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1 Acknowledgments

Projects like this are challenging and require ongoing effort from the participants and support from key people to provide local insights and supply the grease to keep the wheels of bureaucracy turning! In this regard Sairusi Bulai and his able assistant Bale were ever dependable. Sairusi Bulai's wealth of experience identified the need for the workshop on forestry pest inspections for quarantine staff, and in finding ways through the bureaucracy to get the improvements completed to the building housing the Fiji National Forest Insect Collection.

Without drivers like Peni this project would have found it difficult to achieve it’s objectives. Not only did Peni ferry the Australian participants around when visiting Fiji, but also made sure Lusi got to all the plots at the right time. Similarly, the generous assistance of Mesek Seth in taking us to sites on Santo made it possible to keep project activities progressing there.

2 Executive summary

"Establishing Forest Pest Detection Systems in South Pacific Countries and Australia" (FST/2004/053), took the key findings from a previous ACIAR project (FST/2001/045: "Development of Forest Health Surveillance Systems for South Pacific Countries and Australia") and introduced methods to strengthen capacity to detect exotic forest pests, particularly in the vicinity of ports and other high-risk sites. Importantly this project involved the forestry agencies collaborating with the quarantine agencies of the two participating Pacific island countries – Fiji and Vanuatu. Preparatory research done in Australia developed a combination of insect traps and lures that was effective in attracting all of the key groups of wood-boring insects. Staff from the forest health units (created in the first project) and quarantine agencies were trained in the use of static traps and, with the assistance of the Australian participants, developed a plan for the regular survey of selected sites using static traps supplied through the project. The project also aimed to increase the capacity of the participating countries to screen the collections of wood-boring insects captured during static trap surveys to identify potential new exotic species. This involved strengthening existing insect reference collections or developing new collections of named species of wood-boring insects already present in the countries.

The project was particularly successful in strengthening the capacity of Fiji to routinely monitor plantations, nurseries and hazard sites for exotic insect pests. Mid-project staff changes in Vanuatu resulted in the project having insufficient time for forest health surveillance and static trap survey to be embedded in their routine work plans. Despite this Vanuatu does now have a core group of people trained in basic skills of surveillance / static trapping, and does have institutional support to continue to develop that expertise.

In Fiji, the Forest Protection group of the Forestry Department has done annual static trap surveys of ports / hazard sites, nurseries and plantations since 2006. The method used in initial static trap surveys yielded insect specimens that were too badly decomposed to be identified so the method was refined to to better suit tropical environments. The refinements largely overcame the problem and surveys since 2008 have yielded well-preserved insect specimens that were able to be identified. The Forest Protection group conducted 182 static trap surveys in 2009 and 80 during the first quarter of 2010. These surveys captured 8,626 and 1,024 insect specimens, respectively, for identification. A mounted voucher collection of 69 named wood-boring insect specimens collected from the Fiji surveys was assembled by the Queensland members of the Australian team to lodge in Fiji's Forest Insect Collection. Of biosecurity significance, the Asian Ambrosia Beetle (*Xylosandrus crassisculus*) was detected for the first time in Fiji from the initial static trap surveys done in 2006. Those, and subsequent surveys done during the project showed that the beetle was already well established in the country. This beetle is a pest of nurseries and small seedlings including mahogany.

The Fiji National Forest Insect Collection is the main collection of forest insects of the region. As well as having immense scientific value, the collection is a critical reference resource for forest biosecurity. The collection was in poor condition at the start of the project and at great risk of being irreparably damaged. Infrastructure improvements (replacing a leaking roof, upgrading electrical wiring, repairing air-conditioners and replacing old wooden insect cabinets with steel cabinets), curation work to restored damaged (by mould) specimens and documentation done on the collection during the project has secured it for the medium term at least.

An important aim of the project was to foster greater co-operation between Forestry and Quarantine agencies in raising the prominence of forest biosecurity. Although given strong institutional support in Fiji, initial co-operation at the operational level was patchy. An issue was trying to introduce static trapping at port sites where quarantine operations are concentrated. The port sites were largely un-productive in capturing wood-boring insects and quarantine staff too focussed on inspections to maintain a regular survey program.

The project overcame this issue in two ways. Firstly, it strengthened quarantine operations by providing training to quarantine staff in the recognition of forest and timber insect pests, and in methods for conducting inspections of cargo to detect these pests. Secondly, it shifted the static trap surveys away from the immediate wharf areas to container facilities where cargo is unpacked for distribution. These facilities are embedded in more natural environments that are less hostile for any insects carried in the cargo. At the same time responsibility for conducting the surveys was transferred from quarantine operations staff to staff within the Agriculture Department who were responsible for conducting routine surveys for agricultural pests of quarantine significance. These changes greatly increased the level of co-operation between forestry and quarantine at the end of the project.

In Australia, the project was successful in developing and demonstrating the effectiveness of trapping systems for bark and wood boring pests at urban hazard sites. While no new exotic pests were detected in Australia, there was very good overlap of subfamilies, families and orders trapped (including many established exotics) with that of the targeted exotics, giving us confidence that this trapping will be effective in detecting post border incursions. Additionally, modifications were made to trap designs to better suit them to subtropical and tropical environments, and low-cost locally available alternatives to overseas purchased traps were demonstrated and made available. Trapping was also demonstrated to be effective at detecting low density populations of borers in plantation situations. Concurrent assessment of borer damage in these plantations meant that trap catches could be correlated with to borer damage, demonstrating that static trapping is able to detect plantations that are under stress and have signs of borer attack.

The success of the two ACIAR projects in developing and sustaining capacity in forest biosecurity is best reflected in the summary provided by Fiji's participants from the forestry and quarantine agencies at the final project workshop:

"*Through this project, the Forest Protection component of the FD in Fiji has been enhanced in capacity & technical expertise, such that forest health & border surveillance has been incorporated in the corporate and business plans of the Ministry with funding provided from the research divisions operation budget for future work & the continuation of the current program under the ACIAR project*"

3 Background

Damage from pests and diseases is a major cause of loss of forest productivity in both natural forests and plantations. This project is aimed at protection of plantations (in particular) and native forests in Fiji, Vanuatu and Australia through the establishment of early detection systems. It provided an important complement to a previous project (FST/2001/045) Development of Forest Health Surveillance Systems for South Pacific Countries and Australia, completed in December 2004, which resulted in the establishment of a core of expertise in forest health in participating countries. That project saw the introduction into the Pacific of ongoing systematic surveys for pests and diseases in forest plantations and the establishment of small, trained forest health units in Fiji, Vanuatu, Samoa and Tonga. These forest health units have varied in their ability to become self-sustaining, with Fiji the best situated to continue to operate as a Departmental priority

The underlying principle in forest health surveillance is that early detection of a pest problem allows more scope for its management. There are a number of exotic pests and diseases that, if they became established, would cause major losses to the region's very valuable timber industries. For example, the mahogany shoot borer *Hypsipyla robusta*, which is established in the Western Pacific to Vanuatu but has not been found further east, poses a great risk to Fiji's substantial plantations of mahogany (50000 ha worth $A200 million) were it to be accidentally introduced. The ambrosia beetle, *Crossotarsus externedentatus*, which is capable of attacking many species of living trees, is a serious pest in Fiji and Samoa but is not yet known from Tonga and Vanuatu. There are numerous other exotic pests which, if they became established, would cause significant economic damage. An example is the recent quarantine interception of Sirex noctilio in Fiji. Fiji has some 41 000 hectares of Pinus caribaea which is a host for this well known pest responsible for the death of over five million pine trees valued at $10-12 million in one outbreak in Australia in the late 1980s. Two new tree pest discoveries in Hawaii in 2005 - the Erythrina gall wasp *Quadrastichus erythrinae* and the Eucalyptus or guava rust *Puccinia psidii* – emphasise the threat posed to the region by exotic organisms and the need for early warning systems. The gall wasp threatens the destruction of all Erythrina species while the guava rust threatens species in the Family Myrtaceae (Australia's eucalypt-dominated ecosystems are particularly at risk).

Some of the pests and diseases involved are capable of early and serious damage to the quality and value of standing timber. Without preventative measures, at least one serious incursion, resulting in major and immediate economic losses, is almost certain within the next five to ten years. This threat is now well recognised in Pacific countries. At the concluding workshop of the project just completed, the major forest health needs in the Pacific were identified as increased training, a focus on surveys of high risk areas, increased quarantine awareness, and pest and disease identification. Priorities identified for further work included the establishment of post-barrier trapping programs and sentinel plantings of commercially important species with regular inspections by local forest health staff.

Project FST/2001/045 demonstrated how difficult it is to detect symptoms of damage by organisms such as stem borers and fungal canker at low incidence in plantation trees by any of the surveillance methods currently available. The implication for forest growers is that incursions of these types of exotic forest pests are unlikely to be detected sufficiently early to allow eradication. Therefore, surveillance for such pests is best focused on high-risk areas around ports and container facilities to provide a higher level of insurance that new incursions will be detected before they become established in valuable forest areas.

Some major target pests are the cedar shoot caterpillar which devastates commercial plantings of high value Meliaceae species, wood and bark beetle pests (particularly scolytids, longicorn beetles and siricid wood wasps) of pines and hardwoods, lepidopterous defoliators of important species such as whitewood, *Endospermum medullosum*, guava rust and Erythrina gall wasp The project aimed to provide a method which will greatly increase the chances of detecting significant pest incursions at a much earlier stage by focussing on these high risk areas and using more sensitive detection tools. Simple and robust technologies involving static trapping systems and sentinel plantings offer the best means of early detection for these pests in high risk sites.

The Australian component, conducted in Queensland and Tasmania, tested a range of attractants and pheromones for selected forest insect groups. Modifications to traps and protocols necessary to successfully trap target insects in subtropical and tropical conditions were developed and evaluated (including low-cost trap and lure designs) and applied in Australia, Fiji and Vanuatu. Also evaluated was whether the static trapping method can be successfully extended into forest areas to detect low population levels of borers in mid-rotation plantations of eucalypts and pine, Surveys of actual damage levels from these pests in the plantations were then correlated with static trap catches thus enabling the sensitivity of the static trapping systems in detecting low levels of damage to be determined. This work therefore successfully demonstrated the applicability of this technology to the participating countries which have a wide range of potentially damaging species of boring insects posing a threat to commercial tree plantations and unique needs in terms of trap and lure design.

The project accords well with priorities identified for ACIAR's forestry program in the Pacific, in particular 'sustainable management (and protection from pests and diseases) of high value plantations and native forests'. It also is in accord with current Australian Government initiatives to develop hazard site surveillance systems at key ports in this country.

4 Objectives

To identify suitable static traps for target pest groups and establish these at high hazard areas in each participating country.

To determine appropriate species for sentinel plantings (small plantings of the host trees of target pest species) for each country, and deploy these plantings near high hazard areas.

To train Forest Health Surveillance personnel in each participating country in trapping techniques; efficient survey of sentinel plantings; collection and identification of major pests; and efficient communication protocols within the Region.

To develop trap/lure combinations in Australia which are effective in attracting and trapping wood boring insects which attack eucalypts and pines, and test these in mid-rotation plantations in Tasmania and Queensland.

5 Methodology

5.1 Design of trap-lure combinations

5.1.1 Trial 1: Combinations of alpha- and beta-pinene lures to trap Sirex

Reported in Bashford, R. (2008) The development of static trapping systems to monitor for wood-boring insects in forestry plantations. *Australian Forestry*, **71(3)**: 236-241.

Trial 1.1: To compare the attractiveness of different mixtures of α-pinene and β-pinene to female Sirex wood wasp.

Six combinations of α-pinene and β-pinene pouch lures (plus no-lure control) installed in an intercept panel-trap were tested for their attractiveness to female *Sirex noctilio* (measured as number of insects caught/trap). The trial was done during the Sirex flight season in a mid-rotation, unthinned *Pinus radiata* plantation in northern Tasmania.

Trial 1.2: To compare the trapping efficiency of two types of static traps using mixed volatile lures. Five static-trap pairs each with a Lindgren funnel trap and an Intercept panel trap and fitted with mixed α-pinene (70%) and β-pinene (30%) pouch lures were installed in a mid-rotation unthinned *P. radiata* plantation in northern Tasmania. The total number of female Sirex wasps captured in the two trap types during the Sirex flight season were compared.

5.1.2 Trial 2: Effectiveness of lures containing different eucalypt stress volatiles in capturing wood-boing insects in a *Eucalyptus nitens* plantation.

Reported in Bashford, R. (2008) The development of static trapping systems to monitor for wood-boring insects in forestry plantations. *Australian Forestry*, **71(3)**: 236-241.

Five volatile chemicals known to be emitted from stressed trees were tested for their effectiveness in attracting wood-boring insects in eucalypt plantations. The stress volatiles tested were: (i) ethanol; (ii) cineole; (iii) phellandrene; (iv) α-pinene; (v) α- β-pinene mixture (70:30). Pouch lures containing the stress volatiles were fitted to Intercept panel traps: a panel trap with no lure was used as a control treatment.

Traps were installed in a 7-year-old *Eucalyptus nitens* plantation in northern Tasmania during a severe drought event in 2004-5. Two replicates were installed in each of a thinned and adjacent unthinned stands and operated for a six-month period (October 2004 – March 2005). Each replicate consisted of a transect of the six traps, spaced 30 m apart. Within each stand, the lures were placed in the traps in mirror order in each transect.

In order to determine the full suite of stem-boring species present within the plantation, we reared species from a sample of logs taken from dead, attacked trees and placed in an insectary. A pair of Malaise traps was placed in both the thinned and unthinned sections of the plantation during October 2004 and March 2005. Two bucket black-light traps, one in each of the thinned and unthinned sections, were also run opportunistically during 2004–2005 when suitable weather coincided with visits to service the static traps.

5.2 Use of static traps for pest monitoring in plantations

5.2.1 Relationship between static trap catches and stress / borer damage in mid-rotation *Eucalyptus* plantations

(see Wotherspoon *et al.* in Appendix for the full report)

The aim of this study was to test the usefulness of static traps as early warning to detect plantations at risk of damage from wood-boring insects. The study tested this by comparing the incidence of symptoms indicative of stress or borer attack with the diversity and abundance of wood-boring insects captured in static traps installed in 19 mid-rotation *Eucalyptus globulus* and *E. nitens* plantations in northern Tasmania. In an attempt to provide a gradient in stress levels, the plantations were selected to span a wide range of site-moisture levels determined on the basis of long-term average annual rainfall. Each plantation was classified into one of three classes based on average annual rainfall: <1000mm; 1000-1500mm; and >1500mm. Nine plantations were selected to include in the <1000mm class and five plantations in each of the other two rainfall classes. Once all of the plantations were selected, the actual mean annual rainfall for each plantation was estimated using the Esoclim module in ANUCLIM Version 5.1.

Assessment of borer and stress damage

Stratified random sampling was used to provide a relatively even distribution of sample points across each plantation. Plantations were divided equally in to three sections by area. Three plots of 45 trees were randomly located in each section using a 100m grid and random number generator. Each plot comprised five sub-plots of nine trees (3x3) set out in a "cross", each sub-plot was separated from the adjoining plot by three rows or trees (Figure 5.2.1.1). This sampled 405 trees for each plantation.

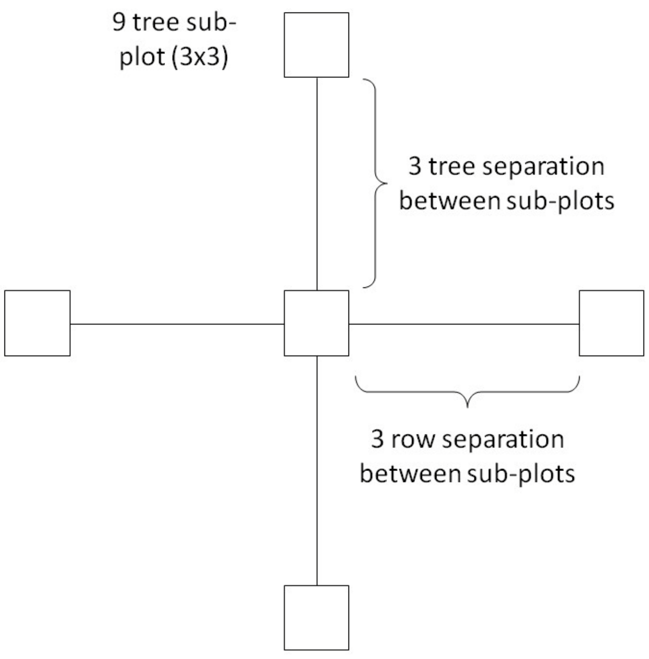

Figure 5.2.1.1 Plot layout used for borer damage surveys.

A general visual assessment of each tree was made to characterise the general vigor of the tree and for the presence of symptoms of stress or borer damage. The presence of the following was recorded for each tree: (i) healthy, (ii) pruned, (iii) dead, (iv) stressed (thin crown, dull foliage), (v) overtopped, (vi) broken stem, (vii) dead foliage, (viii) epicormics, (ix) kino bleeds, (x) cracks in to wood with sawdust, (xi) defects with sawdust/kino, (xii) exit holes, (xiii) webbing (cossid moths), (xiv) *Phoracantha* damage,

(xv) sawdust piles at the base of the tree, (xvi) transverse weevil (*Pelororhinus transversus*) damage, (xvii) *Culama* damage at base of tree.

Static trap survey of wood-boring insects

Two Intercept™ panel traps, baited with α-pinene and ethanol lures, were deployed in each of the 19 plantations. Traps were run for two six-week periods between November - December 2006 and February - March 2007. The traps were cleared fortnighly during each trapping period.

Insects were sorted in to relevant target groups: cerambycids (longicorn beetles), buprestids (jewel beetles), curculionids (weevils), cossids (wood moths), hepialids (swift moths) and scolytids (bark beetles). All specimens were identified to genus and most were identified to species. The number of individuals of each species captured in each plantation was tallied.

Analysis

Analysis of variance or the non-parametric Kruskall-Wallis test, was used to test the significance of differences among the three rainfall classes in the abundance of tree stress and damage symptoms and the abundance and diversity of wood-boring insects.

Regression analysis was used to measure the strength of correlation between (i) stress / damage symptoms and the abundance / diversity of wood-boring insects; (ii) stress / damage symptoms and rainfall; (iii) abundance / diversity of wood-boring insects and rainfall.

5.2.2 Static trapping for early detection of exotic species in *Pinus* plantations

5.2.2.1 Tasmanian study

Reported in Bashford, R. (2008) The development of static trapping systems to monitor for wood-boring insects in forestry plantations. *Australian Forestry*, **71(3)**: 236-241.

Trapping stations consisting of three Lindgren funnel traps arranged in a triangle configuration (5 m between each trap) were established in four mid-rotation, unthinned *P. radiata* plantations, three in northern Tasmania (Virginstow, Lisle and Retreat) and one in southern Tasmania (Pittwater). The traps were each fitted with α-pinene / ethanol lures and 30% solution of ethylene glycol was used as a preservative. The traps were run between January and March 2004, and trap catches were cleared fortnightly. The lures were replaced every six weeks.

Insects recovered from the traps were sorted to separate the target groups (Scolytinae, Platypodinae, Cerambycidae, Buprestidae, Bostrichidae and Siricid wood wasps) and specimens were identified, where possible, to the species level.

5.2.2.2 Queensland study

Research into pest detection systems in Queensland focussed on (1) re-examining data from trapping carried out in exotic plantations of *Pinus* spp. in Southeast and Far North Queensland, (2) hazard site surveillance in Brisbane,

- ***Softwood plantation trapping***

  We used data collected in surveys previously conducted by QDPI between August 2004 and January 2005 in *Pinus caribea* plantations in the Beerburrum, Toolara, (SEQ) and Cardwell (FNQ) forestry districts (Figure 5.2.2.2.1).

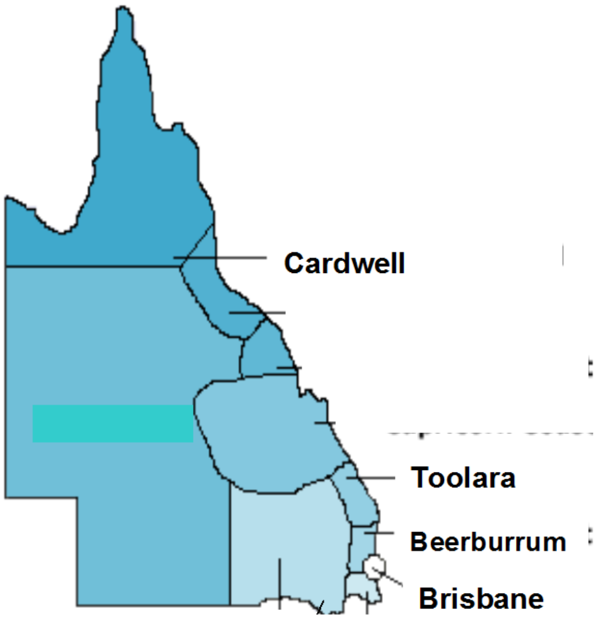

Figure 5.2.2.2.1. Location of plantation districts in Queensland surveyed by static trapping to detect wood-boring insects.

Trapping was conducted continuously in five compartments per district between August 2004 and January 2005. Traps were located in compartments that had been: (a) scorched by fire (two months to two years prior), (b) were storm damaged or stressed, (c) recently thinned/pruned, (d) recently clear felled (3-6 months prior) or (e) healthy stands.

Wood and bark boring insect target groups for trapping were beetles in the Scolytinae, Platypodinae, Cerambycidae, Buprestidae, Bostrichidae and Siricid wood wasps.

Trapping stations in each compartment consisted of:

- Three Lindgren funnel traps with ethanol + α-pinene lures.
- One intercept panel trap with ethanol-only lures.
- Timber billets (as attractants only)

The trapping stations were arranged as shown in Figure 5.2.2.2.2. Preserving fluid used in the traps was a mix of 20% ethanol, 5% glycerol and 1% detergent in water. Traps were emptied every 2 weeks and the lures changed every 4 weeks (FPQ).

Insects recovered from the traps and that emerged from the log billets were sorted to separate the target groups and specimens were identified, where possible to the species level.

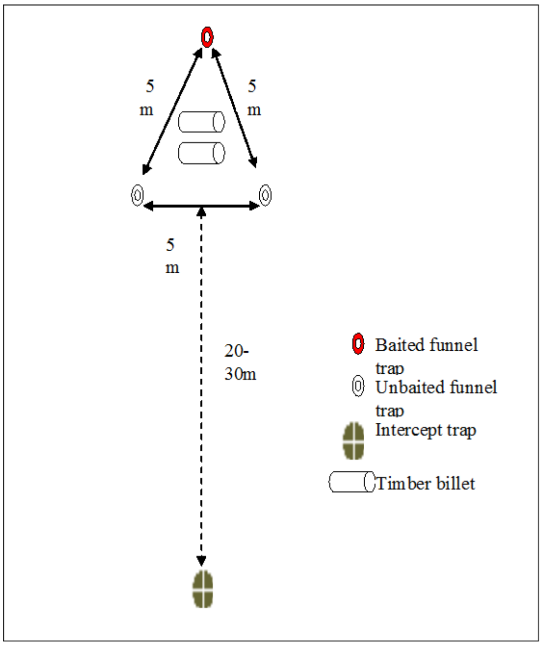

Figure 5.2.2.2.2. Layout of trapping stations

Hazard site surveillance

Reported in Wylie, F.R.; Griffiths, M. and King, J. (2008) Development of hazard site surveillance programs for forest invasive species: a case study from Brisbane, Australia. *Australian Forestry* **71(3)**: 229–235.

A sample of target sites for hazard site surveillance were chosen from among three risk categories (*sensu* Self and Kay 2005):

- Primary risk sites (port environs, international airport environs)
- Secondary risk sites (container devanning sites, quarantine approved premises (QAPs), importers of raw material (e.g.timber merchants))
- Tertiary risk sites (botanic gardens, military camps)

Lures were selected after an analysis of potential pests threats and with regard to the availability of particular chemical attractants and their accompanying traps. Six different lures were chosen:

- Ipsenol (*Ips* bark beetles - some species),
- ips-dienol (other *Ips* species),
- frontalin (some *Dendroctonus* species & other bark beetles);
- exo-brevicomin (other *Dendroctonus* species),
- α-pinene + ethanol (general wood and bark boring insects); and,
- disparlure (Asian gyspy moth).

The dispalure was used with a Delta sticky trap, while the remainder were used in Intercept panel traps. Five panel traps each with one of different lures were deployed at each trapping station: a sixth trap containing no lure was included to serve as a control. The traps were separated by a distance of at least 10 m 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. The panel traps 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.

Trapping was done over two successive years. During the first year (February 2006 – February 2007) the traps were run continuously at four sites in the Brisbane area:

(i) close to the Port of Brisbane within a cluster of QAPs and with mixed natural and planted trees;

(ii) a site on the fringe of the port area that contained a small plantation of Pinus elliottii;

(iii) a QAP in the suburbs (an importer of containerised timber); and,

(iv) a timber yard with new and recycled material.

A fifth set of six traps was run concurrently with the four permanent sites listed. This set of traps was relocated to various locations in response to post-border incidents or if chosen sites yielded low trap catches.

In the following year (commencing February 2007) five sets of traps were each run for four 4-week periods to cover each of the four seasons. Two of the sites surveyed during the previous year were chosen together with three new sites:

(i) Brisbane Botanic Gardens;

(ii) a timberyard; and,

(iii) a site adjacent to a timber wharf at the Port of Brisbane.

Insects recovered from the traps were sorted to separate the target groups and specimens were identified, where possible to the species level.

5.3 Detection surveys in Pacific countries

The in-country component commenced with an initial project workshop for participants. The agenda for this workshop is outlined in Appendix 1. At this workshop training was provided in the installation and management of static traps (Appendix 1) and sentinel trees. Following the workshop the country participants returned to their countries, each with one Australian team member. The Australian team member assisted each of the participating countries in setting-up static traps and sentinel trees in:

- A high risk, port environs site, typically the major port servicing international trade. A set of static traps will also be set up in a forested area near the port environs.
- Plantations of main species of importance to forestry
- Forest nurseries

One Lindgren funnel trap and one Intercept panel trap were installed at each survey site. Ethanol / α-pinene lures were used with these traps. A Delta trap with an Asian gypsy moth pheromone lure was also installed at the high risk site.

Once traps and sentinels were established, the participating countries managed them, with monthly servicing/ inspections and sending captured insects to QDPI&F for sorting, identification and mounting.

Country visits by the Australian participants were made at 6-12 monthly intervals after the initial country visits to take a voucher collection of insects that were trapped in each of the participating countries, to monitor progress and continue training. A taxonomist visited Fiji 12 months after the monitoring commenced to provide training and identify specimens for the beginning of the voucher collections. A final workshop was held in Brisbane in May 2010 to collate and discuss the results of the project and to fully hand over management of the surveillance system to the participating countries. This included developing protocols with the country participants for the use and maintenance of the voucher collections to screen static trap catches for potential new incursions.

5.3.1 Static trap surveys

5.3.1.1 Fiji

Table 5.3.1.1. Location of static trapping sites in Fiji.

Trap number	Type	Location	Latitude	Longitude
96	Lindgren	Suva Port - Main office building		
94	Panel			
89	Delta			
100	Lindgren	Suva Port - Fence adjacent to main office building		
97	Panel			
95	Delta			
88	Delta	Suva Port - 2nd hand car area, Shed 5, Freezer number 1		
95	Lindgren	Suva Port - North gate entrance		
92	Panel			
99	Lindgren	Suva - QAP export freight station, Tamavuua Wai	S18^{0}06.6'	E178^{0}26.0'
93	Panel		"	"
78	Lindgren	Colo-I-Suva nursery	S18^{0}03.490'	E178^{0}27.480'
75	Panel		"	"
76	Lindgren	Colo-I-Suva nursery	S18^{0}03.466'	E178^{0}27.489'
77	Panel		"	"
73	Lindgren	Colo-I-Suva compartment 23 (mahogany)	S18^{0}03.593'	E178^{0}28.650'
74	Panel		"	"
71	Lindgren	Colo-I-Suva compartment 23 (mahogany)	S18^{0}03.584'	E178^{0}28.680'
72	Panel		"	"
68	Lindgren	Colo-I-Suva seed orchard (mahogany)	S18^{0}02.831'	E178^{0}27.627'
67	Panel		"	"
69	Lindgren	Colo-I-Suva seed orchard (mahogany)	S18^{0}02.830'	E178^{0}27.637'
70	Panel		"	"
64	Lindgren	Lololo nursery (*P. caribaea*)	S17^{0}34.608'	E177^{0}34.630'
63	Panel		S17^{0}34.625'	E177^{0}34.792'
65	Lindgren		S17^{0}34.566'	E177^{0}34.736'
66	Panel		S17^{0}34.559'	E177^{0}34.774'
59	Lindgren	Dras plantation - burnt (*P. caribaea*)	S17^{0}35.102'	E177^{0}31.884'
60	Panel		S17^{0}35.096'	E177^{0}31.895'
61	Lindgren	Dras plantation - unburnt (*P. caribaea*)	S17^{0}35.127'	E177^{0}31.919'
62	Panel		S17^{0}35.118'	E177^{0}31.934'
56	Lindgren	Tavakubu plantation (*P. cairbaea*)	S17^{0}39.416'	E177^{0}29.765'
55	Panel		S17^{0}39.439'	E177^{0}29.764'
58	Lindgren		S17^{0}39.407'	E177^{0}29.800'
57	Panel		S17^{0}39.431'	E177^{0}29.798'

5.3.1.2 Vanuatu

Table 5.3.2.1. Location of static trapping sites estabished in October 2006 on Vanuatu.

Trap number	Type	Location	Latitude	Longitude
A	Panel	Vila, Forest Nursery	S17° 42.345´	E168° 19.211´
B	Lindgren			
C	Lindgren	Teouma Valley (Terminalia)	S17° 46.278´	E168° 24.297´
D	Panel			
E	Panel	Summit Estate (Sandalwood)	S17° 40.864´	E168° 14.192´
F	Lindgren			
G	Panel	Malafau (Whitewood)	S17° 34.108´	E168° 17.391´
H	Lindgren	Paunagisu (Whitewood)		

5.3.2 Sentinel plantings near high-hazard sites

The Australian participants liaised with project collaborators in Fiji and Vanuatu to arrange the selection of appropriate species to include in a sentinel planting. The sentinel species were mainly chosen from among the priority species identified in the country plans of the original project (detailed below). The country participants arranged to propagate each of the selected sentinel species and have them grown to a size suitable for deployment as sentinel trees during the initial country visits by the Australian participants.

Sentinel trees need to be kept low or cropped for ease of inspection and it is likely that young trees in pots or planting bags will be deployed, and rotated or replaced as required. The trees would need to be watered daily and pruned to maintain new leaf flush. It was proposed that paired species be deployed in two blocks at each port and surveyed each month for pests and pathogens. In the species lists below, guava has been included for detection of guava rust and coral tree for detection of Erythrina gall wasp.

Fiji

- Port: Suva
- Species: Caribbean pine (*Pinus caribaea*), Mahogany (*Swietenia macrophylla*), Red cedar (*Toona ciliata*), Whitewood (*Endospermum macrophyllum*), Sandalwood (*Santalum* sp.), guava (*Psidium guajava*), eucalypt (*Eucalyptus* sp.), Coral tree (*Erythrina variegata*).

Vanuatu

- Port: Port Vila (Efate)
- Species: Whitewood (*Endospermum medullosum*), Sandalwood (*Santalum* sp.), Caribbean pine (*Pinus caribaea*), guava (*Psidium guajava*), eucalypt (*Eucalyptus* sp.), Coral tree (*Erythrina variegata*).

6 Achievements against activities and outputs/milestones

Objective 1: To identify suitable static traps for target pest groups and establish these at high hazard sites in each participating country

no.	activity	outputs/ milestones	completion date	comments
1.1	Establish static traps at the main ports of entry in each participating Pacific country	Early detection systems for exotic forest pests established in each participating country		Trapping systems have been established in both countries and are operational and successful Change in emphasis from ports to other hazard sites
		Traps and attractants available for deployment by the time of the first workshop.	Yr 1, m 3-9	Completed
		Sites for static trapping selected by the time of the first Australian visit to each country.	Yr 1, m 9	Completed
		Traps established during visit by Australian project team members immediately post-workshop.	Yr 1, m 9-10	Completed
		Personnel and scheduling for trap system discussed at workshop and confirmed at time of trap establishment in-country.	Yr 1, m 9-10	Completed

PC = partner country, A = Australia

Objective 2: Determine appropriate species for sentinel plantings for each country and deploy these near high-hazard areas

no.	activity	outputs/ milestones	completion date	comments
2.1	Establish sentinel plantings at the main ports of entry in each participating	Sentinel plantings for early detection of exotic forest pests established in each	Yr 1, m 4	Sentinel plantings have been established in both countries and are operational.

	Pacific country.	participating country		
		Select and propagate appropriate species to include in sentinel plantings.	Yr 1, m 9-10	Completed (see previous reports)
		Deploy sentinel species at the ports of Suva in Fiji, and Port Vila in Vanuatu.	Yr 1, m 10 to Yr 3 m 12	Problems with maintenance, upkeep, inspection and access to sentinel plants have been an ongoing issue with this part of the program. A more sustainable approach may be to carry out regular, structured surveys of vegetation near port environments, e.g. the Botanic Gardens in Suva. Plants at Port Vila were unable to be inspected during the December 2008 visit due to access issues at the port, illustrating that this a real issue with sentinel plants.
		Inspect sentinel plantings monthly for insects and fungal diseases. Water plants daily, prune and replace as necessary.	Yr 1, m 9-10 to Yr 3, m 12	

PC = partner country, A = Australia

Objective 3: Train forest health surveillance personnel in participating countries in trapping techniques, efficient survey of sentinel plantings, collection and identification of major pests, and efficient communication protocols within the region.

no.	activity	outputs/ milestones	completion date	comments
3.1	Conduct training programs for forest health staff in the ongoing trapping and survey program	Increased skills of forest health staff. Hold workshop in Fiji to provide training to project staff in all aspects of the trapping and sentinel tree program.	Yr 1, m 9	Completed. Fiji now has 6 staff capable of implementing this program
		Continue training by means of in-country visits by Australian project teams.	Yr 1, m 10; Yr 2 m 9; Yr 3, m 9	Simon Lawson visited Vanuatu in December 2008 and gave Forestry staff training and background in the trapping program. New lures and traps were delivered. (See Appendix 3).

3.2	Assist participating countries with collection, storage and identification of trapped insects to enable compilation of a voucher collection of significant forest pests	Voucher collections established to enable rapid screening for new incursions. Provide training in curation and taxonomy at initial Workshop in Fiji Continue training during in-country visits by Australian project teams and taxonomist	Yr 1, m9 Yr 1, m10; Yr 2, m 3; Yr 2, m 9; Yr3, m9	Completed Training provided to 10 Fiji Quarantine staff and 2 FFD staff.
3.3	Assist participating countries with the use of voucher collections to rapidly screen insect samples collected from static traps and other surveys for potential new incursions	Forest health staff trained and able to rapidly screen insect samples for potential new incursions. Provide training in the use of voucher collections for rapid screening of insect samples at initial workshop in Fiji Continue training during in-country visits by Australian project teams and taxonomist	Yr 1, m 9 Yr 1, m10; Yr 2, m 3; Yr 2, m 9; Yr3, m9	Completed. As above for 3.2 for visits by Dick Bashford (Fiji, August 2008) Judy King and Ross Wylie (Fiji, March 2009) and Simon lawson (Vanuatu, December 2008).
3.4	Enhance communication between forestry, agriculture and quarantine staff in participating countries on forest health matters.	Enhanced communication mechanisms on forest health established. At the workshop, outline the response plans for each country and discuss the roles and responsibilities of the various organisations in the event of an incursion of a forest pest.		Completed. Now easier for FFD to import/export forest products with ease since Quarantine staff are more aware of forestry consignments and procedures for permits.

Objective 4: Develop trap/lure combinations in Australia which are effective in attracting and trapping wood boring insects which attack eucalypts and pines, and test these in mid-rotation plantations in Tasmania and Queensland.

no.	activity	outputs/ milestones	completion date	comments
4.1	Design and	Effective trapping		

	establish trap/lure combinations for wood borers in Australian eucalypt and pine plantations and conduct surveys of mid-rotation plantations to test efficiency of trapping systems	systems developed for eucalypt and pine wood borers. Static trapping validated as effective early warning system for eucalypt and pine wood borer infestations.	Yr 1, m 6	Completed
		Australian project staff to meet at the commencement of the project to finalise design of trap/lure system and to discuss agenda for initial workshop in Fiji.	Yr 1, m 9 -m 12	For Queensland & Tasmania trapping program results see comments in sections 7.1 &7.2.
		Deploy traps in plantations in Tasmania and Queensland during the September-December flight season of the main pest species.	Yr 2, m 5	
		Conduct intensive ground surveys in the plantations to detect damage symptoms of wood boring insects. Compare results of trapping and surveys	Yr 2, m 12	

PC = partner country, A = Australia

7 Key results and discussion

7.1 Design of trap-lure combinations

A full description of the results of three separate studies examining trap-lure combinations have been published in the following papers:

Bashford, R. (2008) The development of static trapping systems to monitor for wood-boring insects in forestry plantations. *Australian Forestry*, **71(3)**: 236-241. (Trials 1 and 3)

Wylie, F.R., Griffiths, M. and King, J. (2008) Development of hazard site surveillance programs for forest invasive insect species: a case study from Brisbane, Australia. *Australian Forestry* **71**, 229–235. (Trial 2)

7.1.1 Trial 1: Combinations of α- and β-pinene lures to trap *Sirex*

There was a significant difference ($F_{6,14} = 19.5$, MSE = 2.238; $P<0.001$) in the capture rates among lures with different ratios of α- and β-pinene. Lures containing α- : β-pinene in the ratio of 70:30 were significantly more effective in capturing *Sirex* females than any other combination of α- and β-pinene (Figure 7.1.1.1). Of the remaining lures, their effectiveness in attracting *Sirex* females declined as the proportion of β-pinene in the mixture increased.

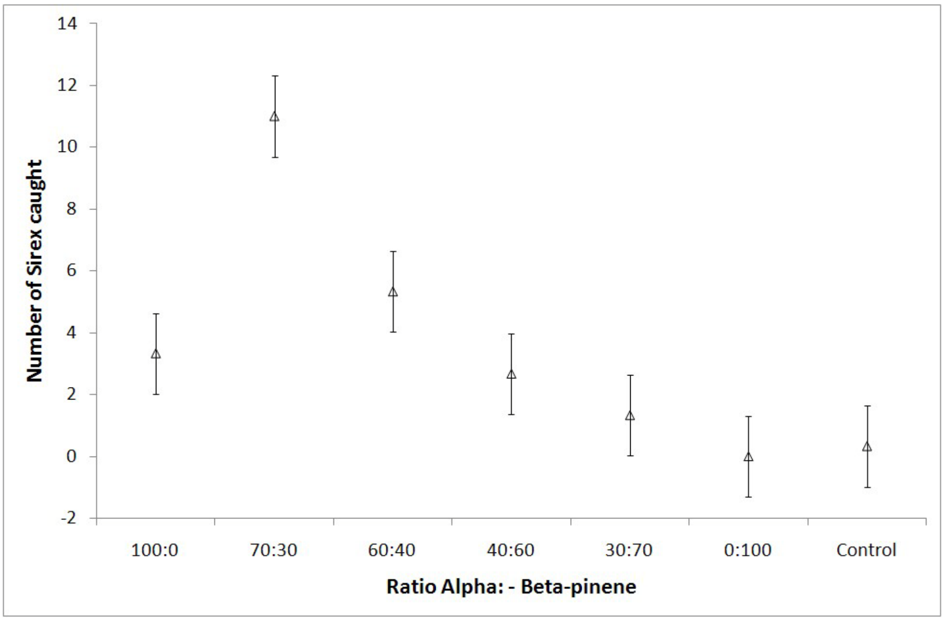

Figure 7.1.1.1. Average (with 95% LSD) number of female Sirex wasps caught in panel traps containing lures with different ratios of α- : β-pinene.

7.1.2 Trail 2: Comparison of the effectiveness of trap-lure combinations in tropical environments

Similar numbers of taxa (35-46 species) were trapped for all lure types (Table 7.1.2.1). Control (no lure but with ethyl alcohol, glycerol, water & detergent in the preserving fluid) caught a smaller, although similar, number of species as the baited traps - ethyl alcohol is an attractant itself. Some lures were more attractive to particular species than others.

However, the majority of the instances of lure-specific attraction were for rare species: 29 of the 40 species strongly associated with one particular lure (66.7% or more of total captures of that species) were singletons (Table 7.1.2.1). Previously no specific lure was known for Bostrichidae but 11 species and 685 individuals were trapped, approximately equally among the lure types.

Table 7.1.2.1. Number of species and (specimens), partitioned by Family / Sub-family, caught in Intercept™ panel traps for each of six different types of lure.

Family / Sub-family	Control	α-pinene + ethanol	Exo-brevicomin	Frontalin	Ips-dienol	Ipsenol	Total
Anobiidae	2 (36)	3 (116)	3 (29)	2 (116)	4 (51)	3 (109)	4 (457)
Bostrichidae/Lyctinae		1 (12)		1 (15)	1 (1)	1 (4)	1 (32)
Bostrichidae	5 (55)	6 (122)	8 (63)	8 (130)	6 (156)	6 (159)	11 (685)
Buprestidae	1 (1)				2 (2)	1 (1)	3 (4)
Cerambycidae	11 (36)	8 (14)	13 (21)	9 (55)	12 (31)	11 (25)	35 (182)
Curculionidae/Platypodinae		2 (22)	2 (5)	1 (14)	2 (31)	1 (47)	2 (96)
Curculionidae/Scolytinae	16 (367)	22 (1234)	19 (709)	23 1517)	19 (1047)	22 (991)	33 (5865)
Grand Total	35 (495)	42 (1520)	45 (827)	44 (1847)	46 (1296)	45 (1336)	89 (7321)
Number of species strongly associated with lure	6	6	6	7	7	8	
Number of singletons associated with lure	5	4	5	4	5	6	

A summary of the advantages/ disadvantages of different trap types for tropics/subtropics, based on a review of their performance during operational trapping programs in plantations and hazard sites that were conducted in Queensland (reported in 7.2.2), is a follows:

Intercept™ Panel trap:

- Catches a similar range and number of species/ specimens as the Lindgren trap.
- Much cheaper than the Lindgren trap.
- Preserving fluid evaporates faster than in Lindgren.

Lindgren trap:

- Similar catch to panel trap
- Lower evaporation of preserving fluid.

- Easier to empty and service than panel trap.
- Expensive.

Japanese trap:

- Designed for catching *Monochamus*. Catches a smaller range of species than panel or Lindgren.
- Evaporation from wide pan much greater rate than for other traps.

An optimal trap design for the tropics would be a hybrid design that uses the simpler and cheaper materials of the panel trap but has a smaller collection container, similar to that used in the funnel trap.

7.1.3 Trial 3: Effectiveness of lures containing different eucalypt stress volatiles in capturing wood-boring insects in a *Eucalyptus nitens* plantation.

Intercept™ panel traps containing lures with different known volatile compounds produced by stressed eucalypts were tested to compare the diversity and abundance of wood-boring insects that they captured in two sections of a mid-rotation *Eucalyptus nitens* plantation: one thinned and the other unthinned. The total diversity of wood-boring insects within the plantation during the trial period was 31 species based on sampling using a wide variety of methods.

There were significant differences in the diversity of insect species captured both among the different lures ($F_{5,17}$ = 9.43; MSE=5.45; P = 0.0002), and between thinned and unthinned stands ($F_{1,17}$ = 18.34; MSE=5.45; P=0.0005),. There was no significant interaction between lure and stand treatment. The diversity of wood-boring insects in the unthinned stand was 50% greater than in the thinned stand. The ethanol ultra-high-release (UHR) lure captured a significantly greater diversity of wood-boring insects than all other lures (1.4 - 2.8 time the diversity caught using other lures). One of the ethanol UHR lures captured 29 of the 31 species that were recorded in the plantation.

The ethanol UHR lure captured a greater abundance of wood-boring insects than the other lures, however, the difference in the abundance of wood-boring insects captured using the different lures here did not reach statistical significant ($F_{5,17}$ = 2.38; MSE = 151.6; P = 0.082).

7.2 Use of static traps for pest monitoring in plantations

7.2.1 Relationship between static trap catches and stress / borer damage in mid-rotation *Eucalyptus* plantations

(see Wotherspoon et al. (2011) in Appendix for the full report)

A total of 1194 specimens of wood-boring beetle representing 35 species were caught over the three-month trapping period. Of the 7,695 trees assessed for health status: 5,695 (74%) were healthy, 1,850 (24%) showed symptoms of stress and 1,171 (15%) showed signs of borer damage. At the level of individual plantations, between 8-308 (mean = 63) specimens of wood-boring beetles and between 4-18 (mean = 9) species were caught. Corresponding damage levels in individual plantations ranged between 6-46% (mean =

16% of trees) showing signs of borer damage and 8-75% (mean = 25% of trees) showing symptoms of stress.

Both the incidence of damage symptoms and the diversity of wood-boring beetles showed strong negative correlations with mean annual rainfall. In contrast, the abundance of wood-boring beetles showed little variation with rainfall on most sites. The abundance results were distorted by very much higher abundances (5-9 times the median) of wood-boring beetles in three plantations - all at the lower end of the rainfall range. The diveristy, but not the abundance, of wood-boring beetles was positively correlated with the incidence of damage symptoms in the plantations.

Among the 35 wood-boring beetle species captured in the static traps seven were significantly correlated with the incidence of either symptoms of stress or signs of wood-borer damage. Three scolytids (*Xyleborus compressus, Xyleborus saxeseni* and *Xylosandrus solidus*), a lucanid (*Lamprima aurata*) and the anobiid (*Trypopitys multimaculatus*) were all significantly and positively correlated with the incidence of trees exhibiting symptoms of stress. Two cerambycids (*Epithora dorsalis* and *Phacodes obscurus*), both occurring at very low incidence, were significantly and positively correlated with the incidence of trees showing signs of borer damage. The low number of cerambycids captured in the static traps may have been because of timing: trapping was done towards the end of the peak period of emergence of many cerambycid species.

Thus the results allow us to conclude that static trapping is able to detect plantations that are under stress and have signs of borer attack. However, for a useful operational method of monitoring we need a better understanding of the spatial scales at which static trap results reflect damage in a plantation. To do this we need to answer the following questions:

- How do static trap results vary spatially within a plantation?
- How does local damage in a plantation co-vary with variation in static trap results?

A separate study, independent of this ACIAR project, is being done in Tasmania to try to answer these questions.

7.2.2 Static trapping for early detection of exotic species in *Pinus* plantations

7.2.2.1 Tasmanian study

This study examined the diversity of wood-boring insects captured in Lindgren funnel traps containing a generalist lure containing 96% ethanol mixed with α-pinene.

This trap-lure combination caught between 7-11 species of wood-boring among the four Tasmanian pine plantations surveyed, with an average of between 13-86 insects caught per trap (Table 7.1.2.1). Species from the Scolytinae were caught in the greatest abundance, and contributed to 78% of the specimens caught. The Anobiidae were the next most abundant group caught, contributing to 14% of the specimens caught.

Xyleborinus saxesini was trapped in abundance in the three plantations in northern Tasmania. This is the first official record for this species in Tasmania and extends its known range in Australia. All other known established exotic species of wood-boring insects of *Pinus radiata* in Tasmania were caught in at least one of the plantations. *Ips grandicollis* was not captured providing on-going confirmation that this species remains absent from the state (as the same trapping system regularly caught *Ips* in Queensland). With the exception of Retreat plantation (lowest diversity and abundance of insects) the range of species caught was similar in each of the plantations.

Table 7.1.2.1. Capture rates of wood-boring insects using Lindgren funnel traps with ethanol - alpha-pinene lures from four Tasmanian *Pinus radiata* plantations. Species marked with an asterisk are exotic species that have become established in Tasmania.

Species	Pittwater (8 traps)	Lisle (3 traps)	Virginstow (3 traps)	Retreat (3 traps)
*Sirex noctilio**	16	2	11	3
*Hylurgis ligniperda**	449	2	45	0
*Hylastes ater**	74	12	5	0
Platypus subgranosus	2	18	6	13
*Ernobium mollis**	76	3	4	0
Trypopitys multimaculata	42	1	2	1
*Xyleborinus saxesini**	0	39	33	17
Xyleborus compressus	3	8	2	0
Xylosandrus truncatus	3	0	0	0
Xylebosca bisponosa	2	0	0	1
Hadrobregmus australiensis	1	0	0	0
Cryphalus pilosellus	17	11	18	1
Hadrobregmus aeriolicollis	0	0	0	3
Total insects trapped	685	96	126	39
Mean no insects / trap	86	32	42	13
Number of species / site	11	9	9	7
Number of unique species	2	0	0	1

7.2.2.2 Queensland

Plantation

Due to the large number of samples and insects present in each sample, only 40% of total samples were sorted and identified. This sub-sample of collections yielded 18,095 specimens from 41 target species. The Scolytinae dominated the beetle fauna caught, contributing 99.2% of all specimens. The three most abundant scolytids - *Xyleborus ferrugineus, X. perforans* and *Xyleborinus saxeseni* - contributed 85% of the total insects caught (Table 7.2.2.2.1). However, *X ferrugineus* was only caught in plantations from the southern districts (Beerburrum and Toolara). This species was responsible for much of the damage to stored logs salvaged after the 1987 fires in Beerburrum.

The detection of *Hylurgus ligniperda* in Beerburrum and Toolara Districts (Table 7.2.2.2.1) represents an extension of the range of this species in Queensland. Previously it was only known to occur in Passchendaele area. While *Ips grandicollis* was abundant in the southern Districts, it remains absent from Cardwell (Table 7.2.2.2.1).

Table 7.2.2.2.1. Number of specimens of target species captured in static traps installed in *Pinus caribea* plantations in Beerburrum, Ingham and Toolara, Queensland.

Species	Family/Subfamily	Beerburrum	Cardwell	Toolara	Total
Xyleborus ferrugineus	Scolytinae	6817		404	7221
Xyleborus perforans	Scolytinae	2886	2550	947	6383
Xyleborinus saxeseni	Scolytinae	428	176	1215	1819
Ips grandicollis	Scolytinae	379		324	703
Cyclorhipidion agnatus	Scolytinae		411		411
Ambrosiodmus compressus	Scolytinae	238	11	94	343
Xylosandrus solidus	Scolytinae	68		173	241
Hypothenemus seriatus	Scolytinae	11	116	94	221
Xyleborus affinis	Scolytinae		139		139
Xyleborus annexus	Scolytinae	51	63	8	122
Xyleborus analis	Scolytinae	83			83
Xylopsocus gibbicollis	Bostrichidae	29	1	22	52
Hypothenemus birmanus	Scolytinae	1	42	6	49
Xyleborus eximius	Scolytinae	2	42		44
Ambrosiodmus latecompressus	Scolytinae	36			36
Amasa truncatus	Scolytinae	1		30	31
Ernobius mollis	Anobiidae	5		22	27
Cyrtogenius brevior	Scolytinae		26		26
Xyleborus similis	Scolytinae	10	8	1	19
Cacodacnus planicollis	Cerambycidae	12		4	16
Crossotarsus kuntzeni	Platypodinae			16	16
Hylurgus ligniperda	Scolytinae	11		5	16
Hypothenemus melasomus	Scolytinae	3	12	1	16
Hypothenemus eruditus	Scolytinae		10		10
Xylodeleis obsipa	Bostrichidae	8	1		9
Xyleborinus artestriatus	Scolytinae		7		7
Crossotarsus subpellucidus	Platypodinae		6		6
Deroptilinus granicollis	Anobiidae	5			5
Bostrychopsis jesuita	Bostrichidae	3	1		4
Coccotrypes carpophagus	Scolytinae	3			3
Xyleborus ipidia	Scolytinae		1	2	3
Ancita marginicollis	Cerambycidae	2			2
Eccoptopterus spinosus	Scolytinae		2		2
Platyomopsis sp.	Cerambycidae		2		2
Xylobosca bispinosa	Bostrichidae	2			2
Coptocercus sp.	Cerambycidae	1			1
Dinoderus minutus	Bostrichidae	1			1
Eidophelus hornus	Scolytinae		1		1
Microperus eucalypticus	Scolytinae	1			1
Temnosternus planiusculus	Cerambycidae			1	1
Xylothrips religiosus	Bostrichidae		1		1

Beerburrum had the highest diversity and abundance of species and a comparable number of unique species as Cardwell (Table 7.2.2.2.2). Toolara had fewer species and considerably fewer unique species than the other two Districts.

Table 7.2.2.2.2. Number of species (number of unique species) and total number of specimens from each of the target families captured in static traps in three districts.

Family / Sub-family	Beerburrum	Toolara	Cardwell
Anobiidae	2 (1) 10	1 (0) 22	
Bostrichidae	5 (2) 43	1 (0) 22	4 (1) 4
Cerambycidae	3 (2) 15	2 (1) 5	1 (1) 2
Curculionidae/Platypodinae		1 (1) 16	1 (1) 6
Curculionidae/Scolytinae	18 (4) 11,029	14 (0) 3,304	17 (7) 3,617
Total for District	28 (9) 11,097	19 (2) 3,369	23 (10) 3,629

The status of plantations in which the static traps were installed had a significant effect on diversity of insect species captured. There were significanly greater numbers of insect species were trapped from compartments recently thinned that had retained stumps and thinnings on site. By contrast, fewer insect species were collected from compartments that had been cleared and contained no standing trees (Figure 7.2.2.2.1).

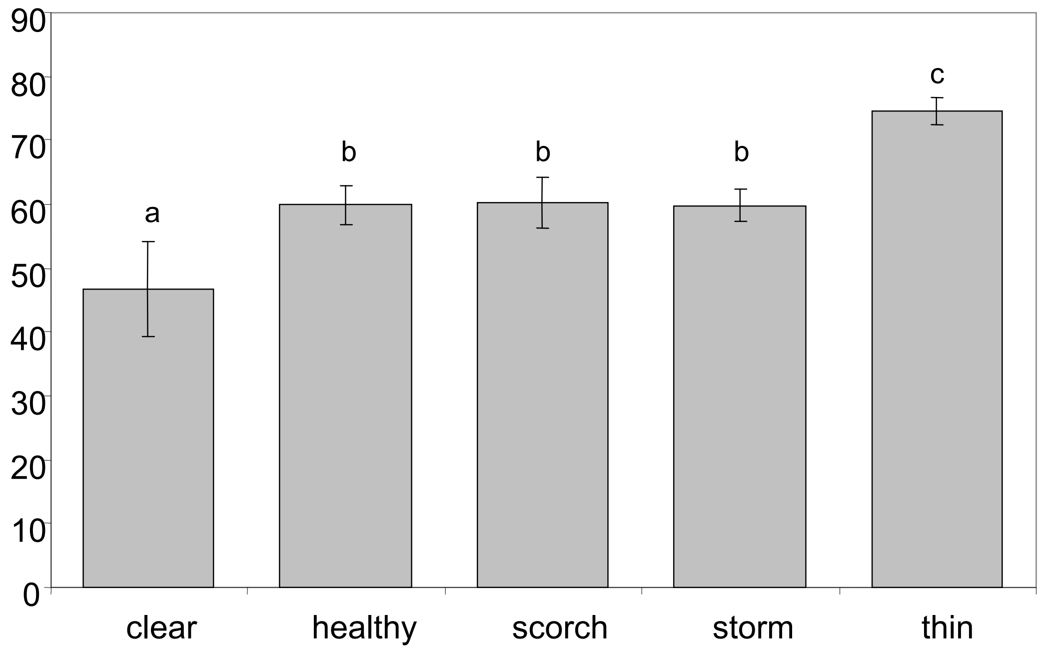

Figure 7.2.2.2.1. Mean (± SE) percentage of insect species trapped within each category of plantation status relative to the total number of insect species collected within the particular district.

Hazard site surveillance

A total of 7,321 individuals from 89 species and were caught in the traps (Table 7.2.2.2.3). These included: Scolytinae (33 spp); Cerambycidae (35 spp); Bostrichidae (11 spp); Platypodinae (2 spp.); Anobiidae (4 spp.); Buprestidae (3 spp.). Scolytinae were the most abundant taxa making up 83% of the catch.

No new exotics were trapped. However, 19 species representing 60% of the specimens trapped were exotic species that are already established in Australia.

Site effects were significant. One site, a timber yard with considerable vegetation, yielded 40% of all specimens caught in the program and 80% of the species. Similarly, the type of vegetation was significant: more pine pests were caught at sites with host trees present.

Table **7.2.2.2.3.** Number of specimens of taxa from target families captured in static traps installed at hazard sites in the Brisbane area.

Family / (Sub-family) / Species	Total	Family / (Sub-family) / Species	Total
Anobiidae		**Cerambycidae**	
Hadrobregmus australiensis	407	*Paradisterna plumifera*	4
Lasioderma serricorne	25	*Phoracantha semipunctata*	4
Deroptilinus granicollis	24	*Adrium artifex*	3
Stegobium paniceum	1	*Agrianome spinicollis*	3
Bostrichidae		*Amphirhoe decora*	3
Xylopsocus gibbicollis	508	*Thoris septemguttata*	3
Xylothrips religiosus	70	*Chlorophorus curtisi*	2
Rhizopertha dominica	63	*Exocentrus* sp.	2
Lyctus brunneus	32	*Pachydissus sericeus*	2
Xylodeleis obsipa	18	*Phoracantha punctata*	2
Xylobosca bispinosa	12	*Rhinopthalmus* sp.	2
Trogoxylon ypsilon	4	*Stenocentrus ostricilla*	2
Bostrychopsis jesuita	3	*Bethelium signiferum*	1
Xylion cylindricus	3	*Brachytria varia*	1
Trogoxylon sp.	2	*Ceresium* sp.	1
Dinoderus minutus	1	*Coptocercus crucigerus*	1
Xylopsocus burnsi	1	*Didymocantha obliqua*	1
Buprestidae		*Essisus dispar*	1
Agrilus mastersi	2	*Illaena* sp.	1
Melobasis purpurascens	1	*Itheum vittigerum*	1
Melobasis sexplagiata	1	*Lygesis cylindricollis*	1
Cerambycidae		*Prosoplus iratus*	1
Syllitus tuberculatus	45	*Prosoplus* sp.	1
Ancita marginicollis	43	*Sybra* sp.	1
Coleocoptus senio	13	*Syllitosimilis aberrans*	1
Aridaeus thoracicus	10	*Tritocosmia atricella*	1
Pachydissus sp.	10	*Xystrocera virescens*	1
Syllitus sp.	6	**Curculionidae/Platypodinae**	
Coptocercus aberrans	4	*Platypus parallelus*	93
Coptocercus biguttatus	4	*Notoplatypus elongatus*	3

Table **7.2.2.2.3.** ***(Continued)*** Number of specimens of target species captured in static traps installed at hazard sites in the Brisbane area.

Family / (Sub-family) / Species	Total	Family / (Sub-family) / Species	Total
Curculionidae/Scolytinae		**Curculionidae/Scolytinae**	
Hypothenemus seriatus	2304	*Xylosandrus discolor*	14
Ips grandicollis	956	*Cyrtogenius brevior*	6
Xyleborus perforans	711	*Xyleborus ipidia*	6
Eccoptopterus spinosus	484	*Cyrtogenius dimorphus*	4
Coccotrypes carpophagus	308	*Coccotrypes* sp.	2
Hylurdrectonus corticinus	234	*Ficicis varians*	2
Xyleborinus saxeseni	142	*Xyleborus analis*	2
Xyleborus similis	124	*Ambrosiodmus latecompressus*	1
Xylosandrus solidus	99	*Cryphalus* sp.	1
Xyleborus ferrugineus	90	*Hylurgus ligniperda*	1
Hypothenemus eruditus	81	*Hypocryphalus* sp.	1
Amasa truncatus	77	*Hypothenemus* sp.	1
Hypothenemus melasomus	66	*Microperus eucalypticus*	1
Coccotrypes dactyliperda	42	*Xyleborinus artelineatus*	1
Hypothenemus birmanus	41	*Xyleborus eximius*	1
Xyleborus annexus	35	*Xylosandrus morigerus*	1
Ambrosiodmus compressus	26		

7.3 Detection surveys in Pacific countries

7.3.1 Static trap surveys

7.3.1.1 Fiji

Between September 2006 – December 2009 a total of 278 samples collected from static traps installed in nine localities on Viti Levu, Fiji, were sent to Brisbane for sorting and identification by Dr Judy King (DEEDI, Queensland), a member of the Project Team. A total of 4,259 specimens, representing 46 species, from the target insect groups (scolytids, platypodids, bostrichids, cerambycids and circulionids) were identified Table 7.3.1.1.1).

Table 7.3.1.1.1. Summary of static trapping surveys done in Fiji 2007-2010. [1.] Number of collections sent to Brisbane for sorting, identification and mounting. [2.] Number of identified specimens from target taxa. [3.] Raw count of the total number of specimens in samples. [4.] One sample did not have details of collection date.

Year	Trap clearances	Specimens collected/identified
2006	5[1]	8[2]
2007	45[1]	153[2]
2008	60[1]	779[2]
2009	182 (167[1])	8,626[3] (3,311[2])
2010 (first quarter)	80	1,024[3]
Total	278[1,4]	4,259[2]

An issue, particularly with the early collections, was the high level of decomposition of the specimens: many specimens in badly affected collections had decayed to such an extent that they had fragmented and could not be identified. This reflected the challenges of running static traps in tropical climates where heavy rain dilutes the preservative solution, rendering it less effective. The problem was resolved using several approaches including: siting the traps under shelters offering some rain protection; removing some of the funnels in the Lindgren traps to reduce their rain interception area; and, shortening the period of time between collections. In combination, these tactics were effective as the proportion of collections that were decayed decreased from more than 30% to less than 5% as the project progressed (Figure 7.3.1.1.1.).

There were significant differences ($F_{2,274}$=33.6, MSE=0.324, $P<0.001$ for log-transformed data) among seasons in the average number of species from the target groups in each collection. Collections made during the dry season (June-September) contained, on average, 2.1 and 2.6 times as many species per collection, as collections made during the early wet season (October-December) and late wet season (March-May), respectively (Table 7.3.1.1.2). There were also significant differences (Kruskal-Wallis rank-test statistic = 47.2, $P<0.001$) among seasons in the number of specimens from the target groups in each collection: Collections made during the dry season had 4.5 and 5.8 times the number of specimens per collection as collections made during the early and late wet seasons, respectively (Table 7.3.1.1.2.).

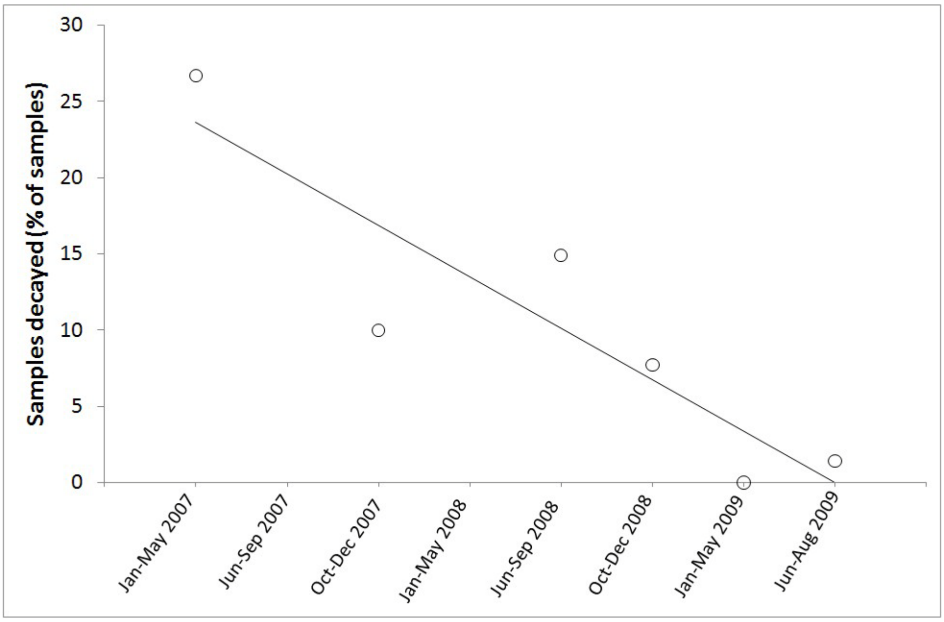

Figure 7.3.1.1.1. Percentage of static trap collections from Fiji that had decayed during six collection periods between 2007-2009.

Table 7.3.1.1.2. Captures of each species by season. [1.] One collection of nine specimens did not have collection date information.

	Dry	Early wet	Late wet	Total
Number of samples collected	188	48	41	277[1]
Total number of species	44	22	14	46
Mean number of species / collection	3.05_a (±0.20)	1.42_b (±0.41)	1.15_b (±0.44)	2.49
Total number of specimens	3,882	220	148	4,250[1]
Mean number of specimens / collection	20.7_a (±4.4)	4.6_b (±8.7)	3.6_b (±9.4)	15.3

Scolytinae dominated the trap captures in Fiji and contributed 94.1% of all insects from the target groups that were captured. This mirrored the results of recent hazard site surveys done in the Brisbane area (Wylie et al. 2008). Bostrichidae and Platypodinae, each contributing about 2.5% to the trap captures, were the next most numerous groups.

Three scolytids, *Xyleborus affinis* (sugar cane shoot borer), *X. perforans* (island pinhole borer) and *Xylosandrus crassiusculus* (Asian ambrosia beetle) dominated the static trap captures, contributing two-thirds of the total number of specimens in the target groups that were captured (Table 7.3.2.3). The detection of *X. crassiusculus* in this project represents the first record of this species in Fiji. However, its widespread distribution throughout Viti Levu (Table 7.3.2.3) indicates that it has been present in Fiji for some time.

There were significant differences among sites in both the diversity (Kruskall-Wallis rank test statistic = 76.5, P<0.001) and abundance (Kruskall-Wallis rank test statistic = 75.6, P<0.001) of insects from the target groups captured. Most of the trapping sites in western Viti Levu, within the *Pinus caribea* plantation areas, captured a significantly higher diversity and abundance of beetles from the target groups than the other sites (Table

7.3.1.1.3). Importantly, the trapping sites at the quarantine facilities at Suva Wharf had significantly lower diversity and abundance of beetles than all other sites. This reflects the urban environment in which the wharf is situated with very few trees and shrubs in the immediate surrounds. By contrast the EFS Container Facility (a high-risk devanning site), which was situated in the urban fringes with more surrounding vegetation, had a diversity and abundance of beetles comparable with forest sites such as Colo-i-Suva and Vunimaqao (Table 7.3.1.1.3).

Table 7.3.1.1.3. Captures of each species by location.

	Trap location									
Number of occasions caught (Individuals caught)	Colo-i-Suva	Drasa	EFS Suva	Lasa	Lololo	Nabou	Suva wharf	Tavakubu	Vunimaqao	Total
Xyleborus affinis	17 (42)		6 (22)	1 (391)	32 (530)		1 (1)		7 (25)	64 (1011)
Xyleborus perforans	22 (91)	2 (20)	10 (12)		21 (746)	2 (21)	1 (8)		9 (22)	67 (920)
Xylosandrus crassiusculus	72 (415)	1 (2)	21 (129)	1 (20)	31 (258)	2 (5)	3 (14)	2 (20)	14 (51)	147 (914)
Hypothenemus birmanus	13 (33)	2 (3)	4 (5)	1 (29)	30 (216)		1 (1)	1 (15)	9 (37)	61 (339)
Xyleborinus perexiguus	9 (18)		15 (72)	1 (3)	15 (40)	1 (30)	2 (12)	1 (1)	8 (20)	52 (196)
Xyleborus ferrugineus	11 (13)	1 (1)	3 (3)	1 (2)	21 (142)	2 (3)			4 (5)	43 (169)
Hypothenemus seriatus	7 (13)	1 (9)	7 (15)	1 (2)	13 (89)				4 (8)	33 (136)
Xylosandrus morigerus	15 (22)	1 (2)	5 (5)	1 (3)	17 (89)				2 (3)	41 (124)
Xylothrips religiosus	3 (5)	1 (1)		1 (1)	13 (57)	1 (1)		1 (1)	2 (2)	22 (68)
Cryphalus sp.1	6 (26)				2 (22)				4 (13)	12 (61)
Platypus gerstaekeri	2 (47)		1 (1)		1 (3)	1 (1)			1 (1)	6 (53)
Crossotarsus externetentatus	7 (15)		3 (17)		1 (1)		2 (2)			13 (35)
Xylosandrus fijianus	9 (25)		2 (3)		1 (5)				1 (2)	13 (35)
Dinoderus minutus	1 (3)	1 (1)			4 (7)		3 (3)		6 (13)	15 (27)
Acicnemis biconifer	3 (20)				3 (3)				3 (4)	9 (27)
Hypothenemus eruditus	1 (2)				6 (17)				1 (2)	8 (21)
Hypocryphalus laticollis	2 (18)				1 (1)					3 (19)
Coccotrypes fijianus	1 (2)		1 (1)		7 (11)		1 (1)			10 (15)
Platypus parallelus					3 (3)		1 (1)		1 (6)	5 (10)
Sinoxylon anale	1 (1)				4 (6)					5 (7)
Coccotrypes carpophagus	2 (3)		3 (4)							5 (7)
Adoretus versutus	2 (2)		1 (1)		1 (2)				1 (1)	5 (6)
Euwallacea fornicatus	1 (1)				1 (1)		1 (1)		2 (3)	5 (6)
Himatum sp.1	1 (1)				3 (3)				2 (2)	6 (6)

Xyleborus aplanatidiclivis	2 (2)			3 (3)						5 (5)

Table 7.3.1.1.3. Captures of each species by location (continued)

	Trap location									
Number of occasions caught (Individuals caught)	Colo-i-Suva	Drasa	EFS Suva	Lasa	Lololo	Nabou	Suva wharf	Tavakubu	Vunimaqao	Total
Xyleborus similis					3 (4)				1 (1)	4 (5)
Sueus niisimai	1 (1)				1 (2)		2 (2)			4 (5)
Xylodeleis obsipa		1 (2)			1 (1)					3 (3)
Hypocryphalus perminimus	1 (1)			1 (1)					1 (1)	3 (3)
Xylopsocus gibbicollis					1 (2)					1 (2)
Coccotrypes sp. 1			1 (2)							1 (2)
Hypocryphalus sp.					2 (2)					2 (2)
Ambrosiophilus wilderi					1 (1)					1 (1)
Euwallacea destruens	1 (1)									1 (1)
Euwallacea piceus			1 (1)							1 (1)
Euwallacea sp. 1	1 (1)									1 (1)
Xyleborinus artelineatus	1 (1)									1 (1)
Xyleborus partitus									1 (1)	1 (1)
Xylosandrus compactus	1 (1)									1 (1)
Coccotrypes cyperi					1 (1)					1 (1)
Cryphalus capucinomorphus					1 (1)					1 (1)
Diapus quinquespinatus	1 (1)									1 (1)
Scolytomimus ?maculatus							1 (1)			1 (1)
Xylopsocus castanoptera					1 (1)					1 (1)
Number of samples	109	3	36	1	61	5	34	2	27	278
Number of species caught	32	9	17	9	34	6	13	5	22	46
Mean number species / collection	2.0_{b}	$3.7_{a,b}$	2.4_{b}	9.0	4.1_{a}	1.8_{b}	0.6_{c}	$3.0_{a,b}$	$3.1_{a,b}$	2.5
Number of individuals caught	828	41	295	452	2,270	61	48	38	223	4,259
Mean number of individuals / collection	7.6_{b}	$13.7_{a,b}$	8.2_{b}	452	37.3_{a}	$12.2_{a,b}$	1.4_{c}	$19_{a,b}$	8.3_{b}	

A mounted voucher collection of beetles collected from the static traps surveys and from *ad hoc* collections during country visits, was assembled and presented to the country participants at the final project workshop held at Brisbane in May 2010. This voucher collection will be housed in the Fiji National Forest Insect collection as a resource for the ongoing screening and identification of future static trap surveys. Table 7.3.1.1.4 lists the species contained in that voucher collection.

Table 7.3.1.1.4. Species list of voucher specimens collected in Fiji.

SCOLYTIDAE Tribe Xyloborini *Ambrosiophilus wilderi* (Beeson) *Euwallacea destruens* (Blandford) *Euwallacea fornicatus* Eichhoff *Euwallacea piceus* (Motschulzky) *Xyleborinus artelineatus* (Beeson) *Xyleborinus perexiguus* Schedl *Xyleborinus ?spiniposticus* Wood *Xyleborus affinis* Eichhoff *Xyleborus aplanatidiclivis* Schedl *Xyleborus ferrugineus* (F.) *Xyleborus partitus* Browne *Xyleborus perforans* Wollaston *Xyleborus similis* Ferrari *Xylosandrus compactus* (Eichhoff) *Xylosandrus crassiusculus* (Motschulzky) *Xylosandrus fijianus* (Schedl) *Xylosandrus morigerus* (Blandford) Tribe Dryocoetini *Coccotrypes carpophagus* (Hornung) *Coccotrypes cyperi* (Beeson) *Coccotrypes fijianus* (Schedl) Tribe Cryphalini *Cryphalus* sp.1 (Det. R. Beaver) *Cryphalus capucinicollis* Schedl *Cryphalus capucinomorphus* Schedl *Cryphalus syvicola* (Perkins) *Cryphalus ? sylvicola* (Perkins) *Hypocryphalus laticollis* Browne *Hypocryphalus perminimus* (Schedl) *Hypothenemus birmanus* (Eichhoff) *Hypothenemus eruditus* Westwood *Hypothenemus seriatus* (Eichhoff) *Hypothenemus* sp.1= *H. ?seriatus* Det. R. Beaver *Scolytogenes puncticollis* (Schedl)	Tribe Ipini *Orthotomicus angulatus* (Eichhoff) Tribe Xyloctonini *Scolytomimus* prob. *maculatus* Beeson Tribe Hyorrhynchini *Sueus niisimai* (Eggers) **PLATYPODIDAE** *Platypus gerstaekeri* Chapuis *Platypus parallelus* (F.) *Crossotarsus externadentatus* (Fairmaire) *Diapus quinquespinatus* (Chapuis) **BOSTRICHIDAE** *Xylothrips religiosus* Boisduval *Xylopsocus castanoptera* (Fairmaire) *Dinoderus minutus* (F.) *Sinoxylon anale* **CERAMBYCIDAE** *Oopsis mutator* (F.) *Xystrocera globosa* (Olivier) *Olethrius brevicornis* Dillon and Dillon *Ceresium unicolor* (F.) **CURCULIONIDAE** *Acicnemis biconifer* Fairemaire *Himatum* sp.1 *Hylesinus* sp.1 Unidentified species Cu 1-5

7.3.1.2 Vanuatu

Static trapping on Vanuatu yielded 75 collections, roughly one quarter the number obtained from Fiji. Only three of the collections were from high risk sites (Table 7.3.1.2.1.). The number of identified species was particularly low: only 8 taxa from the target groups could be identified to the species or genus level (Table 7.3.1.2.2.). Of note, and in contrast with other static trapping surveys done during the project, was the low number of species from the Scolytinae collected. The detection of *Xyleborinus exiguus* was initially thought to be significant as it was presumed to be an oriental species with significant invasive potential (Kirkendall and Ødegaard 2007; Beaver 2005), although not considered to be a particularly aggressive species (Browne 1961). However, *X. perexiguus* (which has a Pacific distribution) has since been synonymised with *X. exiguus* (Hulcr and Cognato in press) and so this turned out to be a record of an endemic species, not a detection of an exotic.

The practice of hand picking the specimens from the collection containers in the field may have contributed to the low diversity of Scolytinae in the Vanuatu collections. This practice carries the risk that small taxa will be overlooked and discarded from the sample collection. Another contrast was the static trapping sites in Vanuatu: the majority were in agroforestry situations which may support a less diverse wood and bark beetle fauna.

Table 7.3.1.2.1. Details of static trap sites on Efate and the number of sample collections from each trap site returned to Australia for identification.

Site	Trap	Trap type	Host	Number of samples
Forestry Nursery Vila	A	Panel		7
	B	Funnel	Sandalwood	8
Malafau	G	Panel	Whitewood	9
Paunagisu	H	Funnel	Whitewood	6
Summit Estate	E	Panel	Mahogany	11
	F	Funnel	Sandalwood	8
Teouma Valley	C	Funnel	Terminalia	12
	D	Panel	Terminalia / whitewood	11
Vila wharf				3

Table 7.3.1.2.2. Species list of specimens collected by static trapping in Vanuatu.

CERAMBYCIDAE *Ceresium unicolor* (F.) VaCe sp.1 - 5 BRENTIDAE *Eubactrus semiaeneus* Lacordaire *Eubactrus* sp.1 CURCULIONIDAE *Himatum* sp.1 VaCu sp.1-4	CURCULIONIDAE / SCOLYTINAE *Xyleborus perforans* (F.) *Xyleborinus exiguus* (Walker) *Hypothenemus birmanus* (Eichhoff) *Hypothenemus* sp. (Det R. Beaver) VaSc sp.1-4

7.3.2 Sentinel plant surveys in Pacific countries

7.3.2.1 Fiji

Potted seedlings of *Pinus caribaea*, *Swietenia macrophylla* (Mahogany), *Santalum* sp. (Sandalwood), *Psidium guajava* (guava) were installed at Suva Wharf to serve as sentinel plants. However, the growing environment was harsh and seedlings were difficult to maintain in the healthy condition necessary to be effective sentinels. While there were plans to find an alternative, more suitable location to establish sentinel plants as planted seedlings this did not eventuate.

7.3.2.2 Vanuatu

Five species (two from the original target list) were propagated and installed at Port Vila wharf: *Terminalia cattapa* (Natopoa), *Sweetenia macrophylla* (Mahogany), *Santalum austrocaledonum* (Sandalwood), *Agathis macrophylla* (Kauri), and *Endospermum medullosum* (Whitewood). Sentinel plants were installed and maintained at two sites within the Port Vila wharf: the container area (Figure 7.3.2.2.1) and the wharf proper (7.3.2.2.2).

Figure 7.3.2.2.1. Sentinel plants installed at the container depot, Port Vila wharf.

Figure 7.3.2.2.2. Sentinel plants installed at the Port Vila wharf.

The sentinel plants remained in a generally healthy condition when inspected six months after their initial establishment (May 2007) but their rapid growth necessitated regular replacement of the plants. Two insect pests were detected on the sentinel plants, a spiralling whitefly on a *Terminalia cattapa* (Figure 7.3.2.2.3) and a scale on *Santalum* (Figure 7.3.2.2.4). There are several spiralling whitefly pests of quarantine significance to Vanuatu so attempts were made to get the pest identified in Brisbane. However, the specimens taken back to Brisbane did not contain the nymph stage that was needed for identification. By the time of the next country visit (October 2007) quarantine staff reported that theft of the sentinel plants was an ongoing problem, and led to the decision to abandon the sentinel tree program.

Figure 7.3.2.2.3. Spiralling whitefly on *Terminalia cattapa* sentinel

Figure 7.3.2.2.4. Scale on *Santalum* sentinel

7.3.3 Forest health surveillance in Pacific countries

7.3.3.1 Fiji

Project staff (Silviculture Research Division, Forestry Department) were trained in the techniques of Forest Health Surveillance during the first ACIAR project. Since the completion of that project, forest health surveys have been included in annual work programs. The surveys are done in second rotation mahogany plantations, pine plantations and trial plots evaluating indigenous and exotic tree species (particularly *Santalum* spp.).

During the current project (2006 – 2009) health surveys were done in 15 plantations / trial plots. In addition 13 surveillance visits were done during country visits by the Australian project participants (Table 7.3.3.1.1).

The spectrum of pests and diseases found during the health surveys was similar to those seen during the initial project. Those causing mortality of young seedlings (*Phellinus*, *Armillaria* and termites) remain the most significant threats to the mahogany and sandalwood plantations. Fire remains the main threat to the *Pinus caribea* plantations. Several minor defoliators, particularly of sandalwood were detected. Their identities remain unresolved.

Table 7.3.3.1.1. Details of health surveys done in Fiji during country visits by Australian project participants.

Date of visit	Summary of health surveys and key findings
September 2006	Appendix 11.3 Field notes October 2006 (Karl Wotherspoon) • Lololo sandalwood plantation – leaf chewing, suspected weevil collected for identification; orange “rust” on leaves of S. album, resulting in leaf chlorosis (no ID made); *Phellinus* and *Armillaria* butt rot – affected plants to be destroyed. • *Pinus caribea* plantation Nalowelo Rd – generally healthy apart from some fire damage – no bark beetles seen • Nabou *P. caribea* nursery – generally healthy • Vunimaqo sandalwood plantation – *S. album* appeared healthier than *S. yasi*, main damage was leaf scorch from salt spray • Nukurua mahogany plantation compartment 035 2006 – very dense weed growth smothered seedlings, concluded little point in doing health surveys until plantations 2 years old. • Colo-I-Suva nursery – Case moth and leaf webber larvae on Santalum yasi collected for rearing.
October 2007	Appendix 11.6 Report from country visit to Fiji - 1-4 October 2007 (Tim Wardlaw). • Vunimaqo sandalwood plantation – significant deterioration in health over 4.5 years since the trial was established. Widespread mortality – *Phellinus, Armillaria* and termites associated with some of the deaths. Recommended as useful place to screen future *Santalum* seedlots for pest and disease resistance.
July 2008	Appendix 11.9 Report from country visit to Fiji, 10th July – 23rd July 2008 (Dick Bashford) • Nabou Pinus caribea – hand collecting of scolytids from logs in recently burnt plantation • Colo-i-Suva – leaf skeletonize larvae on tree-food plant collected for rearing • Forest Park (Colo-i-Suva) – borers in dying *Atuna racemosa* (Makite) – logs collected to attempt to rear borers • Nursery (Colo-i-Suva) – defoliating caterpillars on sandalwood – sprayed with insecticide.
August 2009	Appendix 11.13 Report of field visit to Fiji, 10th August – 19th August 2009 (Dick Bashford) • Lololo sandalwood plantation – collected dead tree riddled with scolytids to rear out insects, tortricid leaf weeber collected to attempt to rear out moth. • Lololo Landowner sandalwood plots – saw white cushion scale, black hard scale, aphids, tortricid leaf rollers, ladybird beetles and scolytid borers

7.3.3.2 Vanuatu

Due to staff turn-over, none of the project participants had any prior experience in doing health surveys, so any health surveillance activities were restricted to visits by the Australian participants. Health surveys were done during three country visits to Vanuatu, with a total of 16 sites visited by the Australian project participants (Table 7.3.3.2.1).

Significant results from the health surveys are as follows:

- The whitewood skeletoniser remains a major threat to whitewood, currently the major species being planted in reafforestation projects in Vanuatu. The identity of the moth responsible for the skeletonsing remains undetermined as all collections of larvae made for rearing through to the adult stage have been lost or mislaid. This outcome has been the result of high staff turnover and the loss (from fire) of the Luganville offices of the Forestry Department.
  While skeletoniser damage appears severe (December 2007 report – Appendix 11.11), the trees appear to have a strong capacity to recover lost foliage (October 2008 report – Appendix 11.14). However, this does not necessarily mean that the skeletoniser is not having an impact on growth.
  Focussed research is needed to understand this threat.
- The detection of pink disease on sandalwood represents the first record of this pathogen in Vanuatu and the first record of the disease on sandalwood. On other species this disease can cause branch and stem dieback and eventually tree death through girdling. Given the importance of sandalwood in the region, this disease constitutes a significant threat.
- The detection of shoot borer damage in a young mahogany plantation, albeit at very low incidence, is a worrying find. The absence of any insects associated with the damage precluded any confirmation or otherwise of cedar tip moth. This pest was detected from Vanuatu in the previous ACIAR project, however, all affected trees were supposedly culled and destroyed. Revisits to the affected plantation have been apparently made by Mesek Seth (Forestry Department, Luganville) with the report that damage has not progressed.
  It remains a high priority to confidently determine the status of this shoot borer damage.

Table 7.3.3.2.1. Details of health surveys done in Vanuatu during country visits by Australian project participants.

Date of visit	Summary of health surveys and key findings
October 2006	Appendix 11.4 Report from initial country visit to Vanuatua: 3-6 October 2006 (Dick Bashford and Janet McDonald) • Port Vila sandalwood processing factory – extensive termite galleries causing significant losses in sandalwood • Shark Bay (Santo) – unidentified pyralid defoliating whitewood; *Phellinus* butt rot killing whitewood and mahogany; • Ross Point (South Santo) – Significant mortality in mahogany planting due to *Phellinus*

Table 7.3.3.2.1. (Continued) Details of health surveys done in Vanuatu during country visits by Australian project participants.

Date of visit	Summary of health surveys and key findings
December 2008	Appendix 11.11 Report from country visit to Vanuatu - 7-12 December 2008 (Simon Lawson) • Melcoffee nursery – minor leaf damage (defoliation and leaf spottiong)of Flueggia and Terminalia seedlings • Jubillee Farms – mixed species planting suffering intense competition from *Merremia* vine • Santo Industrial Forest Plantation Project trials – spiralling whitefly and leaf galls on whitewood, severe skeletoniser damage to whitewood, larvae collected for rearing by Melcoffee staff • Port Vila – recent detection of Erythrina gall wasp
October 2009	Appendix 11.14 Vanuatu Trip Report: 26-30 October 2009 (Tim Wardlaw) • Lorum 2-year-old whitewood – early infestation by skeletoniser (failed to track-down specimens left for rearing in Dec 2008), black mould (*Meiliolaceae*) on underside of whitewood leaves and having minimal impact on health • Lorum 20-year-old whitewood – good recovery from heavy defoliation that was detected in December 2008. • Industrial Forestry Plantation – no health problems seen • Forestry Nursery, Luganville – no major health problems seen apart from localised fungal shoot blight (no attempt to isolate and determine causal agent) • Nacota Farm sandalwood in agroforestry planting – detected for the first time pink disease (Corticium salmoniocolor) causing severe branch dieback of sandalwood, termite activity in one dead 3-year-old sandalwood. • Mixed woodlot of 5-year-old mahogany at Nakere – trees healthy, no problems seen • Whitewood plantation at Nakere – early signs of skeletoniser damage appearing • Taula Ministry School 2-year-old mahogany plantation – shoot borer damage seen on two mahogany seedlings, and shoots of mature *Pometia pinnata,* no insects were seen. Possible cedar tip moth re-incursion • Mid-rotation whitewood plantation at Luganville Airport – severe stem deformation due to early severe competition from big leaf (*Merrimea peltata*)

8 Impacts

8.1 Scientific impacts – now and in 5 years

8.1.1 Fiji Forest Insect Collection

Central to the sustainability of the project's scientific impacts was the need to have good, well-preserved, working collections of endemic and exotic forest insects available as working resources for quarantine authorities and forestry agency researchers in the partner countries. During the project, the bulk of identifications of trapped insects were carried out by collaborating entomologists in Australia, or sent for identification to other specialists around the world, including Dr Roger Beaver for Scolytidae and the British Museum of Natural History for others. In the future it is clear that identifications of the target groups will need to be carried out locally when trap catches are screened, and that, at a minimum, access to voucher collections of target insects was an essential tool for this purpose.

The Fiji Forest Insect Collection contains the most extensive collection of forest insects in the South Pacific. Early on in the project it was noted that the condition of this collection had deteriorated and was in need of curation and improved storage facilities, and that the building housing it required some minor renovations, including the maintenance of the electrical systems that support the air conditioning that is essential to maintain the collection in good condition. This work was carried out and the condition of the collection and its maintenance has been vastly improved. In addition, copies of all insect records were made and these are now housed with the collections at Forestry Tasmania and the Department of Employment, Economic Development & Innovation, ensuring that this information is preserved independently of the collection in Fiji.

Importantly, the collection is now in a suitable state to be used as a working insect collection for use in ongoing pest detection systems in Fiji and elsewhere in the Pacific, and not simply as a museum piece. This aspect of its usefulness has been emphasised to project partners. The Quarantine workshop carried out in 2009 highlighted this to Quarantine Department officers who had previously been unaware of this resource and how they could utilise it in the future in their role at the quarantine border. Fiji Forestry Department officers are already using the collection to assist in identifying material in their trap catches.

With regular curation and maintenance on the collection and the building in which it is located, the Fiji Forest Insect Collection will continue to be an ongoing resource for the region over at least the next five years and hopefully well beyond that.

8.1.2 Trapping efficiency and design

The project clearly demonstrated the efficacy of the trapping systems tested in their capability for early detection of wood and bark boring pests at hazard sites in the Pacific and Australia. The ability of traps to detect established endemic insects (including established exotics) in the target groups and a new exotic (*Xylosandrus crassisculus* in Fiji) gives a firm scientific underpinning to their deployment in Quarantine systems and, further, the ability to use these systems to demonstrate area freedom from particular pests which may be important for market access in the future.

The initial trap designs and preservative fluid designs deployed were designed for temperate climates which do not have the intense rainfall and constant high temperatures characteristic of the subtropics and tropics. The modifications we tested during the program significantly improved the quality of insects caught at both hazard sites and in plantations, especially in Fiji. This means that trapping reliability is enhanced and that managers and decision makers can now be more confident in the outputs from these pest detection systems.

Traps and lures used initially in the program were off-the-shelf items sourced from overseas suppliers. For developing countries these are somewhat expensive to purchase and their cost may impact negatively on the potential long-term sustainability of these programs. Low-cost options (e.g. modified PET drink bottle traps and alcohol in Ziploc bag lures) that can substitute for these traps were also tested and presented to participating countries as potentially effective and sustainable alternatives to the standard traps and lures.

8.1.3 Plantation monitoring

A basis for relating trap catches of insect borers in plantations to borer damage was established in Australia. This finding has several potential uses as a monitoring tool for forest managers in Australia and the Pacific. The methodology is particularly suited to assisting in determination of high risk sites such that early silvicultural interventions can be used to prevent significant damage occurring, and to detect plantations which currently may be at risk of developing high levels of borer attack. This may be particularly important in relation to assessing risk in relation to climate change in the future.

8.2 Capacity impacts – now and in 5 years

8.2.1 Fiji

Capacity changes over the life of the project

Staffing in the Fiji Forestry Department was generally stable with continuity over the duration of both the previous and current projects, with Ms Sanjana Lal and Mrs Lusiana Tuvou being involved in both projects, and with Salaseini Bureni and Aisake Vucago being involved servicing traps while Lusiana Tuvou was on maternity leave. Sanjana Lal was promoted within the Department during the project and so had a reduced amount of hands-on involvement, but in her new role was important in promoting the benefits of surveillance/pest detection systems for Fiji such that this is now included in the routine budgeting and ongoing operations for the Department. This stability in personnel and their continuing training and acquisition of new skills has contributed greatly to enhancing Fiji's capacity for early detection of pest species, and as outlined above in 8.1, their capacity to identify target insects.

Capacity within Fiji Quarantine also improved greatly over the duration of the project. There was initial continuity from the previous project, with Mr Satya Nand being our initial collaborator, but there was little other commitment in terms of staff allocation, and for the first two years of the project, the Forestry Department took on the role of setting, clearing and maintaining traps at the port and environs. The turning point for Quarantine's involvement and overall awareness in the project came through the initiation, through an in-country visit, of the delivery of a three-day training workshop in April 2009 that trained 10 Quarantine and two Forestry staff in Quarantine Pests of Timber. At this time stage Ilaisa Dakaica was appointed as project collaborator and he was instrumental in driving a more active involvement by Quarantine in the project and in collaborating more effectively with Forestry. The workshop resulted in greatly enhanced awareness of the importance of forest and timber pests by officers in Fiji Quarantine and their capacity to conduct surveillance and identify these pests.

It is difficult to assess impacts on capacity outside of the project at this time. However, the extensive contact of our forestry collaborators with Fiji Pine and Fiji Hardwood Corporation through the placement and servicing of traps in these plantations throughout the project is likely to have increased both the awareness of exotic pests of staff in these organisations, and their capability to report them to the relevant individuals/authorities. The initial detection of the Asian ambrosia beetle *Xylosandrus crassiusculus* and the subsequent finding that it was already widely distributed in Fiji was of particular importance for mahogany plantations as this pest may impact on plantation establishment and potentially wood quality, and could necessitate changes in nursery and silvicultural practices. In addition, the finding of the exotic Asian subterranean termite *Coptotermes gestroi* in Lautoka in 2010 also demonstrated increased levels of collaboration between Forestry and Quarantine, and also their ability to access external advice and support via SPC and ACIAR project collaborators.

8.2.2 Vanuatu

Capacity changes over the life of the project

In contrast to the situation in Fiji, the Vanuatu Forestry Department experienced a high turnover of staff involved over the period of the project which had negative impacts on their ability to deliver the same level of trapping outcomes that was achieved in Fiji. There was minimal continuity from the previous program, with Ms To'ufau Kalsakau involved only in the initial workshop before being assigned to other duties. Mr Atchison Smith unfortunately passed away in the first year of the project, and no replacement was appointed to carry on the project activities in Santo. However, by project end the capability within the Department had been significantly improved, with several younger and enthusiastic staff (in particular Mr Presly Dovo, Ms Anne-Marie Sarisets and Mr James Samuel) gaining training in forest health surveillance and pest detection systems and they were directly responsible for improved outcomes in the trapping and surveillance aspects of the program toward the end of the project. If this stability in staffing can continue over the next five years Vanuatu will be well placed to maintain its capacity in forest health.

Discussions with management in Forestry has also indicated their continuing recognition of the importance of forest health surveillance and a desire to increase their capacity in forest health generally, especially given the need to protect investments in the potential expansion of whitewood and sandalwood plantation forestry in the country, and to continue to assist farmers with community woodlots. There is also now an emphasis by the Department to expand its surveillance activities to parts of the country other than the main islands of Efate and Santo. In particular, they see the most important next step as improving their skills and capacity in managing pests, given that the two ACIAR Pacific forest health projects have provided them with the capability to carry out structured forest health surveillance in plantation and native forests and to detect early incursions of new pests through trapping programs. To fully capitalise on the current capacity and ensure its sustainability over the next five years, further training of staff such as Presly Dovo that have the skills, potential and desire to acquire skills in applied pest management would be highly advantageous.

Greater stability in staffing on the project occurred within the Vanuatu Department of Livestock and Quarantine. Mr Timothy Tumukon remained as the primary contact throughout the duration of the project, continuing this role from the previous ACIAR forest health project. Ms Linette Berukilulu maintained and carried out the trapping and sentinel plant program at the Port of Vila, which linked her responsibilities with an existing fruit fly trapping program co-funded by the Vanuatu government and SPC. Ms Miriam Seth also assisted with pathology identifications.

At the final project workshop, Quarantine expressed their intent in the future to maintain the trapping activities as a component of their core surveillance systems, expand trapping activities to include Luganville port on Santo, and revise and include forest pest emergency response guidelines in the country's Generic Emergency Pest Response Plan.

A major planned outcome of the project for Quarantine was the construction of a new laboratory facility to provide improved facilities for entomology and pathology operations and better house reference collections. Delays were initially experienced with obtaining the necessary governmental permissions for construction of the facility. These delays then meant that that the amount initially budgeted for the laboratory as part of the project became inadequate to meet the required standards. Since then, Quarantine has been unable to find alternative sources of funding to obtain the necessary extra funding to construct this new facility. These funds have been spent on supporting a one-off joint forest health surveillance activity between Quarantine and the Forests Department, and other activities relevant to the project's objectives.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

Worldwide, the economic impact resulting from incursions of exotic/invasive forest pest species is increasing. This impact includes loss of income, costs for recovery actions, cessation of forestry activities when recovery is not possible, protection costs, monitoring costs, and costs for pest and disease control. In addition to direct costs there are also often serious impacts on a country’s international trade when restrictions are imposed by trading partners because of the presence of a damaging pest. Since the commencement of this project, the trend in movements of invasive pests and diseases around the world has continued and may be accelerating with the growth in world trade, tourism and the opening of new markets.

The direct economic impacts of biosecurity-focussed projects such as this are inherently difficult to assess, since success ensures that the status quo is maintained, and failure that negative economic impacts will accrue. The original project document outlined the potential economic impacts of a number of our target insects, such as the mahogany shoot borer, *Sirex* wood wasp, bark and ambrosia beetles, gypsy moth, and guava rust, on the commercial, natural and community forests of Fiji and Vanuatu. In particular a pest such as *Sirex* wood wasp was estimated to have a potential impact of $60 million on the Fiji pine industry, while introduction of the mahogany shoot borer would mean the termination of planting and replanting of mahogany in Fiji, exports of which were worth about FJD$17million in 2010.

In outlining the need for this project, it was estimated that “without preventative measures, at least one serious incursion, resulting in major and immediate economic losses, is almost certain within the next five to ten years”. During the lifetime of the project, incursions of three new invasive forest species and one new timber-in-service pest have been confirmed, all of them in Fiji. Assessing when these introductions have occurred can be difficult. At least two of these invasives appear to have been established in Fiji for some time.

For example with the Asian ambrosia beetle, the high numbers of individuals caught in traps and it’s widespread distribution on Viti Levu indicates it had likely been established in Fiji some years prior to 2006. At this stage, the impact of this beetle on forestry in Fiji is unknown, but it has the potential to cause losses in nurseries and also degrade to value of harvested mahogany logs and sawn timber.

Similarly, the scale and distribution of the infestation of the Asian subterranean termite found in Lautoka in November 2009 indicated that it was likely to have been present there for many years (possible decades) prior to its discovery. Control and repair measures have so far cost more than FJD$4.1 million, and there have in addition been costly social disruptions, with some heavily infested homes and other buildings condemned as structurally unsound and residents forced to relocate.

The detection of this invasive forest pest and a timber pest during the lifetime of our project further emphasises the rate at which these insects are moving around the world, their potentially high economic impact, and the need to detect them early, so that eradication and containment remain as effective and low-cost management options. In particular, the termite incursion in Lautoka has caused a much higher awareness across government and communities of the importance of biosecurity generally, and how invasive insects can impact heavily on the economy. In this case, apart from the direct costs of the $4.1 M management program, we need also to consider the opportunity costs if this money were to have been invested elsewhere in the Fiji economy.

8.3.2 Social impacts

Our project by its design did not have a strong emphasis on social impacts. However, there has been a very equitable gender makeup within the partner teams in each country, and so women have contributed strongly to the project outcomes in both Fiji and Vanuatu. We anticipate that they will also be regarded as role models within their communities and encourage more women to take up roles in the forestry sciences, and particularly in biosecurity.

By far the largest potential social impacts of the project result from protecting the positive effects that forestry, both commercial plantation forestry and native and community forestry, has on national, rural and community and economies in terms of sustaining jobs and income.

8.3.3 Environmental impacts

Although our project focussed mainly on commercial forestry in both partner countries, we also targeted generalist invasive pests such as Gypsy Moth that can impact across plantation forestry, horticulture and natural forests, and other invasives such as the Eryrthrina gall wasp. that is a threat to native coral tree species across the Pacific.

The environmental impacts envisaged at the commencement of the project were:

- Higher levels of insurance providing more security for native and plantation forests. (Establishment of invasive species, especially on islands, can have severe negative impacts on native ecosystems, particularly on their unique endemic biodiversity)
- Protecting future productivity of forests encouraging increased plantation establishment, reducing the pressure to harvest native forests.
- Increased establishment of woodlots and plantations on degraded lands providing significant environmental benefits.

In general, the environmental impacts of the project are almost impossible to quantify, especially in the short term and in the absence of a major incursion. One example of a new incursion of an environmental pest that our project focussed on and its impacts are discussed briefly below.

Eryrthrina gall wasp

Eryrthrina gall wasp is a threat to native and ornamental coral tree species across the Pacific. At the beginning of the project this pest was known to be spreading rapidly through the region, and had potentially reached New Caledonia by 2006. The gall wasp was subsequently detected in Fiji in September 2008 and in Vanuatu in November 2008, although in both locations it showed signs of having been present for some time prior to the initial detection.

Within the project, sentinel plants were the method of choice to detect this pest, but as discussed previously in annual reports and in this document, severe difficulties were encountered with establishing and maintaining these plants within the environs of the Port of Suva and Port Vila. Therefore, the first detections of the gall wasp were made in street and other mature trees in each country, by quarantine or other authorities.

We do not currently know what impact the wasp is having on host trees in both countries, but the successful release of a biological control agent in Hawaii in 2008 gives encouragement that this pest can be successfully and economically controlled across the

Pacific. It is possible that the wasp parasitoid will also spread across the Pacific unassisted as has its host, but assistance with biological control programs across the Pacific would hasten this control and lessen the deleterious effects of the gall wasp in the short term. This is turn would lower the risk of the gall wasp introduction to Australia and other locations where it is currently not established.

8.4 Communication and dissemination activities

8.4.1 Field Guide

One of the major dissemination impacts of the project was the production of 300 copies of a 47-page field guide ("Forest health guide: symptoms of insect and fungal damage on trees") to aid in the identification of pest and disease damage symptoms. The guide was developed by the Australian project participants in cooperation with the Fiji and Vanuatu collaborators and published by the Department of Primary Industries & Fisheries, Queensland (now the Department of Employment, Economic Development & Innovation) in September 2006. Copies of the guide were delivered to project collaborators at the workshop held in Suva in September/October 2006, and in subsequent in-country visits by the Australian partners, and on each occasion participants were given guidance on its usage.

The guide featured images and descriptions of generic types of insect and fungal damage, as well as specific information on some of the key agents targeted in this project (e.g. mahogany shoot borer, bark beetles, erythrina gall wasp, and eucalyptus rust), and also included a list of equipment required for field surveys and a copy of the forest heath field form.

This publication has proved to be very popular, not just within the project, but has also been used in other overseas aid projects that the Australian collaborators have been involved in, particularly in Vietnam and southern Africa. As only a handful of copies of the guide now remain, consideration could be given by ACIAR to republishing it either ‘as is’ or in a revised form.

8.4.2 Website

The previous project (FST/2001/045 - Development of forest health surveillance systems for South Pacific countries and Australia) produced a website that is still hosted on the Secretariat of the Pacific Community (SPC) server (http://www.spc.int/pps/ACIAR/aciar_project.htm).

The project lead organisations (DEEDI & Forestry Tasmania) are currently in the process of planning a new website that will again be hosted on the SPC server. SPC has given in principle support to hosting the new site, which should be online by around July/August 2011. The site will include ACIAR reports, information on setting up and running pests detection trapping systems, modifying traps for local conditions and making low-cost traps, links to online sources such as PaDIL (that can assist in diagnostics), and other information relevant to forest pest detection and surveillance more generally. To maximise impact, information on the project on the ACIAR website should include a link to these pages once they are established. The availability of this information online will assist in sustaining project outcomes and impacts into the future.

8.4.3 Asia Pacific Forest Invasive Species Network (APFSIN)

Project members have been very strongly involved in this important regional forest biosecurity coordination network (http://apfisn.net/) since the project commenced. In particular, the project supported involvement by Ms Sanjana Lal as the representative of the Fiji Forestry Department in APFISN meetings and workshops in: Malaysia in 2007 on “Developing Invasive Species Management Plans”; the APFISN workshop in Vietnam in

April 2008 on "Risk-based targeted surveillance for forest invasive species"; an APFISN-associated International Workshop/Training course on invasive species in China in October 2008; and another APFISN workshop in Malaysia in December, 2009. Sanjana was active in these meetings in communicating the objectives and successes of this project and the potential application of similar early detection/rapid response (EDRR) systems across the region. Additionally, and supported by APFISN, Dr Tim Wardlaw and Dr Ross Wylie coordinated the APFISN workshops held in Malaysia in 2007 and Hanoi in 2008, and Dr Wylie the most recent of these held in Bhutan in 2010.

While these workshops have been highly valuable in promoting awareness of forest invasive species issues in the Asia-Pacific region and increasing capacity and developing skills for pest risk analysis, contingency planning and species management plans, it seems that what is now required from APFISN is a greater focus on implementing on-ground application of EDRR systems across the region.

As a sustainable long-term impact of this project, and using the success of this project for guidance, ACIAR may therefore consider engaging with APFISN in promoting these practical biosecurity systems more widely in the region.

8.4.4 Quarantine & Forestry Cooperation and Communication

Enhanced cooperation between Quarantine and Forestry Departments has been a continuing focus of the two forest biosecurity projects in the Pacific. In particular, this has been more relevant for Fiji, since the close proximity of the offices and laboratory of the two organisations at Port Vila in Vanuatu have tended to make cooperation and collaboration easier there.

Following an in-country visit by Tim Wardlaw in 2008, the Fiji Quarantine Department expressed a strong desire for extra training in timber entomology for Quarantine staff, which was delivered through the training workshop carried out in 2009 by Dr Ross Wylie and Dr Judy King (see 8.2.1, above). Forestry department staff also attended this workshop, and noticeably better cooperation and communication has been evident since then, especially during the response to the finding of the Asian subterranean termite in Lautoka in 2010, in particular during subsequent management planning and operations during the control program. This was also apparent at the project finalisation workshop in Brisbane in April 2010.

This situation is a marked improvement on the condition of the relationship at the end of the previous project and the beginning of this one, and gives us increased confidence that the realised impacts of improved communication and cooperation can be continued over the longer term.

8.4.5 Communication and Engagement with Communities

Project staff in both Vanuatu and Fiji have been actively engaged with local communities, schools and farmers in increasing awareness of the importance of forest health surveillance. In Vanuatu, the Forestry Department is intending to develop posters on insects aimed at increasing awareness of farmers and in schools for children.

8.4.6 Other Project Publications

Project staff produced a range of scientific publications (listed in 10.2) which have assisted with dissemination of key project research to the wider scientific community.

9 Conclusions and recommendations

9.1 Conclusions

This project has significantly advanced forest biosecurity both in Australia and in Pacific island countries, particularly Fiji. As a result of the project we can confidently predict that key families of wood-boring insects will be collected using suitable traps and lures deployed at appropriate sites. The static trapping surveys done in Tasmania, Queensland and Fiji each captured a large number of wood-boring species, including many of the known exotic species that have become established in the respective regions. Each region showed the same dominance of the Scolytinae bark beetles in the trap catches.

From the biosecurity perspective, the static trapping surveys in both Australia and the two participating Pacific countries, expanded our understanding of the colonisation of exotic wood and bark-boring species:

- *Xylosandrus crassiusculus* was detected for the first time in Fiji and shown to be well established;
- *Hylurgus ligniperda* has spread further north beyond its known range in Queensland;
- *Xyleborinus saxesini* was trapped widely in Tasmania, expanding the Australian distribution as currently reported in official records.

Site-selection was shown to be important, particularly for hazard-site surveys: built-up sites with little surrounding vegetation or timber captured a low diversity and abundance of species from within the target groups.

From a health surveillance perspective, the Australian research component has shown that the diversity of wood-boring species captured in static traps is a good predictor of the presence of stress symptoms or borer damage in the plantation trees: the diversity of scolytids predicted stress-type symptoms, while the diversity of cerambycids predicted borer damage symptoms.

Importantly, this project extended the use of static trapping technologies into tropical climates, which provide more challenging conditions for recovering specimens in remain in a good condition for identification. Adaptive management was a key reason for the successful transfer of static trapping into tropical climates, the success of this was clearly shown in the decrease over time of decayed specimens collected from surveys done in Fiji.

The use of sentinel plants at wharf facilities proved to be difficult to manage and yielded little useful biosecurity intelligence. However, sentinel surveys remain a key component for forest biosecurity for pests / pathogens not surveyed by static traps. Future designs should focus more on permanent plantings in parks and gardens in the environs of high-risk sites.

The benefits of staff continuity have been clearly demonstrated in this project through the outcomes achieved by Fiji in comparison with those achieved in Vanuatu. While Vanuatu have indicated a desire to develop forest pest and disease expertise, a suitably committed candidate did not commence on the project in sufficient time to benefit from training-by-doing.

9.2 Recommendations

- Routinely screen static trap specimens to isolate new or unusual specimens that require further ID. This was the final aim of the project but still needs to be put into practice. The country participants are still reluctant to use the insect collection as a working reference collection to screen static trap catches. Need encouragement to do the preliminary screening to separate into morphospecies, screen against voucher series (the voucher collection generated through the project should be much more accessible than the main collection for this) and separate out those that are new (not previously collected). May be best done through training in Australia on sorting trap catches into groups and then conducting a preliminary screening against vouchers. Week-long course would probably be sufficient. The final step is then what to do to get this reduced number of suspected new species verified. One idea suggested was the use of the "remote microscope system" (True Blue brand) developed by AQIS for their quarantine inspectors.
- Good progress has been made towards getting a system in place for surveillance to detect new exotic incursions. However, the system was only just starting to get adopted into routine work programs. Recommend that provision be made for follow up visits to the countries by project members to review ongoing activites started by the project. Funds required to do this would be modest in comparison with a full project.
- Contingency plans. We should encourage Fiji to document their response to the termite incursion in Lautoka – how do the steps taken match with what was contained in the contingency planning done at the contingency planning workshop done during the first ACIAR? This may be an effective way of identifying the need for further training in contingency planning. The forest quarantine workshop was an effective means of exposing quarantine officers, who had a primarily agricultural focus, to forest pests of quarantine significance. Perhaps a similar approach can be taken with contingency planning training if specific needs are identified.
- Need a forum for the ongoing reporting of forest biosecurity surveillance activities in Pacific countries. Recommend that forest pests and disease status be included as a regular agenda item at future Heads of Agriculture and Forestry meetings.
- Significant forest health threats were identified on Vanuatu during this and the previous project. More focussed work is required to resolve these threats. There may be potential for suitable candidates to conduct research on these unresolved threats as part of post-graduate training. This would help progress the Forestry Department's stated desire to develop in-house capacity in forest pests and diseases.

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