditions to other countries. This is known as 'evidence of absence' and is critical information to support access to markets within Australia and overseas.

Delimiting the spread of pests – The ability to define where pests are present and where they are not provides critical information to support decisions for an eradication response.

Monitoring established pests – This includes surveillance for pests such as Queensland and Mediterranean fruit flies, and grapevine phylloxera, which are only found in some parts of Australia.

OVERSIGHT OF PLANT PEST SURVEILLANCE

National Plant Biosecurity Surveillance Strategy

The National Plant Biosecurity Surveillance Strategy (NPBSS) was developed in 2013 to guide national efforts to improve and reform surveillance arrangements. The NPBSS underpins the National Plant Biosecurity Strategy (see page 20) and complements the National Plant Biosecurity Diagnostic Strategy (see page 166).

Implementation of the 2013–20 NPBSS has played a key role guiding activities to support improvements to the national plant biosecurity surveillance system.

Some of the key achievements of the 2013–20 NPBSS include:

- implementation of the Plant Surveillance Network Australasia–Pacific (PSNAP)
- development of the national data aggregation system, AUSPest*Check*™, to connect and coordinate surveillance data systems across Australia
- creation of a suite of industry surveillance strategies to establish partnerships to improve national surveillance outcomes.

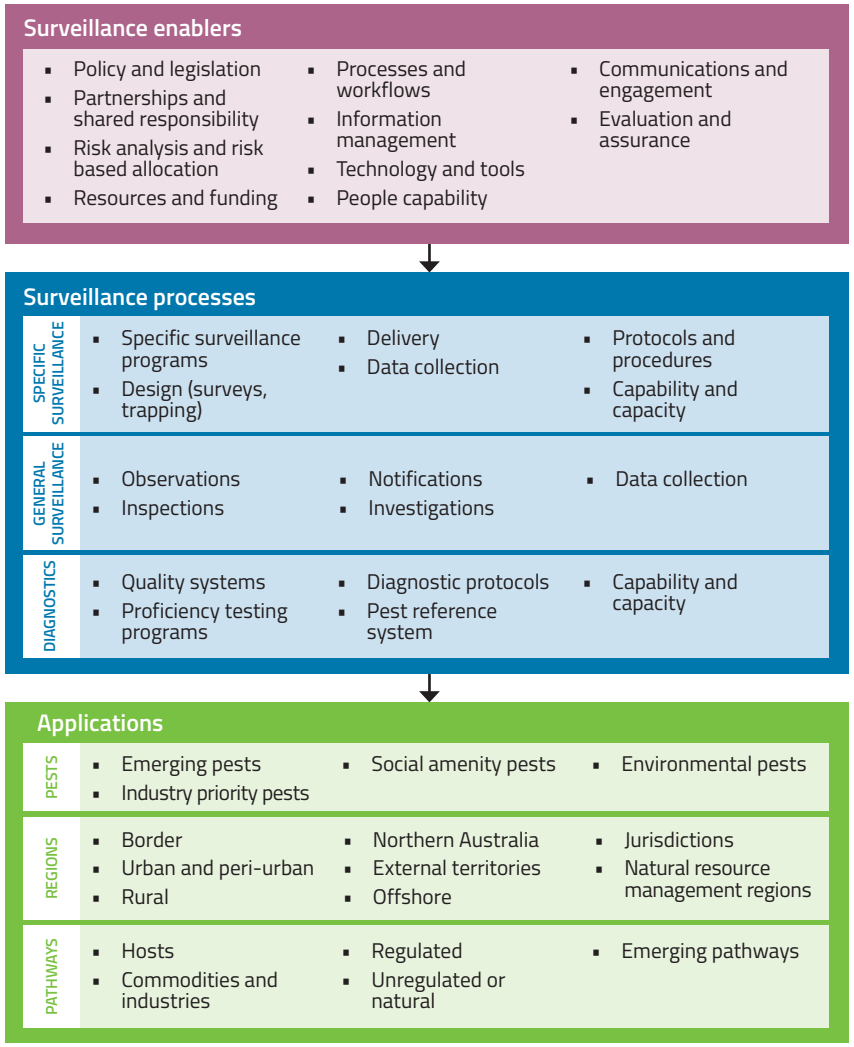
Work is underway to develop a revised ten-year NPBSS and implementation plan to provide continued benefits for the national plant health surveillance system. It is expected that this work will be completed during the first half of 2021.

National Plant Biosecurity Surveillance System framework

Under the National Plant Biosecurity Surveillance System framework developed in 2017 (see Figure 90), the Department of Agriculture, Water and the Environment (DAWE), peak industry bodies, state and territory governments, Plant Health Australia (PHA), community and environmental stakeholders work in partnership to carry out biosecurity surveillance and analysis.

The framework provides an overview of the national system and is used to identify areas for improvement and reform. It was developed as part of the Australian Government's investment in improving biosecurity surveillance and analysis through the Agricultural Competitiveness White Paper.

Figure 90. National Plant Biosecurity Surveillance System framework



Australia's national surveillance system framework, developed in 2017. Image courtesy of the Department of Agriculture, Water and the Environment

Subcommittee on National Plant Health Surveillance

The Subcommittee on National Plant Health Surveillance of the Plant Health Committee (PHC) provides coordination and leadership for plant pest surveillance in Australia. The subcommittee comprises representatives from the Australian Government, state and territory governments, PHA and the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

In 2020 the key roles of the subcommittee were:

- overseeing the development of National Surveillance Protocols, including the process for review
- supporting the PSNAP to improve connections between surveillance practitioners and build capacity and capability for surveillance
- coordinating and overseeing the development of a website to support the network
- designing processes to prioritise national surveillance efforts
- supporting review of the NPBSS
- enhancing the collaboration, coordination, efficiency and effectiveness of surveillance efforts nationally.

Plant Surveillance Network Australasia–Pacific

The PSNAP was established in 2017 and encourages membership from a range of stakeholders including, but not limited to, state and territory governments, the Australian Government, CSIRO, PHA, universities and plant industry experts.

Activities are coordinated via a network implementation working group and a network coordinator, operating out of PHA. The network provides a platform for communication about plant pest surveillance and acts as a coordination point for surveillance professionals and practitioners to strengthen surveillance capacity and capability.

The Annual Surveillance Workshop is delivered by PHA to share ideas and knowledge, and to provide professional development opportunities. The network is supported by a website **plantsurveillancenetwork.net.au** which contains resources, news and events on plant pest surveillance.

GOVERNMENT SURVEILLANCE PROGRAMS

Specific surveillance is where checks or surveys are made for particular pests, and records are captured. Most specific surveillance is done by governments, but plant industries also undertake specific surveillance for pests of concern.

The most extensive programs for specific surveillance – in terms of the number of pests and the wide range of locations where surveillance occurs – are the National Plant Health Surveillance Program, the National Border Surveillance Program (see page 145), the Northern Australia Quarantine Strategy (see page 146) and surveillance programs for fruit flies (see page 146). There are also programs that are partnerships between industry and government(s) such as the National Bee Pest Surveillance Program (see page 154) and the Grains Farm Biosecurity Program (see page 205).

These and other surveillance activities across Australia (as shown in Table 52 on page 158) occur in addition to the surveillance undertaken to eradicate pests (see Chapter 6).

National Plant Health Surveillance Program

The National Plant Health Surveillance Program is managed by DAWE in collaboration with state and territory governments.

The program, in place since the 1990s, provides funds to state and territory governments to look for pests of particular concern. It provides important 'early detection' surveillance for Australia's top 40 unwanted and exotic National Priority Plant Pests (see page 41), and other biosecurity risks.

Surveillance is conducted around international entry points such as airports and seaports, where exotic pests could potentially enter Australia and spread. This includes trapping for 'hitchhiker' pests such as the brown marmorated stink bug and gypsy moths, which could arrive on imported cargo and quickly move into nearby peri-urban or urban areas if not intercepted quickly.

Plants around the country are also checked for signs of the nation's most unwanted exotic plant pest, *Xylella fastidiosa*, as part of the program's early detection activities.

Information collected by the program provides a critical source of the 'evidence of absence' data needed to support trade and market access for Australian producers.

Annual Surveillance Workshop 2020

Over 120 people working in pest surveillance attended the fourth Annual Surveillance Workshop in December 2020 with representatives from several plant industries, the Australian Government, state governments, research agencies, Fiji, New Zealand and Timor-Leste.

Delivered by PHA, the two-day virtual workshop built a better understanding of surveillance activities and initiatives in the wider plant pest surveillance system, connected stakeholders, facilitated capability building and grew the Plant Surveillance Network Australasia–Pacific.

The workshop theme aligned to the International Year of Plant Health was 'International, Regional, National and Local – where do you fit in the surveillance continuum?'. Program topics included international surveillance systems, post-border surveillance, cross-industry plant pest surveillance initiatives, urban surveillance and farm monitoring.

Input was also sought from participants on the future activities of the Plant Surveillance Network Australasia–Pacific and the structure and content of National Surveillance Protocols.

More information is available on the Plant Surveillance Network Australasia–Pacific website **plantsurveillancenetwork.net.au**

INDUSTRY SURVEILLANCE STRATEGIES AND PROGRAMS

Examples of industry surveillance programs (as shown in Table 52 on page 158) include those for grains, cotton, honey bees, mangoes, sugarcane and vegetables, and they are often facilitated by industry biosecurity officers. Surveillance programs for the citrus and forest industries, for which specific national strategies were released in 2018, are being established.

National Bee Pest Surveillance Program in Derby, WA. Image courtesy of WA DPIRD

National Forest Biosecurity Program

Activities to initiate a National Forest Biosecurity Program continued in 2020 with the National Forest Biosecurity Coordinator (employed by PHA) progressing the establishment of a government–industry partnership to enhance forest pest surveillance.

An assessment of the high-risk pathways for the entry of forest pests into Australia and high-risk site surveillance in QLD, NSW and VIC is being used to identify the requirements for a risk-based national program of surveillance for forest pests.

The National Forest Biosecurity Surveillance Strategy 2018–23 and its implementation plan guide the program, in consultation with industry, government and the R&D sector. The program is overseen by a National Forest Biosecurity Surveillance Group, with the coordinator working directly with industry, state governments and environmental groups. In 2020 the coordinator role was funded by the Australian Forest Products Association (see page 102).

National Bee Pest Surveillance Program

The National Bee Pest Surveillance Program is an example of a strong biosecurity partnership between the industries that rely on pollination, all state and territory governments, the Northern Australian Quarantine Strategy team and the Australian Government, as well as port staff and beekeepers.

The program, led by PHA, has coordinated surveillance activities at ports nationwide since 2012. It is an early detection system for a wide range of pests and diseases of honey bees.

The program uses a variety of surveillance activities for 14 exotic bee pests and pest bees, four regionalised but significant bee pests, and continued surveillance of European honey bee (*Apis mellifera*) swarms at ports that could have hitchhiked on cargo and be carrying exotic pests.

A total of 175 sentinel hives of European honey bees were located at 33 sea and airports in 2020. Sentinel hives contain active European honey bee colonies that are inspected for bee pests including Varroa mite, exotic bee viruses, tracheal mite, Tropilaelaps mites, large African hive beetle, small hive beetle and Braula fly. Apart from detections of established pests in known regions, no exotic bee pests were detected.

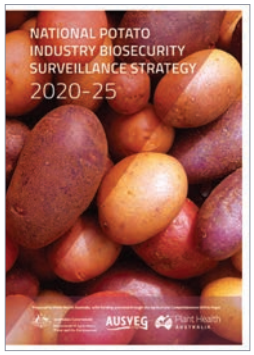
Floral sweep netting is also carried out near ports for the early detection of exotic pest bees including red dwarf honey bee, the giant honey bee, exotic and established strains of Asian honey bee and bumble bees. European honey bees collected by sweep netting may also be inspected for exotic pests.

Australia also had 200 empty hive boxes, termed catchboxes, positioned across 26 ports. Approximately 1,600 inspections took place for the presence of either European or Asian honey bees. European honey bee swarms were captured on eight occasions, and despite these catchboxes not being particularly suitable for Asian honey bees, this species was captured once. In addition, three European honey bee swarms, and two Asian honey bee swarms, were collected at or near Australian ports.

Development of surveillance strategies

The following surveillance strategies were funded by DAWE's Agricultural Competitiveness White Paper to support plant industries.

National Grain Biosecurity Surveillance Strategy 2019–29 – Provides a framework for continued freedom from the impacts of exotic pests and demonstration of pest status claims. It supports ongoing market access and enhances the productivity and international competitiveness of the Australian grain industry.



National Tropical Plant Industries Biosecurity Surveillance Strategy 2020–25 – Developed following extensive consultation with plant industries and governments, because northern Australia presents unique biosecurity challenges due to its high plant diversity, sparse population, extensive coastline and isolated growing regions.

National Potato Industry Biosecurity Surveillance Strategy 2020–25 – Developed to guide a coordinated approach to surveillance for the detection of new pests and the collection of data and information on the presence or absence of pests to support international and domestic market access.

Inaugural winner of the Dr Kim Ritman Award for Science and Innovation

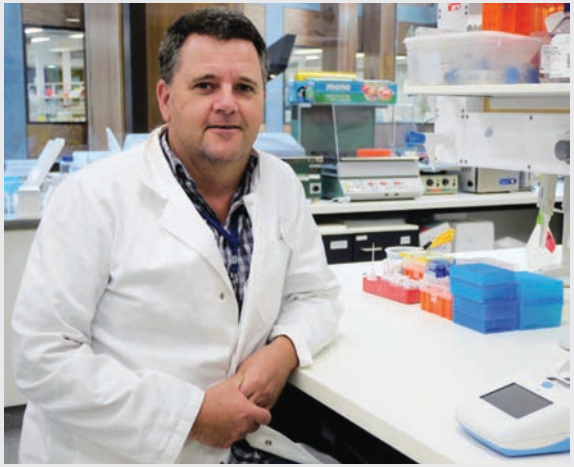
In November 2020, Professor Brendan Rodoni was announced as the inaugural winner of the Dr Kim Ritman Award for Science and Innovation. This category of the Australian Biosecurity Awards was created to honour the late Dr Kim Ritman's legacy that helped strengthen our biosecurity system to better manage the risk of exotic plant pests and diseases.

Brendan Rodoni, Research Director, Microbial Sciences, Pests and Diseases with Agriculture Victoria and a joint appointee with La Trobe University, was recognised for his outstanding scientific contributions and national leadership in improving Australia's capability in managing plant biosecurity risks.

Highly respected with a wealth of knowledge, Professor Rodoni's understanding of both the theoretical and practical perspectives of biosecurity have made him an influential and impactful scientist and educator, locally and internationally.

With a strong ethos of delivery of outcomes for stakeholders, a sense of public purpose and a passion for people and capability development, his efforts have contributed significantly to innovations in biosecurity.

More information about Professor Rodoni is on the ABA website **agriculture.gov.au/aba**



Brendan Rodoni, winner of the inaugural Dr Kim Ritman Award for Science and Innovation. Image courtesy of Agriculture Victoria

Building strong and integrated surveillance technology

The iMapPESTS: Sentinel Surveillance for Agriculture program is creating national cross-industry surveillance capability to help Australia's plant industries more effectively manage airborne pests and pathogens.

The program uses a mobile network of smart surveillance tools, with specialised trapping technology, deployed across Australia to monitor the presence of high priority pests and pathogens affecting major agricultural sectors, including grains, cotton, sugar, horticulture, wine, forestry, and also emerging industries.

The mobile 'sentinel' units incorporate airborne trapping equipment, a weather station, telemetry and power to capture samples for downstream laboratory analysis and reporting. Various techniques are used to determine which pests and pathogens are present, and in what quantities, based on defined lists of priority targets. Next generation sequencing technologies provide insect diversity data, including for beneficials and predators, to give a picture of insect population dynamics.

The resulting data are collated, visualised and shared with industry and government stakeholders to guide the direction and intensity of scouting efforts and pest control actions on-farm. The system can also facilitate a rapid, coordinated response during incursions, including use in delimiting surveys and proof-of-freedom claims.

More information is available at **www.imappests.com.au**

iMapPESTS is led by Hort Innovation and funded by DAWE as part of its Rural R&D for Profit Program, and the seven plant-based RDCs: Hort Innovation, GRDC, SRA, CRDC, Wine Australia, AgriFutures Australia and FWPA.

(from L to R) iMapPESTS Sentinels 2, 3 and 1 set up at SARDI's Waite Campus in Adelaide, SA. Image courtesy of asbCreative

GENERAL SURVEILLANCE PROGRAMS

General surveillance programs raise awareness about pests with growers and the wider community and rely on people to look for and report anything unusual.

Growers undertake a wide range of routine crop monitoring activities to inform production practices and manage established pests and diseases. Biosecurity manuals, industry newsletters, fact sheets, webpages and apps developed by industry, PHA and governments provide information that encourage the reporting of unusual pest or disease symptoms that may be detected during crop monitoring.

Findings made by general surveillance activities can be reported to state or territory government agriculture departments via the Exotic Plant Pest Hotline, 1800 084 881.

Surveillance for exotic pests is also an important component of emergency responses and is covered in Chapter 6.

Queensland fruit fly surveillance in Nedlands and Dalkeith regions, WA. Image courtesy of WA DPIRD

International Plant Sentinel Network

The International Plant Sentinel Network (IPSN), coordinated by Botanic Gardens Conservation International, acts as an early warning system to recognise new and emerging pest and pathogen risks. Created in 2014, initially as a Euphresco project, the IPSN has established national and international partnerships between plant scientists, botanic gardens and arboreta.

Gardens and arboreta hold a range of native flora, exotic plants and close relatives of crops, making them ideal sentinels to detect new plant pest or disease incursions in Australia. With millions of visitors every year, they are also an invaluable way to inform the community about plant biosecurity.

By building connections with international networks, Australian plants in botanic gardens and arboreta overseas act as sentinels that may identify potential threats to the health of our unique flora.

Sentinel plants also provide information which can help:

- increase understanding about 'known' pests and diseases (e.g. dispersal mechanisms, origin)
- identify new pest–host associations (e.g. suggest which species of plant may be particularly susceptible or resistant to a particular pest)
- identify potential biocontrol agents.

As of 2020, seven Australian botanic gardens – the Australian National Botanic Gardens (Canberra), National Arboretum Canberra, Royal Botanic Garden Sydney, Royal Botanic Gardens Victoria, Kings Park and Botanic Garden, Botanic Gardens of South Australia and Royal Tasmanian Botanical Gardens – were part of the network. More information is available from **plantsentinel.org**

The IPSN has been carrying out a pilot study in Australia and New Zealand to determine the feasibility of utilising botanic gardens collections for general surveillance of pests and disease issues on three plant species that are priorities in the United Kingdom (*Quercus robur*, *Pinus sylvestris* and *Rosa* spp.) This activity is funded by the Department for Environment, Food and Rural Affairs in the UK, from April 2020 to March 2021.

PHA is working with Australian botanic gardens and arboreta on a project entitled 'Establishing a program of plant pest surveillance', where a network of staff and volunteers in botanic gardens and arboreta has been formed to raise awareness of biosecurity and to undertake surveillance for key pests.

Boosting pest surveillance by gardeners

Agriculture Victoria's Urban Plant Health Network (UPHN) uses social media in combination with an extensionAUS™ website, **extensionaus.com.au/urbanplanthealthnetwork,** to boost general surveillance efforts by urban and community gardeners in Melbourne.

The online community of practice puts gardeners in touch with a team of scientists and industry experts who share information about exotic pests and diseases that might be found in the home garden. Gardeners are encouraged to look out for and report anything unusual using the MyPest*Guide*™ Reporter app. In 2020, the UPHN focused on six exotic pests:

- brown marmorated stink bug
- glassy winged sharpshooter
- Asian citrus psyllid
- spotted wing drosophila
- red imported fire ant
- Asian honey bee

To increase awareness about these pests and how to report them, UPHN posted content on social media, collaborated with PHA on a webinar series, and created the Top 6 Pests Activity Book and Pest Warrior Comic Book for kids.

In just 15 months, the UPHN grew from having 10 to 22 core members from 11 different industry and science-based organisations, and 1,160 followers on Facebook (@urbanplanthlth).

The Urban Plant Health Network put gardeners in touch with a team of scientists and industry experts to share information about exotic pests and diseases that might be found in the home garden

PLANT PEST SURVEILLANCE PROGRAMS IN 2020

The following figures show the same surveillance programs by target host (Figure 91) and target pest type (Figure 92).

During 2020, 117 plant pest surveillance programs were undertaken, which are detailed by jurisdiction in Table 52.

Figure 91. Surveillance programs by target host

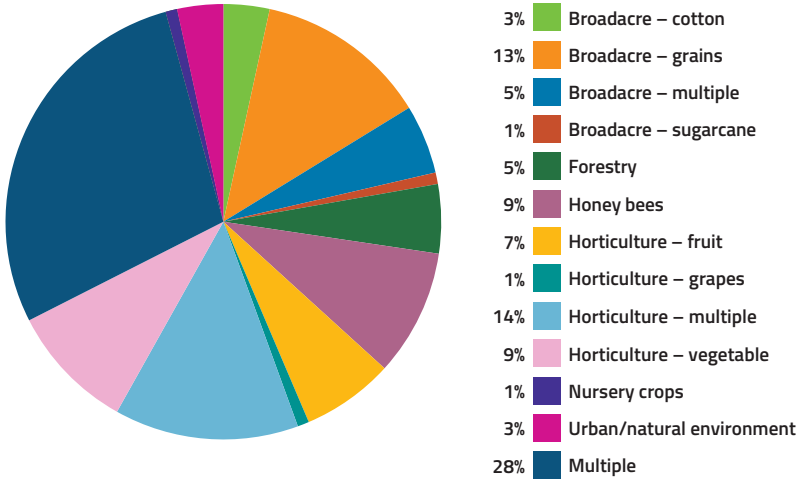


Figure 92. Surveillance programs by target pest type

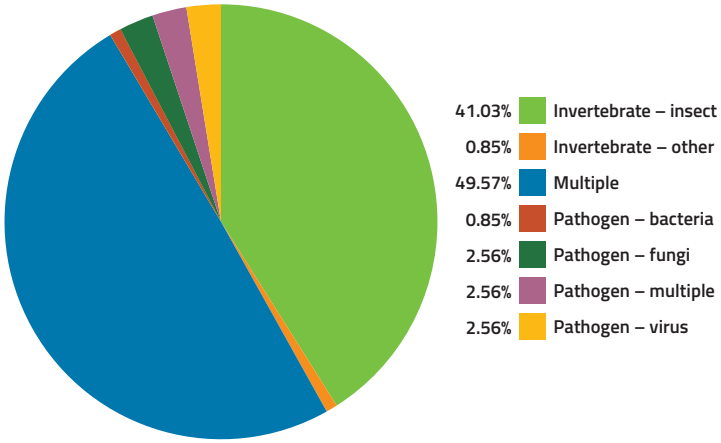


Table 52. Australia's plant biosecurity surveillance programs

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Australian Government			
External Territories Surveillance Program	Various environmental, production and ornamental plants	High priority exotic pests	General and specific
International Plant Health Surveillance Program	Tropical horticultural, environmental and agricultural species	High priority exotic pests	General and specific
National Bee Pest Surveillance Program	Bee swarms at first points of entry	*Varroa destructor, V. jacobsoni, Tropilaelaps clareae, T. mercedesae, Acarapis woodi, Oplostoma fuligineus, Braula coeca,* acute bee paralysis virus, deformed wing virus, slow paralysis virus, *Apis cerana, A. dorsata, A. florea, Bombus terrestris and* new exotic swarms of *A. mellifera*	General (noting other stakeholders conduct the targeted surveillance required under this program)
National Border Surveillance Program	Plant families of high economic importance and known or potential key hosts of specific exotic pests, focusing on regulatory import pathway risks	Specific high priority exotic pests and any pest belonging to key taxonomic groups	General and specific
National Plant Health Surveillance Program (delivered through states and territories)	Various, based on the species surveyed	High priority exotic pests including exotic gypsy moth and fruit fly species	General and specific
Northern Australia Quarantine Strategy – exotic fruit fly trapping	Various	Exotic fruit flies including *Bactrocera dorsalis, B. latifrons, B. trivialis, B. umbrosa, Zeugodacus atrisetosa, Z. cucurbitae, Z. decipiens*	Specific
Northern Australia Quarantine Strategy – pest and disease surveys	Tropical horticultural, environmental and agricultural species	123 high priority exotic pests, diseases and weeds	General and specific

Table 52. Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within New South Wales			
Area wide management – vegetable diseases	Multiple hosts including Cucurbitaceace and Brassicaceae	Various endemic and exotic high priority pests including cucumber green mottle mosaic virus	Specific
Asian market access for citrus and cherries	Cherries and citrus	Queensland fruit fly (*Bactrocera tryoni*), lesser Queensland fruit fly (*Bactrocera neohumeralis*), various cue lure attracted exotic fruit flies	Specific
CGMMV Pest Free Place of Production	Cucurbits	Cucumber green mottle mosaic virus	Specific
Citrus budwood mother tree inspections	Multiple citrus hosts	Various graft transmissable diseases and other high priority pests	Specific
Diseases of cotton	Cotton	Exotic strains of bacterial blight (*Xanthomonas campestris*), cotton blue disease (Luteovirus), cotton leaf curl virus (Begomovirus), Texas root rot (*Phymatotrichum omnivorum*), exotic strains of Verticillium wilt (*Verticillium dahliae*), exotic strains of Fusarium wilt (*Fusarium oxysporum* f. sp. *vasinfectum*)	Specific
Exotic fruit flies – Riverina	Various horticultural crops (citrus, stone fruit)	Mediterranean fruit fly (*Ceratitis capitata*), other tri lure responsive exotic fruit flies	Specific
Exotic longhorn beetle trapping	Various hosts around ports	Asian longhorn beetle (*Anoplophora glabripennis*), Japanese pine sawyer beetle (*Monochamus alternatus*), brown mulberry longhorn beetle (*Apriona germari*)	Specific
Fall armyworm	Maize, other summer grain crops	Fall armyworm (*Spodoptera frugiperda*)	Specific
Forestry Corporation of NSW Forest Health Surveillance	General forests	Various exotic and endemic high priority pests	Specific

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within New South Wales (continued)			
Forest High-Risk Surveillance Program	Multiple	Various exotic and endemic high priority pests of *Pinus* spp.	Specific
Khapra beetle	Grain processing facility	*Trogoderma granarium*	Specific
National Bee Pest Surveillance Program	Ports and surrounding environment	*Varroa destructor, V. jacobsoni, Tropilaelaps clareae, T. mercedesae, Acarapis woodi, Oplostoma fuligineus, Braula coeca,* acute bee paralysis virus, deformed wing virus, slow paralysis virus, *Apis cerana, A. dorsata, A. florea, Bombus terrestris* and new exotic swarms of *A. mellifera*	Specific
National Plant Health Surveillance Program – multi pest surveillance	Multiple	Multiple including *Bactrocera albistrigata, B. carambolae, B. caryae, B. correcta, B. curvipennis, B. dorsalis, B. facialis, B. kandiensis, B. kirki, B. melanotus, B. occipitalis, B. passiflorae, B. psidii, B. trilineola, B. trivialis, B. umbrosa, B. xanthodes, B. zonata, Ceratitis capitata, Zeugodacus cucurbitae, Z. tau,* gypsy moth (*Lymantria* spp.), glassy winged sharpshooter (*Homalodisca vitripennis*), *Xylella fastidiosa,* fire blight (*Erwinia amylovora*), brown marmorated stink bug (*Halyomorpha halys*), exotic mites (*including Brevipalpus* spp., *Aceria granati*), Asian citrus psyllid (*Diaphorina citri*), African citrus psyllid (*Trioza erytreae*), huanglongbing (*Candidatus* Liberibacter asiaticus), citrus canker (*Xanthomonas axonopodis* subsp. *citri*), and invasive ants (*Solenopsis* spp., *Wasmannia auropunctata, Anoplolepis gracilipes*)	Specific
National tomato potato psyllid and zebra chip surveillance	Solanaceous hosts	Tomato potato psyllid (*Bactericera cockerelli*)	Specific
Onion diseases – Riverina	Onions, garlic	White rot (*Sclerotium cepivorum*), onion smut (*Urocystis cepulae*), onion rust (*Puccinia allii*)	Specific

Table 52. Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within New South Wales (continued)			
Serpentine leafminer	Multiple horticultural and ornamental hosts	Serpentine leafminer (*Liriomyza huidobrensis*)	Specific
Within the Northern Territory			
Area Freedom Surveillance Program	Horticultural crops	Queensland fruit fly (*Bactrocera tryoni*)	Specific
Major Industry Monitoring and Surveillance	Mango	Mango malformation (*Fusarium mangiferae*), mango pulp weevil (*Sternochetus frigidus*), mango seed weevil (*Sternochetus mangiferae*), mango gall midges (*Procontarinia* spp.) and red banded mango caterpillar (*Deanolis sublimbalis*)	General and targeted
National Bee Pest Surveillance Program	Ports and surrounding environment	*Varroa destructor, V. jacobsoni, Tropilaelaps clareae, T. mercedesae, Acarapis woodi, Oplostoma fuligineus, Braula coeca, Aethina tumida,* acute bee paralysis virus, deformed wing virus and slow paralysis virus, *Apis cerana, A. dorsata, A. florea, Bombus terrestris,* and new exotic swarms of *A. mellifera*	Specific
National Plant Health Surveillance Program – multi pest surveillance	Multiple	Multiple including citrus canker (*Xanthomonas axonopodis* pv. *citri*), huanglongbing (*Candidatus* Liberibacter spp.), Asiatic citrus psyllid (*Diaphorina citri*), giant African snail (*Achatina fulica*), glassy winged sharpshooter (*Homalodisca vitripennis*), Pierce's disease (*Xylella fastidiosa*), banana black sigatoka (*Mycosphaerella fijiensis*), red imported fire ant (*Solenopsis invicta*), electric ant (*Wasmannia auropunctata*), yellow crazy ant (*Anoplolepis gracilipes*), *Bactericera cockerelli, Candidatus* Liberibacter solanacearum, potato leafminer, pea leafminer, serpentine leafminer (*Liriomyza huidobrensis*), American leafminer (*Liriomyza trifolii*), vegetable leafminer (*Liriomyza sativae*), exotic fruit flies (*Bactrocera* spp. and *Ceratitis* spp.)	Specific
Within the Northern Territory (continued)			
Plant Pest Diagnostic Service – broadacre cropping	Broadacre crops	All pests and pathogens that can affect broadacre crops (pastures)	General
Plant Pest Diagnostic Service – horticulture	Horticultural crops	All pests and pathogens that can affect horticultural crops (mango, chilli, watermelon, Cucurbitaceae)	General
Regional Fruit Fly Monitoring and Surveillance	Horticultural crops	Exotic fruit flies (*Bactrocera* spp. and *Ceratitis* spp.)	Specific
Within Queensland			
Area freedom surveys	Multiple	Multiple pests	Specific
Area wide management of vegetable diseases	Multiple vegetable hosts	Multiple viruses and bacterial pests	Specific and general
Banana pest surveillance	Banana	A range of banana pests	General
Grain bulk handling companies	Stored grains	Endemic and exotic stored grain pests	General
Endemic and exotic diseases of cotton	Cotton	Exotic strains of bacterial blight (*Xanthomonas campestris*), blue disease (suspected Luteovirus), cotton bunchy top virus, cotton leaf curl virus (Begomovirus), cotton leafroll dwarf virus (Polerovirus), Texas root rot (*Phymatotrichum omnivorum*), exotic strains of Verticillium wilt (*Verticillium dahliae*), exotic strains Fusarium wilt (*Fusarium oxysporum* f. sp. *vasinfectum*) and all other exotic viruses. Endemic cotton diseases, including *Fusarium* and *Verticillium* spp.	Specific
Endemic and exotic grains virus surveys	Grains and cotton	Various viruses, especially aphid transmitted Polerovirus complex	Specific
Exotic Fruit Fly in the Torres Strait Program	Multiple	Exotic fruit fly including *Bactrocera* and *Zeugodacus* spp.	Specific
Forest High-Risk Surveillance Program	Multiple	Various exotic and endemic high priority pests of *Pinus* spp.	Specific
General forest pest surveillance	Multiple	General forest pests	General

Table 52. Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within Queensland (continued)			
Grow Help Australia diagnostic service project	Fruit, vegetable and ornamental hosts	All pests and pathogens that can affect horticultural crops, national parks, gardens, hobby growers and home gardeners. Commonly encountered pathogens include *Phytophthora* spp., *Fusarium* spp., *Colletotrichum* spp., *Alternaria* spp., *Rhizoctonia* spp., *Pythium* spp., *Ralstonia* spp., *Erwinia* spp. and viruses	General
National Bee Pest Surveillance Program	Ports and surrounding environment	*Varroa destructor, V. jacobsoni, Tropilaelaps clareae, T. mercedesae, Acarapis woodi, Oplostoma fuligineus, Braula coeca, Aethina tumida,* acute bee paralysis virus, deformed wing virus and slow paralysis virus, *Apis cerana, A. dorsata, A. florea, Bombus terrestris,* and new exotic swarms of *A. mellifera*	Specific
National Grain Insect Resistance Monitoring Program	Grains	Lesser grain borer (*Rhyzopertha dominica*), rice weevil (*Sitophilus oryzae*), rust-red flour beetle (*Tribolium castaneum*), rusty grain beetle (*Cryptolestes ferrugineus*), sawtoothed grain beetle (*Oryzaephilus surinamensis*)	Specific
National Plant Health Surveillance Program	Multiple	Multiple, including exotic fruit flies, exotic gypsy moths, Pierce's disease (*Xylella fastidiosa*) and glassy winged sharpshooter (*Homalodisca vitripennis*)	Specific
Panama TR4 Program	Banana	Panama disease (*Fusarium oxysporum* f. sp. *cubense*)	Specific
Plant Pest Diagnostic Service – broadacre cropping	Broadacre field crops	All pathogens that can affect broadacre crops (cotton, grains, pastures)	General
Post-Entry Quarantine inspections	Broadacre field crops (e.g. cotton, sorghum, maize, peanuts)	All pathogens that affect broadacre field crops	General
Silverleaf whitefly resistance monitoring	Cotton	Silverleaf whitefly (*Bemisia tabaci* B-type)	Specific
Sucking pest management in cotton	Cotton	Solenopsis mealybug (*Phenacoccus solenopsis*)	Specific
Within Queensland (continued)			
Sugar industry surveys, seed cane inspections, variety trials and general pest surveys	Sugarcane	Ratoon stunting disease (*Leifsonia xyli* subsp. *xyli*), leaf scald (*Xanthomonas albilineans*), sugarcane mosaic virus (Potyvirus), Fiji leaf gall (Fiji disease virus (Fijivirus), sugarcane smut (*Sporisorium scitamineum*), sugarcane rust (*Puccinia melanocephala, P. kuehnii*), yellow spot (*Mycovellosiella koepkei*), exotic pests and diseases	General and specific
Surveys and associated diagnostics of the incidence and severity of diseases of cereals and pulses within the northern region	Cereals and pulses	Various pests and diseases of cereals and pulses in the northern region	General and specific
National tomato potato psyllid and zebra chip surveillance	Solanaceae	Tomato potato psyllid (*Bactericera cockerelli*) and *Candidatus* Liberibacter solanacearum	Specific
West Indian drywood termite surveys	Timber structures	West Indian drywood termite (*Cryptotermes brevis*)	Specific
Fall Armyworm Response Project monitoring	Multiple	Fall armyworm (*Spodoptera frugiperda*)	General and specific
Serpentine leafminer monitoring	Multiple	Serpentine leafminer (*Liriomyza huidobrensis*)	General and specific
Bee pests and pest bees diagnostic service	European honey bee	Multiple pests	General and specific
Within South Australia			
Area freedom surveys	Multiple	Multiple pests	General and specific
Bee surveillance – endemic disease	European honey bees	American foulbrood (*Paenibacillus* spp.)	General and specific
Giant pine scale industry surveillance program	Pinaceae	Giant pine scale (*Marchalina hellenica*)	General and specific
Grains Farm Biosecurity Program	In-crop and stored grains	Various, including barley stripe rust (*Puccinia striiformis* f. sp. *hordei*), Khapra beetle (*Trogoderma granarium*), Karnal bunt (*Tilletia indica*), Russian wheat aphid (*Diuraphis noxia*), Sunn pest (*Eurygaster integriceps*), wheat stem rust (*Puccinia graminis* f. sp. *tritici*), wheat stem sawfly (*Cephus cinctus*)	General and specific
Grape phylloxera	*Vitus vinifera*	Grapevine phylloxera (*Daktulosphaira vitifoliae*)	General and specific

Table 52. Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within South Australia (continued)			
Mediterranean fruit fly	Horticultural crops	Mediterranean fruit fly (*Ceratitus capitata*)	General and specific
National Bee Pest Surveillance Program	Ports and surrounding environment	*Varroa destructor, V. jacobsoni, Tropilaelaps clareae, T. mercedesae, Acarapis woodi, Oplostoma fuligineus, Braula coeca,* acute bee paralysis virus, deformed wing virus and slow paralysis virus, *Apis cerana, A. dorsata, A. florea, Bombus terrestris* and new exotic swarms of *A. mellifera*	General and specific
National Plant Health Surveillance Program – multi pest surveillance	Multiple	Multiple, including exotic invasive ants (*tramp ants*), Asian and African citrus psyllids (*Diaphorina citri, Candidatus* Liberibacter africanus), huanglongbing (*Candidatus* Liberibacter asiaticus), citrus canker (*Xanthomonas axonopodis* pv. *citri*), glassy winged sharpshooters (*Homalodisca vitripennis* and *H. coagulata*), brown mamorated stink bug (*Halyomorpha halys*), *Xylella fastidiosa*	General and specific
Ports of Entry Trapping Program	*Eucalyptus* spp., ornamental trees	Exotic gypsy moths (*Lymantria* spp.)	General and specific
Ports of Entry Trapping Program	Various fruit fly hosts	Multiple – *Bactrocera albistrigata, B. carambolae, B. caryae, B. correcta, B. curvipennis, B. dorsalis, B. facialis, B. kandiensis, B. kirki, B. melanotus, B. occipitalis, B. passiflorae, B. psidii, B. trilineola, B, trivialis, B. tryoni, B. umbrosa, B. xanthodes, B. zonata, Ceratitis capitata, C. rosa, Zeugodacus cucurbitae, Z. tau*	General and specific
Mediterranean fruit fly	Horticultural crops	Mediterranean fruit fly (*Ceratitis capitata*)	General and specific
Queensland fruit fly	Horticultural crops	Queensland fruit fly (*Bactrocera tryoni*)	General and specific
Tomato potato psyllid program	Solanaceae	Tomato potato psyllid (*Bactericera cockerelli*)	General and specific
Tomato yellow curl leaf virus	Solanaceae	Tomato yellow curl leaf virus	General and specific
Trogoderma glabrum program	Multiple	*Trogoderma glabrum*	General and specific

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within Tasmania			
Bee surveillance – endemic disease and pests	European honey bees	American foulbrood (*Paenibacillus* spp.), European foulbrood (*Melissococcus pluton*), chalkbrood (*Ascophera apis*), sacbrood (*Nosema apis, N. ceranae*), sacbrood virus (*Morator aetatulas*), greater wax moth (*Galleria mellonella*), lesser wax moth (*G. achroia grisella*), European wasps (*Vespula germanica*), *Braula coeca*, bumble bee (*Bombus terestris*)	General and specific
Blueberry rust surveillance	Commercial blueberry crops and wholesale nurseries	Blueberry rust (*Thekopsora minima*)	Specific
Codling moth trapping surveillance	Apples, cherries	*Codling moth* (*Cydia pomonella*)	Specific
Fruit fly trapping surveillance	Host fruit trees, fruit and vegetables	*Bactrocera dorsalis, B. tryoni, Ceratitis capitata* and exotic fruit flies	Specific
National Bee Pest Surveillance Program	Ports and surrounding environment	*Varroa destructor, V. jacobsoni, Tropilaelaps clareae, T. mercedesae, Acarapis woodi, Oplostoma fuligineus, Aethina tumida,* acute bee paralysis virus, deformed wing virus and slow paralysis virus, *Apis cerana, A. dorsata, A. florea, Bombus terrestris* and new exotic swarms of *A. mellifera*	Specific
National Plant Health Surveillance Program – multi pest surveillance	Multiple	Brown marmorated stink bug (*Halyomorpha halys*), citrus canker (*Xanthomonas citri* subsp. *citri*), gypsy moths (including *Lymantria albescens, L. atameles, L. concolor, L. dispar asiatica, L. dispar dispar, L. dispar japonica, L. dissoluta, L. fumida, L. marginata, L. minomonis, L. monacha, L. postalba, L. pulverea, L. sinica, L. umbrosa, L. xylina*), huanglongbing (*Candidatus Liberibacter asiaticus*), *Bactericera cockerelli, Diaphorina citri, Trioza erytreae, B. trigonica, Trioza apicallis,* Pierce's disease (*Xylella fastidiosa*), glassy winged sharpshooter (*Homalodisca vitripennis*), *Bactrocera, Zeugodacus* and *Ceratitis* spp. (exotic fruit fly species)	Specific
Silverleaf whitefly surveillance	Nursery stock	Silver leaf whitefly (*Bemisia tabaci*)	Specific

Table 52. Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within Tasmania (continued)			
Tomato potato psyllid	Commercial potato and tomato crops, community gardens, urban pathways	Tomato potato psyllid (*Bactericera cockerelli*)	Specific
Warehouse beetle and Khapra beetle trapping surveillance	Stored grains, grain processors and animal feed outlets	Warehouse beetle (*Trogoderma variable*), Khapra beetle (*Trogoderma granarium*)	Specific
Within Victoria			
Online public reporting	All hosts, general surveillance	All plant pests	General
Area freedom surveillance for market access	Blueberries, port area, processed tomatoes and potatoes	Blueberry rust (*Thekopsora minima*), red imported fire ant (*Soelenopsis invicta*), tomato yellow leaf curl virus, tomato potato psyllid (*Bactericera cockerelli*), grapevine phylloxera, bacterial canker, cucumber green mottle mosaic virus, green snail, pyriform scale	Specific
Crop Safe Program	In-field grains	American serpentine leaf miner (*Liriomyza trifolii*), maize leafhopper (*Cicadulina mbila*), turnip moth (*Agrotis segetum*), barley stem gall midge (*Mayetola hordei*), European wheat stem sawfly (*Cephus pygmeus*), cabbage seedpod weevil (*Ceuthorhynchus assimilis*), canola Verticillium wilt (*Verticillium longisporum*), Fusarium wilts of chickpea (*Fusarium oxysporum* f.sp. *ciceris*) and canola (*Fusarium oxysporum* f.sp. *conglutinans*), barley stripe rust (*Puccinia striifomis* f.sp. *hordei*), lentil rust (*Uromyces viciae-fabae*), lupin anthracnose (*Colletotrichum lupini*) and Karnal bunt (*Tilletia indica*), lentil anthracnose (*Colletotrichum truncatum*), Khapra beetle (*Trogoderma granarium*)	General
Exotic fruit flies – Sunraysia	Various horticultural crops (citrus, stone fruit)	Mediterranean fruit fly (*Ceratitis capitata*)	Specific
Within Victoria (continued)			
Forest Health Surveillance Program	Multiple	Various exotic and endemic high priority pests of *Pinus* spp. Japanese sawyer beetle (*Monocamus alternatus*), wood wasp (*Urocerus fantoma*), black spruce longhorn beetle (*Tetropium castaneum*), brown spruce longhorn beetle (*Tetropium fuscum*), pine wilt nematode (*Bursaphelenchus* spp.) and dutch elm disease	Specific
Forest Health and Biosecurity Surveillance system	Multiple	Various exotic and endemic high priority pests	Specific
Grains Farm Biosecurity Program	In-crop and stored grains	Multiple including barley stripe rust (*Puccinia striiformis* f. sp. *hordei*), Khapra beetle (*Trogoderma granarium*), Karnal bunt (*Tilletia indica*), Sunn pest (*Eurygaster integriceps*), wheat stem rust (*Puccinia graminis* f. sp. *tritici*), wheat stem sawfly (*Cephus cinctus*)	Specific
MyPestGuide e-surveillance	All hosts, general surveillance	All plant pests	General and specific
National Bee Pest Surveillance Program	Ports and surrounding environment	*Varroa destructor, V. jacobsoni, Tropilaelaps clareae, T. mercedesae, Acarapis woodi, Oplostoma fuligineus, Braula coeca,* acute bee paralysis virus, deformed wing virus, slow paralysis virus, *Apis cerana, A. dorsata, A. florea, Bombus terrestris* and new exotic swarms of *A. mellifera*	Specific
National Plant Health Surveillance Program – multi pest surveillance	Multiple	Multiple including citrus canker (*Xanthomonas axonopodis* pv. *citri*), exotic fruit flies (*Bactrocera* spp., *Ceratitis captitata*), Pierce's disease (*Xylella fastidiosa*), glassy winged sharpshooter (*Homalodisca vitripennis*), plum pox virus, Asian gypsy moth (*Lymantria dispar* and other *Lymantria* spp.), brown marmorated stink bug (*Halyomorpha halys*), Asian citrus psyllid (*Diaphorina citri*), African citrus psyllid (*Trioza erytreae*) and spotted wing drosophila (*Drosophila suzukii*)	Specific
National tomato potato psyllid and zebra chip surveillance	Solanaceous hosts	Tomato potato psyllid (*Bactericera cockerelli*)	Specific
Passive MedFly Program	Fruit trees in backyards	Mediteranean fruit fly (*Ceratitis capitata*)	General

Table 52.Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within Victoria (continued)			
Urban Plant Health Network	Multiple plant hosts in periurban landscape, including community gardens	Various, including brown marmorated stink bug (*Halyomorpha halys*), Asian citrus psyllid (*Diaphorina citri*), African citrus psyllid (*Trioza erytreae*), Asian honeybee, red imported fire ant (*Solenopsis invicta*), spotted wing drosphila (*Drosophila suzukii*) and glassy winged sharpshooter (*Homalodisca vitripennis*)	General
Victorian funded containment program	Pasture and fruit trees	Green snail (*Cantareus apertus*)	Specific
Within Western Australia			
Agrisearch	Grain crops	Grain pests	General
AgWest grain testing laboratory	Grain crops	Grain pests	General
Ant Blitz	Urban areas	Browsing ant (*Lepisiota frauenfeldi*), red imported fire ant (*Solenopsis invicta*), Small black sugar ant (*Lepisiota capensis*)	General
Biosecurity Blitz	General surveillance, all hosts	All plant pests	General
Brown marmorated stink bug	General surveillance, all hosts, urban areas	Brown marmorated stink bug (*Halyomorpha halys*)	Specific
Candidatus Liberibacter solanacearum	Tomato, potato, capsicum, chilli and eggplant crops	Tomato potato pysllid (*Bactericera cockerelli*)	General
Codling moth surveillance	Pome fruit	Codling moth (*Cydia pomonella*)	Specific
European wasp surveillance	Urban areas and horticultural crops	European wasp (*Vespula germanica*)	General and specific
Within Western Australia (continued)			
Grains Farm Biosecurity Program	In-crop and stored grains	Various, including barley stripe rust (*Puccinia striiformis* f. sp. hordei), Khapra beetle (*Trogoderma granarium*), Karnal bunt (*Tilletia indica*), Russian wheat aphid (*Diuraphis noxia*), Sunn pest (*Eurygaster integriceps*), wheat stem rust (*Puccinia graminis* f. sp. *tritici*), wheat stem sawfly (*Cephus cinctus*)	General and specific
Medfly Area Freedom (Ord River Irrigation Area)	Many horticultural hosts	Mediterranean fruit fly (*Ceratitis capitata*)	Specific
MyCrop e-surveillance	Broadacre crops, general surveillance	All plant pests	General and specific
MyPestGuide e-surveillance	All hosts, general surveillance	All plant pests	General and specific
National Bee Pest Surveillance Program	Ports and surrounding environment	*Varroa destructor, V. jacobsoni, Tropilaelaps clareae, T. mercedesae, Acarapis woodi, Oplostoma fuligineus, Braula coeca,* acute bee paralysis virus, deformed wing virus, slow paralysis virus, *Apis cerana, A. dorsata, A. florea, Bombus terrestris* and new exotic swarms of *A. mellifera*	Specific
National grain insect resistance monitoring program	Grain crops	Grain pests	Specific
National Plant Health Surveillance Program – multi pest surveillance	Pome and citrus crops	Multiple including Asian citrus psyllid (*Diaphorina citri*), citrus canker (*Xanthomonas axonopodis* pv. *citri*), citrus longicorn beetle (*Anoplophora chinensis*), glassy winged sharpshooter (*Homalodisca vitripennis*), *Xylella fastidiosa*, brown marmorated stink bug (*Halyomorpha halys*)	Specific
National Variety Trials	Grain crops	Grain pests	General
Pantry Blitz	Stored grain products	Khapra beetle (*Trogoderma granarium*)	General
PestFax e-surveillance	Broadacre crops	All plant pests	General

Table 52.Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within Western Australia (continued)			
Port of Entry – Asian gypsy moth trapping	More than 600 forest, orchard, ornamental and native species	Asian gypsy moth (*Lymantria dispar*)	Specific
Port of Entry – fruit fly trapping	Horticultural hosts	Various *Bactrocera* and *Ceratitis* spp.	Specific
Queensland fruit fly surveillance	Many horticultural hosts	Queensland fruit fly (*Bactrocera tryoni*)	Specific
Sentinel stored products merchants	Stored grain products	Khapra beetle (*Trogoderma granarium*)	General and specific
Seed potato schemes	Seed potatoes	Tomato spotted wilt virus, potato leafroll virus, potato virus S, X and Y, potato spindle tuber viroid, potato cyst nematode	General and specific
Tramp ant surveillance	Environmental, urban areas, ports of entry, other high-risk sites	Browsing ant (*Lepisiota frauenfeldi*), red imported fire ant (*Solenopsis invicta*), small black sugar ant (*Lepisiota capensis*)	General

Legend

f. sp. forma specialis
pv. pathovar
sp. species
spp. multiple species
syn. synonym

** General surveillance is a range of crop monitoring and awareness activities outside of specific surveys that can be used to detect the presence or absence of pests, including the presence of new or unusual pests or symptoms. Targeted surveillance is where checks or surveys are made for particular pests, and records are captured.*

Diagnostics – identifying plant pests and diseases

Accurate diagnosis of plant pests and diseases underpins all aspects of the plant biosecurity system. The cause of poor plant health can sometimes be difficult to determine. There can be many different causes for a given symptom, not all of them related to insects or pathogens. The health of a plant may be affected by soil structure and nutrients, weather conditions, amount of light, other environmental and cultural conditions, as well as the activities of animals and people.

It is essential that diagnostic services can quickly and accurately identify if a plant health issue is caused by a pest or disease and, if so, whether it is an established or exotic pest species. The differences between species can be very minor, making identification a matter of an expert undertaking close examination, morphological comparison to reference species or using molecular techniques.

Diagnostics also supports many of the management practices that are integral to the production and trade of plant products. Pest management programs, including the selection and application of farm chemicals, rely on the accurate identification of pests. Rapid identification supports quarantine processes such as maintaining pest free areas, which allow access to domestic and international markets.

DPIRD expert taxonomist for pest insects. Image courtesy of WA Agriculture Authority

OVERSIGHT OF NATIONAL PLANT BIOSECURITY DIAGNOSTICS

National Plant Biosecurity Diagnostic Strategy

The National Plant Biosecurity Diagnostic Strategy (NPBDS) has guided activities to support the strengthening of the diagnostic sector since its completion in 2012. The NPBDS underpins the National Plant Biosecurity Strategy (see page 20) and complements the National Plant Biosecurity Surveillance Strategy (see page 151) and the draft National Plant Biosecurity Preparedness Strategy, the development of which was progressed in 2020.

The 2012 NPBDS sets out the recommendations and actions necessary to ensure Australia has the people, infrastructure, diagnostic standards and tools to provide delivery of plant biosecurity diagnostic services.

Some of the key achievements include:

- implementation of the National Plant Biosecurity Diagnostic Network
- improved and enhanced output of National Diagnostic Protocols
- development of laboratory standards with accreditation and proficiency testing.

A revised NPBDS and implementation plan are being developed to guide activities over the next decade to ensure Australia's diagnostic system remains robust and effective. This work is expected to be completed during the first half of 2021.

Subcommittee on Plant Health Diagnostics

The Subcommittee on Plant Health Diagnostics (SPHD) provides leadership in plant pest diagnostics policy, standards and coordination for Australia. This subcommittee of the Plant Health Committee was established to sustain and improve the quality and reliability of plant pest diagnostics.

Implementation of the NPBDS is led by SPHD, ensuring the diagnostic system effectively supports the broader biosecurity system.

Key roles and responsibilities of SPHD include:

- reviewing and developing diagnostic policies, protocols and standards
- reviewing, developing and implementing strategies to address national capability and capacity issues
- endorsing National Diagnostic Protocols (NDPs) (see Figure 93 on page 168)
- coordinating and fostering the National Plant Biosecurity Diagnostic Network
- building national capability through a professional development framework
- driving the development and uptake of accreditation and quality management systems for diagnostic laboratories
- improving the surge capacity of diagnostic services to support plant pest responses.

National Plant Biosecurity Diagnostic Network

The National Plant Biosecurity Diagnostic Network (NPBDN) was formed to help build and maintain diagnostic capability and capacity for Australia and New Zealand.

The network comprises experts across the diagnostic system, from entomologists and plant pathologists, through to response program managers and policy makers. Members are from a range of organisations including, but not limited to, state and territory governments, the Australian Government, CSIRO, PHA, universities and the New Zealand Ministry for Primary Industries.

Activities are coordinated via a network implementation working group and a network coordinator, operating out of PHA. The network facilitates communication between experts and sharing of diagnostic resources, and offers professional development activities and a proficiency testing program. Each year the Annual Diagnosticians' Workshop brings members of the network together to share ideas and knowledge, and to identify future activities.

An integrated, national network has numerous benefits, including more efficient delivery of services, preventing duplication of effort, identifying and addressing gaps, and providing surge capacity during incursions.

The network is supported by a PHA-hosted website **plantbiosecuritydiagnostics.net.au** which contains resources, member expertise and contact details, news, events and various tools to assist in pest identification.

Annual Diagnosticians' Workshop 2020

The ninth Annual Diagnosticians' Workshop held in Brisbane in March 2020 attracted more than 80 participants involved in plant health diagnostics, who were keen to build their network, share their experiences and strengthen capability of the National Plant Biosecurity Diagnostic Network.

The attendees represented 19 organisations including all jurisdictions, the New Zealand Ministry for Primary Industries, Scion Research, CSIRO, Sugar Research Australia, multiple universities and PHA.

The theme for the workshop was 'Over the horizon – pests and tests' and included a number of presentations on different technologies including:

- next generation sequencing for viruses
- MALDI-TOF mass spectrometry for bacterial pathogens
- diagnostics for particular pests including African citrus greening
- *Dickeya fangzhongdai* and honey bee mites.

Four researchers who received residential placements offered by the National Plant Biosecurity Diagnostic Network also delivered presentations on their work.

Participants at the Annual Diagnosticians' Workshop, Brisbane, March 2020

NATIONAL DIAGNOSTIC PROTOCOLS

National Diagnostic Protocols (NDPs) are documents that contain detailed information about a specific plant pest or related group of pests, to allow accurate taxonomic identification.

They comply with International Standards for Phytosanitary Measures (ISPM) 27, Diagnostic Protocols for Regulated Pests, and include diagnostic procedures and data on the pest, its hosts, taxonomic information, detection methods and identification. New protocols include diagnostic information relevant to surveillance activities and the high throughput of samples.

The protocols are used in:

- emergency responses to exotic plant pests
- general surveillance for pest status
- testing of material for compliance with certification procedures
- surveillance as part of an official control or eradication program
- pest diagnostic operations associated with phytosanitary certification
- routine diagnosis of pests found in imported consignments
- detection of a pest in an area where it is not known to occur.

SPHD is responsible for endorsing the protocols, setting them as the agreed procedures for definitive identification of pests in the event of an incursion. The use of endorsed NDPs provides confidence in diagnostic outcomes and consistency across the laboratories of the NPBDN. Table 53 lists the published NDPs available on the NPBDN website **plantbiosecuritydiagnostics.net.au**

The protocols are developed according to SPHD Reference Standards, which include the processes of peer review, verification and endorsement as shown in Figure 93.

These reference standards cover:

- Reference Standard 1: Glossary of Terms (Version 4)
- Reference Standard 2: Development of Diagnostic Protocols – Procedures for Authors (Version 7)
- Reference Standard 3: Guidelines for the Approval Process of National Diagnostic Protocols (Version 5.2)
- Reference Standard 4: Guidelines for Verification and Peer Review Reports (Version 4).

The International Plant Protection Convention (IPPC) has diagnostic protocols that are recognised internationally. Where an IPPC diagnostic protocol exists, it is used in preference to an NDP, unless it is shown that the NDP has improved procedures for Australian conditions. NDPs may also contain additional information to aid diagnosis. IPPC protocols are available on the IPPC website **ippc.int/en/core-activities/standards-setting/ispms**

Figure 93. National Diagnostic Protocol endorsement process

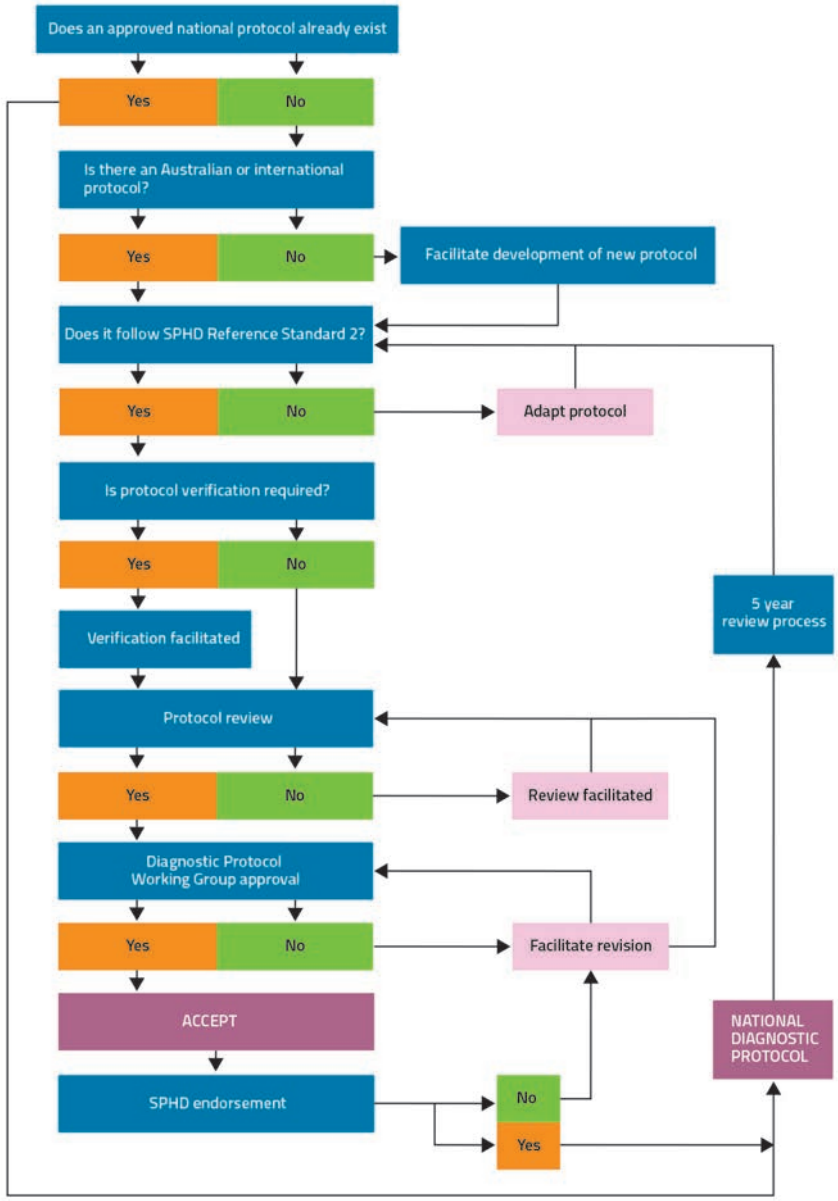


Table 53. National Diagnostic Protocols

Scientific name	Common name	NDP* number
Endorsed protocols		
Adoxophyes orana	Summer fruit tortrix	30
Bactericera cockerelli	Tomato potato psyllid	20
Candidatus Liberibacter asiaticus	Huanglongbing	25
Candidatus Liberibacter solanacearum	Zebra chip	18
Candidatus Phytoplasma pruni	X disease	17
Candidatus Phytoplasma prunorum	European stone fruit yellows	12
Cherry leaf roll virus (Nepovirus)	Blackline	10
Clavibacter michiganensis subsp. *sepedonicus*	Potato ring rot	8
Cryphonectria parasitica	Chestnut blight	11
Dendronoctonus valens	Red turpentine beetle	24
Diaporthe helianthi	Sunflower stem canker	40
Diuraphis noxia	Russian wheat aphid	28
Echinothrips americanus	Poinsettia thrips	4
Endocronartium harknessii	Pine gall rust	32
Fusarium oxysporum f. sp. *ciceris*	Fusarium wilt of chickpea	36
Homalodisca vitripennis	Glassy winged sharpshooter	23
Leptinotarsa decemlineata	Colorado potato beetle	22
Liriomyza trifolii	American serpentine leafminer	27
Lymantria dispar	Asian gypsy moth, gypsy moth complex	42
Mayetiola destructor	Hessian fly	41
Monilinia fructigena	Apple brown rot	1
Neonectria ditissima	European canker	21
Ophiostoma ulmi	Dutch elm disease	37
Phakopsora euvitis	Grapevine leaf rust	29
Phyllosticta ampelicida (syn. *Guignardia bidwellii*)	Black rot	13
Phytophthora ramorum	Sudden oak death	5
Phytoptus avellanae	Hazelnut big bud mite	39

Scientific name	Common name	NDP* number
Endorsed protocols(continued)		
Plenodomus tracheiphilus (syn. *Phoma tracheiphila*)	Mal secco	26
Plum pox virus (Potyvirus)	Plum pox virus	2
Potato mop top virus (Pomovirus)	Potato mop top virus	15
Potato spindle tuber viroid (Pospiviroidae)	PSTVd	7
Protopulvinaria pyriformis	Pyriform scale	33
Puccinia striiformis f. sp. *hordei*	Barley stripe rust	38
Pulvinaria iceryi	Pulvinaria scale	34
Pyricularia oryzae (syn. *Magnaporthe grisea*)	Rice blast	14
Roesleria subterranea	Grape root rot	35
Scirtothrips perseae	Avocado thrips	3
Synchytrium endobioticum	Potato wart	16
Tilletia indica	Karnal bunt	19
Uromyces viciae-fabae (lentil strain)	Lentil rust	31
Xanthomonas citri subsp. *citri*	Citrus canker	9
Xylella fastidiosa	Pierce's disease	6
Draft protocols		
Agrilus planipennis	Emerald ash borer	
Austropuccinia psidii	Guava (eucalyptus) rust	
Banana bract mosaic virus (Potyvirus)	Banana bract mosaic virus	
Begamovirus group	Begamovirus group	
Burkholderia glumae	Panicle bight	
Bursaphelenchus cocophilus	Red ring nematode	
Bursaphelenchus xylophilus	Pine wilt nematode	
Bymovirus group	Bymovirus group	
Candidatus Phytoplasma solani	Bois noir	
Ceratocystis spp. *including C. maginecans, C. eucalypticola, C. fimbriata*	No common name	

** National Diagnostic Protocol reference number*

Table 53. National Diagnostic Protocols (continued)

Scientific name	Common name
Draft protocols (continued)	
Ceratovacuna lanigera	Sugarcane woolly aphid
Chilo spp. *including C. auricilius, C. infuscatellus, C. partellus, C. polychrysus, C. sacchariphagus, C. terrenellus*	Gold fringed rice borer, top borer, spotted stem borer, dark headed stripe borer, spotted borer and stem borer
Cicidula mbila	South African maize leafhopper
Citripestis sagittiferella	Citrus fruit borer
Colletotrichum lentis	Lentil anthracnose
Coptotermes spp. including *C. formosanus, C. gestroi*	Subterranean termite
Coryphodema tristis	South African cossid moth
Cotton leaf curl virus (Begomovirus)	Cotton leaf curl disease
Cotton leaf roll dwarf virus (Polerovirus)	Cotton leaf roll dwarf virus
Cryptotermes spp. including *C. brevis, C. dudleyi, Incisitermes minor*	Drywood termite
Daktulosphaira vitifoli	Grape phylloxera
Deanolis sublimbalis	Red banded mango caterpillar
Dendroctonus spp.	Southern and mountain pine beetles
Diaphorina citri	Asian citrus psyllid
Drosophila suzukii	Spotted wing drosophila
Dysaphis plantaginea	Rosy apple aphid
Erionata thrax	Banana skipper butterfly
Erwinia amylovera	Fire blight
Fusarium circinatum	Pine pitch canker
Fusarium oxysporum f. sp. *cubense*	Panama disease
Fuvovirus group	Wheat soil-borne virus group
Giberella fujikuroi	Bakanae
Globodera pallida, G. rostochiensis	Potato cyst nematode
Grapevine flavescence doree phytoplasma	Flavescence doree
Grapevine red blotch virus (Grablovirus)	Grapevine red blotch virus
Heterodera spp.	Cyst nematodes

Scientific name	Common name
Draft protocols (continued)	
Honey bee viruses	Deformed wing virus strains, slow bee paralysis virus strains and acute bee paralysis virus
Hordieivirus group	Hordieivirus group
Hyalesthes obsoletus	Cixiidae plant hopper
Lepisiota frauenfeldi, L. incisa	Browsing ant
Liriomyza huidobrensis	Pea leafminer
Lissorhoptrus oryzophilus	Rice water weevil
Lobesia botrana	European grapevine moth
Maize dwarf mosaic virus (Potyvirus)	Maize dwarf mosaic virus
Orthaga euadrusalis	Mango web weaver
Pantoea stewartii	Stewart's wilt of maize
Pecluvirus group	Pectovirus group
Pernoscleospora spp.	Sugarcane downy mildew
Phyllosticta spp. including *P. cavendishii, P. maculata, P. musarum*	Banana freckle
Phymatotrichum omnivorum	Texas root rot
Phytophthora infestans A2	Late blight
Planococcus ficus	Vine mealybug
Pomacea canaliculata	Golden apple snail
Pseudocercospora fijiensis, Mycosphaerella eumusae	Black Sigatoka, eumusae leaf spot
Pseudococcus maritimus	Grape mealybug
Pseudomonas syringae pv. *papulans*	Blister spot of apple
Pseudopezicula tetraspora	Angular leaf scorch grape
Raffaelea lauricola	Laurel wilt and vector beetle
Ralstonia spp. including *R. solanacearum, R. syzygii* subsp. *celebesensis*	Moko, bugtok and banana blood disease
Ramu stunt (Tenuivirus)	Ramu stunt
Red clover vein mosaic virus (Carlavirus)	Red clover vein mosaic virus
Scirpophaga excerptalis	Top shoot borer

Table 53. National Diagnostic Protocols (continued)

Scientific name	Common name
Draft protocols (continued)	
Scirpophaga nivella	White rice borer
Scirtothrips aurantii	South African citrus thrips
Scolytines	Bark beetles
Sitobian avenae	English grain aphid
Stagonospora sacchari	Leaf scorch of sugar
Sternochetus frigidus	Mango pulp weevil
Sugarcane white leaf phytoplasma	Sugarcane white leaf phytoplasma
Tilletia barclayana (syn. *T. horrida*)	Kernel smut of rice
Trioza erytreae	African citrus psyllid
Trogoderma granarium	Khapra beetle
Tropilaelaps spp.	Tropilaelaps mites
Verticillium dahliae (defoliating strain)	Verticillium wilt
Wheat spindle streak mosaic virus (Bymovirus)	Wheat spindle streak mosaic virus
Xanthomonas axonpopodis pv. *allii*	Xanthomonas leaf blight (onion)
Xanthomonas citri subsp. *malvacearum*	Hyper virulent bacterial blight of cotton
Xanthomonas fragariae	Angular leaf scorch of strawberry
Xanthomonas vasicola pv. *musacearum*	Banana bacterial wilt
Xylella exotic leafhopper vectors (*Acrogonia terminalis, Cicadella viridis, Dilobopterus costalimai, Draeculacephala minerva, Graphocephala atropunctata, Oncometopia fascialis, Xyphon fulgidum*)	Xylella exotic leafhopper vectors
Xylella exotic vectors (*Philaenus spumarius*)	Meadow spittlebug
Xylophilus ampelinus	Bacterial blight of grapevine

Legend

Endorsed – the protocol has been assessed and endorsed by the Subcommittee on Plant Health Diagnostics as a National Diagnostic Protocol

Draft – the protocol is under development, an old draft, or in the pre-endorsement review process

f. sp. – forma specialis

pv. – pathovar

spp. – multiple species

subsp. – subspecies

syn. – synonym

Farmer and researchers. Image courtesy of CSIRO

WA Grains Biosecurity Officer examining specimen under a microscope. Image courtesy of WA DPIRD

DIAGNOSTIC SERVICES IN AUSTRALIA

Diagnostic services are distributed across every state and territory in Australia. Services are delivered by a range of agencies, including state and territory governments, the Australian Government, commercial and private diagnostic laboratories, museums, the CSIRO and universities.

Australia's diagnostic facilities and their services are detailed in Table 54.

Services may be provided on an ad hoc, commercial or nationally coordinated basis, as required. Diagnostic operations are often performed as part of collaborative research activities that focus on specific pests of concern.

Table 54. Australia's diagnostic services, their capabilities, accreditations and collections

Laboratory and location	Organisation	Diagnostic capability	Accreditation	Collections
Australian Capital Territory				
Black Mountain Laboratories, Canberra	CSIRO Health and Biosecurity	Bee pathogens		
Black Mountain Laboratories, Canberra	CSIRO Health and Biosecurity	Fungi identification		
Black Mountain Laboratories, Canberra	National Research Collections Australia, CSIRO (Australian National Herbarium)	Fungi identification, weeds and seeds		Herbarium and fungi collections
Black Mountain Laboratories, Canberra	National Research Collections Australia, CSIRO (Australian National Insect Collection)	Insect, nematode and mite identification, molecular biology		Insect, nematode, mite, other arthropod (e.g. spider, centipede), earthworm and other invertebrate collections
New South Wales				
Agricultural Scientific Collections Unit, Orange Agricultural Institute, Orange	NSW DPI	Invertebrates and pathogens, specialist insect and mite identification (mycology and entomology)	National Association of Testing Authorities (NATA) accreditation (ISO/IEC 17025:2005)	Fungi, bacteria and arthropods
Australian Cotton Research Institute, Narrabri	NSW DPI, CSIRO	Cotton pathology (e.g. mycology, virology and bacteriology)	ISO9001	
Australian Museum, Sydney	Australian Museum	Entomology		Entomology
Cereal Rust Laboratory, Cobbitty	NSW DPI, University of Sydney	Rust pathology		
CSIRO Cotton Research Unit, Narrabri	CSIRO	Entomology		
Elizabeth Macarthur Agricultural Institute, Menangle	NSW DPI	Invertebrates and pathogens (virology, bacteriology and mycology)	NATA accreditation (ISO/IEC 17025:2005); DAWE Approved Arrangement site (biosecurity containment BC2 and BC3)	Fungi, bacteria and nucleic acids
Forest Health Management Laboratory, West Pennant Hills	NSW DPI	Internal routine diagnostics		
Grafton Agricultural Research and Advisory Station, Grafton	NSW DPI	Insect pests		
Macleay Museum, Sydney	University of Sydney	Entomology		Entomology
Operational Science, Mascot	DAWE	Pest and disease identification, collection and rearing of immature stages of arthropods. Pathology investigation to determine causal agent	DAWE accredited quarantine containment 5.2/7.2	Entomology
Royal Botanic Garden, Sydney	NSW Office of Environment and Heritage	Plant pathogens, using both classical and molecular methods		
Tamworth Agricultural Institute, Tamworth	NSW DPI	Invertebrates and pathogens (entomology, plant pathology and broadacre crops)		
Wagga Wagga Agricultural Institute, Wagga Wagga	Charles Sturt University, NSW DPI	Plant pathology and molecular biology		
Yanco Agricultural Institute, Yanco	NSW DPI	Invertebrates and pathogens (vegetables and rice pathology)		

Table 54. Australia's diagnostic services, their capabilities, accreditations and collections (continued)

Laboratory and location	Organisation	Diagnostic capability	Accreditation	Collections
Northern Territory				
CSIRO Tropical Ecosystems Research Centre, Darwin	CSIRO	Ant identification for general public and biosecurity purposes		Tropical Ecosystems Research Centre ant collection
Entomology Laboratory, Berrimah	NT Department of Industry, Tourism and Trade	Insects and mites, molecular biology		Northern Territory Economic Insect Reference Collection and insect DNA collection
Herbarium, Flora and Fauna Division, Palmerston	NT Department of Environment and Natural Resources	Plant identification for general public and commercial purposes	Registration for exchange (export and import) of scientific specimens	Native plant collection of the Northern Territory
Natural Sciences, Museum and Art Gallery of the Northern Territory, Darwin	Museums and Art Galleries of the Northern Territory	Mollusc, insect, fish and other faunal identifications for the general public, commercial and biosecurity purposes	Registration for exchange (export and import) of scientific specimens	Mollusc, insect, arachnid and myriapod collections of the Northern Territory fauna with some interstate and overseas material. Also extensive reference collections and expertise covering fish, terrestrial vertebrates and marine invertebrates
Northern Australia Quarantine Strategy Regional Laboratory, Darwin	Department of Agriculture, Water and the Environment	Tropical plant pests. Plant pathology including microscopy, serology and molecular assays (conventional and real time PCR), NGS sequencing (minION), for selected organisms. Entomology and botany including microscopy and molecular capacity		Plant pathology: herbarium specimens, desiccated virus and virus-like disease collections in tissue and nucleic acids from Australia and northern neighbouring countries. Entomology: Northern Territory Quarantine Insect Collection which comprises pinned, wet and slide-mounted insect pests primarily from WA, NT and Timor Leste; includes the National Arbovirus Monitoring Program collection of Culicoides biting midges
Plant Pathology Laboratory, Berrimah		Plant pathology, virology, bacteriology, PCR, mycology and diagnostics	Registered for exchange of scientific specimens (Australian native non-CITES specimens) and the index herbarium	Northern Territory Plant Pathology Herbarium and plant pathogen nucleic acids collection
Queensland				
Biosecurity Queensland Control Centre, Berrinba	QDAF	Fire ants		Fire ant reference collection
Bowen Research Station, Bowen	QDAF	Entomology		
Cairns Research Station, Cairns	QDAF	Plant pest and disease triage		
Centre for Tropical Agriculture, Mareeba	QDAF	Entomology, plant pathology, molecular and bacteriology		Entomology

Table 54. Australia's diagnostic services, their capabilities, accreditations and collections (continued)

Laboratory and location	Organisation	Diagnostic capability	Accreditation	Collections
Queensland (continued)				
Ecosciences Precinct, Dutton Park	QDAF	Entomology, plant pathology, virology, bacteriology, mycology, nematology, molecular biology and exotic fruit fly screening	DAWE Approved Arrangement for Class 5.2 and 5.3. Biosecurity containment levels BC2 and BC3. NATA Accredited ISO/IEC 17025:2018	Plant pathology and entomology
Gatton Research Station, Gatton	QDAF	Vegetable pests and diseases		
Maroochy Research Station, Nambour	QDAF	Plant pathology		
Northern Australia Quarantine Strategy Regional Laboratory, Cairns	DAWE	Tropical plant pests. Plant pathology including microscopy, serology and molecular assays (conventional and real time PCR) for selected organisms. Entomology including microscopy and limited molecular capacity. Botany including microscopy		Plant pathology: herbarium specimens and desiccated virus and virus-like disease collections. Entomology: extensive insect collections including overseas specimens and a large fruit fly collection
Queensland Alliance for Agriculture and Food Innovation, St Lucia, Dutton Park, Warwick, Nambour	Queensland Alliance for Agriculture and Food Innovation, University of Queensland	Plant pathology and virology		
Queensland Museum, South Brisbane	Queensland Museum	Acaralogy and entomology		Acarology and entomology
South Johnstone Research Station, South Johnstone	QDAF	Nematology, entomology and plant pathology		
Sugar Research Australia, Indooroopilly, Woodford, Mackay, Tully	Sugar Research Australia	Sugarcane pests and diseases		
Toowoomba Research Station, Toowoomba	QDAF	Field crop pests and diseases, molecular, entomology, virology, nematology and mycology		
University of Southern Queensland, Toowoomba	University of Southern Queensland	Plant pathology and nematology		
South Australia				
Australian Wine Research Institute, Urrbrae, Adelaide	Australian Wine Research Institute	Viticulture virology (molecular)		
Intertek, Adelaide	Intertek	Potato black leg (molecular)		
School of Earth and Environmental Sciences, Adelaide	University of Adelaide	Entomology		
South Australian Research & Develiopment Institute (SARDI), Urrbrae, Adelaide	SARDI (PIRSA)	Molecular diagnostics and surveillance, plant pathology (cereals, pulse and horticulture), nematology, entomology	Molecular Diagnostics Laboratory is NATA accredited under Biologicals and for potato virus testing. DAWE accredited containment facilities for insects and plants (BC2)	Entomology collection, Adelaide University
South Australian Museum, Adelaide	SA Department of Premier and Cabinet	Entomology		

Table 54. Australia's diagnostic services, their capabilities, accreditations and collections (continued)

Laboratory and location	Organisation	Diagnostic capability	Accreditation	Collections
Tasmania				
Plant Diagnostic Services, New Town (satellite entomology laboratories at Devonport and Launceston)	DPIPWE	Entomology, plant pathology (virology, mycology, nematology and bacteriology including molecular testing), TASAG ELISA testing services (virology)	Laboratories DAWE containment approved, Virology section have NATA accreditation (ISO/IEC 17025:2005)	Insect reference collection
Queen Victoria Museum and Art Gallery, Launceston	Queen Victoria Museum and Art Gallery	Insect identification for the general public		Invertebrate reference collection covering most groups including insects
Seed Analysis Laboratory, Mt Pleasant	DPIPWE	Feed grain quarantine assessments for declared species	International Seed Testing Association accredited	Prohibited and quarantinable species seed reference collection
Staphyt, Devonport	Staphyt, Australasia	Plant pathology		Prohibited and quarantinable species seed reference collection
Sustainable Timber Tasmania Laboratory, Derwent Park, Hobart	Sustainable Timber Tasmania	Limited pathology diagnostics, particularly focusing on testing for *Phythophthora cinnamomi*. Entomology, specialising in beetles for internal projects		
Tasmanian Museum and Art Gallery, Hobart	Tasmanian Museum and Art Gallery	Entomology, specialising in beetles and moths, and insect identification for the general public		Tasmanian forest insect collection, herbarium including weeds and fungi
University of Tasmania Cradle Coast Campus, Burnie	University of Tasmania, Tasmanian Institute of Agriculture	Plant pathology (mycology including molecular testing)		Limited collection of fungal pathogens
University of Tasmania Sandy Bay Campus, Hobart	University of Tasmania, Tasmanian Institute of Agriculture	Entomology, plant pathology, forest pathology and molecular testing	Laboratory DAWE containment approved	Insect reference collection
Victoria				
Agriculture Victoria, AgriBio, Bundoora	DJPR	Commercial diagnostic laboratory for general plant pathology, pathogen identification, entomology, mycology, virology, nematology, bacteriology, fungal and insect taxonomy, high throughput molecular diagnostics and weeds	DAWE accredited quarantine containment 5.2. Laboratory is NATA accredited under AgriBusiness. NATA accredited for potato virus testing, phytoplasma, nematology, fruit fly and phylloxera identification	Victorian Plant Pathogen Herbarium: 43,000 specimens of fungi, bacteria, nematodes and a limited number of viruses. Victorian Agricultural Insect Collection (VAIC): 200,000 invertebrate specimens. Victorian Agricultural Insect Tissue Collection: DNA collection associated with VAIC
Agriculture Victoria, Horsham	DJPR	CropSafe Program: general plant pathology, entomology and virology (grains focus); Post-Entry Quarantine Facility (grains)	DAWE accredited quarantine containment 5.2/6.1	Fungal, bacterial and virus pathogen working collections pertaining to temperate grain crops; Australian Gene Bank (grain germplasm)
Operational Science Laboratory, Tullamarine Airport	DAWE	Entomology and plant pathology	DAWE accredited quarantine containment 5.2/7.2	Entomology collection

Table 54. Australia's diagnostic services, their capabilities, accreditations and collections (continued)

Laboratory and location	Organisation	Diagnostic capability	Accreditation	Collections
Victoria (continued)				
Plant Post-Entry Quarantine facility, Mickleham	DAWE	General plant pathology including mycology, bacteriology, botany, virology (traditional and modern) and nematology		
National Herbarium of Victoria	Royal Botanic Gardens Victoria	Mycology and weeds		Herbarium, including fungi and weeds
Melbourne Museum	Museums Victoria	Entomology		Entomology collection
Western Australia				
Department of Environmental Biology, Perth	Curtin University of Technology	Mycology		
DPIRD Diagnostic Plant Laboratories, South Perth	DPIRD	Commercial diagnostic laboratory for plant pathogen identification, entomology, nematology, virology, bacteriology, mycology, seeds and limited number of bee pathogens	Seed lab is ISTA and QC2 accredited. Plant quarantine laboratory is QC2 accredited	Western Australian plant pathogen and invertebrate collections
Northern Australia Quarantine Strategy, Broome	DAWE	Identification of quarantine intercept samples, mostly exotic pests		Small reference collection, mostly exotic invertebrates
Operational Science, DA, Perth International Airport	DAWE	Identification of quarantine intercept samples, mostly exotic pests including arthropods, fungi, bacteria and viruses	DAWE accredited quarantine containment 5.2/7.2	Small reference collection, mostly exotic invertebrates with a limited collection of seed and cultures
Phytophthora Laboratory, Murdoch	Murdoch University	Diagnostic laboratory for commercial and research purposes		
Western Australian Museum, Kewdale	Western Australian Museum	Insect identification for general public		Largest invertebrate collection in Western Australia
Western Australian State Agricultural Biotechnology Centre	Murdoch University	Commercial and research molecular biology laboratory for plant pathogen identification		

Image courtesy of Agriculture Victoria

NATIONAL REFERENCE COLLECTIONS

Biological reference collections are an essential part of the plant biosecurity system, providing validated reference specimens for comparison during the identification of a plant pest. Comprehensive and well-maintained collections are a vital tool to support effective diagnostics, and they are also used for other purposes, such as biodiversity or scientific research.

Most biosecurity and biodiversity reference collections contain:

- **Exotic pest specimens** – necessary for identification since these pests are not present in Australia.
- **Common native relatives and look-alikes of exotic pests** – essential for comparison when identifying exotic or unknown pests, and used in the development of effective diagnostic methods.
- **Type specimens** – definitive and validated specimens of a species or strain, which are important for taxonomic research and diagnostics.
- **Historical material and records** – including vouchers and evidence of surveillance or distribution.

Diagnosticians use collections to determine the status of a pest and to support export market access. Proof of area freedom requires vouchering of specimens and records under international standards including ISPM 8, Determination of Pest Status in an Area, a service that is provided by Australia's collections.

The National Plant Pest Reference Collections Strategy[45] and implementation plan were developed by SPHD in 2018. Implementation of the strategy will ensure reference collections are integrated into the plant biosecurity system, coordinated with other system components, and can support Australia's trade and biosecurity activities.

In 2020, implementation of the strategy was undertaken to:

- confirm specimens of the National Priority Plant Pests were present in Australian reference collections
- determine a prioritised approach to address any key gaps
- develop nationally agreed standards for curation and the vouchering of specimens.

45 Plant Health Australia (2018). National Plant Pest Reference Collections Strategy. Accessed online 17 April 2020 from planthealthaustralia.com.au/wp-content/uploads/2019/06/Plant-Pest-Reference- Collections-Strategy.pdf.

IDENTIFICATION OF FRUIT FLIES

The accurate identification of fruit flies is a key component of Australia's biosecurity system that underpins the domestic movement of fruit and vegetables, maintains international market access for Australian producers and protects Australia's borders from exotic pest incursions.

The latest version of the Australian Handbook for the Identification of Fruit Flies (v 3.1) was released in 2018. The volume was developed in consultation with, and input from, fruit fly entomologists, scientists, academics and diagnosticians from Australia and overseas, including government departments of agriculture or primary industries and research institutions.

The handbook consists of two integrated components: an illustrated hardcopy identification 'bench-top handbook' and an online resource.

The fully illustrated handbook includes new images of all target species and revised information pages. The handbook includes 65 pests and close relatives in Dacinae (Bactrocera, Dacus, Zeugodacus, Ceratitis), Trypetinae (Anastrepha, Rhagoletis, Toxotrypana), Phytalmiinae (Dirioxa) and Drosophilidae (*Drosophila suzukii*). Introductory sections support bench-top diagnostics, and links to the online resource provide more in-depth information (e.g. molecular diagnostic techniques).

The Fruit Fly Identification Australia website **fruitflyidentification.org.au** is a companion to the handbook and includes:

- high-resolution diagnostic images of target species
- pages detailing information about all high priority target pests and non-pest close relatives
- a 3D rotating fly and glossary of morphological terms
- supplementary information on molecular diagnostic tools and applications
- a completely new and fully illustrated lucid key to 65 species, including all high priority target taxa and readily confused non-pest Australian species.

Sterile Insect Technique (SIT) in Queensland fruitfly (Bactrocera tryoni) stained with pink dye. Image courtesy of Pia Scanlon, WA DPIRD

ONLINE SYSTEMS SUPPORTING PLANT BIOSECURITY

Digital resources are of increasing importance to plant biosecurity, providing fast access to and analysis of information. Many online systems are used by stakeholders in the biosecurity system.

AUSPest*Check*™

AUSPest*Check*™ is a system developed by PHA for coordinating and hosting surveillance data on the presence or absence of exotic and established pests around Australia. This system can collate surveillance data from multiple industry and government sources and provide registered participants information of pest status around the country, using alerts, tables, maps and graphics. During 2020, AUSPest*Check*™ facilitated proof-of-concept trials for coordinating surveillance data online.

All the information is integrated to allow mapping and searching for information about plant pests. Standardised data are uploaded either manually using preformatted templates, or automatically from pre-existing databases or systems via an application programming interface.

MyPest*Guide*™ Reporter

MyPest*Guide*™ Reporter is a free surveillance data capture and reporting app developed and operated by the WA Department of Primary Industries and Regional Development (DPIRD) primarily for use by the broader community and industry.

Using MyPest*Guide*™ Reporter, users send images of plant pests or symptoms directly to government diagnostic services for identification and receive a response back through the app.

To improve Australia's ability to collect general surveillance data and encourage reporting of new pests, requirements for national implementation of the MyPest*Guide*™ Reporter app are being investigated.

The Pest and Disease Image Library

The Pest and Disease Image Library (PaDIL) is a repository of high-quality images displaying the key diagnostic features of each pest and disease specimen and facilitates simple image comparison between features of similar species to assist with specimen triaging and taxonomic identification.

PaDIL contains detailed records of invertebrates, bacteria, fungi, viruses, viroids and phytoplasmas that threaten field crops, pasture, forestry, horticulture, marine, human health and animals. The resources within PaDIL assist government and industry to make decisions intended to protect Australia's economy, environment, human health and amenity from invasive threats. PaDIL is hosted and managed by PHA and jointly owned and governed by the DAWE, PHA, Museums Victoria and WA DPIRD.

The Australian Plant Pest Database

The Australian Plant Pest Database (APPD) is a key reference system for plant pests. The APPD contains information on validated specimen records of plant pests and diseases of significance to agriculture (including pastures), forestry or the environment.

Currently the APPD draws information from 18 databases throughout Australia. The database is interrogated during every plant pest incursion in Australia to assist with pest status information.

The Biosecurity Portal

The Biosecurity Portal is hosted by PHA, bringing together a suite of online biosecurity information that can be found at **biosecurityportal.org.au**. At the end of December 2020, there were 21 active Biosecurity Portal SharePoint sites, with another two new sites under construction.

Sites on the Biosecurity Portal fall into four categories:

- tools and databases, such as the Australian Plant Pest Database
- knowledge bases and data libraries, such as the Fruit Fly Body of Knowledge
- shared spaces for committees and working groups, such as the National Fruit Fly Strategy Advisory Committee
- awareness and information resources.

Other resources

Databases of agreed import policies (BICON) and export conditions (MICoR) are maintained by the DAWE, as described in Chapter 4.

PHA also has the Pest Information Document Database on its website. This database holds factsheets, contingency plans, diagnostic protocols and other information specific to Australia's high priority exotic pests to support stakeholders in the biosecurity system.

Moth borer, Chilo terenellus, larva in sugarcane, PNG. Image courtesy of Sugar Research Australia

Image courtesy of Tamara Hepburn - Australian Macadamia Society