Threat Specific Contingency Plan for the Nursery & Garden Industry Australia

Glassy-winged sharpshooter

Homalodisca vitripennis

(formally *H. coagulata*)

Department of Agriculture and Fisheries (Queensland) and

Nursery & Garden Industry Health Australia

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AUDAX AT FIDELIS

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1 Purpose and background of this contingency plan

This contingency plan provides background information on the pest biology and available control measures to assist with preparedness for an incursion into Australia of glassy-winged sharpshooter (GWSS; *Homalodisca vitripennis*). While the greatest biosecurity risk from the GWSS is as the vector for *Xylella fastidiosa* (Pierce's disease), the scope of this contingency plan is for an incursion of the GWSS only. *X. fastidiosa* is not recorded as present in Australia and there is a separate contingency plan for this pest[1].

Any Response Plan developed for GWSS using information in whole or in part from this contingency plan must follow procedures as set out in PLANTPLAN and be endorsed by the National Management Group prior to implementation.

This contingency plan was developed for the Nursery and Garden Industry Australia (NGIA), and therefore is focussed on production nurseries covered by this association. In the event of an incursion, operations not covered by the NGIA (e.g. retail nurseries) will not be eligible for Owner Reimbursement Costs, as defined in the Emergency Plant Pest Response Deed (EPPRD), if affected by actions carried out under the Response Plan.

2 Australian nursery industry

The Australian nursery industry is a significant horticultural sector with a combined supply chain (production to retail/grower) valued at more than $6 billion dollars annually. The industry employs approximately 45,000 people spread over more than 20,000 small to medium sized businesses including production nurseries and retail outlets. The industry is located predominantly along the Australian coastline and in major inland regions servicing urban and production horticulture.

An analysis by Market Monitor (2009) estimated the total GVP of nursery production in Australia to be approximately $1.8 billion in 2008/09 (see table below). Unfortunately, more recent national figures are not available, as other data sources are either in aggregate form (e.g. ABS, which includes cut flowers and turfgrass) or a gross under-estimation of actual production values. There is recent data specifically available for Queensland, which values the nursery production sector at $902M (DAF AgTrends April 2017), more than twice the stated value reported by Market Monitor. This suggests that total industry GVP could be above $3 billion. Regardless, the Australian nursery production sector represents one of the largest and most diverse horticultural industries in the nation. Nursery production is a highly diverse primary industry servicing the broader $14 billion horticultural sector within Australia (Table 1).

[1] Contingency plan for Pierce's disease can be found at **http://www.planthealthaustralia.com.au/wp-content/uploads/2013/08/Pierces-disease-CP.pdf**

Table 1. *Nursery production supply sectors within Australian horticulture*

Production Nursery	Horticultural markets	Economic value
Container stock[2]	Ornamental/urban horticulture	$2 billion retail value
Foliage plants[2]	Interior-scapes	$87 million industry
Seedling stock[3]	Vegetable growers	$3.3 billion industry
Forestry stock[4]	Plantation timber	$1.7 billion industry
Fruit and nut tree stock[3]	Orchardists (citrus, mango, etc)	$5.2 billion industry
Landscape stock[2]	Domestic & commercial projects	$2 billion industry
Plug and tube stock[5]	Cut flower	$319 million industry
Revegetation stock[2]	Farmers, government, landcare	$109 million industry
Mine revegetation	Mine site rehabilitation	Value unknown
	Total horticultural market value	**$14.5 billion**

3 Impact of glassy-winged sharpshooter

The glassy winged sharpshooter (GWSS) is an insect native to the south-eastern United States, with its natural range including Texas, Georgia, Florida and north-east Mexico (Young 1958; Triapitsyn and Phillips 2000). It was accidentally introduced into southern California in the early 1990s, probably as egg masses on plant foliage (Varela *et al*. 2016). GWSS is now considered a serious threat to California's crops and ornamental plants. Since the Californian introduction, GWSS has spread to French Polynesia (Secretariat of the Pacific Community 2002), the Cook Islands (The Ministry of Agriculture and Forestry) and Easter Island (Petit *et al.* 2008).

GWSS is a large leafhopper that obtains its nutrients by feeding on fluids from the water conducting plant xylem tissue, in most cases feeding on the stems of plants rather than leaves. Feeding activity rarely causes significant damage by itself, although the insect excretes copious amounts of liquid that can make leaves and fruit appear white washed (**Error! Reference source not found.**) when dry. The biosecurity risk associated with GWSS comes as it is the vector of the pathogenic bacterium *Xylella fastidiosa*. This bacterium is the causal agent of many devastating plant diseases, including Pierce's disease of grape, variegated citrus chlorosis, phony peach disease, plum leaf scald, olive quick decline syndrome as well as severe leaf scorches in oleander, almond, avocado, coffee, pear, pecan, mulberry, sycamore, elm, maple and oak. It also infects landscape plants in California causing sweet gum dieback and cherry plum leaf scorch. GWSS is of enormous concern to California agriculture, threatening their wine and table grape industry. GWSS flies further than native sharpshooters in the US, increasing bacterial spread and seriously threatens agricultural production.

The economic impact of GWSS in Australia would be dependent on the presence or absence of the damaging *X. fastidiosa* pathogen. If both GWSS and *X. fastidiosa* were present in Australia, the economic impact of GWSS would most likely be very high. Rathe *et al.* (2012) suggest that the

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[2] Data sourced from Market Monitor

[3] Data sourced from Horticultural Handbook 2004

[4] Data sourced from ABARE 2005

[5] Data sourced from industry

Figure 1. *White washed appearance of citrus fruit covered in GWSS excrement*

Australian environment is suitable for the establishment of GWSS, and that Australian native plant species are likely to serve as *X. fastidiosa* hosts and sources of inoculum.

In the United States where both GWSS and *X. fastidiosa* is present, Pierce's disease has had a major economic impact on the Californian grape, citrus and nursery industries, with annual costs associated with the disease estimated at $USD 104 million (Tumber *et al.* 2013). These costs include direct disease losses (e.g. death and decline of vines/trees), as well as efforts to mitigate damage. The main burden of the compliance costs (i.e. shipping protocol measures such as inspections, pesticide sprays and quarantines) in California has been borne by the nursery industry, and have been estimated at $USD 91 million between 1999 and 2010. Luck *et al.* (2001) indicated that Pierce's disease could be as serious in Australia as it has been in California.

Aside from the major impact of GWSS vectoring *X. fastidiosa*, GWSS can be a severe nuisance pest when high densities of the pest are present. Following the introduction of GWSS into French Polynesia in 1999, GWSS numbers became very high in Tahiti. This has occurred for a number of reasons, including the abundance of suitable native and exotic host plants, the mild climate which permits year-round breeding, and the lack of natural enemies and competitors which exist in natural or urban settings (Pilkington *et al*. 2005). At night, large numbers of adult insects are attracted to lights around shops, houses and airport hangars. The insect has been reported to 'bite' people when adults land on skin and probe sweat glands with mouth parts. 'Sharpshooter rain' (excessive fluid excretion from large populations feeding in trees) is a major nuisance in Tahiti and has led to the decline and partial defoliation of ornamental street trees (CABI 2017). Copious amounts of GWSS excrement can also make the leaves and fruit of plants appear whitewashed when dry (Varela *et al.* 2016). Where heavy populations of the insect are present, small plants may wilt during hot weather as a result of GWSS feeding. The high numbers of GWSS in French Polynesia poses a significant biosecurity threat to Australia, particularly since they are attracted to airport hangar lights at night and are known to enter open plane doors (CABI 2017).

4 Biology and pest management

4.1 Pest details

Common names:	Glassy-winged sharpshooter (GWSS)
Scientific name:	*Homalodisca vitripennis* (Germar 1821)
Synonyms:	*Tettigonia vitripennis; Tettigonia coagulata; Homalodisca coagulata*; *Homalodisca triquetra*
Taxonomic position:	Kingdom, Animalia; Phylum, Arthropoda; Class, Insecta; Order, Hemiptera; Family, Cicadellidae

4.2 Pest description

GWSS are large insects about 12 mm in length with a dark brown to black colouring with a lighter underside. The upper parts of the head and back are stippled with ivory or yellowish spots, with wings that are partly transparent with reddish veins (**Error! Reference source not found.**). Watery excrement often collects on either side of the insect, appearing as large white spots. GWSS eggs are laid together on the underside of leaves (Figure 3), usually in groups of 10-12. The eggs are easier to observe following hatching, when they change in appearance from green water blisters to leave tan to brown scars on the leaves. The immature nymphs are wingless and brownish-grey in colour.

Figure 2. GWSS dorsal (left) and lateral (right) views. Images taken from PaDIL

[6]

Figure 3. *Egg masses of the GWSS positions just under the lower leaf epidermis*

4.3 Life cycle

The GWSS produces two generations a year in southern California. After a peak in adult activity during the winter months, oviposition begins in late winter and early spring peaking in May. Adults live for about two months. Before laying eggs, the female secretes a chalky white substance that is held on its wings. They lay small sausage shaped eggs side by side in masses of 10-12 eggs, on average. The eggs are laid just under the lower leaf epidermis of host plants. After laying the eggs, they are covered with the chalky material held on her wings, which provides a level of protection from parasitoids. Thus, the white spots on the wings are only visible on females shortly before laying a batch of eggs. Egg masses appear as greenish water blisters beneath the leaf. The nymphs hatch after about two weeks and proceed to feed on leaf petioles or small stems, while progressing through 5 moults before becoming winged adults.

A second peak in adult activity occurs in the summer during July and August. Peak oviposition in these first generation adults occurs in August. After the eggs have hatched, the old egg mass blister than appears as a tan to brown scar. In the US, oviposition is greater in laurel sumac, macadamia, lemon and the ornamental *Pittosporum* species than in most other oviposition hosts (Phillips, 1999b).

In Tahiti, GWSS is multivoltine (i.e. has more than two generations each year and these generations can overlap). Populations of GWSS in Tahiti have grown exponentially since introduction of the pest, in part due to this high rate of reproduction.

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[6] www.padil.gov.au

In Australia, therefore, the lifecycle could range from having only two generations in more temperate climates to having many generations in more tropical regions.

Feeding behaviour and mortality is strongly temperature dependent. Feeding is only initiated when temperatures are above 10°C (Son et al. 2012). Temperature also influences mortality. All adults died within 48 hours at 40.8°C and extended periods of time (days) below 10°C also cause significant mortality (Son et al. 2010), presumably from lack of feeding. Son et al. (2010) also developed a highly accurate model to predict winter mortality.

4.4 Dispersal

Adult GWSS are strong flyers and can move rapidly from plant to plant. Adults will only fly during warm conditions, above 11°C (Pollard and Kaloostian 1961). However, more recent research indicates that flying adults are rarely trapped below 18°C (Blackmer et al. 2006). Adults are more likely to fly between 10am and 2pm. Release and recapture research indicates that after 3 days 50 and 99% of individuals remained within 31 and 150m from release site (Blackmer et al. 2006) with temperature being the main variable that explains dispersal patterns, i.e. warmer temperature lead to greater dispersal.

Adults fly at low altitudes, with greater than 95% flying 7m or less of the ground (Blua and Morgan 2003). GWSS are not strongly directional flyers, tending to make many short, erratic flights (Turner and Pollard 1959).

Nymphs are wingless but can distribute themselves by walking and jumping through the canopy or dropping from plants and walking to new hosts. Most rapid and long distant movement is as viable egg masses in nursery stock of either crop or ornamental plants (CABI 2017).

4.5 Host range

Due to its polyphagous feeding habit, GWSS has a very long list of hosts on which it has been reported. The California Department of Food and Agriculture website[7] currently lists over 300 genera as hosts of GWSS (See Section 10.1). Plants at all stages of development can be attacked by the GWSS. Important agricultural and ornamental hosts include grape, citrus, peach, plum, olive, almond, almond, avocado, coffee, pear, pecan, mulberry, oleander, sycamore, elm, maple, oak, sweet gum and cherry plum. However, plants with surplus irrigation are preferred over plants growing under water deficit (Nadel et al. 2008).

As GWSS continues to expand its range within California following its introduction in 1990, both the ovipositional and feeding host lists continue to expand, primarily within ornamental plant species grown in nurseries or landscape gardens. As it is a xylem feeder, it circumvents secondary plant defence chemistry found in phloem sap and, as a result, appears to be able to feed on most plant species. The high volume of xylem fluid intake required limits its survival to situations in which continued contact with a living host is possible. Only the egg stage is capable of survival for 2 or 3 weeks on excised fresh and moist plant foliage.

Rathe *et al.* (2012) suggest that, should GWSS and *X. fastidiosa* become established in Australia, a pathosystem involving native and exotic Australian plants would most likely come into play. In a study conducted in the USA by Rathe *et al.* (2014), a number of native Australian plant species have been

[7] Source - California Department of Food and Agriculture – Plant Health and Pest Prevention Services
https://www.cdfa.ca.gov/pdcp/Documents/HostListCommon.pdf

shown to be suitable as feeding, oviposition and/or nymph development hosts of GWSS. *Leptospermum laevigatum*, *Acacia cowleana*, *Eremophila divaricata*, *Eucalyptus wandoo*, *Hakea laurina*, *Melaleuca laterita* and *Swainsona galegifolia* had evidence of adult or nymph presence, whereas *L. laevigatum*, *A. cowleana*, *Banksia ericifolia*×*B. spinulosa*, *Correa pulchella*, *E. divaricata*, *E. wandoo*, *H. laurina*, and *S. galegifolia* were found to be suitable oviposition hosts. Host species which supported all three life stages (egg, nymph and adult) of GWSS in the field (*L. laevigatum*, *A. cowleana*, *E. divaricata*, *H. laurina*, and *S. galegifolia*) were categorised as 'high risk' by the authors. Further research will undoubtedly uncover additional Australian native host species which are suitable hosts of GWSS.

4.6 Symptoms

GWSS feeds on the nutrient poor liquid in the plants xylem and therefore must consume copious amounts of fluid to gain enough nutrients to grow and reproduce. Consequently, the adults and nymphs excrete large amounts of liquid while feeding, resulting in the fruit and foliage having a white washed appearance (Figure 1).

Extremely high populations of GWSS have been shown to reduce fruit quality and yield of coastal lemons and Valencia oranges in southern California.

Feeding causes no visible signs of damage, even though the insect consumes hundreds of times its body weight per day in xylem fluid. Most non xylem feeding leafhoppers produce a sugary or particulate excrement but the excrement of xylem feeders is very watery, high in ammonia and dries to a fine, whitish powder which can cover the stems, foliage and fruit when the insects are abundant (Phillips 1998). High densities of feeding sharpshooters excrete enough waste products to cause a 'rain', which falls from the trees. This rain can be seen easily on sunny days and can be felt on the skin. This phenomenon is highly evident in Tahiti where puddles form on roads and sidewalks as result of sharpshooter rain.

Egg masses are usually laid into recently expanded foliage. Older foliage will contain the distinctive scars left after the eggs have hatched. When populations are more abundant, egg masses can be laid into the rind of immature fruits of crops such as citrus and melon. Old hatched egg masses appear as grey or tan scars on surface of the rind (Blua *et al.* 1999).

If *X. fastidiosa* entered Australia with the GWSS, the resulting symptoms of this pathogen could also be used for detection of GWSS spread and establishment. The most characteristic symptom of *X. fastidiosa* pathogen is the development of leaf scorch, where parts of apparently healthy leaves suddenly dry, turning brown. Drying spreads and the whole leaf may shrivel and drop. For a more detailed explanation of *X. fastidiosa* and GWSS symptoms and damage, refer to factsheets on the Plant Health Australia[8] and **NGIA** websites. Further information and images can also be found on the Pest and Disease Image Library (PaDIL) and Pest Identification Tool websites[9].

4.7 Current geographic distribution

GWSS is native to the subtropical gulf states of south-eastern USA, in areas with a high water table where wild hosts produce the luxuriant growth necessary to sustain the xylem feeder. GWSS can also

[8] **http://www.planthealthaustralia.com.au/pests/xylella-fastidiosa/ http://www.planthealthaustralia.com.au/pests/glassy-winged-sharpshooter/**

[9] **http://www.padil.gov.au/ https://www.pestid.com.au/**

be found in the more arid regions of southern Texas and north-eastern Mexico, especially irrigated habitats, landscape gardens and citrus orchards. GWSS has also become a problem pest of ornamentals and native plants in French Polynesia and crops and ornamentals in southern, central and northern California (Blua *et al.* 1999).

Based upon a range of data sources (including EPPO 2014[10]), the CABI Invasive Species Compendium for *H. vitripennis*[11] lists the current presence of GWSS in the following countries/states: USA - Alabama, Arizona, Arkansas, California (restricted distribution), Florida, Georgia, Hawaii (unconfirmed report) Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Texas; Mexico (restricted distribution); Chile (restricted distribution); Cook Islands and French Polynesia.

Modelling data suggests that much of coastal Australia has temperatures suitable for the survival of both GWSS and *X. fastidiosa* (Rathe *et al.* 2012). GWSS distribution is limited by cold and drought stress, and as such, it is predicted that vector (and pathogen) establishment and incursion severity would be greatest in the tropical and subtropical northern regions of Australia. Drought stress may exclude GWSS from the Australian interior, with the exception of irrigated crop production areas such as Sunraysia.

As GWSS is a strong flyer and easily spread via the movement of host plants or by accidental entry into aircraft, the pest could potentially become distributed across most of the Australian mainland in regions with a favourable climate for establishment (Rathe *et al.* 2012).

4.8 Diagnostic information

The relevant State Chief Plant Health Manager will select the diagnostic facilities to be used during a response to a GWSS incursion. Contact details for a number of diagnostic facilities can be found in Appendix 2.

An expert with a good knowledge and understanding of Australian sharpshooters would be required to identify the pest. A diagnostic protocol has been prepared for GWSS (Fletcher 2013[12]). Care must be taken in distinguishing Australian leafhoppers from GWSS as some Australian species share some features with GWSS (Table 2; and refer to Fletcher (2013) for comparative images).

[10] **https://www.eppo.int/DATABASES/pqr/pqr.htm**

[11] **http://www.cabi.org/isc/datasheet/27561**

[12] **http://plantbiosecuritydiagnostics.net.au/wordpress/wp-content/uploads/2015/03/NDP-23-Glassy-winged-sharpshooter-Homalodisca-vitripennis-V1.2.pdf**

Table 2. *Australian Auchenorrhyncha species that share characteristics with GWSS (Fletcher 2013)*

Cicadellidae: Ledrinae: Thymbrini. (see Figure 5 in Fletcher 2013) Species of this tribe sometimes have an expanded head with prominent eyes although the face is not swollen as in GWSS. Also, the tegmina are opaque and cover the sides of the abdomen laterally.
Cicadellidae: Ledrinae: Stenocotini. Stenocotini (see Figures 6 and 7 in Fletcher 2013) often have the tegmina glassy transparent between the veins although, in those species, the anterior expansion of the head is due to an expanded pronotum rather than an expanded head. In *Ledracotis gunnensis* Evans, it is the head that is expanded and this species can also have the face medially bulging, although not swollen. *L. gunnensis* can easily be differentiated from GWSS by having tegmina which are opaque and cover the sides of the abdomen laterally.
Cicadellidae: Tartessinae. (see Figure 8 in Fletcher 2013) Some Tartessinae are brown and large but do not have the head expanded and swollen like GWSS. One species, *Tartessoides griseus*, has the male large with an expanded head although it is not swollen and it has a dense covering of hairs. Expansion of head anteriorly is due to prominence of pronotum rather than an expanded head as in GWSS. Tartessini all have the appendix (the apical membrane beyond the apical crossveins) extending around the apex of the tegmen.Tegmina cover the abdomen laterally. Proconiini can be separated from Stenocotini by key characters provided by Fletcher 2009.
Cicadellidae: Ledrinae: Ledrini. (see Figure 9 in Fletcher 2013) The ledrines have the head expanded, sometimes quite markedly, but the face is always flattened or even concave to enable the leafhoppers to fit against the stems on which they feed. The tegmina cover the sides of the abdomen laterally, the head is not swollen dorsoventrally and the face is covered with dense hairs. Although often large and brown, tartessines do not have the head expanded, the tegmina are usually opaque and cover the sides of the abdomen laterally and the appendix extends around the apex of the tegmen.
Cicadellidae: Euacanthellinae: Euacanthellini. (see Figure 10 in Fletcher 2013) *Euacanthella palustris* Evans is normally brachypterous (i.e. have non-functional wings) but occasionally occurs in a macropterous form which has certain similarities to GWSS. However, the tegmina are opaque and cover the sides of the abdomen laterally. All Australian Ledrini have the head expanded anteriorly with the eyes situated laterally at the base. In all species, however, the face is concave or flattened in order that the leafhoppers can fit against the branches on which they feed.
Cercopoidea. (see Figures 11 and 12 in Fletcher 2013) Spittlebugs and their relatives are xylem feeders and therefore have the frons expanded to enclose the muscles of the feeding pump. However, the general structure of spittlebugs is quite different from GWSS. The head is not triangularly expanded, the tegmina are coloured, often quite brightly, and cover the abdomen laterally and the pronotum is often convex giving the insects a humped appearance quite different to the generally flattened and elongate appearance of GWSS.
The Australian Cicadellinae all belong to the Tribe Cicadellini (see Figures 13 and 14 in Fletcher 2013) and differ from GWSS in lacking the broadly triangular vertex (upper most surface of the head) and in coloration. Species of *Ishidaella* Matsumura (Figure 14) have blue-black tegmina and yellow bodies with black markings while Australian species in other genera (e.g. Figure 12) are whitish or pale yellow, usually with dark markings. These belong to the same leafhopper subfamily as GWSS although, as with *C. spectra* in Figure 13, a different tribe. The face of the head is swollen as with all xylem feeders but in general appearance and colour, species of *Ishidaella* are quite distinctive. They are also appreciably smaller than GWSS. There are nine species of *Ishidaella* recognised in Australia and all have similar coloration. Some species are very common in suburban garden.

4.9 Pest management

Pest management guidelines described in this contingency plan relate only to GWSS. Pathogens that may be carried by the GWSS, such as *X. fastidiosa*, may require alternative management strategies which are not covered in this document. For information regarding Pierce's disease and other diseases caused by *X. fastidiosa*, a separate contingency plan is available on the Plant Health Australia website[13]

4.9.1 Detection and monitoring

Careful detection and monitoring of pest populations is a crucial component of GWSS management in California. Although GWSS adults are large enough to be seen with the naked eye, they are difficult to see in the field due to their brown colouration (which blends well with the colour of twigs) and their ability to hide when movement is detected (Varela *et al*. 2016).

Detection and monitoring strategies include visual inspection of plants in association with the use of yellow sticky traps, aerial and/or sweep nets, and beat sheets. These strategies are discussed in detail in Section 6.

4.9.2 Chemical control

Chemical control of GWSS is not commonly employed in countries where it is endemic, as suppression of the insects rarely lead to a significant reduction in the incidence of any pathogens it may vector (CABI 2017). However, chemical control can be used to slow the dispersal of the vector to new ranges, and may be implemented where the aim is the eradication or containment of the insect pest following an incursion. It is likely that chemical control would be the first line of defence for an Australian GWSS incursion event (Rathe *et al.* 2012).

While there are no prescribed chemical control programs for GWSS within their natural range in south-eastern USA, there are IPM programs in place in areas of California (CABI 2017). While a number of insecticides with efficacy against GWSS are available for use in the USA, the main insecticide used to protect plants susceptible to *X. fastidiosa* in both commercial agriculture and urban landscape situations in California, is imidacloprid (Varela *et al.* 2016). Soil applied imidacloprid was reported to give more effective and long-lasting control compared to foliar applied imidacloprid, and was less disruptive to parasitic wasps used for biological control, but takes several weeks to become effective. The application of imidacloprid as a systemic insecticide can suppress a GWSS population by 95% for to 5 months (CABI 2017). Rathe *et al.* 2012 commented that soil applied imidacloprid results in high adult mortality for up to 4 weeks, but would likely have the same effect on non-target native Australian herbivorous insects. They also noted that egg masses are difficult to control using systemic insecticides such as soil-applied imidacloprid, as the developing embryo of GWSS eggs is encased within the leaf. While foliar applications of imidacloprid may increase residues of the compound in the surrounding leaf tissues as well as nymph mortality following emergence, they also result in mortality of parasitoids.

The kaolin clay product Surround®, which disrupts GWSS feeding behaviour and reduces the incidence of Pierce's disease in grapevines, is sometimes used by organic growers in California for GWSS management in place of imidacloprid (Tubajika *et al.* 2003), as are pyrethrin products such as Pyganic®.

A summary of insecticides with efficacy against GWSS and approved for use in nurseries in the USA (CDFA 2016b) is shown in Table 3. The use of these chemicals may be considered as a response to a GWSS incursion into Australia. However, any chemicals used for the eradication or control of

[13] **http://www.planthealthaustralia.com.au/wp-content/uploads/2013/08/Pierces-disease-CP.pdf**

GWSS in Australia must be registered for use through the Australian Pesticides and Veterinary Medicines regarding this process visit the APVMA website (Table 4)[14].

Combinations of group 3A and 4A products are likely to both kill adults for perhaps 5 weeks and stop egg batches from being deposited on the plants within the same period. Applications of foliar imidacloprid and thiamethoxam also were found to stop eggs already laid on plants from hatching (Grafton-Cardwell et al. 2003).

Table 3. *Pesticides which are approved for use in California for control of GWSS in nurseries*[15]

Active Ingredient	Product
imidacloprid	Admire Pro® *
imidacloprid	Alias 4F® *
acetamiprid	Assail 30 SG®
acetamiprid	Assail 70 WP®
permethrin	Astro®
cyfluthrin	Baythroid XL®
imidacloprid	CoreTect Tree & Shrub Tablets® *
cyfluthrin	Decathlon® 20 WP
cyfluthrin/imidacloprid	Discus®
chlorpyrifos	Dursban™ 50W
chlorpyrifos	Lorsban® 4E
tau-fluvalinate	Mavrik Aquaflow®
acephate	Orthene® 97
imidacloprid	Quali-Pro Imidacloprid 2F®
carbaryl	Sevin SL®**
bifenthrin	Talstar S Select®
fenpropathrin	Tame 2.4 EC Spray®**
neem oil	Triact 70®
acetamiprid	Tristar® 30 SG
acetamiprid	Tristar® 8.5 SL

[14] **www.apvma.gov.au**

[15] from **https://www.cdfa.ca.gov/pdcp/Documents/NSATP.pdf**

Table 4. Products currently registered in Australia for use against leafhoppers generally relevant to the production nursery industry.

Active ingredient/s	Mode of action group	Home & Garden use	Commercial use	Registered on	Efficacy
Phorate	1B	No	Yes	Various ornamentals	
Methidathion	1B	No	Yes	Ornamentals, trees, shrubs in nurseries, parks, gardens and forestry situations	
Dimethoate	1B	No	Yes	Various ornamentals and wildflowers, selected fruit and vegetable crops	
Piperonyl butoxide & Pyrethrins	3A	Yes	Yes, but not well specified on some labels	Vegetables and ornamentals growing outdoors and hardy indoor plants. Some labels allow for application on buildings and equipment	
Esfenvalerate	3A	Yes	No	Home and garden ornamentals, domestic and commercial buildings.	
Acetamiprid	4A	No	Yes	Indoor and outdoor ornamental plants	Adults, inhibits oviposition, stops eggs from hatching (Grafton-Cardwell 2003)
Imidacloprid	4A	No	Yes	Non-food nursery stock (PER81707)	Adults, inhibits oviposition, stops eggs from hatching (Grafton-Cardwell 2003)
Petroleum oils	NA	No	Yes	Non-food nursery stock (PER81707)	
Buprofezin	16	No	Yes	Non-food nursery stock (PER81707)	Immature stages (Prabhaker and Toscano 2007)
Chlorantraniliprole plus thiamethoxam	28 plus 4A	No	Yes	Non-food nursery stock (PER81707)	

4.9.3 Biological control

In the south-eastern United States and north-eastern Mexico, several species of mymarid and trichogrammatid parasitic wasps are known to parasitise GWSS eggs (Pilkington *et al*. 2005). The parasitic mymarid wasps *Gonatocerus ashmeadi*, *G. triguttatus*, *G. morrilli* and *G. fasciatus* are the most common natural enemies associated with GWSS in the south-eastern United States (Triapitsyn and Phillips 2000). As part of an area-wide GWSS control program in southern California, the University of California and the Californian Department of Food & Agriculture imported these four parasitoids from south-eastern states in the late 1990s, cleared them through quarantine and introduced them into agricultural and urban areas in California between 2000 and 2005 (Pilkington *et al*. 2005). Current observations suggest that the parasitoids are now widespread throughout the region and are active in suppressing GWSS populations, despite the fact that active releases of these parasitoids are no longer occurring. Quite effective control has been obtained in some areas using these parasites, with the rate of parasitism generally increasing over the season. Rates of 10-50% during the first period of egg laying in spring have been reported, and up to 90-100% during the second egg-laying period in summer/early autumn (Varela *et al*. 2016).

Biological control of GWSS using *G. ashmeadi* has been extremely successful in French Polynesia where natural enemies are lacking. Since the parasitoid *G. ashmeadi* was introduced into Tahiti in 2005, parasitism of GWSS eggs has averaged 80-100% (Grandgirard *et al*. 2008). Prior to the release of *G. ashmeadi*, surveys conducted on the French Polynesian island of Mo'orea indicated that less than 2% of GWSS eggs were parasitised by parasitoids (Pilkington *et al*. 2005).The success of the introduction of *G. ashmeadi* was likely due to overlapping GWSS generations, providing a continuous supply of egg masses for parasitoids, a situation that may occur in northern Australia (Rathe *et al*. 2012).

Rathe *et al*. 2012 recommend that, in advance of a possible GWSS invasion, screening of *G. ashmeadi* should be undertaken proactively under quarantine conditions. Providing non-target impact studies indicate acceptable levels of risk, this parasitoid would then be available for immediate establishment against GWSS. While this would be ideal the likelihood of funding such research seems slim.

Biological control mechanisms would not be expected to provide a mechanism for eradication of GWSS, but would help lower populations and reduce the risk of spreading vectored pathogens, such as *X. fastidiosa*.

5 Pest risk ratings and potential impacts

A pest risk analysis has been carried out on this insect, taking into account the entry, establishment and spread potentials, together with the economic and environmental impact of establishment. A summary of these ratings are shown in Table 5. Based on this information, GWSS is considered a medium overall risk to Australia

Table 5. *Pest risk ratings for GWSS as determined in the IBP for the Nursery and Garden Industry*

Potential or impact	Rating
Entry potential	Medium
Establishment potential	Medium
Spread potential	High
Economic impact	High
Overall risk	**Medium**

5.1 Phytosanitary risk

GWSS has been found in the mild winter regions of southeast United States. The greatest threats to Australia for the GWSS are to regions with mild winters where one or more of the following crops are grown: grapes, citrus, almond, stone fruits (*Prunus* spp.), coffee, oleander, or where tree species potentially affected by leaf scorch diseases occur.

In the USA there is an internal quarantine against movement within the state of California from areas of known infestation to central and southern California. Australia has also imposed quarantine against this pest as no vectors of *X. fastidiosa* are known to exist in this country. Tahiti poses a major infestation epicentre for the south Pacific and a risk to Australia. Large numbers are attracted to hangar lights at night and yellow colour on sides of planes may attract flying sharpshooter, which can enter open plane doors. Dead sharpshooters have been found in cargo bins and to restrict spread, planes and cargo bins should be disinfested before leaving the country.

In relation to import conditions for GWSS, Australia has recently (2015) revised import conditions for *X. fastidiosa*. Import of nursery stock and plant material from countries where *X. fastidiosa* is known to occur must be tested off-shore and certified as free from *Xylella* by the government of the exporting country. Material that does not meet these requirements must be held and tested in an approved post-entry quarantine facility for 12 months. Alternatively, nursery stock material may be hot water treated, followed by standard post-entry quarantine screening arrangements. An approved arrangement in accordance with Australia's requirements to ensure the health of plants must be in place for off-shore certification of nursery stock from high risk countries. A phytosanitary statement must accompany germplasm imports from countries where *X. fastidiosa* is not known to occur. The Department of Agriculture and Water Resources maintain the BICON (Biosecurity Import Conditions System)[16] database which details specific import conditions, treatment and permit requirements for commodities imported into Australia.

[16] **http://www.agriculture.gov.au/import/online-services/bicon**

5.2 Entry potential

Rating: MEDIUM

GWSS are strong fliers and can move rapidly from one plant to another and also have a wide known host range (that may continue to increase to include new species given further research). However, the most likely pathway of entry is as a hitchhiker on plant material and transport machinery (for details see Table 5). From this information, the entry potential has been rated as **medium**.

A possible method of entry of GWSS into Australia would be the importation of nursery plant stock. Evidence suggests that the leafhopper entered California in nursery stock as eggs, which are difficult to detect. Since then agricultural quarantine inspections have frequently intercepted leafhopper specimens.

Table grape exports into Australia could also be a potential entry pathway for sharpshooter. The risk of GWSS arriving in Australia would in some part be related to the number of insects present in the source areas from which the table grape exports originate. In the early part of the table grape season when the insect is extremely active and all forms of the insect can be found in vineyards and in other orchards the risk of the insect entering Australia would be higher.

5.3 Establishment potential

Rating: MEDIUM

The wide host range of GWSS together with suitable environmental conditions, would allow for the establishment of GWSS in many regions of Australia. Therefore, the likelihood of GWSS establishment in Australia following entry is considered **medium**.

Table 6. *Potential entry pathways for GWSS into Australia*[17]

Parameter	Details
Plant parts that can carry GWSS in transport/trade	• Fruits (including pods) can carry eggs internally – visible to the naked eye • Leaves can carry eggs and nymphs both internally and externally – visible to the naked eye • Stems, shoots, trunks and branches can carry nymphs and adults externally – visible to the naked eye
Plant parts not known to carry GWSS in transport/trade	• Bark • Bulbs, tubers, corms and rhizomes • Growing medium accompanying plants • Flowers, inflorescences, cones and calyx, where stem material is not present • Seedlings and micropropagated plants (without stems suitable for feeding or foliage suitable for oviposition) • Roots • True seeds (include grain) • Wood

[17] Information taken from CABI (2017) **http://www.cabi.org/isc/datasheet/27561**

Parameter	Details
Transport pathways for long distance transport	• Adults can be carried within transport vehicles • Adults and nymphs can be moved in storage and transport bins
Main pathways for the likely entry of GWSS into Australia	• Nursery stock for planting (excluding seeds and fruit) of known susceptible hosts • Foliage of cut branches (for ornamental purposes) of susceptible foliar hosts • Fruit of susceptible hosts

5.4 Spread potential

Rating: HIGH

GWSS adults are strong flyers allowing rapid movement of the insect. In addition, all life stages can move on machinery, equipment and plant material. These factors combined with the wide distribution of suitable host species results in a **high** spread potential for GWSS.

In America, GWSS has been spread through transportation of commercial nursery products. As a consequence of this pathway, state authorities have imposed agricultural quarantine restrictions on the movement of all nursery material headed for areas that do not have GWSS.

5.5 Economic impact

Rating: HIGH

The economic impact of GWSS would be dependent on the presence of the damaging *X. fastidiosa* pathogen. The impact of direct feeding damage on host plants from GWSS is low. However, GWSS acts as a vector for *X. fastidiosa*, which is not currently present in Australia. There is a chance that GWSS could carry *X. fastidiosa* if it were to arrive in Australia. If *X. fastidiosa* was also present, the economic impact of GWSS would be considered **high**.

GWSS and Pierce's disease (*X. fastidiosa*) represent a major threat to agricultural industries in California. Losses of $33 billion to the grape industry alone, potential losses of commercial agriculture and nursery crops would also be high (USDA Environmental Assessment 2002).

5.6 Overall risk

Rating: MEDIUM

Based on the individual ratings above, the combined overall risk is considered **medium**.

6 Surveillance and collection of samples

Information provided in the following sections provides a framework for the development of early detection and delimiting surveys for GWSS in Australia, with emphasis on production nurseries.

Detection and delimiting surveys are required to delimit the extent of the GWSS outbreak, ensuring areas free of the pest retain market access and appropriate quarantine zones are established.

6.1 Technical information for planning surveys

When developing surveys for GWSS presence and/or distribution, the following characteristics of the pest provide the basic biological knowledge that informs the survey strategy:

- GWSS is similar to a number of endemic sap-sucking insects (see Fletcher 2013) which need to be considered in diagnosing samples
- Endemic host species in Australia are likely to be numerous and widely dispersed
- The risk of pest movement on machinery, equipment and personal effects is high
- Significant proportions of Australia have favourable climatic conditions for GWSS spread and establishment
- GWSS adults and older nymphs are primarily stem feeders, with a preference for new flush growth and vertically-oriented shoots/twigs (opposed to horizontally-oriented shoots/twigs) (CDFA 2016)
- GWSS flight activity is greatest during the warmer parts of the day (between late morning and afternoon). The flight temperature threshold for GWSS is approximately 18°C (CDFA 2016a)
- Due to its brown colouration, GWSS adults can blend in quite well with the colour of twigs and therefore can be quite difficult to see despite their relatively large size (ca. 12 mm long) (Varela *et al*. 2016). When an adult detects movement, it hides by moving to the other side of the twig or branch
- A whitish powdery coating on leaves or fruit may indicate GWSS feeding

6.2 Surveys for early detection of an incursion in a production nursery

If an incursion of GWSS is to be eradicated in a production nursery, it must be detected early, before the insect has had the opportunity to disperse to a large extent. It is therefore necessary to consider pathways and plan surveys accordingly. Important points to consider when developing early detection surveys are:

- The greatest entry risk currently comes from importations of host plants or other goods. Therefore surveys at importing production nurseries and ports are required.
- Awareness information should be targeted at people who are in regular close contact with potential hosts in high risk areas or movement vectors (e.g. production nursery operators).
- Systematic and careful inspection of nursery crops and propagative plant material is essential to prevent introduction of GWSS and limit its spread within and from infested production nurseries. Early detection of the pest, while at very low levels, will provide the best chance of eradication. BioSecure *HACCP* guidelines provide detailed procedures for crop monitoring, import inspection and site surveillance (NGIA, 2016).

- An inspector must be trained to recognize the basic identification of all stages of GWSS, including egg masses, nymphs and adults as well as other similar insects for comparison (see Section 4.78). A production nursery layout map that includes approximate locations of known host species will be required to develop a strategy for surveys. A survey map should include species and cultivar names, locations, approximate quantity and sources of targeted plants within the area. During the survey walkthrough, record the date, observations, and sampling information directly onto the survey map. The recorded information should be reviewed and used to develop an efficient survey strategy each time the production nursery is inspected.
- Begin the inspection with an overview of the area from the crop perimeter or with a quick walk-through. If suspicious symptoms or stages of GWSS are apparent, immediately examine them more closely and collect samples if required. If no symptoms are apparent from the overview inspection, start the complete inspection by walking a systematic path through the crop. A common survey technique is to move relatively quickly down a walkway and scan both sides of adjacent production beds, back and forth. If suspicious symptoms are seen, inspect plants more closely. A good-quality 10x magnification hand lens can help identify many pest symptoms. If plants are found with suspicious symptoms or stages of GWSS are apparent, a sample should be taken and the plant marked with plastic tape or a flag with the location noted on the survey map. Also, a few plants can be selected at random to closely inspect for GWSS. Surveys can be prioritised to highest risk stock. Summaries of BioSecure *HACCP* crop monitoring procedures for both protected and unprotected nursery production areas are shown in Tables 7 and 8.
- Stock or cuttings of hosts from outside sources should be monitored closely. Note outside sourced plants on survey maps for weekly examination.

Effective ways to monitor GWSS in commercial production nurseries are:

- Standard yellow sticky card monitoring traps – yellow sticky cards can be used for surveillance and early detection of GWSS in a production nursery. Colour preference for GWSS is not known, but yellow traps are known to attract GWSS. This method will only detect adult GWSS when at relatively high population densities. GWSS are also attracted to black and incandescent lights. BioSecure *HACCP* (NGIA 2016) provides detailed information on the use of sticky traps, including trap density, positioning, replacement frequency, inspection frequency, and inspection procedures for production nurseries.
- Beat sheets, beat trays or sweep nets – when the ambient temperature is cool (below 15°C), GWSS can be detected by placing a white sheet underneath the canopy, then striking or shaking the canopy vegetation and examining the debris. Sweeping an insect net through the foliage is also suitable (Phillips 1999a; Varela *et al.* 2001).
- Visual inspections – visual inspection is the best method for detecting all stages of the sharpshooter. GWSS is a stem feeder and leaves very little visible symptoms of its feeding other than white, powdery dried excrement on plant surfaces (**Error! Reference source not found.**1). Examine leaf petioles, twigs and small branches for the presence of nymph and adult sharpshooters and the underside of leaves to detect egg masses. Procedures for crop monitoring in production nurseries are detailed in BioSecure *HACCP* (NGIA 2016), and are summarised in Tables 7 and 8.

Where GWSS is found in a production nursery that is in close proximity to potential host trees and shrubs, periodically inspect nearby hosts for signs of GWSS infestation. Infested sources within the production nursery may provide an opportunity for GWSS to spread to trees and shrubs outside the production nursery. Procedures for site surveillance are detailed in BioSecure *HACCP* (NGIA 2016).

Agricultural inspectors and other production nursery visitors should avoid moving contaminated plant material between production nurseries. Shoes, tools and vehicle tyres should be thoroughly washed of soil and then sanitised with a registered disinfectant. Extra precaution should be taken when working in areas known to be infested, including disposable overalls, overboots and hat covers that may be used and disposed of on-site.

In California, GWSS detection surveys are generally conducted in nurseries (as well as urban and residential areas) between the months of May (mid-spring) and October (mid-autumn) (CDFA 2014). This involves the use of yellow sticky traps and visual inspection of host plants. If GWSS is detected in an area not known to be previously infested, a delimitation survey is triggered. A similar approach is likely to be helpful in the event of an incursion in Australia.

Table 8. *Summary of monitoring processes for protected production areas as described in BioSecure HACCP Guidelines*

The frequency of crop monitoring is determined by the crop production cycle, immediate past surveillance results, and potential seasonal risks - but must be undertaken at not more than 7 day intervals.
If applicable, be aware of beneficial insects that may have been introduced into the area to be monitored by checking the 'Beneficial Organism Release Record'.
Begin each crop monitoring process in sterile or clean areas or those of high risk, such as propagation facilities or crop hardening off areas, and move progressively into less high risk areas such as hardened finished crops ready for despatch or known hardy crops.
Initially, upon entering the protected structure, pay close attention to crops around entry ways such as doors, gates, curtains, etc. and along main thoroughfares such as access roads, paths or laneways.
Place a flag or other marker at the entrance to the block or sampling area at the beginning of each crop monitoring activity.
Vary the entrance point to the crop monitoring area (1 to 3 m) for each subsequent crop monitoring activity to avoid inspecting the same plants each time.
Enter each block or benched area with plant material growing and visually inspect for abnormal plant growth and pest and disease symptoms or weed growth.
Walk at random through the area in a zigzag pattern with the scout following the same general pattern at each crop monitoring activity.
Make an effort to select those plants that appear less healthy for visual inspection.
Inspect at least 35 plants from within each plant group. NOTE: A plant group for monitoring purposes means a lot or batch of plants of the same species or 'type' grown on one of more blocks or benched areas within the same general location. An example of plants of the same 'type' would be Brassica species.
Inspect below surface plant parts, when possible and practical, including the plant roots and growing media for signs of pests, diseases and contaminants by randomly sampling the crop and removing the container to expose the root system.
If physiological problems are suspected take a sample of growing media for analysis along with vegetative parts if symptoms are being expressed on foliage. Samples should be collected in separate containers and marked appropriately.
Replace the plant in the container.
Inspect the tops and undersides of leaves, flowers, branches and stems looking for any direct evidence of insects, mites or diseases.

Inspect the length of stems and branches for insects, mites, and disease symptoms.
During individual plant inspections strike the foliage over a white sheet of paper/surface or a paper plate/container to dislodge small pests, primarily mites and thrips, for easier viewing.
When problems are identified increase the number of plants inspected in those areas.
Determine a rough count of plants per block with symptoms of disease or insect injury or weed infestation to establish % of crop affected.
If unable to identify pests and diseases in the field collect samples and follow up later. Clearly mark the container(s) and bag(s) containing any suspect pest/disease/weed samples.
NOTE: If a suspect emergency or quarantine plant pest, disease or weed is detected, stop the inspection, ensure consignment is isolated and secured from contact between staff and others and notify the business's BioSecure HACCP Certification Controller. To contact the relevant state or territory government biosecurity agency use the Exotic Plant Pest Hotline – 1800 084 881
Check for a problem(s) that has or have occurred regularly in the past until certain it is not present.
Record on the 'Crop Monitoring Record' sheet, pest numbers present and presence or absence of quarantine pests and diseases and any plant physiological problems discovered.
Observe any situational problems such as malfunctioning sprinkler heads, poor drainage, weeds, etc.
Using an identification guide, identify any samples collected. Seek expert opinion if hard to identify organisms are collected within the samples e.g. Department of Agriculture.
Routinely inspect growing areas and remove alternate hosts and reservoirs of disease and insect vectors, including weeds, crop residue, and old plants that will not be marketed.

Table 8. *Summary of monitoring processes for unprotected production areas as described in BioSecure HACCP Guidelines*

Unprotected Crop Monitoring Process/Requirement
The frequency of crop monitoring is determined by the crop production cycle, immediate past surveillance results and potential seasonal risks but at not more than 7 day intervals.
If applicable, be aware of beneficial insects that may have been introduced into the area to be monitored by checking the 'Beneficial Organism Release Record'.
Begin each crop monitoring process in sterile or clean areas or those of high risk, such as propagation facilities or crop hardening off areas, and move progressively into less high risk areas such as hardened finished crops ready for despatch or known hardy crops.
Pay particular attention to areas on the windward side and close to vegetative areas, waterways, water storage, vegetative waste dumps, etc.
Place a flag or other marker at the entrance to the block or sampling area at the beginning of each crop monitoring activity.
Vary the entrance point to the crop monitoring area (1 to 3 m) for each subsequent crop monitoring activity to avoid inspecting the same plants each time.
Enter each block, growing bed or benched area with plant material growing and visually inspect for abnormal plant growth and pest and disease symptoms or weed growth.
Walk at random through the area in a zigzag pattern with the scout following the same general pattern at each crop monitoring activity.
Make an effort to select those plants that appear less healthy for visual inspection.

Inspect at least 35 plants from within each plant group. NOTE: A plant group for monitoring purposes means a lot or batch of plants of the same species or 'type' grown on one of more blocks or benched areas within the same general location. An example of plants of the same 'type' would be Brassica species.
Inspect below surface plant parts, when possible and practical, including the plant roots and growing media for signs of pests, diseases and contaminants by randomly sampling the crop and removing the container to expose the root system.
If physiological problems are suspected take a sample of growing media for analysis along with vegetative parts if symptoms are being expressed on foliage. Samples collected in separate containers and marked appropriately.
Replace the plant in the container.
Inspect the tops and undersides of leaves, flowers, branches and stems looking for any direct evidence of insects, mites or diseases.
Inspect the length of stems and branches for insects, mites, and disease symptoms.
During individual plant inspections strike the foliage over a white sheet of paper/surface or a paper plate/container to dislodge small pests, primarily mites and thrips, for easier viewing.
When problems are identified increase the number of plants inspected in those areas.
Determine a rough count of plants per block with symptoms of disease or insect injury or weed infestation to establish % of crop affected.
If unable to identify pests, diseases or weeds in the field collect samples and follow up later. Clearly mark the container(s) and bag(s) containing any suspect pest/disease/weed samples.
Check for a problem(s) that has or have occurred regularly in the past until certain it is not present.
Record on the 'Crop Monitoring Record' sheet, pest, disease or weed numbers present and presence or absence of quarantine pests and diseases and any plant physiological problems discovered.
Observe any situational problems such as malfunctioning sprinkler heads, poor drainage, weeds, etc.
Using an identification guide, identify any samples collected. Seek expert opinion if hard to identify organisms are collected within the samples e.g. Department of Agriculture.
Routinely inspect growing areas, borders, etc and remove alternate hosts and reservoirs of disease and insect vectors, including weeds, crop residue, and old plants that will not be marketed.
NOTE: If a suspect emergency or quarantine plant pest, disease or weed is detected, stop the inspection, ensure consignment is isolated and secured from contact between staff and others and notify the business's BioSecure *HACCP* Certification Controller. To contact the relevant state or territory government biosecurity agency use the Exotic Plant Pest Hotline – 1800 084 881.

6.3 Delimiting surveys in the event of an incursion

- In the event of an incursion, delimiting surveys will be required to inform the decision-making process.
- The size of the survey area will depend on the size of the area known to be infested and the population itself (number of individuals and the age structure of the population). Prevailing winds and climatic conditions and movement of plant material during the period prior to detection will also influence subsequent surveillance. However, it is recommended to initially concentrate on highest risk areas within 400m of the infested property, followed by lessor risk areas within the area.
    - In California, a delimitation survey is triggered when GWSS is detected in an area not known to be previously infested. CDFA protocols dictate that all plants within a ¼ mile (400 m) radius of the original detection site be inspected (CDFA 2016a). Additional

find locations then are used as epicentres to expand survey boundaries by additional ¼ mile (400 m) increments. It has been noted that yellow sticky traps alone are generally not sufficient to detect low level GWSS infestations, and as such should be used in association with visual survey methods for delimitation (CDFA 2014).

- All potential host species (refer to Section 4.5 and 10.1) should be surveyed, with particular attention paid to the species in which the pest was initially detected.
- Surveillance for GWSS should be based on a combination of the following methods (CDFA 2016a):
    - Visual inspection of plants for all adults, nymphs, nymphal cast skins, egg masses and egg scars. Old egg scars are visible on both leaf surfaces, making them easier to detect than newly laid eggs. A representative sample of leaves should be turned over to detect egg masses. When searching for active life stages of the insect on individual plants, the probability of detection will be increased by considering the following traits of GWSS: adults and older nymphs are primarily stem feeders, new flush growth is preferred, and the insects usually select vertically-oriented shoots/twigs rather than horizontally-oriented shoots/twigs.
    - Nets (aerial and sweep) can be used to increase the effectiveness of visual searches. Either aerial or sweep nets can be used to capture GWSS adults, but aerial ones are generally considered to be more effective because they are lighter, more manoeuvrable, have larger openings, are often equipped with longer handles, and easier to retrieve captured individuals. Sweep nets are however particularly suited to sampling from short (ca. 1.2 m) woody and herbaceous plants, such as those found in nurseries, although care must be taken to ensure that plants are not injured during the process. Since GWSS adults may be widely scattered in an area and resting on non-host plants, sweep nets should always be done in association with visual examination of plants. The effectiveness of sweep nets is greatest when temperatures are below 18°C.
    - Beat sheets are particularly effective for sampling for GWSS nymphs (and their cast skins) on susceptible plant parts such as erect flush growth. Like sweep nets, beat sheets are best used at times of the day when temperatures are low and the insects are less active.
    - Standard yellow sticky traps should be used as part of the surveillance strategy. The Californian Department of Food and Agriculture have set out guidelines for trap density, trap timing, host selection, trapping sites and placement, trap replacement and inspection for delimitation surveys in urban and rural residential areas, nurseries, cropland and citrus packinghouses in non-infested counties of California (CDFA 2016a). BioSecure *HACCP* (NGIA 2016) also provides detailed information on the use of sticky traps specifically in relation to production nurseries.
- Surveillance will need to be accompanied with public awareness material, personal visits to households and businesses within the surveillance zone and buffer zones, signage and targeted awareness material for businesses.

6.4 Collection and treatment of samples

Protocols for the collection, transport and diagnosis of suspect Emergency Plant Pests (EPPs) must follow PLANTPLAN (Plant Health Australia, 2016). Any personnel collecting samples for assessment should notify the diagnostic laboratory prior to submitting samples to ensure expertise is available to undertake the diagnosis.

Sampling techniques for GWSS as described in Fletcher (2013) is shown below.

Number of specimens to be collected

It is recommended to collect at least 5 adults (individuals with wings). The aim is to obtain a male. Females are identifiable as belonging to tribe Proconiini but males are needed to confirm species identification. Therefore, 5 individuals maximises the likelihood of obtaining a male in good condition that can be identified to species level.

Preferred stage to be collected

Adults, identifiable by the presence of wings.

How to collect

Hand collecting into glass vials or vacuum collecting either with vacuum sampler or pooter (aspirator). Adults and nymphs are normally found on the trunk and stems of the host plant. Eggs are laid into underside of leaf in an ovoid or quadrate group (Figure 1b).

How to collect plant sample if required

Leaves with suspect egg masses should be picked and refrigerated (not frozen). Transfer to diagnostic centre to be carried out as soon as possible for examination.

How to preserve plant sample

Leaves with suspect egg masses can be stored for a few days between sheets of moist newspaper and kept refrigerated (not frozen).

How to preserve GWSS

Adults and nymphs can be placed in 70% and 100% (for molecular testing) ethanol and stored indefinitely. Adults can also be stored dried but may become brittle and may be damaged in transit.

How to transport GWSS

Dried specimens can be packed in tissue in a vial, which is then packed with cushioning material in a strong box. Transport in ethanol should conform to UN requirements for transport of dangerous goods.

How to transport plant sample

Leaves with egg masses should be mailed as a flat package between sheets of moist newspaper. Mail earlier in the week to avoid weekend delays.

6.5 Epidemiology study

The extent of infestation in a production nursery, on a property or within a region will depend on the initial population size and whether conditions have been favourable for the pest to spread from the initial location, i.e. sufficient temperature. Sampling should be based upon the origins of the initial suspect sample(s). Factors to consider will be:

- The proximity of other susceptible plants to the initial infestation source, including both current and previous crops. This will include crops in the production nursery or on the property with the initial detection and those on neighbouring properties
- Machinery or vehicles that have been into the infested area or in close proximity to the infestation source
- The extent of human movements into and around the infested area. A possible link to the recent importation of plant material from other regions should also be considered
- The source of any nursery stock propagation material

- If any other crops have been propagated from the same source and/or distributed from the affected nurseries
- The climatic conditions at the infected premises will also influence the extent of infestation as indicated in section 4.

6.6 Pest free area guidelines

Determination of Pest Free Areas (PFAs) should be completed in accordance with the International Standards for Phytosanitary Measures (ISPMs) 8 and 10 (IPPC 1998a, 1999).

General points to consider are:

- Design of a statistical delimiting field survey for the presence of the insect on host plants
- Surveys should be completed as described in the BioSecure *HACCP* manual (Nursery & Garden Industry Australia, 2016. Appendix 1 (A1) – Procedures), including crop monitoring procedures, site surveillance, import inspections and weed monitoring procedures
- Surveys should also consider alternative hosts (see Section 4.5) and not be limited to the primary infested host

  Information (including absence of the pest) should be recorded

Additional information is provided by the IPPC (1995) in Requirements for the Establishment of Pest Free Areas. This standard describes the requirements for the establishment and use of PFAs as a risk management option for phytosanitary certification of plants and plant products. Establishment and maintenance of a PFA can vary according to the biology of the pest, pest survival potential, means of dispersal, availability of host plants, restrictions on movement of produce, as well as PFA characteristics (size, degree of isolation and ecological conditions).

6.7 Market access impacts

Should GWSS be detected or become established in a region within Australia, there will be significant implications for both domestic and international market access in relation to movement of GWSS host material and possible carriers of GWSS. Plant parts such as fruit (including pods), leaves, stems (aboveground), shoots, trunks and branches are all know to support at least one form of GWSS life stage (eggs, nymphs, adults) (CABI 2017). Viable egg masses on nursery plants is the most likely means of GWSS introduction into new areas and countries. Shipment of fresh fruit in cartons is another effective pathway for long distance dispersal of GWSS.

6.7.1 Domestic market access

In the event that GWSS gains entry and become established in a region within Australia, the movement of nursery stock and produce from GWSS host species will be regulated to restrict spread of the pest to other localities/states. Detection and delimitation surveys will form the basis of maintaining market access for areas free of GWSS.

In California, nurseries in GWSS infested areas are only able to ship plant stock to uninfested areas of the state through adherence to strict risk mitigation protocols. These include inspections (prior to shipping as well as prior to sale at receiving nurseries), treatment of nursery stock when necessary (e.g. insecticide application), certification of shipments and quarantines. Detailed protocols for GWSS detection and delimitation surveys in different areas within California[18], as well as GWSS treatment protocols for nursery stock in California[19], are readily available. Protocols are also in place in California regarding the shipment of bulk (not commercially packed) citrus fruit and grapes, including approved postharvest treatments and field monitoring to establish that fruit has originated from a non-infested orchard[20].

6.7.2 International market access

Should GWSS be detected or become established in a region within Australia, overseas countries where the pest is not present may impose strict requirements in relation to the importation of nursery stock and produce from GWSS host species, including pre- and post-entry quarantine (for nursery stock), and various treatments which may need to be applied to the commodity. MICoR (Manual of Importing Country Requirements) is a DAWR website[21] which sets out the requirements that Australian exporters and the Department of Agriculture must meet for products and commodities to be accepted for import into specific overseas countries. MICoR is updated when there is a change to an importing country's requirements.

In the event of a GWSS incursion in Australia, the establishment of declared pest free areas within Australia will be of critical importance in the maintenance of access to international markets.

7 Course of action

Additional information is provided by the IPPC (1998b) in Guidelines for Pest Eradication Programmes. This standard describes the components of a pest eradication program which can lead to the establishment or re-establishment of pest absence in an area. A pest eradication program may be developed as an emergency measure to prevent establishment and/or spread of a pest following its recent entry (re-establish a PFA) or a measure to eliminate an established pest (establish a PFA). The eradication process involves three main activities: surveillance, containment, and treatment and/or control measures.

The course of action to a GWSS incursion outlined in this document relates only to the GWSS. Pathogens that may be carried by the GWSS, such as *X. fastidiosa*, may require alternative response strategies which are not covered in this document. A separate contingency plan[22] has been specifically developed for Pierce's disease and other diseases caused by *X. fastidiosa*, with emphasis on production nurseries.

7.1 Tracing

Trace backs and trace forwards are essential for delimiting survey activities following an initial detection. Trace backs attempt to determine the source of the infestation whereas trace forwards further define potential spread of the pest. There are many potential sources of trace backs/trace forwards. These are summarised to assist in the investigations to locate potential populations of

[18] **https://www.cdfa.ca.gov/pdcp/Documents/2016_Detection&DelimitationProtocols.pdf**

[19] **https://www.cdfa.ca.gov/pdcp/Documents/Nursery%20Stock%20BMPs%2009_11.pdf**

[20] **https://www.cdfa.ca.gov/plant/peir/docs/final/Volume-1_Main-Body.pdf**

[21] **http://micor.agriculture.gov.au/Pages/default.aspx**

[22] **http://www.planthealthaustralia.com.au/wp-content/uploads/2013/08/Pierces-disease-CP.pdf**

GWSS. However, not all of these will be relevant to all scenarios so one must determine the importance of certain lines of investigation on a case by case basis. In any case, trace backs and trace forwards will identify movement linked to IPs (Infested Premises), CPs (Contact Premises) and SPs (Suspect Premises).

7.1.1 Trace backs

For trace backs, investigate where the infested material may have been purchased or obtained. This may include (not an exhaustive list):

- Retail nursery, weekend or road-side market, or internet sale
- Production nursery – trace back to mother stock plants
- Staff, visitors, etc., both domestic & international
- Legal or illegal importation of plant material
- Items of equipment, machinery and vehicles which have been shared between properties (e.g. storage and transport bins)

Trace back plant movements should focus on stock that was received within 6 months of the detection, or longer if deemed necessary.

7.1.2 Trace forwards

Trace forwards should focus on:

- Local movement of GWSS to other host plants. GWSS tends to make many short flights, covering hundreds of meters over days or weeks (assuming that there are sufficient host plants available and warm temperatures (section 4.4).
- Prevailing wind conditions as leafhoppers can also be transported by wind over long distances (EFSA 2013).
- Long distance movement of plants via sale of plants:
    - At production nurseries there should be records of where consignments of plants have been sold. Sales of all host plants should be investigated from the last 6-12 months, or longer if deemed necessary. Keep in mind the likely lifecycle of GWSS in the region that it has been detected. If it is a temperate climate where only a small number of generations are known per year, investigations should date back for two generations (refer to the biology, Section 4.2). In a more tropical region where multiple overlapping generations are expected, 6 months may be sufficient and more practical.
    - At retail outlets, markets etc. – this will cause the scope of residential surveillance to be widened substantially.
- Premises linked directly with the initial detection, particularly where movement of vehicles or freight may have moved GWSS long distances
- Linkages to commercial production, particularly areas where host species are present

- Premises that have received equipment, vehicles, machinery or the like from the IP

For both trace forward and trace back plant movements, the critical period could be longer than the stated time periods. This period of time should, of course, be modified based on the individual circumstances of the detection. However, an initial period of six months for trace forward and twelve months for trace back is suggested as a suitable compromise between scientific rigour and the practicalities of responding to a detection.

7.2 Quarantine and movement controls

Consult PLANTPLAN (Plant Health Australia, 2016) for administrative details and procedures.

- Plant material including host nursery stock (containerised and bare rooted) and host plant produce including fruit, leaves, etc. at the site of infestation to be subject to movement restrictions
- Plant material other than a host but a potential carrier of GWSS including nursery stock and plant produce to be subject to movement restrictions
- Machinery, equipment, vehicles and disposable equipment in contact with infested plant material, or growing media/soil (in the event that it is infested with coincidental soil borne diseases) in close proximity to the site of infestation, to be subject to movement restrictions.

Movement of people, vehicles, equipment and plant material, from and to affected properties or areas, must be controlled to ensure that the pest is not moved off-property. GWSS is known to hitchhike on vehicles therefore particular care should be taken to reduce risk wherever possible. Movement controls can be achieved through the following, however specific measures must be endorsed in the Response Plan:

- Signage to indicate quarantine area and restricted movement into and within these zones
- Fenced, barricaded or locked entry to quarantine areas
- Movement of equipment, machinery, plant material by permit only. Therefore, all non-essential operations in the area or on the property should cease
- Where no dwellings are located within these areas, strong movement controls should be enforced
- Where dwellings and places of business are included within the Restricted and Control Areas movement restrictions are more difficult to enforce, however limitation of contact with infested plants should be enforced
- If a production nursery is situated within the Restricted Area, all operations must be managed under high health procedures and no material may be removed without permission, due to the high likelihood of pest spread. Movement restrictions would be imposed on both host and non-host material with appropriate risk mitigation measures implemented
- Residents should be advised on measures to minimise the inadvertent transport of GWSS from the infested area to unaffected areas
- Clothing and footwear worn at the infested site should either be double-bagged prior to removal for decontamination or should not leave the site until thoroughly disinfected, washed and cleaned
- Plant material or plant products must not be removed from the site unless approved to do so under appropriate risk mitigation measures

- Prior to leaving the affected area, all machinery, equipment and vehicles should be thoroughly washed, rinsed and disinfected with appropriate detergents and disinfectants. Machinery should be inspected for the presence of insects and if found treatment with insecticide may be required. The clean down procedure should be carried out on a hard surface, preferably a designated wash-down area, to avoid mud being re-collected from the affected site onto the machine. When using high pressure water, care should be taken to contain all plant material and mud dislodged during the cleaning process.

7.3 Destruction strategy

7.3.1 General procedures for control

- Keep traffic out of affected areas and minimise movement in adjacent areas
- Adopt best-practice property hygiene procedures to retard the spread of the pest between fields and adjacent properties
- After surveys are completed, destruction of the infested plant material is an effective control
- Conduct on-going surveillance of infested areas to ensure the pest is eradicated
- Do not use any material from infested plants for propagation

7.3.2 Destruction protocols

- Infested plants should be destroyed
- Infested plant material and disposable equipment should be disposed of by autoclaving, high temperature incineration, or double-bagging and deep burial into landfill sites
- Machinery used in destruction processes should be thoroughly washed, rinsed and disinfected with appropriate detergents and disinfectants.
- Insecticides effective against GWSS, including imidacloprid, should be applied (see Section 4.9.3 for information on insecticides)

7.3.3 Decontamination protocols

A range of insecticides are known to be effective in causing mortality in a nursery setting, including those listed in Table 4. Research has indicated that products from pyrethroids (group 3A) and neonicitinoids (group 4A) are very effective at killing adult GWSS (Grafton-Cardwell et al 2003). Disinfestation within a framework of combined *X. fastidiosa* and GWSS should focus on removing and killing insects and plant material that may vector *X. fastidiosa*.

Machinery, equipment and vehicles in contact with infested plant material or growing media/soil, or present within the Quarantine Area, should be thoroughly washed to remove plant material and growing media/soil using high pressure water or by scrubbing with products such as a degreaser/detergent, and disinfected with an appropriate sanitising agent in a designated wash down area. When using high pressure water, care should be taken not to spread plant material. High pressure water should be used in wash down areas which meet the following guidelines:

- Located away from crops or sensitive vegetation
- Readily accessible with clear signage
- Access to fresh water and power
- Mud free, including entry and exit points (e.g. gravel, concrete or rubber matting)
- Gently sloped to drain effluent away
- Effluent must not enter water courses or water bodies
- Allow adequate space to move larger vehicles
- Away from hazards such as power lines
- Waste water, growing media/soil or plant residues should be contained (see Appendix 18 of PLANTPLAN) (Plant Health Australia, 2016)
- Disposable overalls and rubber boots should be worn when handling infested plant material or growing media/soil in the field. Boots, clothes and shoes in contact with infested plant material or growing media/soil should be disinfected at the site or double-bagged to remove for cleaning
- Skin and hair in contact with infested plant material or growing media/soil should be washed

Procedures for the sterilisation of plant containers and growing media are provided within the BioSecure *HACCP* Guidelines, however, in the event of a GWSS incursion, procedures outlined in the BioSecure *HACCP* Guidelines may not be effective for the destruction of the pest. Any sterilisation procedure must be approved for use in the endorsed Response Plan.

7.3.4 Priorities

- Confirm the presence of the pest
- Prevent movement of vehicles and equipment through affected areas
- Stop the movement of any plant material that may be infested with the pest
- Determine the strategy for the eradication/decontamination of the pest and infested host material
- Determine the extent of infestation through survey and plant material trace back

7.3.5 Plants, by-products and waste processing

- Any infested plant material removed from the site should be destroyed by (enclosed) high temperature incineration, autoclaving or deep burial. It should be noted that this is also the requirement for destruction of material infected with *Xylella fastidiosa*.
- As the pest can be mechanically transmitted, plant debris from the destruction zone must be carefully handled and transported for destruction
- Infested areas or nursery yards should remain free of susceptible host plants until the area has been shown to be free from the pest

7.3.6 Disposal issues

- Particular care must be taken to minimise the transfer of infested plant material or insects from the area
- Host material, including leaf litter, should be collected and incinerated or double bagged and deep buried in an approved site

7.4 Containment strategies

For some exotic pest incursions where eradication is considered impractical, containment of the pest may be attempted to prevent or slow its spread and to limit its impact on other parts of the state or country. Containment is currently being considered for inclusion within the EPPRD. The decision on whether to eradicate or contain the pest will be made by the National Management Group, based on scientific and economic advice.

8 Technical debrief and analysis for stand down

Refer to PLANTPLAN (Plant Health Australia, 2016) for further details

The emergency response is considered to be ended when either:

- Eradication has been deemed successful by the lead agency, with agreement by the Consultative Committee on Emergency Plant Pests and the Domestic Quarantine and Market Access Working Group
- Eradication has been deemed impractical and procedures for long-term management of the pest risk have been implemented

A final report should be completed by the lead agency and the handling of the incident reviewed.

Eradication will be deemed impractical if, at any stage, the results of the delimiting surveys lead to a decision to move to containment/control.

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10 Appendices

10.1 Currently known hosts of glassy-winged sharpshooter[23]

Scientific Name	Common Name
Abelia spp.	Abelia
Acacia spp.	Acacia
Acer spp.	Japanese Maple
Aeonium spp.	Aeonium
Aeschynanthus spp.	Basket plant
Aesculus spp.	Horsechestnut
Agapanthus spp.	Agapanthus
Agave spp.	Agave
Agonis spp.	Willow myrtle
Ajuga spp.	Bugleweed
Albizia spp.	Albizzia
Aleurites spp.	Aleurites
Alnus spp.	Alder
Aloe spp.	Aloe plant
Aloysia spp.	Lemon verbena
Alpinia spp.	Ginger
Alsophila spp.	Australian tree fern
Alstroemeria spp.	Peruvian lily
Althaea spp.	Hollyhock
Amaranthus spp.	Amaranth
Ambrosia spp.	Ragweed
Amelanchier spp.	Serviceberry
Ananas spp.	Ananas
Anigozanthos spp.	Kangaroo Paw
Annona spp.	Annona (cherimoya)
Antirrhinum spp.	Snapdragon
Aptenia spp.	Aptenia
Aralia spp.	Japanese aralia
Aralia spp.	Threadleaf aralia
Arbutus spp.	Strawberry tree
Archontophoenix spp.	Seaforthia
Arctostaphylos spp.	Manzanita
Arecastrum spp.	Queen Palm
Aristolochia spp.	Brazilian dutchman's pipe
Aronia spp.	Chokecherry
Asclepias spp.	Milkweed
Asparagus spp.	Asparagus
Aspidistra spp.	Aspidistra

[23] Source: Californian Department of Food & Agriculture **https://www.cdfa.ca.gov/pdcp/Documents/HostListCommon.pdf**

Scientific Name	Common Name
Asplenium spp.	Mother fern
Aucuba spp.	Aucuba
Aucuba spp.	Gold dust plant
Azara spp.	Boxleaf azara
Baccharis spp.	Baccharis
Bauhinia spp.	Bauhinia
Begonia spp.	Begonia
Berberis spp.	Barberry
Betula spp.	Birch
Bignonia spp.	Bignonia
Bougainvillea spp.	Bougainvillea
Brachychiton spp.	Bottle tree
Brunfelsia spp.	Brunfelsia
Buddleja spp.	Butterfly bush
Buxus spp.	Boxwood
Caesalpinia spp.	Caesalpinia
Calliandra spp.	Powderpuff
Callistemon spp.	Bottlebrush
Calodendrum spp.	Cape chestnut
Camellia spp.	Camellia
Campsis spp.	Trumpet creeper
Canna spp.	Canna
Capsicum spp.	Pepper, chili
Carica spp.	Papaya
Carissa spp.	Natal Plum
Carpinus spp.	Hornbeam
Caryota spp.	Fishtail
Casimiroa spp.	White sapote
Cassia spp.	Senna
Castanopsis spp.	Chinquapin
Castanospermum spp.	Castanospermum
Catalpa spp.	Catawba
Ceanothus spp.	Redroot
Cedrus spp.	Deodar cedar
Ceratonia spp.	Carob
Ceratostigma spp.	Ceratostigma
Cercidium spp.	Palo Verde
Cercis spp.	Redbud
Cercocarpus spp.	Mountain mahogany
Cestrum spp.	Cestrum
Chamaedorea spp.	Palms
Chenopodium spp.	Lambsquarter
Chilopsis spp.	Desert willow
Chionanthus spp.	Fringe tree
Chitalpa spp.	Chitalpa
Chlorophytum spp.	St. Bernard's lily
Chorisia spp.	Floss-silk tree
Chrysanthemum spp.	Chrysanthemum
Cinnamomum spp.	Cinnamomum
Cissus spp.	Grape ivy
Cistus spp.	Rock rose
Citrus spp.	Citrus
Clematis spp.	Evergreen clematis
Cleyera spp.	Cleyera
Clivia spp.	Kaffir lily

Scientific Name	Common Name
Clytostoma spp.	Clytostoma
Cocculus spp.	Cocculus
Cocos spp.	Cocos
Coffea spp.	Coffee
Coleus spp.	Coleus
Colocasia spp.	Elephant Ear
Coprosma spp.	Coprosma
Cordyline spp.	Ti
Coreopsis spp.	Coreopsis
Cornus spp.	Dogwood
Corynocarpus spp.	New Zealand laurel
Cotoneaster spp.	Cotoneaster
Crassula spp.	Crassula
Crataegus spp.	Thornless hawthorn
Cupaniopsis spp.	Cupaniopsis
Cuphea spp.	Cuphea
Cycas spp.	Cycad
Cydonia spp.	Quince
Dalbergia spp.	Indian Rosewood
Datura spp.	Jimsonweed
Dianella spp.	Dianella
Dianthus spp.	Dianthus
Dicksonia spp.	Tree fern
Dietes spp.	Dietes
Digitalis spp.	Foxglove
Diospyros spp.	Persimmon
Distictus spp.	Blood-trumpet
Dodonaea spp.	Dodonaea
Dracaena spp.	Dracaena
Duranta spp.	Golden dewdrop
Elaeagnus spp.	Elaeagnus
Elaeocarpus spp.	Elaeocarpus
Ensete spp.	Ensete
Eremophila spp.	Red emu bush
Erigeron spp.	Fleabane
Eriobotrya spp.	Eriobotrya
Erythrina spp.	Coral tree
Escallonia spp.	Escallonia
Eucalyptus spp.	Eucalyptus
Eugenia spp.	Eugenia
Euonymus spp.	Euonymus
Eupatorium spp.	Boneset
Euphorbia spp.	Euphorbia
Euryops spp.	Euryops
Fagus spp.	Beech tree
Fatshedera spp.	Aralia ivy
Fatsia spp.	Japanese fatsia
Feijoa spp.	Feijoa
Ficus spp.	Fig
Forsythia spp.	Golden-bells
Fortunella spp.	Kumquat
Fraxinus spp.	Ash
Gardenia spp.	Gardenia
Gazania spp.	Gazania
Geijera spp.	Geijera
Gelsemium spp.	Yellow jessamine

Scientific Name	Common Name
Geranium spp.	Cranesbill
Gerbera spp.	Transvaal daisy
Ginkgo spp.	Ginko
Gladiolus spp.	Gladiolus
Gleditsia spp.	Honey locust
Gossypium spp.	Cotton
Grevillea spp.	Spider flower
Grewia spp.	Grewia
Griselinia spp.	Griselinia
Hardenbergia spp.	Hardenbergia
Harpephyllum spp.	Kaffir plum
Hebe spp.	Hebe
Hedera spp.	Ivy
Hedychium spp.	Ayo ginger
Helianthus spp.	Sunflower
Hemerocallis spp.	Daylily
Heteromeles spp.	Toyon
Hibbertia spp.	Guinea Gold Vine
Hibiscus spp.	Hibiscus
Howea spp.	Sentry palm
Hydrangea spp.	Hydrangea
Hymenosporum spp.	Hymenosporum
Hypericum spp.	St. John's-wort
Ilex spp.	Holly
Ipomoea spp.	Morning glory
Itea spp.	Itea
Jacaranda spp.	Green ebony
Jasminum spp.	Jasmine
Juglans spp.	Walnut
Juniperus spp.	Juniper
Kalanchoe spp.	Kalanchoe
Koelreuteria spp.	Golden-rain tree
Lactuca spp.	Lettuce
Lagerstroemia spp.	Crape myrtle
Lantana spp.	Shrub verbena
Laurus spp.	Laurel
Leonotis spp.	Lionstail
Lepidospartum spp.	Scalebroom
Leptospermum spp.	Leptospermum
Leucodendron spp.	Leucodendron
Leucophyllum spp.	Texas Ranger
Leucospermum spp.	Pincushion
Ligustrum spp.	Privet
Limonium spp.	Statice
Lippia spp.	Lippia
Liquidambar spp.	Sweet gum
Liriodendron spp.	Tulip tree
Liriope spp.	Giant turf lily
Liriope spp.	Liriope
Litchi spp.	Lychee
Lithocarpus spp.	Lithocarpus
Lonicera spp.	Honeysuckle
Lophostemon spp.	Box tree
Loropetalum spp.	Loropetalum
Luma spp.	Luma

Scientific Name	Common Name
Macadamia spp.	Macadamia
Macfadenya spp.	Cat's claw
Magnolia spp.	Magnolia
Mahonia spp.	Oregon grape
Malus spp.	Apple
Malva spp.	Mallow
Mandevilla spp.	Mandevilla
Mangifera spp.	Mango
Markhamia spp.	Markhamia
Maytenus spp.	Maytenus
Melaleuca spp.	Honey myrtle
Melia spp.	Chinaberry
Metrosideros spp.	Metrosideros
Michelia spp.	Champak
Mirabilis spp.	Umbrella wort
Monarda spp.	Wild bergamot
Monstera spp.	Monstera
Moringa spp	Moringa
Morus spp.	Mulberry
Murraya spp.	Orange Jessamine
Musa spp.	Banana
Myoporum spp.	Myoporum
Myrsine spp.	Myrsine
Myrtus spp.	Myrtle
Nandina spp.	Nandina
Neolitsea spp.	Japanese silvertree
Nephrolepis spp.	Sword fern
Nerium spp.	Oleander
Nicotiana spp.	Tree tobacco
Nyssa spp.	Tupelo
Oenothera spp.	Evening primrose
Olea spp.	Olive
Opuntia spp.	Cactus
Osmanthus spp.	Osmanthus
Osteospermum spp.	Osteospermum
Pachysandra spp.	Spurge
Pandorea spp.	Pandorea
Parkinsonia spp.	Mexican Palo Verde
Parthenocissus spp.	Woodbine
Passiflora spp.	Passion fruit
Pelargonium spp.	Pelargonium
Penstemon spp.	Beard-tongue
Pereskia spp.	Barbados Gooseberry
Persea spp.	Avocado
Philadelphus spp.	Mock orange
Philodendron spp.	Philodendron
Phlox spp.	Phlox
Phoenix spp.	Date palm
Phormium spp.	Flax lily
Photinia spp.	Photinia
Phyla spp.	Frogfruit
Phytolacca spp.	Pokeweed
Pinus spp.	Pine
Piper spp.	Pepper plant
Pisonia spp.	Umbrella catchbird tree

Scientific Name	Common Name
Pistacia spp.	Pistachio
Pithecellobium spp.	Pithecellobium
Pittosporum spp.	Pittosporum
Platanus spp.	Sycamore
Platycerium spp.	Staghorn fern
Plectranthus spp.	Plectranthus
Plumbago spp.	Leadwort
Podocarpus spp.	Podocarpus
Polygala spp.	Milkwort
Polygonum spp.	Polygonum
Populus spp.	Cottonwood
Portulacaria spp	Portulacaria
Prosopis spp.	Mesquite
Protea spp.	Protea
Prunus spp.	Prunus
Pseudopanax spp.	Five finger
Psidium spp.	Guava
Punica spp.	Pomegranate
Pyracantha spp.	Pyracantha/Firethorn
Pyrus spp.	Pear
Quercus spp.	Oak
Raphiolepis spp.	Raphiolepis
Rauvolfia spp.	Indian snakeroot tree
Ravenea spp.	Majestic palm
Rhamnus spp.	Buckthorn
Rhapis spp.	Lady palm
Rhododendron spp.	Azalea
Rhoicissus spp.	Evergreen grape
Rhus spp.	Sumac
Ricinus spp.	Castorbean
Robinia spp.	Locust
Romneya spp.	Matilija poppy
Rosa spp.	Rose
Rubus spp.	Blackberry
Rudbeckia spp.	Coneflower
Ruellia spp.	Mexican bluebells
Salix spp.	Willow
Salvia spp.	Sage
Sambucus spp.	Elderberry
Sapium (Triadica) spp.	Chinese tallow
Sapium spp.	Sapium
Sarcococca spp.	Sweet box
Sassafras spp.	Sassafras
Schefflera spp.	Umbrella tree
Schinus spp.	Schinus
Schlumbergera spp.	Christmas cactus
Simmondsia spp.	Jojoba
Solandra spp.	Gold cup
Solanum spp.	Solanum
Solidago spp.	Goldenrod
Sollya spp.	Australian bluebell creeper
Sonchus spp.	Sonchus
Sophora spp.	Sun king sophora
Sorbus spp.	Mountain ash

Scientific Name	Common Name
Sorghum spp.	Sorghum
Spathodea spp.	African tulip tree
Stenocarpus spp.	Firewheel tree
Stephanotis spp.	Madagascar jasmine
Strelitzia spp.	Bird-of-paradise
Syringa spp.	Lilac
Syzygium spp.	Syzygium
Tabebuia spp.	Trumpet tree
Tecoma spp.	Yellowbells
Tecomaria spp.	Tecomaria
Ternstroemia spp.	Ternstroemia
Tetradium spp.	Bee bee Tree
Thuja spp.	Arborvitae
Thunbergia spp.	Blue sky flower
Tilia spp.	American linden tree
Tipuana spp.	Tipu Tree
Trachelospermum spp.	Trachelospermum
Trachycarpus spp.	Wind palm
Tradescantia spp.	Spiderwort
Tristania spp.	Tristania
Tristaniopsis spp.	Water gum
Tulbaghia spp.	Tulbaghia

Scientific Name	Common Name
Tupidanthus spp.	Tupidanthus
Ulmus spp.	Elm
Vaccinium spp.	Blueberry
Vauquelinia spp.	Arizona rosewood
Veronica spp.	Speedwell
Viburnum spp.	Viburnum
Vigna spp.	Vigna
Vinca spp.	Periwinkle
Viola spp.	Violet
Vitex spp.	Chaste tree
Vitis spp.	Grape
Washingtonia spp.	Washington palm
Wisteria spp.	Wisteria
Wollemia spp.	Wollemia
Xanthium spp.	Cocklebur
Xylosma spp.	Xylosma
Yucca spp.	Yucca
Zamia spp.	Cardboard sago
Zantedeschia spp.	Calla lily
Zea spp.	Zea
Zelkova spp.	Sawleaf Zelkova
Zinnia spp.	Zinnia
Ziziphus spp.	Jujube

10.2 Diagnostic service facilities in Australia[24]

Facility	State	Details
Crop Health Services	VIC	AgriBio Specimen Reception Main Loading Dock, 5 Ring Road La Trobe University, Bundoora VIC 3083 Ph: 03 9032 7515; Fax: 03 9032 7064
DPI New South Wales – Elizabeth Macarthur Agricultural Institute	NSW	Woodbridge Road Menangle NSW 2568 PMB 8 Camden NSW 2570 Ph: (02) 4640 6327; Fax: (02) 4640 6428
SARDI Plant Research Centre – Waite Main Building, Waite Research Precinct	SA	Hartley Grove Urrbrae SA 5064 Ph: (08) 8303 9400; Fax: (08) 8303 9403
Biosecurity Queensland – Department of Agriculture and Fisheries	QLD	DAF Ecosciences Precinct Dutton Park Q 4102 Ph: (07) 3404 6999; Fax (07) 3404 6900
Department of Agriculture and Food, Western Australia (AGWEST) Plant Laboratories	WA	3 Baron-Hay Court South Perth WA 6151 Ph: (08) 9368 3721; Fax: (08) 9474 2658

[24] For use in professional diagnostics and advisory services in the case of an incursion.