Development of hazard site surveillance programs for forest invasive species: a case study from Brisbane, Australia

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Summary

Hazard site surveillance is a system for post-border detection of new pest incursions, targeting sites that are considered potentially at high risk of such introductions. Globalisation, increased volumes of containerised freight and competition for space at domestic ports means that goods are increasingly being first opened at premises some distance from the port of entry, thus dispersing risk away from the main inspection point. Hazard site surveillance acts as a backstop to border control to ensure that new incursions are detected sufficiently early to allow the full range of management options, including eradication and containment, to be considered. This is particularly important for some of the more cryptic forest pests whose presence in a forest often is not discovered until populations are already high and the pest is well established.

General requirements for a hazard site surveillance program are discussed using a program developed in Brisbane, Australia, in 2006 as a case study. Some early results from the Brisbane program are presented. In total 67 species and 5757 individuals of wood-boring beetles have been trapped and identified during the program to date. Scolytines are the most abundant taxa, making up 83% of the catch. No new exotics have been trapped but 19 of the species and 60% of all specimens caught are exotics that are already established in Australia.

Keywords: surveillance; quarantine; interceptions; trapping; hazards; pest management; forest health; plantations; native forests; Queensland

Introduction

Traditionally, most countries have relied on border quarantine as the principal defence against invasive plant pests including forestry pests. Increasing pressures on quarantine services worldwide as a result of globalisation of trade and more rapid transport of goods and people has led to the adoption of additional strategies pre- and post-border. In Australia, pre-border activities to detect or minimise threats from forest invasive species include offshore surveillance, pest risk assessment for a range of species of concern and international cooperation on target pests (Cole 2003; Wylie 2007). Post-border, most forestry agencies within state and territory governments in Australia conduct some level of forest health surveillance or monitoring for both indigenous and exotic pests, mainly in forest plantations. A national Asian gypsy moth trapping program is funded by the Australian government and serviced by state agencies. Australia also uses passive surveillance in the early detection of exotic plant pests and diseases, enlisting the help of industry and the public through a variety of awareness programs.

One of the consequences of the greater volumes of containerised freight and resulting competition for space at domestic ports is that goods more often are being first opened (devanned) at Quarantine Approved Premises (QAPs) some distance from the port of entry. Some containerised goods that receive clearance on the basis of 'tailgate inspections' at the port of entry cannot be adequately inspected until devanning at QAPs, and some cleared on the basis of a 'nil risk' manifest may be devanned at a non-QAP facility (Self and Kay 2005). Thus risk is increasingly being dispersed to sites beyond ports and a system of post-border surveillance targeting these areas, referred to here as 'hazard site surveillance', seems warranted. Support for this approach comes from a recent evaluation of the efficacy of forest health surveillance methods used in forest plantations in Australia (Wardlaw *et al*. 2008). It was concluded that some of the more cryptic forest pests such as insect stem borers and fungal cankers are unlikely to be detected in a forest plantation until populations are already high and the pest is well-established. Often, by the time the pest is found in the forest, it is already too late for eradicative action. Surveillance closer to the potential point of border breach, usually urban areas, is likely to be more effective.

In setting up a hazard site surveillance program it is necessary to:

- know what pests are already present
- know what pests you don't want
- assess the likely pathways for exotic pest entry
- identify and categorise risk sites
- have methods for detecting target pests
- be able to identify what you find.

Each of these requirements is discussed in this paper and a current program in Brisbane, Australia, is presented as a case study including some early results.

General requirements for hazard site surveillance

1. Inventory — know what pests are already present

Knowledge of endemic and established forest organisms is essential for determining the status of any new find. Information comes from many sources, including arthropod and pathogen collections with validated, well-curated specimens; databases; scientific literature; surveillance conducted by forest services; faunal surveys and specialist networks. It is important to recognise the sometimes significant gaps in knowledge of the native fauna. In Australia, for example, there has been only limited surveillance conducted in the 162.5 million ha of native forest, and the systematics of some groups of forest organisms are poorly known.

2. Pest profiling and risk assessment — know what pests you don't want

Information about potential forest pest and disease threats to a country generally comes from international forest health or quarantine networks, scientific literature, conferences and meetings, and sometimes from offshore surveillance in neighbouring countries. In Australia, the Office of the Chief Plant Protection Officer and Plant Health Australia maintain and publish lists of the main pest threats (e.g. Mireku and Roach 2000), and these are updated regularly in consultation with forest health specialists. While experience has shown the difficulty of predicting which forest invasive organism will next establish and become a pest, such lists do promote awareness and aid general preparedness for pest incursions. Assessment of threat or risk takes into account the likelihood of introduction and establishment (degree of invasiveness) and the consequences of establishment (environmental, economic, human health). Biosecurity Australia conducts Pest Risk Assessments for particular species and Import Risk Assessments on requests from importers for product access to Australian markets.

3. Pathway analysis

Identifying incursion pathways provides a tool for intercepting potential invasive organisms by indicating where to look and where to apply appropriate preventative and detection measures pre-border, at border and post-border. A range of information sources may be drawn upon in determining entry pathways, for example quarantine service interception data, import statistics for host commodities, import risk analyses, scientific literature and databases (Cole 2003). As cautioned above, it is difficult to predict what new forest pest or disease will be next to establish, or how it will behave if it does establish, so a generic response capacity is required for pests not specifically targeted.

From pest profiling, risk assessment and pathway analysis a target list of pest groups will emerge. The final choice of targets will be influenced by the ability to detect them by inspection and or trapping.

4. Identifying and categorising risk sites

What constitutes a risk site for exotic forest pest incursions will vary greatly within and between different countries and cities according to such factors as trade patterns, geography, infrastructure and quarantine policy, but some generalisations can be made. Self and Kay (2005), in a consultancy for the Australian Government on targeted post-border surveillance using Brisbane as an example, developed a method to select high-hazard sites that may be broadly useful in Australia and overseas. As a first step they divided likely risk sites into four broad groupings from primary to quaternary, the primary sites being considered of highest risk. Port and international airport environs were classed as primary risk sites, and secondary risk sites included areas where containers are devanned, QAPs and importers of raw material (timber importers). Botanic gardens, military camps and transport corridors were listed as tertiary risk sites, and forests or forest parks within city boundaries as quaternary risk sites. Primary risk sites were recommended as the first choice for trapping and inspections, while other categories could be added if resources permitted.

In determining secondary risk sites Self and Kay (2005), with the assistance of the Australian Quarantine and Inspection Service, compiled a list of business premises involved in importing or handling significant volumes of high-risk items such as timber, timber packaging, wooden furniture and artefacts. Many of these sites were QAPs. Sites were assessed for risk using an arbitrary scale of 1 (low risk) to 5 (high risk) for each of five criteria, viz. type of goods (likelihood of harbouring pests), volume of risk goods, cargo source (potential pest threat from country of origin and similarities of its climate and flora to that of Australia), vegetation at site (extent and type) and habitat (intensity of land development). For each site, scores for the five risk criteria were multiplied and then sites ranked according to their total score. This process aided decision-making in the final selection of sites for surveillance.

5. Detection methods

As mentioned in Subsection 3 above, the final choice of targets for hazard site surveillance will be influenced by the ability to detect candidates by inspection and or trapping. For many pests and diseases of trees, visual inspection for symptoms of disorder is the most common, and sometimes the only, practical method of detection. Tree health assessments in the vicinity of ports or high-risk sites may be undertaken periodically by trained inspectors. This method may be supplemented by the planting of 'sentinel' trees of locally-important species at selected sites and then monitoring these trees at regular intervals. There is now widespread recognition of the pest risks associated with the international movement of forest germplasm and in many countries imports of scions, nursery stock and seed are strictly regulated and monitored. As an additional measure, tree health surveys may be targeted around sites where such material is imported and held.

For some other pest organisms affecting trees and timber, but in particular for insects, trapping is the preferred method of detection. A wide variety of devices or techniques have been developed for this purpose, the type of trap being mainly governed by the behaviour of the target insect species or group. Most detection trapping is structured around the capture of flying adult insects using either 'passive' traps (e.g. suspended net traps, water traps, 'window pane' traps) or luring insects from a distance (e.g. light or bait traps) (Speight and Wylie 2001). For wood-boring insect species, static traps in combination with lures have been used effectively in many countries (Berryman 1986; Speight and Wainhouse 1989; Dimitri *et al*. 1992; Flechtmann *et al*. 2000; Brockerhoff *et al*. 2006). Among the many different trap designs those most commonly used for forestry pests are multi-funnel traps, flight interception traps, pipe traps and sticky traps. Factors such as trap silhouette and the size of entry points for insects may influence the type of insect caught (McIntosh *et al*. 2001). Lures using plant host volatiles, or sex or aggregation pheromones, are now commercially available for some key pest species. Spore traps have been used for the detection of some fungal pathogens.

6. Diagnostics

Diagnostic capacity is a major factor determining the scope of the detection program. If specific pests are being targeted, trap catches can be screened relatively efficiently for those pests by reference to voucher specimens, images, insect keys or molecular diagnostics if available. Some targeted species will be easier to identify than others — for example, large longicorns in comparison to small bark beetles. The initial sorting of the catch is to pest groups of interest; the by-catch is discarded or may be stored for future identification. The volume of material to be sorted and identified, and the taxonomic and technical resources available, will largely determine the size of the trapping program. The assistance of taxonomic specialists in the target species or groups will be needed to confirm identifications and in this regard the charges levied by some organisations for identification may limit what can be achieved. Other requirements are for voucher collections, adequate storage and curation, and databasing of information.

A case study from Brisbane, Australia

In 2006, a hazard site surveillance program was established in Brisbane as part of a national initiative funded in part by the Office of the Chief Plant Protection Officer, in collaboration with state agriculture and forest services, to survey high-risk sites around selected Australian ports for the presence of exotic pests and diseases. For Queensland, the survey focussed mainly on pests and diseases of banana, citrus, grape, mango, forest trees and timber. Additional aims of this pilot study were to collect base data on the status of the target range of organisms at the selected ports and to promote community awareness of the importance of reporting suspect exotic pests (Planck *et al*. 2006). Forestry aspects of the program are discussed below.

Method

Initially, a target pest list of forest pests was prepared which included both individual species and taxa groups (Table 1). This was derived from an assessment of known pest and disease threats from around the world with demonstrated pathways into Australia, as evidenced by a history of border and post-border interceptions. The list was refined according to the availability of appropriate traps and lures to attract the agents. To develop a more complete inventory of the endemic and established forest organisms already present in Brisbane, and thus help in clarifying the status of any new find, it was decided that all specimens collected within the target taxa would be identified to species where possible.

Table 1. Forest pests and fungi target taxa and the methods used to detect them in Brisbane

Target taxa	Trap	Lure
Longicorn beetles (Cerambycidae), particularly:	Panel	α-pinene + ethanol
Anoplophora glabripennis Asian longhorn beetle		
Monochamus alternatus Japanese pine sawyer		
Arhopalus ferus burnt pine longicorn		
Stromatium spp.		
Hylotrupes bajalus European house borer		
Wood wasps (Siricidae), particularly:	Panel	α-pinene + ethanol
Sirex spp.		
Urocerus spp.		
Xeris spp.		
Bark beetles (Scolytinae):		
Ips spp.	Panel	Ipsenol , Ips-dienol
Dendroctonus spp.	Panel	Frontalin, Exo-brevicomin
Other species, especially *Tomicus* spp., *Orthotomicus* spp. and ambrosia beetles	Panel	α-pinene + ethanol
Asian gypsy moth *Lymantria dispar* (Lymantriidae)	Delta	Disparlure
Eucalyptus rust *Puccinia psidii*	Inspection	
Auger and powderpost beetles (Bostrichidae), especially:	Panel	No specific lure
Heterobostrychus aequalis		
H. brunneus		
Lyctus africanus		
Sinoxylon spp.		

Traps chosen for the Brisbane program were Intercept® panel traps (flight interception) for general wood-boring insects and Delta sticky traps for Asian gypsy moth. The targeted insects are known to be attracted to plant host volatiles or to sex or aggregation pheromones, and the lures used in Brisbane were selected from commercially-available products formulated for those species. The target pest groups and trapping methods employed are shown in Table 1. Six traps each with a different lure (ipsenol, ips-dienol, frontalin, exo-brevicomin, α-pinene + ethanol and disparlure) were deployed at each trapping station, with a distance of at least 10 m between traps to avoid interference between attractants. The traps were usually suspended from the branches of trees or from building structures at a height of about 2 m above the ground. They were charged with a preserving fluid of 20% ethyl alcohol, 5% glycerol, 1% non-scented detergent and 74% water. The traps were emptied every two weeks and the lures changed every four weeks. At each site, inspectors examined vegetation for signs of insect or fungal damage using illustrated pocket guides to symptoms as a reference (Mireku and Roach 2000; Wylie *et al*. 2006).

The selection of sites for trapping and inspection was based on the methods outlined by Self and Kay (2005) and those chosen included primary, secondary and tertiary risk sites. Key factors in the selection were the proximity to high-risk locations and the availability of surrounding vegetation, but factors such as ease of access and security for the traps were also important. Five sets of traps were run continuously for a year. Four of the sites remained constant, viz. one site close to the Port of Brisbane within a cluster of QAPs and with mixed natural and planted trees, a site on the fringe of the port area that contained a small plantation of *Pinus elliottii*, one QAP in the suburbs (an importer of containerised timber) and one timber yard with new and recycled material. The remaining set of traps was relocated to other sites either in response to post-border incidents (the wood wasp *Sirex noctilio*, Japanese pine sawyer *Monochamus alternatus* and auger beetle *Heterobostrychus aequalis*) or because catches were very low.

The trapping program commenced in February 2006 and ran continuously for a year to provide information on any seasonal effects. After the first year of continuous trapping in which a baseline was set, the program was modified to run traps four times a year (April, July, October and January) for a four-week period. Again five sites were targeted including sites from the previous year and new sites (Brisbane Botanic Gardens, a timberyard and a site adjacent to a timber wharf at the Port of Brisbane). A 'control' trap having no lure but with the preserving fluid was included at all sites for comparison.

Results

In 32 sampling periods between February 2006 and August 2007, a total of 67 species of wood-boring insects was identified from the trap catches and several other species are awaiting identification (Appendix 1). Sixty of these species are from the target taxa: Scolytinae (29), Cerambycidae (18), Bostrichidae (11) and Platypodinae (2). Although not specifically targeted, four species of Anobiidae and three of Buprestidae were also trapped. No new exotic establishments were detected. Most (48 species, 72%) of the taxa trapped were native to Australia and 19 species (28%) were established exotics. Of the total of 5757 beetles caught, 4756 (83%) were Scolytinae, the most numerous species being *Hypothenemus seriatus* (2125, 37%).

In regard to lure type for wood borers, there is a close similarity in the number of taxa trapped (between 35 and 39 species) for all five lures used (Table 2). Even the 'control' (preserving fluid with an ethyl alcohol content of 20%) garnered 26 species. Ethyl alcohol itself is attractive to many wood-boring beetles and may have enhanced the catches for the species-specific lures. As well, the contribution to trap catches of non-chemical cues has yet to be determined. The numbers of individuals trapped for each lure type was also very similar for four of the lures, with only exo-brevicomin recording a much lower total

Table 2. Number of species and specimens from each target taxa collected in each lure to August 2007

Attribute and taxa	Lure						Total
	Control	α-pinene + ethanol	Exo-brevicomin	Frontalin	Ips-dienol	Ipsenol	
Number of species							
Scolytinae	13	21	17	22	19	21	29
Bostrichidae	5	6	7	9	7	6	11
Anobiidae	2	3	3	2	4	3	4
Platypodinae	0	1	1	1	2	1	2
Cerambycidae	5	4	9	5	5	6	18
Buprestidae	1	0	0	0	2	0	3
Total	26	35	37	39	39	37	67
Number of specimens							
Scolytinae	315	870	610	1198	974	789	4756
Bostrichidae	39	115	41	116	83	118	512
Anobiidae	34	109	21	31	44	95	334
Platypodinae	0	7	4	14	8	47	80
Cerambycidae	19	6	11	7	17	12	72
Buprestidae	1	0	0	0	2	0	3
Total	408	1107	687	1366	1128	1061	5757

(Table 2 and Appendix 1). Numbers in the control were also lower but this is not a straight comparison because a control was maintained continuously at only one site. At that site, however, the performance of the control was comparable to that of the lures, viz. a total of 27 species and 233 individuals were trapped in the control while catches in the five traps with lures ranged from 20 to 29 species and from 193 to 328 individuals. Lure type did have a marked effect at the individual species level. For the seven most abundant species (>200 individuals trapped), *H. seriatus* was particularly attracted to frontalin and ips-dienol, *Xyleborus perforans* to ethanol + α-pinene and exo-brevicomin, *Ips grandicollis*, *Xylopsocus gibbicollis* and *Hadrobregmus australiensis* to ethanol + α-pinene and ipsenol, *Eccoptopterus spinosus* to exo–brevicomin and frontalin, and *Coccotrypes carpophagus* to frontalin.

Site effects were evident at the group and individual species level. An examination of catches at four sites where the sets of traps were maintained continuously for one year showed that one site had a significantly greater number of species and individuals trapped than any of the other three sites (41% of specimens from these four sites and 80% of the species). This site was a timberyard with considerable surrounding natural vegetation. The type of vegetation also has a strong influence: for example 60% of *I. grandicollis* trapped during the program were from a site where there was a small plantation of *Pinus elliottii*, a host for this insect. Nearly all *Hylurdrectonus corticinus* (98%) were from a site at the Brisbane Botanic Gardens where *Araucaria* spp. (a host) is planted, and 90% of specimens of the dampwood borer *H. australiensis* were from a timberyard where considerable aged, recycled timber was stored.

Trap catches in Brisbane were slightly lower over winter, but the main seasonal effect noted was a change in the abundance of individual species at different times of the year. Further trapping will be required to confirm trends.

Discussion

The results of the Brisbane hazard site surveillance program to date are very encouraging. It has demonstrated that the trap–lure combinations employed attract most of the targeted groups, the exceptions being wood wasps and gypsy moths neither of which are known to occur in Queensland. However, the attractiveness of disparlure for gypsy moths and of ethanol + α-pinene for Siricidae has been proven elsewhere (Beroza *et al*. 1973; Otto *et al*. 1988; Bashford 2008). No new exotic species have been found but 19 of the species and more than 60% of the specimens trapped were established exotics, viz. 13 Scolytinae, 1 Platypodinae, 3 Bostrichidae and 2 Anobiidae, demonstrating the potential of this program to detect new incursions. Although no specific lure for Bostrichidae was known at the commencement of this work, 11 species and 512 individuals have now been trapped, with ethanol + α-pinene, frontalin and ipsenol attracting the greatest numbers. This provides some confidence that these lures may be also attractive to the targeted exotic auger and powderpost beetles.

There was little difference in performance between traps baited with plant host volatiles, traps baited with the more species-specific beetle pheromones or unbaited traps in terms of the overall number of taxa or individuals caught. This finding agrees with the results of a recent nationwide survey in neighbouring New Zealand for invasive wood-boring and bark beetles (Brockerhoff *et al*. 2006). At the level of individual species, however, there was a marked difference between lure types in the taxa attracted, and this supports the use in a hazard site trapping program of known attractants for target insects such as species of *Ips*, *Dendroctonus* and *Monochamus*. Scolytinae dominated the catches in Brisbane, contributing 83% of all specimens trapped in 2006–2007, the most numerous species being *H. seriatus* . This insect has a wide range of hosts and breeds in twigs, branches, pods and seeds. Highest catches were recorded at the Brisbane Botanic Gardens where there was a great variety of host material. Scolytinae were also abundant in the New Zealand catches although the proportions were lower — 48% and 25% in 2002–2003 and 2003–2004 respectively. Brisbane catches of Cerambycidae were proportionally much lower (1.2%) than in the New Zealand catches (39% and 26%). The second most numerous group in Brisbane was Bostrichidae (8.9%). Three species of Buprestidae were trapped in Brisbane (two in traps baited with ips-dienol and one in a control) but none in New Zealand. Brockerhoff *et al*. (2006) remarked on the large number of exotic species that were trapped in New Zealand, their high proportion among the overall catch (96% of Scolytinae and Cerambycinae were exotic species) and the clear dominance of just three species. They related this to the relatively low number of exotic wood-boring and bark beetles present in that country and to the fact that the attractants used are typically associated with conifer-infesting beetles and conifers, particularly Pinaceae, which are not present in the New Zealand flora except as introduced trees. In Brisbane, 19 species (28% of the total taxa) and 3484 specimens (60% of the total catch) were established exotics. Most of these have a known association with conifers, but many endemic species including broadleaf tree associates such as the Bostrichidae and some Cerambycidae were also caught in the traps. Queensland does have native conifers such as species of *Araucaria*, *Agathis*, *Callitris* and *Podocarpus* as well as the introduced Pinaceae, but the presence of the broadleaf tree associates in the traps may be more related to the attraction of the ethanol in the preserving fluid or to non-chemical cues. Trap placement and site effects were found to be important in both these programs, higher catches and more species being recorded in open timberyards and wooded areas than inside warehouses and bare industrial sites.

In the first 18 months of the Brisbane program, considerable staff time and associated cost were committed to diagnostics in order to build up base data on the status of the target range of organisms here and to develop a reference collection. Where resources are limited it is still possible to run an effective hazard site surveillance program by screening for a few specific targets, but sorting the catch and preparing the specimens nevertheless requires a reasonable commitment of staff time. Two climate-related problems have been encountered with the panel traps in Queensland, and in the Pacific where a similar project funded by the Australian Centre for International Agricultural Research is underway. In very hot conditions the preservative fluid used in the traps quickly evaporates and in heavy tropical rainfall it is diluted, both situations resulting in deterioration of the catch. Remedies for these problems are now being investigated, and a study has been planned to determine the contribution of non-chemical cues to the trap catches.

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Appendix 1. Number of individuals of each species collected in each lure to August 2007

Species	Family/Subfamily	Control	α-pinene + ethanol	Exo-brevicomin	Frontalin	Ips-dienol	Ipsenol	Total
Hypothenemus seriatus (Eichhoff)[1]	Curculionidae/Scolytinae	196	298	167	635	575	254	2125
Xyleborus perforans (Wollaston)	Curculionidae/Scolytinae	24	154	183	92	73	115	641
Ips grandicollis (Eichhoff)[1]	Curculionidae/Scolytinae		195	7	39	41	216	498
Eccoptopterus spinosus (Olivier)	Curculionidae/Scolytinae	17	60	127	133	85	43	465
Xylopsocus gibbicollis (Macleay)	Bostrichidae	32	76	27	57	54	71	317
Hadrobregmus australiensis Pic	Anobiidae	33	105	16	24	22	90	290
Coccotrypes carpophagus (Hornung)[1]	Curculionidae/Scolytinae	17	33	28	85	38	37	238
Xyleborinus saxeseni (Ratzeburg)[1]	Curculionidae/Scolytinae	10	27	31	28	21	15	132
Xyleborus ferrugineus (Fabricius)[1]	Curculionidae/Scolytinae	16	16	8	10	12	23	85
Xylosandrus solidus (Eichhoff)	Curculionidae/Scolytinae	7	18	13	8	29	7	82
Hypothenemus eruditus Westwood[1]	Curculionidae/Scolytinae		6	5	39	22	8	80
Platypus parallelus (Fabricius)[1]	Curculionidae/Platypodinae		7	4	14	7	47	79
Xyleborus similis Ferrari	Curculionidae/Scolytinae	3	13	9	24	14	6	69

[1]Exotic species now established in Australia

Appendix 1. (continued)

Species	Family/Subfamily	Control	α-pinene + ethanol	Exo-brevicomin	Frontalin	Ips-dienol	Ipsenol	Total
Amasa truncatus (Erichson)	Curculionidae/Scolytinae	2	15	8	18	9	16	68
Xylothrips religiosus (Boisduval)	Bostrichidae	2	11	7	22	11	10	64
Rhizopertha dominica (Fabricius)[1]	Bostrichidae		7	2	12	11	30	62
Hypothenemus melasomus Lea	Curculionidae/Scolytinae	16	2	4	5	18	11	56
Hylurdrectonus corticinus Wood	Curculionidae/Scolytinae		4		50			54
Coccotrypes dactyliperda (Fabricius)[1]	Curculionidae/Scolytinae	2	6	4	11	9	11	43
Hypothenemus birmanus (Eichhoff)[1]	Curculionidae/Scolytinae		7	7	9	12	4	39
Lyctus brunneus (Stephens)[1]	Bostrichidae/Lyctinae		12		15	1	5	33
Xyleborus annexus Schedl[1]	Curculionidae/Scolytinae		3	7	2	9	7	28
Ancita marginicollis (Boisduval)	Cerambycidae	12		1	2	9	4	28
Lasioderma serricorne (Fabricius)[1]	Anobiidae		3	3	7	8	4	25
Deroptilinus granicollis Lea	Anobiidae	1	1	2		13	1	18
Ambrosiodmus compressus (Lea)	Curculionidae/Scolytinae	2	4	1	3	4	3	17
Xylodeleis obsipa (Germar)	Bostrichidae		3	2	3	4	1	13
Xylosandrus discolor (Blandford)	Curculionidae/Scolytinae	3			1	1	7	12
Xylobosca bispinosa (Macleay)[1]	Bostrichidae	3	6	1	1	1		12
Pachydissus sericeus Newman	Cerambycidae	1		1	1	3	2	8
Xyleborus ipidia Schedl	Curculionidae/Scolytinae		6					6
Coleocoptus senio (Newman)	Cerambycidae	2	3	1				6
Cyrtogenius brevior (Eggers)	Curculionidae/Scolytinae				2		3	5
Trogoxylon sp.	Bostrichidae	1		1	3			5
Cyrtogenius dimorphus (Schedl)	Curculionidae/Scolytinae		1		2		1	4
Coptocercus aberrans (Newman)	Cerambycidae		1	1	2			4
Coptocercus biguttatus (Donovan)	Cerambycidae	3	1					4
Agrianome spinicollis (MacLeay)	Cerambycidae				1		2	3
Amphirhoe decora Newman	Cerambycidae	1		1			1	3
Paradisterna plumifera (Pascoe)	Cerambycidae					3		3
Xylion cylindricus Macleay	Bostrichidae	1			1	1		3
Ficicis varians Lea	Curculionidae/Scolytinae		1			1		2
Chlorophorus curtisi (Laporte & Gory)	Cerambycidae						2	2
Phoracantha semipunctata (Fabricius)	Cerambycidae			2				2
Thoris sexguttata Carter	Cerambycidae			2				2
Ambrosiodmus latecompressus (Schedl)	Curculionidae/Scolytinae						1	1
Cryphalus sp.	Curculionidae/Scolytinae						1	1
Hylurgus ligniperda (Fabricius)[1]	Curculionidae/Scolytinae				1			1
Hypocryphalus sp.	Curculionidae/Scolytinae				1			1
Hypothenemus sp.	Curculionidae/Scolytinae					1		1
Xyleborinus artelineatus (Beeson)[1]	Curculionidae/Scolytinae		1					1
Xyleborus eximius Schedl[1]	Curculionidae/Scolytinae			1				1
Notoplatypus elongatus Lea	Curculionidae/Platypodinae					1		1
Aridaeus thoracicus Donovan	Cerambycidae				1			1
Coptocercus crucigerus (Hope)	Cerambycidae			1				1
Prosoplus sp.	Cerambycidae		1					1
Stenocentrus ostricilla (Newman)	Cerambycidae						1	1
Syllitus tuberculatus McKeown	Cerambycidae			1				1
Tritocosmia atricilla Newman	Cerambycidae					1		1
Xystrocera virescens Newman	Cerambycidae					1		1
Agrilus mastersi MacLeay	Buprestidae					1		1
Melobasis purpurascens (Fabricius)	Buprestidae					1		1
Melobasis sexplagiata (Laporte & Gory)	Buprestidae	1						1
Bostrychopsis jesuita (Fabricius)	Bostrichidae				1			1
Dinoderus minutus (Fabricius)[1]	Bostrichidae						1	1
Xylopsocus burnsi Vrydagh	Bostrichidae			1				1
Stegobium paniceum (Linnaeus)[1]	Anobiidae					1		1
Total		408	1107	687	1366	1128	1061	5757

[1]Exotic species now established in Australia