

**INDUSTRY BIOSECURITY PLAN
FOR THE NURSERY & GARDEN INDUSTRY**

Threat Specific Contingency Plan

Citrus longicorn beetle
Anoplophora chinensis

Plant Health Australia

July 2009



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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 the longicorn beetle *Anoplophora chinensis*. While many species of longicorn beetles occur throughout the world, this document will refer only to this species (referred to by the common name Citrus longicorn beetle) unless otherwise stated. It provides guidelines and options for steps to be undertaken and considered when developing a Response Plan to this pest. Any Response Plan developed 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, if affected by actions carried out under the Response Plan.

The information for this plan has been primarily obtained from CABI Crop Compendium (www.cabicompendium.org). Modifications and additions to the plan have been completed to make the information relevant to an incursion of longicorn beetle in the nursery and garden industry.

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.

Nursery production adds value to Australia's primary industry's sector and in 2008/2009 is forecast to contribute more than \$2 billion to the national economy. Nursery production is a highly diverse primary industry servicing the broader \$14 billion horticultural sector within Australia (Table 1).

Table 1. Nursery production supply sectors within Australian horticulture

Production Nursery	Horticultural markets	Economic value
Container stock ¹	Ornamental/urban horticulture	\$2 billion retail value
Foliage plants ¹	Interior-scapes	\$87 million industry
Seedling stock ²	Vegetable growers	\$3.3 billion industry
Forestry stock ³	Plantation timber	\$1.7 billion industry
Fruit and nut tree stock ²	Orchardists (citrus, mango, etc)	\$5.2 billion industry
Landscape stock ¹	Domestic & commercial projects	\$2 billion industry
Plug and tube stock ⁴	Cut flower	\$319 million industry
Revegetation stock ¹	Farmers, government, landcare	\$109 million industry
Mine revegetation	Mine site rehabilitation	Value unknown
Total horticultural market value		\$14.5 billion

3 Eradication or containment determination

Eradication of Citrus longicorn beetle has been, or is currently being, attempted in the Netherlands (eradicated), Italy (restricted distribution, eradication program underway) and the USA (restricted distribution; eradicated from Georgia and Wisconsin). The successful eradication from the Netherlands and early indications from current eradication programs in other countries indicate that this course of action is currently feasible following an incursion.

It should be noted however, that all adult longicorn beetles fly readily and eradication is likely to be considered feasible only if the initial detection is contained within an area small enough and/or isolated enough that an infestation can be destroyed.

The decision to eradicate should be based both on the potential economic impact of tree damage resulting from longicorn beetle infestation and on technical feasibility. Eradication costs must factor in long term surveys to prove the success of the eradication program. Two years with no detections of the pests will be necessary to confirm that no longicorn beetle larvae remain viable before pest free status can be declared.

¹ Data sourced from Market Monitor

² Data sourced from Horticultural Handbook 2004

³ Data sourced from ABARE 2005

⁴ Data sourced from industry

4 Pest information/status

4.1 Pest details

Common names:	Citrus longicorn beetle; Citrus longhorned beetle; Citrus longhorn beetle; Black and white citrus longhorn; Citrus root cerambycid; Mulberry white-spotted longicorn; White-spotted longicorn beetle
Taxonomic position:	Animalia: Arthropoda: Insecta: Coleoptera: Cerambycidae
Scientific name:	<i>Anoplophora chinensis</i> (Forster, 1771)
Synonyms:	<p>While Gressitt (1951) recognized <i>A. chinensis</i> and <i>A. malasiaca</i> as two distinct species, Duffy (1968) considered them a single species. In other literature, <i>A. malasiaca</i> has been treated as synonymous with, or as a variation of, <i>A. chinensis</i> or <i>A. macularia</i> for over 100 years. Most recently Lingafelter and Hoebeke (2002) synonymised <i>A. malasiaca</i> with <i>A. chinensis</i> because they share so many characteristic features.</p> <p>The following species have also been listed as synonyms of <i>A. chinensis</i>:</p> <p><i>Anoplophora chinensis</i> Bates; <i>A. chinensis</i> Breuning 1944; <i>A. malasiaca</i> (Thomson); <i>A. malasiaca malasiaca</i> Samuelson 1965; <i>A. perroudi</i> Pic 1953; <i>A. sepulchralis</i> Breuning 1944; <i>Callophora afflita</i> Thomson 1865; <i>Callophora luctuosa</i> Thomson 1865; <i>Calloplophora abbreviata</i> Thomson 1865; <i>Calloplophora malasiaca</i> Thomson 1865; <i>Calloplophora sepulcralis</i> Thomson 1865; <i>Cerambyx chinensis</i> Forster 1771; <i>Cerambyx farinosus</i> Houttuyn 1766; <i>Cerambyx sinensis</i> Gmelin 1790; <i>Cerambyx pulchricornis</i> Voet 1778; <i>Lamia punctator</i> Fabricius 1777; <i>M. chinensis</i> Forster; <i>M. chinensis</i> Matsumura 1908; <i>M. chinensis macularius</i> Kojima 1950; <i>M. chinensis</i> var. <i>macularia</i> Bates 1873; <i>M. chinensis</i> var. <i>macularis</i> Matsushita 1933; <i>M. chinensis</i> var. <i>sekimacularius</i> Seki 1946; <i>M. macularius</i> Kolbe 1886; <i>M. malasiacus</i> Aurivillius 1922; <i>M. perroudi</i> Pic 1953.</p> <p>The following species have also been recognised as synonyms of <i>A. malasiaca</i>:</p> <p><i>Anoplophora macularia</i> Breuning; <i>Calloplophora macularia</i> Thomson; <i>Melanauster chinensis</i> var. <i>macularia</i> Bates; <i>M. macularius</i> Kolbe; <i>M. chinensis</i> Matsumura.</p>

4.1.1 Background

The citrus longicorn beetle (CLB), *Anoplophora chinensis*, is a large wood-boring beetle endemic to many regions of Asia. Populations of CLB have been detected in regions of Europe and North America, although it has been successfully eradicated from several countries, including mainland USA and the Netherlands. It is considered a destructive pest due to the detrimental effects of the larval feeding activities, that reduce plant vigour and result in plant death in young or small plants.

The CLB attacks a wide range of plant species, particular citrus and other fruit trees. Eggs are usually laid under the bark of the lower trunk or exposed roots. Larvae and pupae remain under the bark or within the woody tissue while feeding on the host plants, and can damage the vascular tissue. The sawdust discarded by the larvae during feeding is the most distinguishing feature of CLB infestation. Adult beetles then exit host tissue and feed on leaves and other foliage. As CLB are large insects, these can easily be seen on the leaves of host plants.

Australia currently has a number of large endemic beetles (>2 cm in length) that share characteristics with the CLB, but none are considered as destructive to commercial plants. CLB can also be confused with the Asian longhorn beetle (*A. glabripennis*; Figure 1), which is exotic and has a similar

geographic distribution to the CLB. The Asian longhorn beetle attacks a comparable host range to CLB and results in similar symptoms.



Figure 1. Beetles of the *Anoplophora* genus include CLB (left) and Asian longhorn beetle (right). Images obtained from www.padil.gov.au.

4.1.2 Life cycle

The CLB life cycle can take up to two years depending on climatic and feeding conditions. In tropical and subtropical regions, the life cycle is completed within a single year. Adults usually survive for about 30 days, although have been recorded as surviving for about 70 days in Japan. In the northern hemisphere, adults appear to be most abundant in spring and summer (May to August) feeding on leaves, petioles and young bark of hosts.

Females lay about 70 eggs under the bark of host trunks, usually in the 60 cm directly above the soil surface. After hatching, larvae tunnel just under the bark of the trunk and branches, and can enter the woody parts of the lower trunk and roots later in development. Pupation takes place within the woody tissue, usually at the upper part of the feeding area.

4.1.3 Dispersal

Like other members of the Cerambycidae family, adult CLB readily fly. The closely related Asian longhorn beetle is a strong flier, with almost all adult beetles dispersing over 1 km from their point of origin. Over the course of a season, these beetles can disperse up to 2.5 km from where they hatched.

The most likely mechanism of dispersal over longer distances is through the movement of eggs, larvae and pupae in woody planting material, such as nursery stock. Entry into Germany and the Netherlands occurred on bonsai plants.

4.2 Affected hosts

4.2.1 Host range

CLB have been recorded as attacking over 100 species of woody trees (CAB International, 2007). Primary hosts are listed as *Citrus sinensis* (navel orange), *C. aurantiifolia* (lime), *C. aurantium* (sour orange), *C. limonia* (mandarin lime), *C. maxima* (pummelo) and *C. nobilis* (tangerine). Other hosts are *Psidium guajava* (guava), *Carya illinoiensis* (pecan), *Malus pumila* (apple), *Casuarina equisetifolia* (Australian pine) and species within *Alnus*, *Litchi*, *Melia*, *Morus*, *Populus* and *Salix*.

Minor hosts listed within CABI are *Acer negundo* (box elder), *Acer palmatum* (Japanese maple), *Acer pictum* (painted maple), *Betula platyphylla* (Manchurian birch), *Broussonetia papyrifera* (paper mulberry), *Cajanus cajan* (pigeon pea), *Carpinus laxiflora*, *Castanea crenata* (Japanese chestnut), *Cryptomeria japonica* (Japanese cedar), *Elaeagnus umbellata* (autumn elaeagnus), *Fagus crenata* (Siebold's beech), *Ficus carica* (fig), *Fortunella margarita* (oval kumquat), *Hedera rhombea* (japanese ivy), *Hibiscus mutabilis* (cottonrose), *Juglans* (walnuts), *Lagerstroemia indica* (indian crape myrtle), *Litchi sinensis*, *Mallotus japonicus*, *Melia azedarach* (Chinaberry), *Morus alba* (mora), *Persea thunbergii*, *Pinus massoniana* (masson pine), *Platanus acerifolia* (London planetree), *Platanus orientalis* (plane), *Prunus armeniaca* (apricot), *Prunus mume* (Japanese apricot tree), *Prunus pseudocerasus* (chinese fruiting cherry), *Prunus yedoensis*, *Pyracantha angustifolia* (Narrow-leaf firethorn), *Pyrus communis* (European pear), *Pyrus pyrifolia* (Oriental pear tree), *Rosa multiflora* (Multiflora rose), *Rubus microphyllus*, *Ulmus davidiana* (japanese elm), *Ulmus pumila* (dwarf elm), *Ziziphus mauritiana* (jujube).

4.2.2 Current geographic distribution

The CLB originates from, and is primarily present, in Asia. Isolated populations have been detected in Europe and North America. This pest been successfully eradicated from the Netherlands and mainland USA.

The following geographic distribution was obtained from CAB International (2007), although it is noted that some citations of earlier pest presence are included even though later authorisation indicates the pest is absent:

- Provinces/sites within China (Anhui, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hainan, Hebei, Hubei, Hong Kong, Hunan, Jiangsu, Jiangxi, Liaoning, Macao, Shaanxi, Sichuan, Taiwan, Xizhang, Yunnan and Zhejiang) either as widespread or present but no further details
- Indonesia (Sumatra) as present but no further details
- Japan (Hokkaido, Honshu, Kyushu, Ryukyu Archipelago and Shikoku) as widespread
- Korea (DPR and Republic of Korea) as present but no further details and widespread respectively
- Malaysia (Peninsular Malaysia) as present but no further details
- Myanmar as present but no further details
- Philippines present but no further details
- Vietnam as restricted distribution
- France as present, few occurrences
- Italy as restricted distribution

- Netherlands as eradicated
- United Kingdom as absent, intercepted only
- USA as restricted distribution (California, absent with interceptions only; Georgia, eradicated; Hawaii, present but no further details; Washington, present with few occurrences; Wisconsin, eradicated).

Further details can be obtained from the EPPO website (www.eppo.org).

4.2.2.1 POTENTIAL DISTRIBUTION IN AUSTRALIA

CLB is considered to be a quarantine pest by the European Union and the European and Mediterranean Plant Protection Organization (EPPO), representing a significant risk to Mediterranean countries, and therefore would be equally considered a risk to Australian citrus growing regions.

4.2.3 Symptoms

The CLB larvae are the most damaging stage of the insects life cycle. Adult females cut a T-shaped slit through the bark in tree trunk close to the ground or on an exposed root and lay an egg. Larvae hatch and bore into the stem, destroying the pith and vascular system of the tree. They enter the heart wood and tunnel up and down, leaving large amounts of frass (sawdust) and wood pulp through holes in the bark. Piles of frass are conspicuous and give an indication of the degree of infestation. Adult beetles eat young leaves, branches and bark (CAB International, 2007). Wounds created by feeding of larvae and adults can increase host susceptibility to secondary plant pathogens. Feeding by larvae can result in death of part, or all, of the tree.

Key symptoms of CLB infestation:

- Presence of feeding adults on foliage
- Round exit holes (6-11 mm), usually towards the base of the trunk (Figure 2)
- Sap bleeding from egg laying sites
- Frass (sawdust) at the base of infested trees
- Possible swellings in the trunk where pupal chambers occur



Figure 2. Round exit hole of CLB in the base of host tree. Image obtained from www.forestryimages.org.

4.3 Diagnostic information

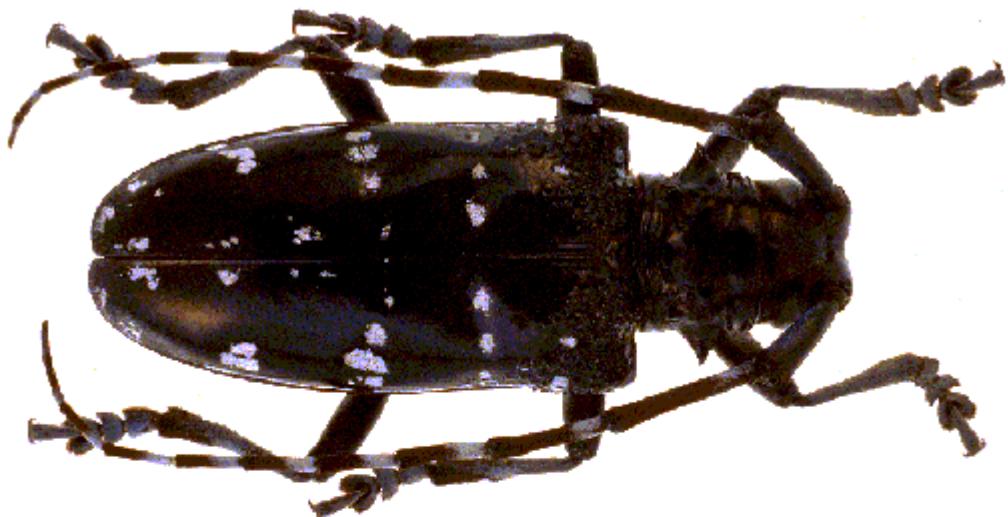
Detailed information on morphology and diagnostic information can be found in Lingafelter and Hoebelke (2002). Key diagnostic features are listed below:

- **Eggs** are elongate, approximately 6 mm long and 1.5-2 mm wide. They are creamy-white, changing to yellow-brown in colour closer to hatching
- **Larvae** (Figure 3) lack obvious legs and are elongate and cylindrical, 50-60 mm long and 5-10 mm (at the broadest point) wide. They taper gradually behind the prothorax towards the end of the abdomen, but are slightly broadened apically. Larvae are creamy white with some chitinized patterns on the prothorax and a pitchy-black head. The pronotum has a narrow orange transverse band near the anterior margin and a large, orange, raised area posteriorly. The ocelli (small eyes), one on each side, are slightly chitinized on the surface and are ventro-lateral to the antennae. The antennae in larvae are very short and three-segmented. An illustrated description of the larvae can be found in Duffy (1968).



Figure 3. CLB larvae. Image obtained from www.forestryimages.org.

- **Pupae** are light yellow in colour with legs and long coiled antennae. They are 24-38 mm long.
- **Adults** (Figure 4) are black and shiny with irregular (10-12) white spots on the outer wing cover. Males are 21 mm in length and females are 37 mm, and have antennae 1.2 (females) to 1.7-2 (males) times the body length. They are typically cerambycid in shape, and the head, antennae, legs and underside are covered with very fine pale-blue to white pubescence. A stout spine extends laterally from each side of the top surface of the protothorax. The head is held vertically downwards. Antennae are inserted on distinct prominences forming a strong V on the top of the head. The basal region of the antennae has a distinct apical scar-like region. The antennae have eleven segments, each marked with a white or light-blue band near its base (Figure 5).
 - In males, the elytra (hardened forewing) is narrow and covers the abdomen
 - In females, the elytra is rounded and is partially covered by the abdomen



Anoplophora chinensis—female



Anoplophora chinensis—male

Figure 4. CLB female (above) and male (below) adults. Image obtained from www.pestalert.org.



Figure 5. Magnified view of CLB antennae showing white to light blue banding pattern. Image obtained from www.padil.gov.au.

4.4 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 impact of establishment. Within the Nursery and Garden Industry Biosecurity Plan (Plant Health Australia, 2008b), the overall risk of the CLB was determined to be very low. However, during the preparation of this plan, literature searches carried out on this pest provided additional information on the entry and spread potentials, resulting in new values being assigned. Based on the updated information, the overall risk of CLB to Australia is considered medium. A summary of these ratings are shown in Table 2.

Table 2. Pest risk ratings for CLB

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

4.4.1 Entry potential

Rating: HIGH

Although CLB is widespread throughout Asia and is a capable flier, natural entry of this pest is considered negligible. The most likely route of pest entry is through eggs, larvae and pupae contained within woody plant material and possibly packing material. Introduction of this pest to other countries, such as Germany and the Netherlands has been by contaminated bonsai plants. While adults are large and easily spotted, the immature stages that would most likely be transported are contained within the wood and would be difficult to spot. Wood-boring beetles are often detected in Australian border or immediate post-border inspections. Therefore, the entry potential of CLB is considered to be **high**.

4.4.2 Establishment potential

Rating: MEDIUM

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

4.4.3 Spread potential

Rating: HIGH

Adult beetles are strong fliers, able to distribute several kilometres from the site of hatching. The wide potential host range, including both cultivated and natural species (see Section 4.2.1), provides a large potential distribution area for the pest. The beetle also has a high reproductive potential, especially in the northern regions of Australia. In addition, CLB is easily transported in a range of plant material and wood products, including logs, wooden packing materials and pallets. Therefore, the spread potential is considered **high**.

4.4.4 Economic impact

Rating: MEDIUM

CLB would cause a **medium** impact to the nursery and garden industry due to the following:

- Directly causes tree mortality or predisposes host to mortality by other organisms

- No effective controls measures exist
- Attacks a wide range of hosts with significant commercial value
- Damage to small young trees is the most serious (Kojima & Hayashi, 1974; Lieu, 1945)

4.4.5 Overall risk

Rating: MEDIUM

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

5 Pest management

5.1 Response checklist

The following checklist (Table 3) provides a summary of generic requirements to be identified and implemented within a Response Plan.

Table 3. Checklist of requirements to be identified in a Response Plan

Checklist item	Further information
Destruction methods for plant material, soil and disposable items	Sections 6.1.1 and 6.1.2
Disposal procedures	Section 6.1.5
Quarantine restrictions and movement controls	Section 6.3
Decontamination and property cleanup procedures	Section 6.5
Diagnostic protocols and laboratories	Sections 4.3 and 9.1
Trace back and trace forward procedures	Section 6.6
Protocols for delimiting, intensive and ongoing surveillance	Section 5.2
Zoning	Section 6.4
Reporting and communication strategy	Section 9.3

Additional information is provided by Merriman and McKirdy (2005)⁵ in the Technical Guidelines for Development of Pest Specific Response Plans.

5.2 Surveys and epidemiology studies

Information provided in Section 5.2.1 to 5.2.3 provides a framework for the development of early detection and delimiting surveys for CLB in Australia.

⁵ Available on the Plant Health Australia website (www.planhealthaustralia.com.au/biosecurity)

Where CLB is found in a production nursery that is in close proximity to potential host trees and shrubs, periodically inspect nearby hosts for signs of CLB infestation. Infested sources within the nursery may provide an opportunity for CLB to spread to trees and shrubs outside the nursery.

Agricultural inspectors and other nursery visitors should avoid moving contaminated plant material between 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 overboots that may be used and disposed of on-site (see Sections 6.1 and 6.5.1).

5.2.1 Technical information for planning surveys

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

- Endemic host species in Australia are likely to be numerous and widely dispersed
- Movement of the pest can occur by insect flight (short distance of up to 2.5 km) or within woody plants or wood products (long distance)
- Adults beetles are large and easily spotted, but immature stages are contained within woody plants and plant products and hard to detect
- Significant proportions of Australia have favourable climatic conditions for CLB spread and establishment

5.2.2 Surveys for early detection of an incursion in a nursery

The eradication of a CLB incursion in a nursery is more likely following early detection of the pest, before the insect has had the opportunity to disperse to a wide area. 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 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 CLB and limit its spread within and from infested nurseries. Early detection of the pest, while at very low levels, will provide the best chance of eradication.
- An inspector must be trained to recognise the basic identification of all stages of CLB, including eggs, larvae, pupae and adults as well as other similar insects for comparison (see Sections 4.2.3 and 4.3). Inspectors should also be able to recognise the tree symptoms of CLB infestation as large amounts of frass are often the most recognisable signs. A 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 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 CLB 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 CLB 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 CLB. Surveys can be prioritised to highest risk stock.
- 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 CLB in commercial nurseries are:

- Identification of frass (sawdust) around the base of infested trees. Frass is ejected through holes in the bark during larval feeding
- Adults are large and can be seen easily with the naked eye
- Vertically scraped sections of bark may indicate adult damage
- Exit holes (Figure 2) and oviposition slits in the base of host trees

5.2.3 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 infested area and the insect population size, proximity of potential host plants, possible movement of plants from the infested area, as well as prevailing winds during the period prior to detection
- All potential host species (refer to Section 4.2) should be surveyed, with particular attention paid to the species in which the pest was initially detected
- If the incursion is in a populated area, publication and distribution of information sheets and appeals for public assistance may assist

5.2.4 Collection and treatment of samples

Protocols for the collection, transport and diagnosis of suspect Emergency Plant Pests (EPPs) must follow PLANTPLAN (Plant Health Australia, 2008a). Any personnel collecting samples for assessment should notify the diagnostic laboratory prior to submitting samples to ensure expertise is available to undertake the diagnosis.

5.2.4.1 COLLECTION OF SPECIMENS

Sampling procedures

Samples to be collected by hand then placed in glass vials. Adults are normally found on the leaves of the host plant. The adults stage is the most definitive for the identification process. Eggs, larvae and

pupae are found under the bark or burrowed into the woody tissue. Extraction of these immature stages should not be attempted as this might damage the eggs, larvae or pupae making identification impossible. The best method of collection for these life stages is to collect the plant material containing the insects, which should be sent in intact.

Number of specimens to be collected

Where possible it is advisable to collect a large number of specimens of all life stages. With adult stages collect a number of specimens of varying size and colour depicting variation in the morphology. While the collection of all life stages is valuable, the adult beetles are the most definitive stages for identification.

Record the identity of the host plant. Record the location, preferably as GPS co-ordinates, or alternatively, a map reference or distance and direction from a suitable landmark. If the land is privately owned, record the owner's details including contact telephone numbers.

How to preserve CLB

CLB adults and other life stages can be placed in 70% ethanol and stored indefinitely, although their colour fades gradually over time.

How to transport CLB

Vials of ethanol should be sealed to avoid leakage and packed with cushioning material in a strong box.

How to collect and send plant samples containing CLB eggs, larvae and pupae

Adults are the preferred stage for identification. However, if adult CLB specimens are not available, eggs, larvae and pupae should be collected but may need to be reared to the adult stage for species identification. In young trees showing signs of CLB egg, larvae or pupae presence (see Section 4.2.3) cut out the region of the trunk or upper roots above and below where the symptoms are present. The plant material should be sealed in a plastic bag and wrapped in sheets of moist newspaper. Each sealed bag should be placed in a second bag along with additional paper to absorb excess moisture. Bagged samples should then be placed in a cardboard box or padded envelope with paper/bubble/foam to fill the remaining space and protect samples during transit.

All sample containers should be clearly labelled with the name, address and contact phone number of both the sending and receiving officers. In addition containers should be clearly labelled in accordance with the requirements of PLANTPLAN (Plant Health Australia, 2008a). Containers should then be carefully sealed to prevent loss, contamination or tampering of samples. The Chief Plant Health Manager will select the preferred laboratory. Additional labelling includes the identification of plant species/parts affected, location of affected plant (where available include GPS reading) as well as symptoms and an image if available.

Refer to PLANTPLAN for packing instructions under IATA 650.

Precaution

Overheating or desiccation of samples prior to despatch should be prevented. Samples may be stored in a fridge (4-10°C) for a few days if necessary.

Receipt

On receipt of the samples the diagnostic laboratory should follow strict quarantine and processing guidelines. In keeping with ISO 17025 refer to PLANTPLAN (Plant Health Australia, 2008a).

5.2.5 Epidemiological study

The extent of infestation in a 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. 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 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

5.2.6 Models of spread potential

No models of spread potential have been developed for CLB.

5.2.7 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 (see Section 5.2 for points to consider in the design)
- Surveys should be completed as described in the BioSecure HACCP manual (Nursery and Garden Industry Australia, 2008), including monitoring processes (summarised in Table 4 and Table 5), indicator plants and weed monitoring
- Surveys should also consider alternative hosts (see Section 4.2.1) and not be limited to the primary infested host
- Information (including absence of the pest) should be recorded

Table 4. Summary of monitoring processes for protected production areas as described in BioSecure HACCP Guidelines

Wear protective clothing when handling suspect samples
Walk at random through the area in a zigzag pattern
Take at least 10 minutes to inspect 10-20 plants or plug trays per 100 m ² of production area
Inspect the tops and bottoms or leaves, looking for any direct evidence of insects
Inspect the entire plant if it has less than 6 leaves, or from larger plants select six leaves from all parts of the plant (upper, lower, middle) and examine them individually
Inspect the length of all trunks, stems and branches for insects and symptoms
If any plants show suspect symptoms or evidence of eggs, larvae or pupae (refer to Section 4.2.3) take a sample (refer to Section 5.2.4) to be formally diagnosed (refer to Section 4.3)
Check for a problem that have occurred regularly in the past, until you are certain it is not present
Record on the „Crop Monitoring Record“ sheet the presence or absence of the pest
Routinely inspect growing areas and remove alternate hosts and reservoirs of the pest, including weeds, crop residues and old plants that will not be marketed

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).

Table 5. Summary of monitoring processes for field production areas as described in BioSecure HACCP Guidelines

Wear protective clothing when handling suspect samples
Pay particular attention to areas on the windward side, the sides bordering ditches, canals or other uncultivated areas and growing block centres
Place a flag or other marker at the entrance to the block or sampling area at the beginning of each inspection
Vary the entrance point in the sampling area (1m to 3m) for each subsequent sampling so that the same plants are not inspected each time
Walk at random through the area in a zigzag pattern
The scout should follow the same general pattern at each sampling
Make an effort to select those plants that appear less healthy for visual inspection
Take at least 10 minutes to inspect 10-20 plants or plug trays per 100 m ² of production area
Inspect the tops and bottoms or leaves, looking for any direct evidence of insects
Inspect the entire plant if it has less than 6 leaves, or from larger plants select six leaves from all parts of the plant (upper, lower, middle) and examine them individually
Inspect the length of all trunks, stems and branches for insects and symptoms
If any plants show suspect symptoms or evidence of eggs, larvae or pupae (refer to Section 4.2.3) take a sample (refer to Section 5.2.4) to be formally diagnosed (refer to Section 4.3)
Check for a problem that have occurred regularly in the past, until you are certain it is not present
Record on the „Crop Monitoring Record“ sheet the presence or absence of the pest
Routinely inspect growing areas and remove alternate hosts and reservoirs of the pest, including weeds, crop residues and old plants that will not be marketed

5.3 Availability of control methods

5.3.1 General procedures for control

- Keep traffic out of affected areas and minimize 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
- On-going surveillance of infested areas to ensure the pest is eradicated
- Do not use any material from infested plants for propagation

5.3.2 Mechanical control

The removal of host trees is an effective control measure for the CLB. Infested trees, including the upper root system, should be burnt or chipped to eliminate the immature stages of the insect. Limiting access of the female adult beetles to the trunk by covering with fine wire mesh reduces populations as eggs cannot be deposited in the host plants.

5.3.3 Biological control

In China, larvae are naturally predated by weaver/red ants (*Oecophylla smaragdina*), preventing the need for chemical control of the beetle (Lieu, 1945; Yang, 1984). A parasitic nematode, *Ontsira anoplophorae*, has been found associated with CLB larvae and is considered to be a possible biological control for CLB (Kashio, 1982; 1986).

Biological control of the adult beetles can be achieved with the pathogenic fungi *Beauveria brongniartii* (Kashio & Ujiye, 1988). This fungus causes high adult mortality, with between 46 and 100% of adult beetles killed when it was delivered on polyurethane sheets wrapped around the lower portion of the trunk.

The effects of these potential biological control organisms have not been tested on Australian flora and fauna. Before any of these organisms are used as part of a control program for CLB, the impact of these organisms in Australia should be fully investigated.

5.3.4 Chemical control

Control of CLB, and other wood-boring insects, is difficult with insecticides as they are generally hidden inside the host material for much of their life cycle. However, insecticide treatments have been successfully used against CLB in citrus orchards in Japan, for example, three treatments per season with methidathion (Komazaki *et al*, 1989).

Systemic insecticides should be injected into the base of infested trees, from where it is circulated into the stems, branches and foliage. This method of insecticide application is effective on both adults and larvae. Tree injection was a successful component of the Asian longhorned beetle eradication program. Imidacloprid was recommended for the CLB eradication in the US.

Any chemicals used for the eradication or control of CLB in Australia must be registered for use through the Australian Pesticides and Veterinary Medicines Authority (APVMA). For information regarding this process visit the APVMA website (www.apvma.gov.au).

6 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 programme which can lead to the establishment or re-establishment of pest absence in an area. A pest eradication programme 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.

6.1 Destruction strategy

6.1.1 Destruction protocols

- Disposable equipment, infested plant material or growing media/soil should be disposed of by autoclaving, high temperature incineration, deep burial, burning or chipping

- Any equipment removed from the site for disposal should be double-bagged
- Machinery used in destruction processes need to be thoroughly washed, preferably using a detergent or farm degreaser
- Insecticides are effective against CLB, including imidacloprid
- Infested plants should be destroyed by chipping or burning

6.1.2 Decontamination protocols

Machinery, equipment and vehicles in contact with infested plant material or growing media/soil, or present within the Quarantine Area, should be washed to remove plant material and growing media/soil using high pressure water or scrubbing with products such as a degreaser or a bleach solution (1% available chlorine) in a designated wash down area. Machinery should be inspected for the presence of insects and if found treatment with a fumigant or insecticide may be required. 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 in PLANTPLAN (Plant Health Australia, 2008a))
- 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 CLB 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.

6.1.3 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

6.1.4 Plants, by-products and waste processing

- Any growing media/soil or infested plant material removed from the site should be destroyed by (enclosed) high temperature incineration, autoclaving or deep burial
- 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

6.1.5 Disposal issues

- Particular care must be taken to minimize 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

6.2 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.

6.3 Quarantine and movement controls

Consult PLANTPLAN (Plant Health Australia, 2008a) for administrative details and procedures.

6.3.1 Quarantine priorities

- Plant material and growing media/soil at the site of infestation to be subject to movement restrictions
- Machinery, equipment, vehicles and disposable equipment in contact with infested plant material or growing media/soil, or present in close proximity to the site of infestation to be subject to movement restrictions

6.3.2 Movement controls

Movement controls need to be put in place to minimise the potential for translocation of the pest as a contaminant of plant material, growing media or other articles.

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. 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 or growing media/soil 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 nursery operations must cease 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
- Residents should be advised on measures to minimise the inadvertent transport of CLB 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 washed and cleaned
- Plant material or plant products must not be removed from the site
- All machinery and equipment should be thoroughly cleaned down with a high pressure cleaner (see Section 6.1.2) or scrubbing with products such as a farm degreaser or a 1% bleach (available chlorine) solution, prior to leaving the affected area. Machinery should be inspected for the presence of insects and if found treatment with a fumigant or 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

6.4 Zoning

The size of each quarantine area will be determined by a number of factors, including the location of the incursion, biology of the pest, climatic conditions and the proximity of the infested property to other infested properties. This will be determined by the National Management Group during the production of the Response Plan. Further information on quarantine zones in an EPP incursion can be found in PLANTPLAN, Appendix 10 (Plant Health Australia, 2008a). These zones are outlined below and in Figure 6.

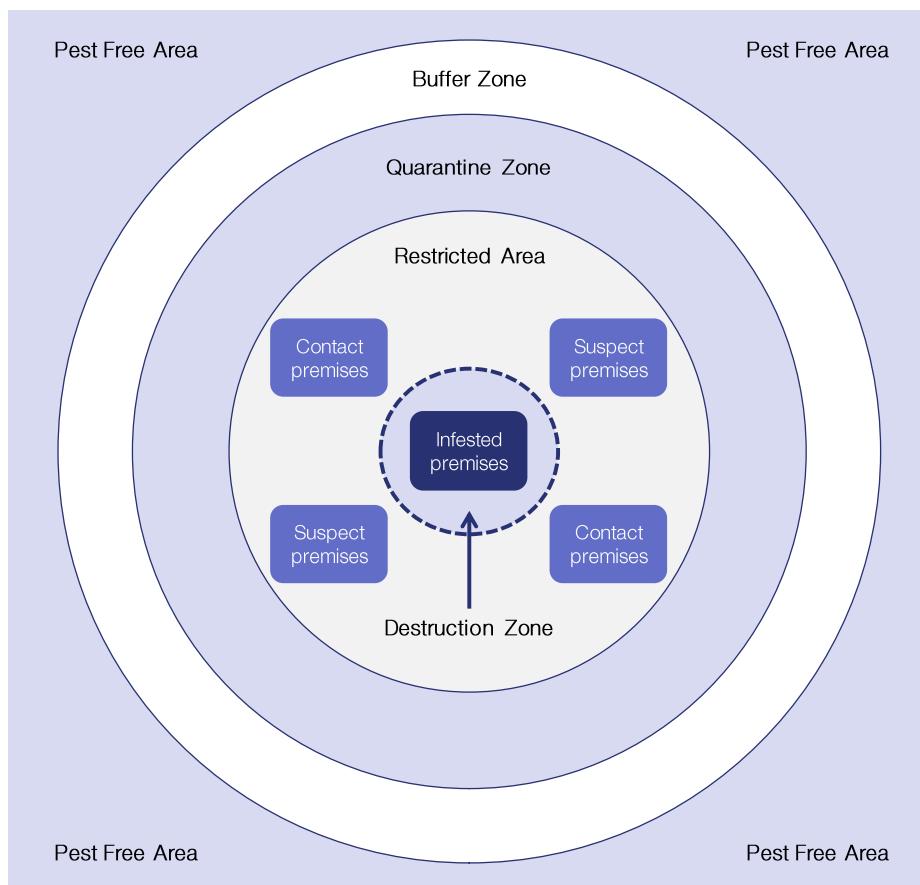


Figure 6. Schematic diagram of quarantine zones used during an EPP incursion

6.4.1 Destruction Zone

The size of the destruction zone (i.e. zone in which the pest and all host material is destroyed) will depend on the ability of the pest to spread, distribution of the pest (as determined by delimiting surveys), time of season (and part of the pest life cycle being targeted) and factors which may contribute to the pest spreading.

All host plants should be destroyed after the level of infestation has been established. The delimiting survey will determine whether or not neighbouring plants are infested and need to be destroyed. Non-host plant material within this zone may be destroyed, based on recommendations in the Response Plan. The Destruction Zone may be defined as contiguous areas associated with the same management practices as the infested area (i.e. the entire nursery, property or forest area if spread could have occurred prior to the infection being identified).

Particular care needs to be taken to ensure that plant material (including non-hosts) is not moved into surrounding areas.

6.4.2 Restricted Area

The Restricted Area is defined as the zone immediately around the infested premises and suspected infested premises. The Restricted Area is established following initial surveys that confirm the presence of the pest. The Restricted Area will be subject to intense surveillance and movement

control with movement out of the Restricted Area to be prohibited and movement into the Restricted Area to occur by permit only. Multiple Restricted Areas may be required within a Control Area.

6.4.3 Quarantine Zone

The Quarantine Zone is defined as the area where voluntary or compulsory restraints are in place for the affected property or properties. These restraints may include restrictions or movement control for removal of plants, people, growing media/soil or contaminated equipment from an infested property.

6.4.4 Buffer Zone

A Buffer Zone may or may not be required depending on the incident. It is defined as the area in which the pest does not occur but where movement controls or restrictions for removal of plants, people, soil or equipment from this area are still deemed necessary. The Buffer Zone may enclose an infested area (and is therefore part of the Control Area) or may be adjacent to an infested area.

6.4.5 Control Area

The Control Area is defined as all areas affected within the incursion. The Control Area comprises the Restricted Area, all infested premises and all suspected infested premises and will be defined as the minimum area necessary to prevent spread of the pest from the Quarantine Zone. The Control Area will also be used to regulate movement of all susceptible plant species to allow trace back, trace forward and epidemiological studies to be completed.

6.5 Decontamination and property clean up

Decontaminant practices are aimed at eliminating the pest thus preventing its spread to other areas.

6.5.1 Decontamination procedures

General guidelines for decontamination and clean up:

- Refer to PLANTPLAN (Plant Health Australia, 2008a) for further information
- Keep traffic out of affected area and minimize it in adjacent areas
- Adopt best-practice property hygiene procedures to retard the spread of the pest between growing areas/fields and adjacent properties
- Machinery, equipment, vehicles in contact with infested plant material or growing media/soil present within the Quarantine Zone, should be washed to remove growing media/soil and plant material using high pressure water or scrubbing with products such as a degreaser or a bleach solution in a designated wash down area as described in Section 6.1.2
- Only recommended materials are to be used when conducting decontamination procedures, and should be applied according to the product label
- Infested plant material should be disposed of by autoclaving, high temperature (enclosed) incineration or deep burial

6.5.2 General safety precautions

For any chemicals used in the decontamination, follow all safety procedures listed within each MSDS.

6.6 Surveillance and tracing

6.6.1 Surveillance

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

Initial surveillance priorities include the following:

- Surveying all host growing properties and businesses in the pest quarantine area
- Surveying all properties and businesses identified in trace-forward or trace-back analysis as being at risk
- Surveying all host growing properties and businesses that are reliant on trade with interstate or international markets which may be sensitive to CLB presence
- Surveying production nurseries selling at risk host plants
- Surveying other host growing properties and backyards

6.6.2 Survey regions

Establish survey regions around the surveillance priorities identified above. These regions will be generated based on the zoning requirements (see Section 6.4), and prioritised based on their potential likelihood to currently have or receive an incursion of this pest. Surveillance activities within these regions will either allow for the area to be declared pest free and maintain market access requirements or establish the impact and spread of the incursion to allow for effective control and containment measures to be carried out. Detailed information regarding surveys for CLB have been outlined elsewhere in this plan (refer to Section 5.2).

Steps outlined in Table 6 form a basis for a survey plan. Although categorised in stages, some stages may be undertaken concurrently based on available skill sets, resources and priorities.

Table 6. Phases to be covered in a survey plan

Phase 1	<ul style="list-style-type: none"> Identify properties that fall within the buffer zone around the infested premise Complete preliminary surveillance to determine ownership, property details, production dynamics and tracings information (this may be an ongoing action)
Phase 2	Preliminary survey of host crops in properties in buffer zone establishing points of pest detection
Phase 3	Surveillance of an intensive nature, to support control and containment activities around points of pest detection
Phase 4	<p>Surveillance of contact premises. A contact premise is a property containing susceptible host plants, which are known to have been in direct or indirect contact with an infested premises or the pest. Contact premises may be determined through tracking movement of materials from the property that may provide a viable pathway for spread of the pest. Pathways to be considered are:</p> <ul style="list-style-type: none"> Items of equipment and machinery which have been shared between properties including bins, containers, irrigation lines, vehicles and equipment The producer and retailer of infested material if this is suspected to be the source of the outbreak Labour and other personnel that have moved from infested, contact and suspect premises to unaffected properties (other growers, tradesmen, visitors, salesmen, crop scouts, harvesters and possibly beekeepers) Movement of plant material and growing media/soil from controlled and restricted areas
Phase 5	Surveillance of production and retail nurseries, gardens and public land where plants known to be hosts of the pest are being grown
Phase 6	Agreed area freedom maintenance, post control and containment

6.6.3 Post-eradication surveillance

The period of pest freedom sufficient to indicate that eradication of the pest has been achieved will be determined by a number of factors, including cropping conditions, the previous level of infestation, the control measures applied and the pest biology.

Specific methods to confirm eradication of CLB may include:

- Monitoring of sentinel plants that have been grown at the affected sites. Plants are to be grown *in situ* under quarantine conditions and monitored for symptoms or other indications of CLB presence
- If symptoms or suspect insects are detected, samples are to be collected and stored and plants destroyed
- Surveys for CLB should be undertaken for a minimum of three years after eradication has been achieved
- Alternate non-host crops should be grown on the site and any self-sown plants sprayed out with a selective herbicide

7 Technical debrief and analysis for stand down

Refer to PLANTPLAN (Plant Health Australia, 2008a) 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.

8 References

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8.1 Related websites

- Australian Pesticide and Veterinary Medicine Authority (www.apvma.gov.au)
- Bark and Wood Boring Beetles of the World (www.barkbeetles.org)
- BugwoodWiki (wiki.bugwood.org)
- CAB Compendium (www.cabicompendium.org)
- EPPO (www.eppo.org)
- Exotic Forest Pest Information System for North America (spfnic.fs.fed.us/exfor)
- NAPPO Phytosanitary Alert System (www.pestalert.org)
- Pest and Disease Image Library (www.padil.gov.au)
- University of Florida – Featured Creatures (entomology.ifas.ufl.edu/creatures)

9 Appendices

9.1 Appendix 1: Standard diagnostic protocols

For a range of specifically designed procedures for the emergency response to a pest incursion refer to Plant Health Australia's PLANTPLAN (www.planthealthaustralia.com.au/plantplan).

9.2 Appendix 2: Resources and facilities

Table 7 provides a list of diagnostic facilities for use in professional diagnosis and advisory services in the case of an incursion.

Table 7. Diagnostic service facilities in Australia

Facility	State	Details
DPI Victoria – Knoxfield Centre	Vic	621 Burwood Highway Knoxfield VIC 3684 Ph: (03) 9210 9222 Fax: (03) 9800 3521
DPI Victoria – Horsham Centre	Vic	Natimuk Rd Horsham VIC 3400 Ph: (03) 5362 2111 Fax: (03) 5362 2187
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
DPI New South Wales – Tamworth Agricultural Institute	NSW	4 Marsden Park Road Calala NSW 2340 Ph: (02) 6763 1100 Fax: (02) 6763 1222
DPI New South Wales – Wagga Wagga Agricultural Institute	NSW	PMB Wagga Wagga NSW 2650 Ph: (02) 6938 1999 Fax: (02) 6938 1809
SARDI Plant Research Centre – Waite Main Building, Waite Research Precinct	SA	Hartley Grove Urrbrae SA 5064 Ph: (08) 8303 9400 Fax: (08) 8303 9403
Grow Help Australia	QLD	Entomology Building 80 Meiers Road Indooroopilly QLD 4068 Ph: (07) 3896 9668 Fax: (07) 3896 9446
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

9.3 Appendix 3: Communications strategy

A general Communications Strategy is provided in Appendix 6 of PLANTPLAN (Plant Health Australia, 2008a; www.planthealthaustralia.com.au/plantplan).

9.4 Appendix 4: Market access impacts

Within the AQIS PHYTO database (www.aqis.gov.au/phyto), export of *Hibiscus* spp. nursery stock requires an additional declaration regarding freedom from CLB when exporting to South Africa (as at July 2009). Should CLB be detected or become established in Australia, additional countries may require a specific declaration or supplementary measures upon export. Latest information can be found within PHYTO, using an Advanced search “Search all text” for *Anoplophora chinensis*.