# Guest editorial and introduction to this special issue

## A decade of forest health surveillance in Australia: an overview

Identifying and managing threats to forests and plantations is an essential element of sound forest management. This includes knowledge of key threatening pests, diseases and processes, employing methods of identifying and mapping these sufficiently early for effective intervention, and application of effective management strategies for control, for limiting their spread and to reduce their impact. Forest health surveillance, and the people who conduct surveys, are an integral part of this process. However, formal forest health survey units (FHSU) were established in Australia only relatively recently. Prior to 1996, surveys of forest health in Australia were generally ad hoc*,* 'reactionary' or pest-specific. In late 1995 Queensland and New South Wales (NSW) established the first FHSUs in Australia, with Tasmania following in 1997 and Victoria in 2001. The first systematic forest health surveys of plantations, conducted by dedicated and trained experts, were undertaken in NSW and Queensland in early 1996.

Forest health surveillance involves systematic surveys of forests — be they production or conservation, plantation or native — by trained specialists. The main purposes of surveys are to:

- detect and map outbreaks and damage by known pests or diseases
- detect change in forest health over time, including the distribution and status of pests or diseases
- detect incursions of exotic pests or diseases.

The papers on which the contributions in this special issue of *Australian Forestry* are based were presented at a workshop titled 'A decade of forest health surveillance in Australia: past, present and future', organised by the Primary Industries Standing Committee's Research Working Group 7 (Forest Health) in Coffs Harbour, NSW, in November 2006. Forest health representatives from each state, as well as invited speakers from New Zealand and the United States, presented their observations and experiences at the workshop. The papers cover four broad themes:

- forest health surveillance methodology in plantations and native forests
- surveys designed specifically for early detection of exotic incursions
- remote sensing technology to enhance forest health surveillance and plantation productivity assessments
- the benefits of forest health surveillance.

The first six papers of this issue describe forest health surveillance methodology for each state. Most surveys are conducted in plantations — both eucalypt (*Eucalyptus* and *Corymbia*) and pine (*Pinus* and *Araucaria*) — with very few in native forests in the eastern states (Queensland, NSW, Victoria and Tasmania). Surveys in native forests in these states tend to be reactionary, in response to a pest outbreak or significant damage event. In contrast, there are routine surveys for native forest disorders in Western Australia (WA) (e.g. for dieback associated with *Phytophthora cinnamomi* and damage from jarrah leaf miner), but few routine forest health surveys of plantations. Surveys in plantations in WA tend to be pest specific, monitoring pest populations for control operations or for research purposes.

Plantation surveillance methodology in most states (NSW, Queensland, Tasmania and South Australia (SA)) is modelled, partly at least, on the New Zealand system (Kershaw 1989), which includes aerial surveillance with fixed-wing or rotary-wing aircraft, drive-through surveys and ground inspections. In contrast, surveillance methodology in Victoria is based on the United States Department of Agriculture Forest Service (USDA-FS) Forest Health Monitoring plot system (Burkman and Hertel 1992). While permanent plots assess only a very small proportion of an estate, they do permit formal monitoring and the establishment of temporal trends. Both systems have advantages and disadvantages for achieving the objectives of forest health surveillance, and current research is investigating and quantifying the benefits of each system in relation to these objectives.

Four states (NSW, Queensland, Tasmania and Victoria) have dedicated FHSUs. These units conduct the surveys, but also rely on ad hoc observations by operational staff. Surveys in SA are conducted by trained operational staff, with data reviewed by the state forest health expert for decisions on pest management. Pest surveys in eucalypt plantations in WA are conducted by an entomologist employed via the Industry Pest Management Group (IPMG), which is funded by industry and the Cooperative Research Centre for Forestry. Surveillance of native forests in WA is conducted by both trained operational staff and forest health experts, depending on the disorder or damage being surveyed. Gunns Ltd (then North Forest Products) in Tasmania is the only private company to employ a full-time forest health expert (from 1998 to 2002), to conduct regular surveys of eucalypt plantations in Tasmania. This program, however, has been discontinued. HVP Plantations (having purchased the Victorian state-owned plantations in 1998) have continued to contract forest health services, including annual forest health surveillance, from state forest health experts now within the University of Melbourne.

New technologies have enhanced the accuracy and efficiency of forest health surveys over the past decade. These include the use of geographic information systems (GIS) – global positioning system (GPS) interface tools, such as iPAQ© (Hewlett-Packard Development Company, LP) and handheld computers using ArcPad© (ESRI, USA) software. These assist navigation and data collection in the field. Laser rangefinders, linked to palmtop computers with integrated GPS, are used to enhance aerial surveys of pine plantations using fixed-wing aircraft in Queensland (Ramsden *et al.* 2005). This system allows highly accurate spatial data to be combined with forest health descriptive data for immediate interpretation within GIS. More recently, the USDA-FS digital aerial sketchmapping (DASM) system has been trialled and is now operationally used to conduct surveys in NSW. Several other states, and survey companies in New Zealand, are now interested in using the DASM system. Improved mobile phone technology and wireless broadband has also enabled images of symptoms and damaging agents to be quickly transmitted from the field for expert opinion and action.

Two things that are particularly apparent from these papers are that forest health surveillance expertise resides now in government organisations or universities, and there is only a small core of personnel dedicated to surveillance, mostly one to two per state. 'Burnout' is an issue, as is finding trained and experienced replacements for those who move on. Now only three people who started surveying at the beginning of forest health surveillance programs 7–12 y ago in Australia are still undertaking routine surveys. In some states (e.g. NSW and Queensland) regular surveys are conducted only in government-managed plantations, and although in other states many large private pine-growing companies conduct regular forest health surveillance, most private eucalypt growers rely on ad hoc detection of problems (some via 'guided ad hoc' surveys, as in the IPMG). Thus, there are large areas of plantation in Australia that are not regularly surveyed.

Aerial detection surveys in the United States and the USDA-FS Forest Health Monitoring program are also described in papers in this issue. Most of the 304 million ha of forested lands in the United States are surveyed on a systematic basis, with surveys supported by substantial federal and state funding: over US$5 million annually for aerial surveys alone, although only a proportion of forests are surveyed each year. A comparable hypothetical figure for aerial surveys of Australia's 149 million ha of forests would be about AU$2.5 million. The *total* budget for forest health surveillance (aerial and ground) in Australia is less than this. Furthermore, less than 1% of the total area of forest in Australia is surveyed, with a skew towards plantations. As such, Australia is unable to report accurately and comprehensively on forest health criteria under the Montreal Process.

The accuracy of aerial detection surveys in the United States — specifically the accuracy of locating damaged areas during sketchmapping surveys — has been quantified. Not surprisingly, adding a 50 m or 500 m buffer (spatial tolerance) around mapped areas increased accuracy, but even the figures for the 50 m spatial tolerance case fell within acceptable accuracy levels for the objectives of most survey missions. No research in Australia has quantified the spatial accuracy of our forest health surveys — that is, the ability of officers to accurately locate and map the extent, incidence and severity of disorders during aerial surveys. Spatial accuracy at the sub-compartment level should be expected, however, since aerial surveys are conducted at a relatively low altitude in well-mapped and well-roaded plantations (cf. higher altitude and native forest and wilderness areas in the United States). Qualitative ground verification of aerial survey observations (i.e. accurately locating on the ground what was mapped in the air) indicates that experienced aerial sketchmappers in Australia are able to accurately locate damaged areas within these spatial limits.

Relatively large areas of native forest are surveyed in WA, due to significant and widespread threatening agents, such as *P. cinnamomi*, but in the eastern states there is no comparable threatening agent that causes damage on such a scale. The recent nomination of bell-miner-associated dieback (BMAD) as a key threatening agent, however, is likely to increase aerial surveillance for damage in native forests in eastern Australia. The November 2006 workshop identified a need to engage environmental agencies, who have not historically conducted forest health surveillance, to address the discrepancy between the treatment of commercial and conservation forests.

New Zealand has been undertaking formal forest health surveillance since 1956. The main aim of surveillance in New Zealand is early detection of exotic pests and diseases, and this is described in one of the invited papers in this issue. This was a primary aim for establishing forest health surveillance systems in several states in Australia, but it has become clear that the type of routine surveys conducted in Australia are insufficient for this purpose (Wardlaw *et al.* 2008). Two papers, for Queensland and Tasmania, in this issue discuss the early detection of exotic pests and diseases in Australia, including hazard-site surveillance and the use of static traps. These surveillance methods can supplement the pre-border systems already in place to reduce the chance of an exotic incursion in Australia. Furthermore, static traps are able to detect specific pest species at low population levels and have been used to supplement forest health surveillance in recent years in Queensland and Tasmania. Currently port-environ surveys for exotic forest pests in most states are limited, and thus there is a significant gap in Australia's biosecurity program. A collaborative federal–state trial (the Hazard Site Surveillance Program) has made significant progress in port-environ survey methodology, but future funding of this program is uncertain. The detection, during routine surveys in NSW in 1997, of the exotic forest pest *Adelges cooleyi*, which was subsequently found to be well-established in Douglas-fir plantations, highlights this gap. The incursion in 2000 and subsequent eradication by 2004 of a pine nematode in Victoria highlights the importance of early detection and action. Expanding current agricultural surveillance (trapping) programs to include key forest pests is one way to close this gap.

Remote sensing technologies reported in this issue will soon be used operationally in several states to enhance forest health surveys and plantation productivity assessments. High-resolution optical sensors, with appropriate processing, can more accurately quantify the incidence of dead and dying trees than even an experienced sketchmapper. Coupled with airborne laser scanners (Lidar), this technology has the potential to enable accurate and comprehensive inventory assessments that were once possible only by much slower ground surveys. Unlike aerial survey by experienced observers, however, these technologies are unable to diagnose disorders, and at present they are less cost effective. As the demand for remote sensing products increases and additional commercial operators come into the market in Australia, the cost of remote data acquisition will decrease. In general, high-resolution data are more expensive than low-resolution data and there are usually trade-offs between spatial, spectral and temporal information. A hierarchical approach may provide a sufficiently effective surveillance framework, incorporating daily, free, MODIS (satellite) data at a 250 m spatial resolution for detecting unexpected changes in canopy biomass. The future could see forest health survey officers using this processed MODIS information to identify and prioritise areas for more intensive aerial or ground surveys. Thus, FHSUs will have more time for assessment and diagnosis and improving pest and disease management strategies, with less time spent in the field and reduced burnout. More affordable remote sensing technology is also likely to increase the area of native forest surveyed in future.

The financial cost of forest health surveillance programs is discussed in this issue. Aerial surveys using fixed-wing aircraft over large areas in the United States can cost as little as US\$0.025 $ha^{-1}$, while the cost of aerial surveys in fixed-wing aircraft over pine plantations in New Zealand can be up to NZ\$0.08 $ha^{-1}$. In contrast, aerial survey using rotary-wing aircraft (helicopters) over pine plantations in Australia can be up to AU\$0.30 $ha^{-1}$. The cost of having a forest health surveillance program in Australia, which includes the cost of employing full-time forest health survey officers, plantation surveillance (aerial and ground), diagnostics, technical and GIS support, and year-round pest and disease management advice, can be up to AU\$1.50 $ha^{-1}$ $y^{-1}$, depending on the size of both the protected resource and the surveillance team.

The benefits of surveys are discussed in several papers. These include:

- identifying research priorities for key or new pests and diseases
- the collection and accumulation of data to assist in identifying risk factors for plantation species
- detection of new and emerging pests and diseases
- identification and mapping of pest outbreaks and damaged areas to assist in operational management (control) of pests and diseases.

A further benefit is that survey data can be used to quantify the cost of damage from pests and diseases, and the impact of this damage on resource volume predictions. One of the reasons that forest health surveillance has not been taken up more by private growers is that the benefits have not been fully articulated. The November 2006 workshop recommended research to quantify the cost-benefit of surveys, using case studies of key pests and diseases to highlight the importance of forest health surveillance and improve its uptake.

In these times when forest certification (e.g. Australian Forestry Standard and Forest Stewardship Council) is becoming increasingly important for marketing timber on the world stage, forest health surveillance is a means of demonstrating that risks to forest health are being managed. Forest health surveys are also a means of demonstrating the effectiveness of operational control programs and to provide confidence to customers that products are derived from healthy, sustainable forests.

Despite its slow adoption and recent pressure on resources (including staff), the future for forest health surveillance in Australia is positive. This is due to the innovative capacity, dedication and enthusiasm of forest health survey officers for their discipline and the forests they protect. Critical also is the support of forest managers who currently benefit from surveys. Many forest managers see annual forest health surveillance as insurance and accept the cost as part of their risk-management strategy. Many also regard having a forest health expert on call for emergency advice as an essential asset. Current and planned research on improving surveillance accuracy and efficiency, quantifying cost-benefits of forest health surveillance and the financial impact of major damaging agents on wood supply predictions, and improving pest and disease management strategies, will benefit forestry in general.

## References


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