Chapter 5

Plant pest surveillance and diagnostics

Post border biosecurity – plant pest surveillance and diagnostics

Since pests can enter the country despite all the precautions in place, Australia has established a unique and highly effective post-border biosecurity system to provide additional protection against exotic pests. Plant pest surveillance and diagnostics are critical components of the system.

Surveillance is a system of checking and recording the presence or absence of plant pests, while diagnostics is used to precisely identify a plant pest, including species that are not known to be present in Australia.

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:

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

Diagnostic services, which rely on scientific expertise, are primarily provided by governments, universities and research organisations, coordinated via a national network.

Definitive identification of pest species, types and strains is done:

- to allow appropriate response to an incursion
- to support pest management
- to provide evidence for 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 is very important during 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

Recognising both the importance of plant health surveillance and the challenges of maintaining an effective plant health surveillance system, the National Plant Biosecurity Surveillance Strategy 2013–20 was developed under the National Plant Biosecurity Strategy to guide national efforts to improve and reform surveillance arrangements. The development of a new ten-year strategy, and an implementation plan for its delivery, commenced in 2019, and will provide a foundation for continued reform and improvement.

National Plant Biosecurity Surveillance System framework

Under the National Plant Biosecurity Surveillance System framework developed in 2017, the Department of Agriculture works in partnership with peak industry bodies, state and territory governments, PHA, community and environmental stakeholders 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 (see Figure 90 on page 152).

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 CSIRO.

In 2019 the key roles of the subcommittee were:

- developing the Reference Standard for National Surveillance Protocols for Plant Pests, including a process for review of National Surveillance Protocols as they are developed
- stablishing the Plant Surveillance Network Australasia-Pacific 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
- reviewing the collection and use of information from general surveillance programs to provide evidence of pest status
- enhancing the collaboration, coordination, efficiency and effectiveness of surveillance efforts nationally.

Plant Health Surveillance Consultative Committee

The Plant Health Surveillance Consultative Committee, established in 2016, helps to guide investment in the national plant biosecurity surveillance system, including projects funded through the Agricultural Competitiveness White Paper. The committee includes members from the Department of Agriculture, Plant Health Committee, Grains Research and Development Corporation, Centre of Excellence for Biosecurity Risk Analysis, Hort Innovation, AUSVEG, Summerfruit Australia, Growcom, National Resource Management Regions Australia and PHA.

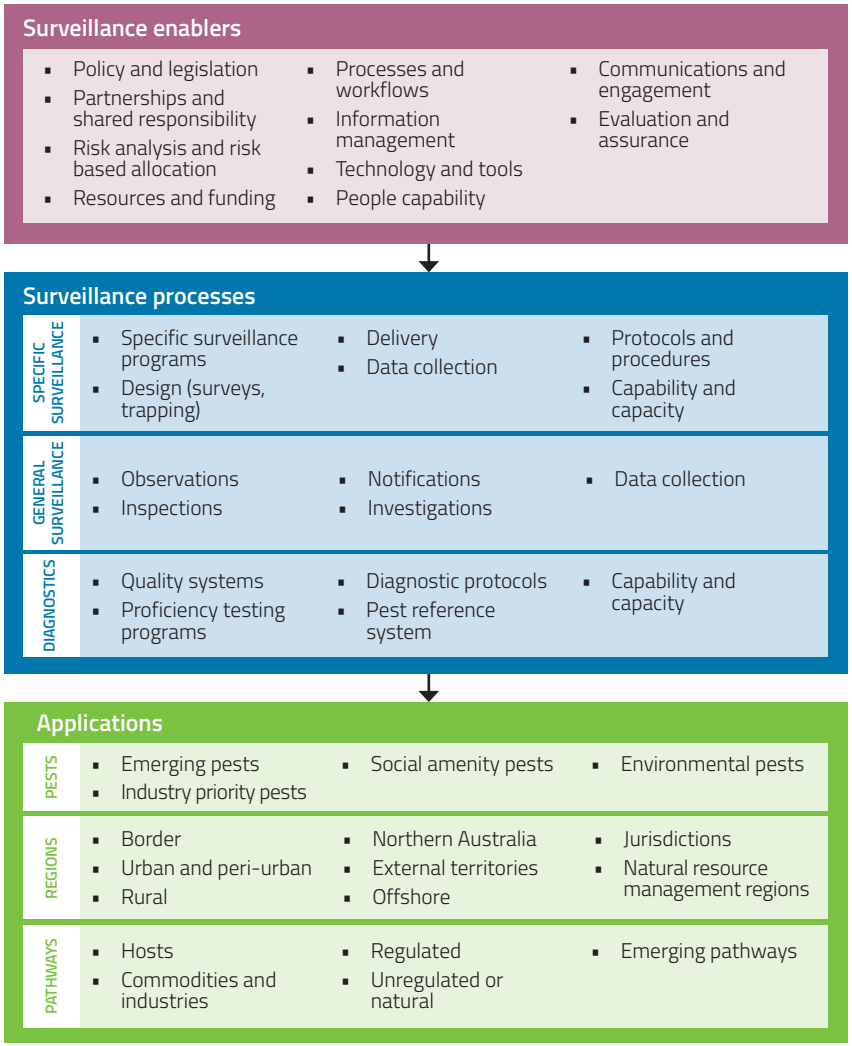
Annual Surveillance Workshop 2019

More than 60 people working in pest surveillance attended the Annual Surveillance Workshop on 13–14 March in Brisbane, becoming part of the newly established Plant Surveillance Network Australasia–Pacific. Attendees came from several plant industries, the Australian Government, state governments, research agencies and New Zealand.

Topics included industry led surveillance, general surveillance, plant pest interception information and pathways for pest movement. These annual workshops are an important way for a wide range of stakeholders to meet, share knowledge and learn about new initiatives in surveillance.

Attendees at the 2019 Annual Surveillance Workshop.

Figure 90. National Plant Biosecurity Surveillance System framework



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

GOVERNMENT SURVEILLANCE PROGRAMS

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

The most extensive programs for targeted 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 146), the Northern Australia Quarantine Strategy (see page 146) and surveillance programs for fruit flies (see page 158). 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 206).

These and other surveillance activities across Australia (as shown in Table 51 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 the Australian Government Department of Agriculture 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, 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 Asian gypsy moth, 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 any 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 also provides a critical source of the 'evidence of absence' data needed to support trade and market access for Australian producers.

Citrus surveillance and pest triage workshop

A citrus surveillance and pest workshop in Mildura in September built the skills of 50 industry and government personnel in triaging priority pests and diseases in the field to reduce the number of samples needing to be sent to diagnostic laboratories. The workshop also covered collection and packaging of samples for transport to diagnostic laboratories.

Attendees from all Australian states and territories, the citrus industry and the New Zealand Ministry for Primary Industries took part in the workshop run by Plant Health Australia. It was supported with funding from the Australian Government Department of Agriculture and in-kind support from Citrus Australia, Agriculture Victoria and NSW Department of Primary Industries.

Participants put their training into practice and conducted surveillance for pests and diseases in two orchards. They were also given a demonstration of the loop mediated isothermal amplification (LAMP) diagnostic technique and visited a fruit packing shed in Mildura.

The workshop helped to share knowledge and information between industry and government personnel on techniques to improve surveillance for citrus pests and sample collection for pest identification. It also increased understanding of the importance of surveillance for early detection and determining pest status.

Surveillance officers taking part in the citrus surveillance and pest triage workshop. Image courtesy of Plant Health Australia.

Forest pest surveillance in NSW

Forest biosecurity surveillance programs for the early detection of exotic forest pests that threaten native forests, plantations and amenity trees in NSW, Victoria and Queensland are now underway.

NSW Department of Primary Industries Forestry, for example, conducts surveillance at high-risk sites around major ports, such as Port Botany and Port Kembla, that have been determined to be likely entry points for exotic pests. Host trees of target pests are visually assessed for damage, and traps with pest-specific lures are installed from October to March to capture pest insects.

The pests targeted include those of *Pinus* species, but also of hardwood species such as eucalypts that can impact on amenity trees and native forests. Surveillance is designed to increase the chance of detecting pests soon after they arrive and before they spread too far, increasing the chance of eradication (if necessary).

Biosecurity surveillance for exotic forest pests and diseases at Port Botany, showing location of hosts surveyed and insect traps monitored (left), and an insect trap hanging in a tree (right).
Image courtesy of NSW DPI Forestry

INDUSTRY SURVEILLANCE STRATEGIES AND PROGRAMS

Examples of industry surveillance programs (as shown in Table 51 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 (see page 207) and forest industries (see below), for which specific national strategies were released in 2018, are being established.

National Forest Biosecurity Program

Activities to initiate a National Forest Biosecurity Program continued in 2019 with the National Forest Biosecurity Coordinator overseeing 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 a pilot of high-risk site surveillance in Queensland, NSW and Victoria 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, environmental groups and other stakeholders.

In 2019 the coordinator role was co-funded by the Department of Agriculture (through the Agricultural Competitiveness White Paper) and the Australian Forest Products Association (see page 84).

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 warning system to detect new incursions of a wide range of pests and diseases of honey bees. It also provides technical, evidence-based information to support pest free status for export negotiations and assists exporters meet export certification requirements.

The program uses a variety of activities to detect 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.

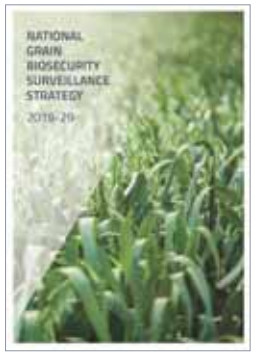
From 1 January to 30 November 2019, 176 sentinel hives of European honey bees were located at 32 sea and airports, an increase from 138 in the previous year. These strategically placed sentinel hives are inspected for bee pests including Varroa mite, bee viruses, Tropilaelaps mites, large African hive beetle, small hive beetle and braula fly.

Floral sweep netting is also carried out near ports for the early detection of exotic pest bees including red dwarf honey bee (*Apis florea*), the giant honey bee (*A. dorsata*), exotic and established strains of Asian honey bee (*A. cerana*) and bumble bees (*Bombus terrestris*). European honey bees collected by sweep netting are also inspected for exotic pests.

With catchboxes also deployed at many ports, there were 1,345 inspections for the presence of European honey bee (EHB, *Apis mellifera*) or Asian honey bee (AHB, *Apis cerana*) in 2019. EHB swarms were captured on five occasions, and despite these catchboxes not being particularly suitable for AHB, this species was captured twice. There were 19 other swarm captures at Australian ports.

Development of new surveillance strategies

The following surveillance strategies funded by the Department of Agriculture's Agricultural Competitiveness White Paper began or were developed in 2019 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 Temperate Fruit Biosecurity Surveillance Strategy** – was developed in consultation with plant industries and most state governments. It covers a diverse range of crops including pome fruit (apples and pears), grapes (table, wine and dried), cherries, stone fruit (apricots, nectarines, peaches and plums), berries (strawberries, blueberries, blackberries and raspberries) and almonds.
- **National Tropical Plant Industries Biosecurity Surveillance Strategy** – was developed following extensive consultation with plant industries and governments. 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** – was 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.

Sentinel hives of European honey bees are located at sea and airports and are routinely inspected for bee pests. Image courtesy of Jenny Shanks

Biosecurity Pathways and Surveillance Strategy workshop

For surveillance to be effective and efficient there must be a strong understanding of which pests should be targeted for surveillance, and the pathways along which they are likely to be found. Industry and government representatives met in Brisbane for a Biosecurity Pathways and Surveillance Strategy workshop on 2–3 April.

Participants gained a greater understanding of the biosecurity risks posed by the range of routes via which pests can get into and travel through northern Australia.

The surveillance activities that are already occurring within many plant production industries were discussed, and how the information gained can be better used to minimise the risk of exotic pests and pathogens becoming established in Australia. The workshop also focused on the establishment of a collaborative surveillance strategy for northern plant-based industries.

Mango production in Bowen, Queensland. Image courtesy of Trevor Dunmall

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 need to undertake routine crop monitoring 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 all encourage the reporting of unusual pest or diseases symptoms.

IF YOU SEE ANYTHING UNUSUAL, CALL THE EXOTIC PLANT PEST HOTLINE

1800 084 881

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

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

International Plant Sentinel Network

The International Plant Sentinel Network is a Euphresco initiative that acts as an early warning system to recognise new and emerging pest and pathogen risks. It does this through a network of national and international partnerships between plant protection scientists, botanic gardens and arboreta.

The Australian National Botanic Gardens (Canberra), National Arboretum Canberra, Royal Botanic Garden Sydney, Royal Botanic Gardens Victoria, and Royal Tasmanian Botanical Gardens were the Australian members of the International Plant Sentinel Network in 2019. For more information go to **plantsentinel.org**

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

Australian plants in botanic gardens and arboreta overseas can act as sentinels and 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.

In 2019 a surveillance network of staff and volunteers in botanic gardens and arboreta was established to raise awareness of biosecurity and to undertake surveillance for key pests.

The Royal Botanic Gardens Melbourne is part of the International Plant Sentinel Network.

Botanic Gardens Biosecurity Network

A new hub of biosecurity information for botanic gardens was launched in November 2019 to build biosecurity knowledge and capacity to protect botanic gardens from plant pests and diseases.

Botanic gardens are the most visited destinations by overseas tourists in Australia, with a high likelihood that exotic pests and diseases will establish there.

The Botanic Gardens Biosecurity Network is a community of practice bringing together botanic gardens staff, friends, volunteers and biosecurity experts. The aim is to empower people in the botanic gardens to spread knowledge about biosecurity through communications and hands-on surveillance activities.

The network will publish practical information and advice for staff of botanic gardens, community interest groups and members of the public to develop their knowledge and skills. This information will enable people to look out for and protect their botanic and home gardens from exotic plant pests and diseases.

Visit the website **extensionaus.com.au/botanicgardensbiosecurity**

Members of the Friends of the Royal Botanic Gardens Melbourne learning about surveillance for plants pests in November 2019.

PLANT PEST SURVEILLANCE PROGRAMS IN 2019

During 2019, there were 112 plant pest surveillance programs undertaken, which are detailed by jurisdiction in Table 51.

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

Figure 91. Surveillance programs by target host

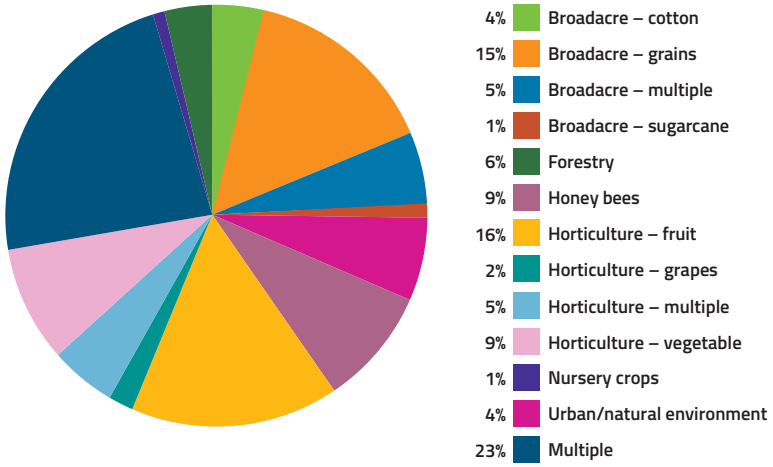


Figure 92. Surveillance programs by target pest type

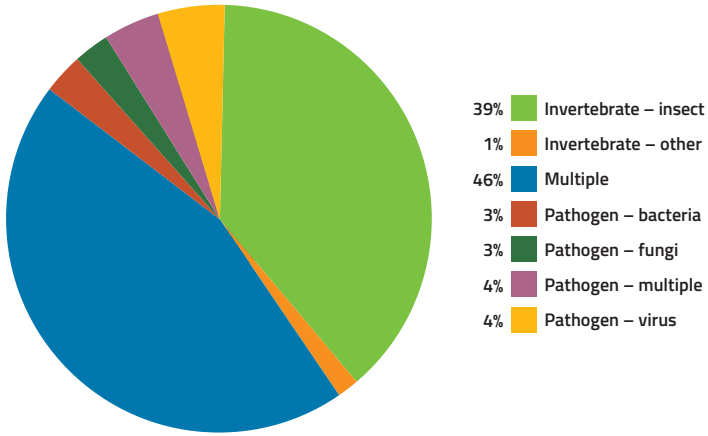


Table 51. Australia's plant biosecurity surveillance programs

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 targeted
International Plant Health Surveillance Program	Multiple surveillance programs of tropical horticultural, environmental and agricultural species	High priority exotic pests	General and targeted
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, Vespa velutina* and new exotic swarms of *A. mellifera*	General (noting other stakeholders conduct the targeted surveillance required under this program)
National Border Surveillance Program	Mutiple surveillance programs focusing on regulatory import pathway risks	High priority exotic pests	General and targeted
National Plant Health Surveillance Program (delivered through states and territories)	Various	High priority exotic pests	General and targeted
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*	Targeted
Northern Australia Quarantine Strategy – fall armyworm	Wild and cultivated gramineous hosts	Fall armyworm (*Spodoptera frugiperda*)	General and targeted
Northern Australia Quarantine Strategy – pest and disease surveys	Multiple surveillance programs of tropical horticultural, environmental and agricultural species	123 high priority exotic pests, diseases and weeds	General and targeted

Table 51. 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	Targeted
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	Targeted
CGMMV Pest Free Place of Production	Cucurbits	Cucumber green mottle mosaic virus	Targeted
Citrus budwood mother tree inspections	Multiple citrus hosts	Various graft transmissable diseases and other high priority pests	Targeted
Citrus canker	Multiple citrus hosts	Citrus canker, *Xanthamonas citri* subsp *citri*	Targeted
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*)	Targeted
Exotic fruit flies – Riverina	Various horticultural crops (citrus, stone fruit)	Mediterranean fruit fly (*Ceratitis capitata*), other tri lure responsive exotic fruit flies	Targeted
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*)	Targeted
Forestry Corporation of NSW Forest Health Surveillance	General forests	Various exotic and endemic high priority pests	Targeted
Forest High-Risk Surveillance Program	Multiple	Various exotic and endemic high priority pests of *Pinus* spp.	Targeted
Grains Farm Biosecurity Program	In-crop and stored grains	Barley stripe rust (*Puccinia striiformis* f. sp. *hordei*), Karnal bunt (*Tilletia indica*), hessian fly (*Mayetiola destructor*), barley stem gall midge (*Mayetiola hordei*)	General
Greater Sydney Local Land Services Periurban Surveillance Program	Multiple plant hosts in periurban landscape, including community gardens	Various, including tomato potato psyllid (*Bactericera cockerelli*), brown marmorated stink bug (*Halyomorpha halys*), Asian citrus psyllid (*Diaphorina citri*), African citrus psyllid (*Trioza erytreae*) and glassy winged sharpshooter (*Homalodisca vitripennis*)	Targeted
Khapra beetle	Stored grain (bulk handlers and farm), grain processing facilities, dry goods manufacturers	*Trogoderma granarium*	Targeted
National Bee Pest Surveillance Program	European honey bee	*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, Vespa velutina* and new exotic swarms of *A. mellifera*	Targeted

Table 51. Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within New South Wales (continued)			
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*)	Targeted
National tomato potato psyllid and zebra chip surveillance	Solanaceous hosts	Tomato potato psyllid (*Bactericera cockerelli*)	Targeted
Onion diseases – Riverina	Onions, garlic	White rot (*Sclerotium cepivorum*), onion smut (*Urocystis cepulae*), onion rust (*Puccinia allii*)	Targeted
Within the Northern Territory			
Area Freedom Surveillance Program	Horticultural crops	Queensland fruit fly (*Bactrocera tryoni*)	Targeted
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	European honey bee	*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, Vespa velutina* and new exotic swarms of *A. mellifera*	Targeted
National Plant Health Surveillance Program – multi pest surveillance	Multiple	Multiple including citrus canker (*Xanthomonas axonopodis* pv. *citri*), huanglongbing (*Candidatus* Liberibacter spp.), Asian 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.)	Targeted
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.)	Targeted

Table 51. Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within Queensland			
Area freedom surveys	Multiple	A range of pests including papaya ringspot virus and banana bunchy top virus	Targeted
Area wide management of vegetable diseases	Multiple vegetable hosts	Multiple viruses and bacterial pests	General and targeted
Banana pest surveillance	Banana	A range of banana 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 Verticillium wilt (*Verticillium dahliae*), exotic strains Fusarium wilt (*Fusarium oxysporum* f. sp. *vasinfectum*) and all other exotic viruses. Endemic cotton diseases, including *Fusarium* spp. and *Verticillium* spp.	Targeted
Endemic and exotic grains virus surveys	Grains and cotton	Various viruses, especially aphid transmitted Polerovirus complex	Targeted
Exotic Fruit Fly in the Torres Strait Program	Multiple	Exotic fruit fly including *Bactrocera* and *Zeugodacus* spp.	Targeted
Forest High-Risk Surveillance Program	Multiple	Various exotic and endemic high priority pests of *Pinus* spp.	Targeted
General forest pest surveillance	Multiple	General forest pests	General
Grain bulk handling companies	Stored grains	Endemic and exotic stored grain pests	General
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	European honey bee	*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*	Targeted
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*)	Targeted
National Plant Health Surveillance Program – multi pest surveillance	Multiple	Multiple, including sugarcane longhorn beetle (*Dorysthenes buqueti*), Asian and citrus longhorn beetle (*Anoplophora* spp.), lychee longicorn beetle (*Aristobia testudo*), lateral-banded mango longhorn beetle (*Batocera rubus*), sawyer beetles (*Monochamus* spp.), drywood longicorn beetle (*Stromatium barbatum*), ambrosia beetles, bark beetles (*Ips* spp.), pine beetles, bark beetles (*Dendroctonus* spp.), wood wasps (Siricid wasps e.g. *Uroceris gigas*), exotic fruit flies (*Bactrocera, Zeugodacus* and *Ceratitis* spp.), gypsy moths (*Lymantria* spp.), Pierce's disease (*Xylella fastidiosa*), glassy winged sharpshooter (*Homalodisca vitripennis*)	Targeted
Panama TR4 Program	Banana	Panama disease (*Fusarium oxysporum* f. sp. *cubense*)	Targeted
Plant Pest Diagnostic Service – broadacre cropping	Broadacre field crops	All pathogens that can affect broadacre crops (cotton, grains, pastures)	General

Table 51. Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within Queensland (continued)			
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)	Targeted
Sucking pest management in cotton	Cotton	Solenopsis mealybug (*Phenacoccus solenopsis*)	Targeted
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 targeted
Surveys and associated diagnostics of the incidence and severity of diseases of cereal and pulses within the Northern Region	Cereals and pulses	Various pests and diseases of cereals and pulses in the Northern Region	General and targeted
Tomato potato psyllid	Solanaceae	Tomato potato psyllid (*Bactericera cockerelli*)	Targeted
West Indian drywood termite surveys	Timber structures	West Indian drywood termite (*Cryptotermes brevis*)	Targeted
Within South Australia			
Area freedom surveys	Multiple	Multiple pests	General and targeted
Bee surveillance – endemic disease	European honey bees	American foulbrood (*Paenibacillus* spp.)	General and targeted
Brown marmorated stink bug	Multiple	Brown marmorated stink bug (*Halyomorpha halys*)	General and targeted
Conifer auger beetle	Conifers	Conifer auger beetle (*Sinoxylon conigerum*)	General and targeted
Exotic longhorn beetle trapping	Rutaceae	Citrus longicorn beetle (*Anoplophora chinensis*)	General and targeted
Giant pine scale	Pinaceae	Giant pine scale (*Marchalina hellenica*)	General and targeted
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 targeted
Grape phylloxera	*Vitus vinifera*	Grapevine phylloxera (*Daktulosphaira vitifoliae*)	General and targeted
Grape vine pinot gris virus	Grape vines	Grape vine pinot gris virus (Trichovirus)	General and targeted
Mediterranean fruit fly	Horticultural crops	Mediterranean fruit fly (*Ceratitis capitata*)	General and targeted
Monochamus Program	*Pinus* spp.	Japanese pine sawyer beetle (*Monochamus alternatus*), pine wilt nematode	General and targeted
National Bee Pest Surveillance Program	European honey bee	*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, Vespa velutina* and new exotic swarms of *A. mellifera*	General and targeted
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*), Khapra beetle (*Trogoderma granarium*), Karnal bunt (*Tilletia indica*), glassy winged sharpshooters (*Homalodisca vitripennis* and *H. coagulata*)	General and targeted
Ports of Entry Trapping Program	*Eucalyptus* spp., ornamental trees	Exotic gypsy moths (*Lymantria* spp.)	General and targeted

Table 51. Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within South Australia (continued)			
Ports of Entry Trapping Program	Various fruit fly hosts	*Multiple – Bactrocera albistrigata, B. carambolae, B. dorsalis, B. facialis, B. kirki, B. melanotus, B. psidii, B. tau, B. trivialis, B. umbrosa, B. xanthodes, B. zonata, Ceratitis capitata, Zeugodacus cucurbitae*	General and targeted
Potato spindle tuber viroid	Solanaceae	Potato spindle tuber viroid	General and targeted
Queensland fruit fly	Horticultural crops	Queensland fruit fly (*Bactrocera tryoni*)	General and targeted
Tomato potato psyllid	Solanaceae	Tomato potato psyllid (*Bactericera cockerelli)*	General and targeted
Tomato yellow curl leaf virus	Solanaceae	Tomato yellow curl leaf virus	General and targeted
Trogoderma glabrum	Multiple	*Trogoderma glabrum*	General and targeted
Within Tasmania			
Bee surveillance – American foulbrood	European honey bees	American foulbrood (*Paenibacillus* spp.)	General
Blueberry rust surveillance	Commercial blueberry crops and wholesale nurseries	Blueberry rust (*Thekopsora minima*)	Targeted
Codling moth trapping surveillance	Apples, cherries	Codling moth (*Cydia pomonella*)	Targeted
Devonport (Stoney Rise) light trapping	Multiple	Numerous flying pests and beneficials	General
Fruit fly trapping surveillance	Host fruit trees, fruit and vegetables	*Bactrocera dorsalis, B. tryoni, Ceratitis capitata* and exotic fruit flies	Targeted
National Bee Pest Surveillance Program	European honey bee	*Varroa destructor, V. jacobsoni, Tropilaelaps clareae, T. mercedesae, Acarapis woodi, Oplostoma fuligineus, Aethina tumida,* acute bee paralysis virus, deformed wing virus, slow paralysis virus, *Apis cerana, A. dorsata, A. florea, Bombus terrestris, Vespa velutina* and new exotic swarms of *A. mellifera*	Targeted
National Plant Health Surveillance Program – multi pest surveillance	Multiple	Brown marmorated stink bug (*Halyomorpha halys*), citrus canker (*Xanthomonas citri* subsp. *citri*), *Liriomyza bryoniae, L. cicerina, L. huidobrensis, L. sativae, L. trifolii,* gypsy moth, 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, Diaporia citri, Trioza erytreae, Bactericera trigonica, Trioza apicallis,* Khapra beetle (*Trogoderma granarium*), Pierce's disease (*Xylella fastidiosa*), glassy winged sharpshooter (*Homalodisca vitripennis*)	Targeted
Silverleaf white fly surveillance	Nursery stock	Silver leaf white fly (*Bemisia tabaci*)	Targeted
Tomato potato psyllid	Commercial potato and tomato crops, community gardens, urban pathways	Tomato potato psyllid (*Bactericera cockerelli*)	Targeted
Warehouse beetle trapping surveillance	Stored grains, grain processors and animal feed outlets	Warehouse beetle (*Trogoderma variable*)	Targeted

Table 51.Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within Victoria			
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*)	Targeted
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
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)*	Targeted
National Bee Pest Surveillance Program	European honey bee	*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, Vespa velutina* and new exotic swarms of *A. mellifera*	Targeted
National Plant Health Surveillance Program – multi pest surveillance	Multiple	Multiple including citrus canker (*Xanthomonas axonopodis* pv. *citri*), fruit flies (*Bactrocera* spp., *Ceratitis capitata*), Pierce's disease (*Xylella fastidiosa*), glassy winged sharpshooter (*Homalodisca vitripennis*), plum pox virus, Japanese sawyer beetle (*Monocamus alternatus*), wood wasp (*Urocerus fantoma*), black spruce longhorn beetle (*Tetropium castaneum*), brown spruce longhorn beetle (*Tetropium fuscum*), Asian gypsy moth *(Lymantria dispar* and other *Lymantria* spp.), pine wilt nematode (*Bursaphelenchus* spp.), brown marmorated stink bug (*Halyomorpha halys*), exotic fruit flies, various *Bactrocera* and *Ceratitis* spp.	Targeted
Victorian funded containment program	Pasture and fruit trees	Green snail (*Cantareus apertus*)	Targeted
Within Western Australia			
Agrisearch	Grain crops	Grain pests	General
AgWest grain testing laboratory	Grain crops	Grain pests	General
Biosecurity Blitz	All hosts	All plant pests	General
Brown marmorated stink bug	All hosts, urban areas	Brown marmorated stink bug (*Halyomorpha halys*)	General and targeted
Browsing ant surveillance	Environmental, urban areas	Browsing ant (*Lepisiota frauenfeldi*)	General
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*)	Targeted

Table 51.Australia's plant biosecurity surveillance programs (continued)

Surveillance program name	Target hosts	Target pests	Type of surveillance*
Within Western Australia (continued)			
European wasp surveillance	Urban areas and horticultural crops	European wasp (*Vespula germanica*)	General and targeted
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 targeted
Medfly Area Freedom (Ord River Irrigation Area)	Many horticultural hosts	Mediterranean fruit fly (*Ceratitis capitata*)	Targeted
MyCrop e-surveillance	Broadacre crops, general surveillance	All plant pests	General and targeted
MyPestGuide e-surveillance	All hosts, general surveillance	All plant pests	General and targeted
National Bee Pest Surveillance Program	European honey bee	*Varroa destructor, V. jacobsoni, Tropilaelaps clareae, T. mercedesae, Acarapis woodi, Oplostoma fuligineus, Braula coeca, Aethina tumida,* acute bee paralysis virus, deformed wing virus (two strains), slow paralysis virus (two strains), *Apis cerana, A. dorsata, A. florea, Bombus terrestris, Vespa velutin* and new exotic swarms of *A. mellifera*	Targeted
National grain insect resistance monitoring program	Grain crops	Grain pests	Targeted
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 (*Xylella fastidiosa*), brown marmorated stink bug (*Halyomorpha halys*)	Targeted
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
Port of Entry – Asian gypsy moth trapping	More than 600 forest, orchard, ornamental and native species	Asian gypsy moth (*Lymantria dispar*)	Targeted
Port of Entry – fruit fly trapping	Horticultural hosts	Various *Bactrocera* and *Ceratitis* spp.	Targeted
Queensland fruit fly surveillance	Many horticultural hosts	Queensland fruit fly (*Bactrocera tryoni*)	Targeted
Sentinel stored products merchants	Stored grain products	Khapra beetle (*Trogoderma granarium*)	General and targeted

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

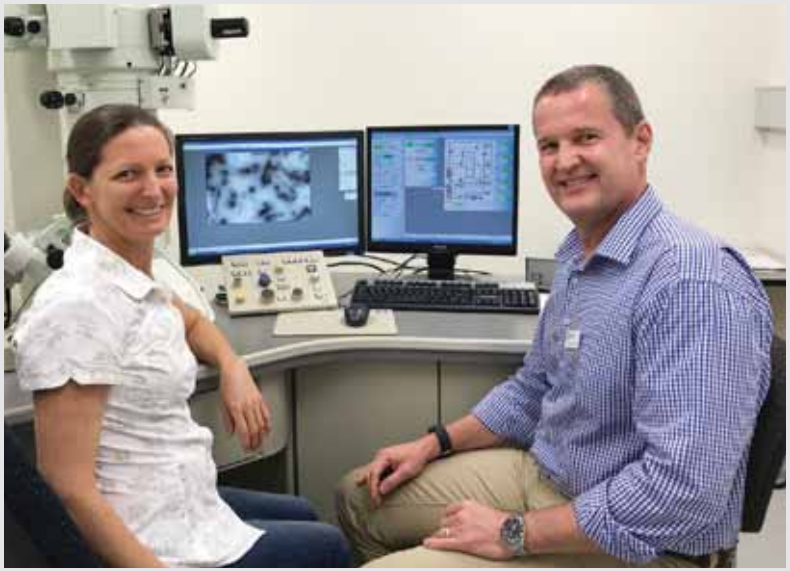
** General surveillance is a range of crop monitoring and awareness activities outside of specific surveys that can be used to detect the presence or absence of pests, including the presence of new or unusual pests or symptoms. Targeted surveillance is where checks or surveys are made for particular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

Building skills through the Diagnostic Residential Program

In 2019 ten members of the National Plant Biosecurity Diagnostic Network from various states and universities took part in the Diagnostic Residential Program. This takes the total number of people who have benefited from the program since its inception to 55.

Plant biosecurity diagnosticians spend 5–14 days in a laboratory or workplace in Australia or overseas that is conducting relevant activities. Residential placements provide opportunities for diagnosticians to share ideas and practices, and to gain essential skills and knowledge relevant to their role and the diagnostic network.

In February 2019 Stefan Harasymow of the WA Department of Industries and Regional Development travelled to the Queensland Department of Agriculture and Fisheries in Brisbane to work with Senior Plant Pathologist Dr Kathy Crew to improve his skills in transmission electron microscopy of plant viruses.



Dr Kathy Crew, Senior Plant Pathologist with Queensland Department of Agriculture and Fisheries (L) with Stefan Harasymow, Laboratory Scientist with Department of Primary Industries and Regional Development WA (R). Image courtesy of Ms Sari Nurulita.

Diagnostics – identifying plant pests and diseases

Accurate diagnosis of plant pests and diseases underpins all aspects of the plant biosecurity system. It is essential that diagnostic services can quickly and accurately identify both established and exotic 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.

The cause of poor plant health can 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.

In the event of a new pest incursion, diagnostic expertise is critical to identify the initial sample, to help determine how widespread the pest is and the appropriate response to it, and eventually to provide the evidence necessary to claim the pest has been eradicated.

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.

OVERSIGHT OF NATIONAL PLANT BIOSECURITY DIAGNOSTICS

National Plant Biosecurity Diagnostic Strategy

The National Plant Biosecurity Diagnostic Strategy, developed in 2012, contains four recommendations to ensure that the diagnostic system meets Australia's needs. They are to:

- develop a nationally integrated plant biosecurity diagnostic network that underpins Australia's plant biosecurity system
- implement and maintain appropriate quality management systems in diagnostic laboratories
- develop and maintain diagnostic capability and capacity for all High Priority Pests
- establish a national plant biosecurity information management framework to optimise data sharing.

Review of this strategy commenced in 2019 in conjunction with review of the National Plant Biosecurity Surveillance Strategy and, once finalised, will guide the improvement and coordination of plant biosecurity diagnostics in Australia.

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.

The implementation of the National Plant Biosecurity Diagnostics Strategy 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
- coordinating national capability building 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.

Network members comprise experts from across the diagnostic system, from entomologists and plant pathologists, through to response program managers and policy makers. They 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 coordinator who was appointed in 2019. 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 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 2019

The Annual Diagnosticians' Workshop held in Sydney in March 2019 attracted more than 60 participants keen to network and share their experiences and knowledge.

Participants heard about the challenges faced by diagnostic laboratories during emergency responses, tricks and tips for the development of lucid identification keys, insights into specific diagnostic activities and some key diagnostic capability challenges in the biosecurity system.

They were also introduced to a new major diagnostic research project for *Xylella fastidiosa* and feedback from an international Xylella workshop.

Participants in the Annual Diagnosticians' Workshop, Sydney, March 2019

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 and identification. New protocols include diagnostic information relevant to surveillance activities and the high throughput of samples.

The protocols are used in:

- 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
- emergency responses to exotic plant pests.

SPHD is responsible for endorsing the protocols, setting them as the agreed procedures for use in the event of an incursion. The use of endorsed NDPs provides confidence in diagnostic outcomes and consistency across the laboratories of the NPBDN.

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 5.1)
- 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 should be used in preference to NDPs, 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

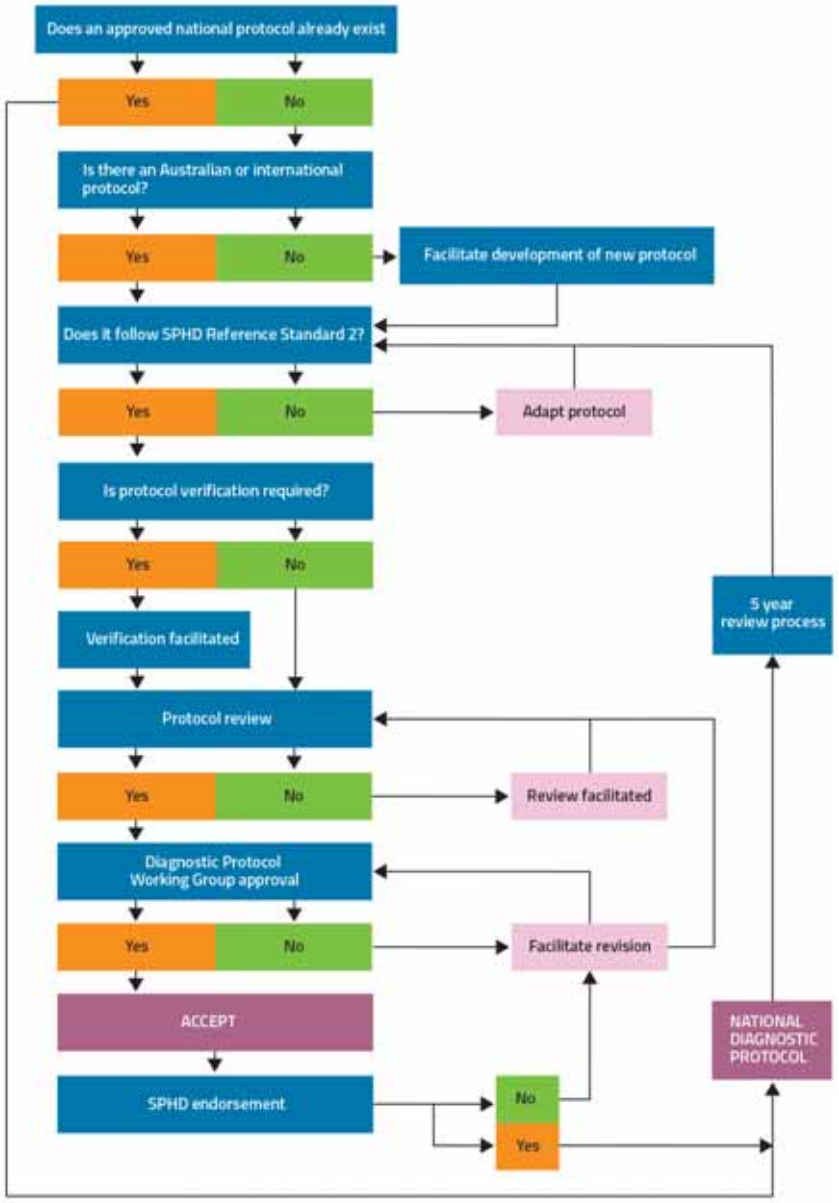


Table 52. National Diagnostic Protocols

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
Guignardia bidwellii	Black rot	13
Homalodisca vitripennis	Glassy winged sharpshooter	23
Leptinotarsa decemlineata	Colorado potato beetle	22
Liriomyza trifolii	American serpentine leafminer	27
Monilinia fructigena	Apple brown rot	1
Neonectria ditissima	European canker	21
Ophiostoma ulmi	Dutch elm disease	37
Phakopsora euvitis	Grapevine leaf rust	29
Phytophthora ramorum	Sudden oak death	5
Phytoptus avellanae	Hazelnut big bud mite	39
Plenodomus tracheiphilus	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	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	
Aphidoidea	Exotic aphid group	
Banana bract mosaic virus (Potyvirus)	Banana bract mosaic virus	
Broad bean mottle virus (Bromovirus)	Broad bean mottle virus	
Broad bean stain virus (Comovirus)	Broad bean stain virus	
Broad bean true mosaic virus (Comovirus)	Broad bean true mosaic virus	
Burkholderia glumae	Panicle bight	
Bursaphelenchus xylophilus	Pine wilt nematode	
Bymovirus group	Soil-borne Gramineae virus	
Candidatus Phytoplasma solani	Bois noir	
Ceratovacuna lanigera	Sugarcane woolly aphid	
Chilo spp., including *C. auricilius, C. infuscatellus, C. partellus, C. polychrysus, C. sacchariphagus* and *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	

** National Diagnostic Protocol reference number*

Table 52. National Diagnostic Protocols (continued)

Scientific name	Common name
Draft protocols (continued)	
Clavibacter michiganensis subsp. *nebraskensis*	Goss's bacterial wilt and blight of corn
Colletotrichum truncatum (lentil strain)	Lentil anthracnose
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
Daktulosphaira vitifoli	Grape phylloxera
Deanolis sublimbalis	Red banded mango caterpillar
Dendroctonus ponderosae	Mountain pine beetle
Diaphorina citri	Asian citrus psyllid
Drosophila suzuki	Spotted wing drosophila
Dysaphis plantaginea	Rosy apple aphid
Erionata thrax	Banana skipper butterfly
Erwinia amylovera	Fire blight
Furovirus group	Soil-borne Gramineae virus
Fusarium circinatum	Pine pitch canker
Fusarium oxysporum f. sp. *cubense*	Panama disease
Giberella fujikuroi	Bakanae
Globodera pallida and *G. rostochiensis*	Potato cyst nematode
Grapevine flavescence doree phytoplasma	Flavescence doree
Hordieivirus group	Virus of *Gramineae*
Hyalensthes obsoletus	Cixiidae plant hopper
Liriomyza huidobrensis	Pea leafminer
Lissorhoptrus oryzophilus	Rice water weevil
Lobesia botrana	European grapevine moth
Lymantria dispar	Asian gypsy moth, gypsy moth complex
Maize dwarf virus (Potyvirus)	Maize dwarf virus
Mayetiola destructor	Hessian fly
Orthaga euadrusalis	Mango web weaver
Pantoea stewartii	Stewart's wilt of maize
Pea early browning virus (Tobravirus)	Pea early browning virus
Pea enation mosaic virus (Enamovirus)	Pea enation mosaic virus
Pecluvirus group	Soil-borne peanut virus
Pepino mosaic virus (Potexvirus)	Pepino mosaic virus
Peronosclerospora sacchari	Sugarcane downy mildew
Phymatotrichum omnivorum	Texas root rot
Phytophthora infestans A2	Late blight
Planococcus ficus	Vine mealybug
Pomacea canaliculata	Golden apple snail
Potyvirus (general)	Potyvirus
Pseudocercospora spp.	Black Sigatoka, yellow Sigatoka, eumusae
Pseudococcus maritimus	Grape mealybug
Pseudomonas papulans	Blister spot of apple
Pseudopezicula tetraspora	Angular leaf scorch grape
Puccinia psidii (exotic strains)	Guava (Eucalyptus) rust
Raffaelea lauricola	Laurel wilt and vector beetle
Ralstonia solanacearum (phylotype IIB)	Moko, bugtok
Ralstonia syzgii subsp. *celebesensis* (syn. *R. solanacearum* race 2, biovar 1)	Blood disease
Ramu stunt (Tenuivirus)	Ramu stunt
Red clover vein mosaic virus (Carlavirus)	Red clover vein mosaic virus
Scirpophaga excerptalis	Top shoot borer
Scirpophaga nivella	White rice borer
Scirtithrips aurantii	South African citrus thrips
Scolytines	Bark beetles
Sesamia grisescens	Stem borer
Sitobian avenae	English grain aphid
Stagonospora sacchari	Leaf scorch of sugar
Sternochetus frigidus	Mango pulp weevil
Sugarcane white leaf phytoplasma	Sugarcane white leaf phytoplasma
Termites (group)	Termites

Table 52. National Diagnostic Protocols (continued)

Scientific name	Common name
Draft protocols (continued)	
Tetranychus spp.	Spider mites
Tilletia controversa	Dwarf bunt of wheat
Tilletia horrida	Kernel smut of rice
Trioza erytreae	African citrus psyllid
Trogoderma granarium	Khapra beetle
Verticillium dahliae	Defoliating strain
Wheat spindle streak mosaic virus (Bymovirus)	Wheat spindle streak mosaic virus
Xanthomonas citri subsp. *malvacearum*	Hyper virulent bacterial blight of cotton
Xanthomonas fragariae	Angular leaf scorch of strawberry
Xanthomonas vasicola pv. *musacearum*	Banana bacterial wilt
Xylophilus ampelinus	Bacterial blight of grapevine

Ledgend

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

Botanic gardens are often visited by overseas tourist, and are a likely entry point for exotic pests and diseases

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 53.

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.

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 lookalikes 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[35] 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 2019, a project in line with the implementation plan began to:

- determine if 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.

Biological reference collections provide validated reference specimens for comparison to identify a plant pest. Image courtesy of Agriculture Victoria

35. 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.

Table 53. 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); DA AA 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	DA	Pest and disease identification, collection and rearing of immature stages of arthropods. Pathology investigation to determine causal agent	DA 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 53. 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 DPIR	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	DA	Tropical plant pests. Plant pathology including microscopy, serology and molecular assays (conventional and real time PCR) for selected organisms. Entomology and botany including microscopy and molecular capacity		Plant pathology: herbarium specimens, desiccated virus and virus-like disease collections and nucleic acids from Australia and northern neighbouring countries. Entomology: Northern Territory Quarantine Insect Collection which comprises general entomology insect pests; WA, NT and Timor Leste Tephritidae; and WA, NT and overseas Culicoides biting midges
Plant Pathology Laboratory, Berrimah	NT DPIR	Plant pathology, virology, bacteriology, PCR, mycology and diagnostics	Registered for exchange of scientific specimens (Australian native non-CITES specimens)	Northern Territory Plant Pathology Herbarium and plant pathogen nucleic acids collection
Queensland				
Biosecurity Queensland Control Centre, Moggill	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
Ecosciences Precinct, Dutton Park	QDAF	Entomology, plant pathology, virology, bacteriology, mycology, nematology, molecular biology and exotic fruit fly screening	DA Approved Arrangement for Class 5.2 and 5.3. Biosecurity containment levels BC2 and BC3	Plant pathology and entomology
Gatton Research Station, Gatton	QDAF	Vegetable pests and diseases		

Table 53. Australia's diagnostic services, their capabilities, accreditations and collections (continued)

Laboratory and location	Organisation	Diagnostic capability	Accreditation	Collections
Queensland (continued)				
Maroochy Research Station, Nambour	QDAF	Plant pathology		
Northern Australia Quarantine Strategy Regional Laboratory, Cairns	DA	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				
SARDI, Adelaide	SARDI	Molecular diagnostics, plant pathology (mycology, nematology, virology, taxonomy), entomology and surveillance	Molecular Diagnostics Laboratory is NATA accredited under Biologicals. NATA accredited for potato virus testing. DA accredited containment facilities for insects and plants	Entomology collection, Adelaide University
School of Agriculture, Food and Wine, Waite Institute, Adelaide	University of Adelaide	Nematology and viticulture virology		
School of Earth and Environmental Sciences, Adelaide	University of Adelaide	Entomology		
South Australian Museum, Adelaide	SA Department of Premier and Cabinet	Entomology		

Table 53. Australia's diagnostic services, their capabilities, accreditations and collections (continued)

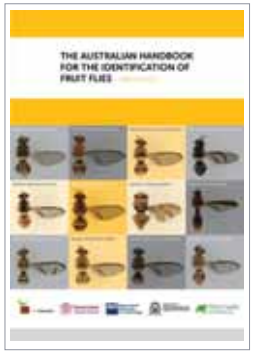
Laboratory and location	Organisation	Diagnostic capability	Accreditation	Collections
Tasmania				
Peracto, Devonport	Peracto	Plant pathology and nematology	Laboratory DA containment approved	
Plant Diagnostic Services, New Town (satellite entomology laboratories at Devonport and Launceston)	DPIPWE	Entomology, plant pathology (virology, mycology, nematology and bacteriology including molecular testing), TASAG ELISA testing services (virology)	Laboratories DA containment approved, TASAG laboratories 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
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, forest pathology and molecular laboratory	Laboratory DA containment approved	Insect reference collection
Victoria				
AgriBio, Bundoora	DJPR, La Trobe University	Commercial diagnostic laboratory for general plant pathology, pathogen identification, entomology, mycology, virology, nematology, bacteriology, fungal and insect taxonomy, high throughput molecular diagnostics and weeds	DA approved AS/NSZ 9001:2000/ QA certification. Laboratory is NATA accredited under Biologicals. NATA accredited for potato virus testing, potato cyst nematode identification, 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
Horsham Research Centre, Horsham	DJPR	General plant pathology and virology (grains focus)		Fungal, bacterial and virus pathogen working collections pertaining to temperate grain crops
Irymple Research Centre, Irymple	DJPR	General entomology		
Operational Science Laboratory, Tullamarine Airport	DJPR	Entomology and plant pathology	DA accredited quarantine containment 5.2/7.2	Entomology collection
Plant Post-Entry Quarantine facility, Mickleham	DA	General plant pathology including mycology, bacteriology, botany, virology (traditional and modern) and nematology		

Table 53. Australia's diagnostic services, their capabilities, accreditations and collections (continued)

Laboratory and location	Organisation	Diagnostic capability	Accreditation	Collections
Victoria (continued)				
Royal Botanic Gardens, Victoria	Royal Botanic Gardens, Victoria	Mycology and weeds		Herbarium, including fungi and weeds
Rutherglen Research Centre, Rutherglen	DJPR	Entomology		
Tatura Research Centre, Tatura	DJPR	Entomology		
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	DA	Identification of quarantine intercept samples, mostly exotic pests		Small reference collection, mostly exotic invertebrates
Operational Science, DA, Perth International Airport	DA	Identification of quarantine intercept samples, mostly exotic pests including arthropods, fungi, bacteria and viruses	DA 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		

Entire fly dorsal classic with wing (B. frauenfeldi). Image courtesy of The Australian Handbook for the Identification of Fruit Flies v3.1

HANDBOOK FOR THE 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 Australian Handbook for the Identification of Fruit Flies – 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 – The companion website **fruitflyidentification.org.au** 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.

ONLINE SYSTEMS SUPPORTING PLANT BIOSECURITY

Digital resources are of increasing importance to plant biosecurity, providing fast download, analysis and access of information. Many online systems are used by stakeholders in the biosecurity system with some of the major ones described here.

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 2019, the Biosecurity Portal housed and linked to 40 websites and shared workspaces making it a key information source for biosecurity stakeholders.

Sites 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 and the Subcommittee on Plant Health Diagnostics
- awareness and information resources such as the Farm Biosecurity website and BeeAware.

The Australian Plant Pest Database

The Australian Plant Pest Database (APPD) at **planthealthaustralia.com.au/appd** is a key reference system for plant pests. The APPD contains information on validated specimen records of pests and diseases of plants with significance to agriculture, forestry, pasture or the environment.

Currently APPD draws information from 18 databases throughout Australia. This database is interrogated during every plant pest incursion that is detected in Australia to assist with pest status information. APPD is housed within the Atlas of Living Australia (ALA). ALA also has information relevant to plant biosecurity as it is a collaborative, national database aggregating biodiversity data from multiple data sources.

AUSPESTCHECK™

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 2019, AUSPest*Check*™ facilitated two proof of concept trials for coordinating surveillance data online. Well over 3 million surveillance records have been added in the database to establish the system.

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

Other resources

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

PHA 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.

Mobile devices such as smart phones and tablets are supplementing online systems, improving accessibility to the tools and integration into biosecurity operations. Various smart phone apps are used by Australians to contribute to biosecurity. Examples include the MyPestGuide™ Reporter, which sends images of plant pests or symptoms directly to government diagnostic services for identification.