

Forest health surveillance in Tasmania

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Summary

Forest health surveillance (FHS) has been routinely conducted in pine and eucalypt plantations in Tasmania's state-owned forests since 1997. The original objectives of FHS included the detection of exotic pests and diseases, managing the risks arising from native pests and diseases, identifying new threats and recommending operational responses to health or performance issues. Surveillance includes a mixture of aerial, roadside and ground or follow-up surveys. The program has undergone a process of constant revision in response to both industry needs and research outcomes. As a result FHS has become a simpler and more cost-effective operation with a focus on the detection of operationally relevant pest and disease problems. The notification and client liaison system ensures that problems are reported in a timely manner and allows for the tracking of operational responses and outcomes. FHS data are collated annually on a state-wide basis and are used to satisfy a range of reporting obligations. A hazard-site surveillance program now provides early warning of exotic pest and disease incursions. Today, FHS still satisfies most of its original objectives and plays an important role in achieving some of Forestry Tasmania's high-level management objectives. It has expanded, and is flexible enough, to incorporate the needs of a range of external clients, as well as including targeted surveys in areas with high non-wood values such as wildlife habitat strips. Furthermore it meets the requirements of certification schemes such as the Australian Forestry Standard and ISO 14000. It is expected that FHS will continue to evolve with the introduction of new technology and in response to the needs of a dynamic industry.

Keywords: forest health; surveillance; disease surveys; insect pests; nutrient deficiencies; methodology; plantations; *Pinus radiata*; *Eucalyptus*; Tasmania

Introduction

Forest health surveillance (FHS), the regular inspection of forests by personnel with expertise in recognising health problems, began in Tasmania in the early 1990s. At this time Norske Skog (formerly Australian Newsprint Mills and then Fletcher Challenge) contracted Forest Research (New Zealand) and then Forestry Tasmania to undertake FHS of their plantation estate on a biennial basis. Dedicated FHS units were formed in Tasmania in 1997. Two major forest growers, each employing two staff, established FHS units — Forestry Tasmania, which focussed on

plantations on state forest as well as some privately-owned estates, and North Forest Products (now Gunns Limited), which focussed on their eucalypt plantation estate (de Little *et al.* 2008). The FHS program run by Forestry Tasmania has continued uninterrupted, while the North Forest Products FHS program was discontinued in 2002 (de Little *et al.* 2008).

The impetus for commencing FHS in Tasmania came from the rapid expansion of eucalypt plantations through the 1990s. Accordingly, the initial focus for FHS was on plantations, both hardwood and softwood. Plantations are still the primary focus of FHS, but other high-value assets such as thinned native forests, wildlife habitat strips (high conservation value) and quarries (to determine *Phytophthora cinnamomi* and weed status for hygiene purposes) have been included in the annual FHS program.

While the establishment of FHS in Tasmania drew from established systems, particularly that used in New Zealand (see Kershaw 1989), methods quickly evolved to suit local conditions, changing requirements and improved understanding. Wardlaw (2008) describes how FHS has evolved in Tasmania over the first decade of its operation. This paper outlines the FHS system currently used by Forestry Tasmania.

Objectives of forest health surveillance

Forestry Tasmania is responsible for the management of 1.5 million ha of land across Tasmania, most of which is state forest. The aim is to manage these forests to provide long-term environmental, social and economic benefits (Forestry Tasmania 2008). The management objectives of Forestry Tasmania to which FHS contributes include:

- Protect and maintain environmental values on state forest. Such values include biodiversity and threatened species, communities and habitats.
- Maintain and enhance productive capacity on state forest. Productive capacity and quality is enhanced through a range of silvicultural and remedial treatments.
- Maintain ecosystem health and vitality on state forest. Environmental monitoring and management for fire, weeds, pests and diseases all contribute to the maintenance of ecosystem health and vitality.
- Maintain a viable research program. Research aims for the continuous improvement in management practices, productivity and sustainability.

FHS contributes to these management objectives through a suite of operational objectives which provided the original justification for the establishment of FHS in Tasmania (Wardlaw 2008):

- detecting incursions of exotic pests and diseases
- managing the risk of losses due to established exotic and native pests and diseases
- identifying new threats from native pests and diseases
- recommending operational responses to detected health or performance issues
- assessing the efficacy of control operations for particular pests and diseases
- helping to demonstrate that current forest management practices are sustainable.

More recently Forestry Tasmania has demonstrated, to the satisfaction of independent third-party auditors, that FHS meets the requirement of a system for protecting its estate from damage agents under the Australian Forestry Standard (Australian Forestry Standard Limited 2007). The procedures governing the conduct of FHS have also been upgraded in accordance with ISO 14001, which deals with environmental management systems (International Organization for Standardization 2008).

Target forest types and areas

The *Forestry Act 1920*, s. 22AA states that a minimum 300 000 m³ of veneer logs and eucalypt sawlogs shall be made available to the veneer and sawmill industries from state forests each year (Tasmanian Government 2007). This is also an obligation under clause 77 of the *Tasmanian Regional Forest Agreement* (Tasmanian Government 1997). Significant areas of eucalypt plantation were established on state forest land commencing in the 1990s to help meet shortfalls in future supply after large areas of crown forest were placed in reserves (Forest and Forest Industry Council 1990). As of 2006 there were 46 751 ha of hardwood plantation on state forest (Fig. 1), of which 12 599 ha were privately owned under lease arrangements. Additionally there were some 52 627 ha of softwood plantation on state forest under various joint venture arrangements with Forestry Tasmania and largely managed by a third party (Forestry Tasmania 2008). Across all tenures there were 155 500 ha of hardwood and 71 600 ha of softwood plantation in Tasmania in 2005 (Parsons *et al.* 2006).

Plantations on state forest are established with the aim of maximising the productivity of each site, consequently maximising the quality and quantity of timber yields, while minimising waste and environmental impact (Forestry Tasmania 2008). Where these plantations have been established for solid-wood products they require intensive silvicultural management, which includes pruning, thinning and often fertilising, to optimise the quality of the final crop. This represents a substantial commercial investment and produces a high-value commercial resource that warrants the expenditure involved in health management, including a health surveillance program. Furthermore there is greater opportunity to actively manage health problems in plantations than is appropriate in native forests where commercial imperatives are not the sole management objective. As such, *Pinus radiata* softwood and *Eucalyptus globulus* and *E. nitens* hardwood plantations are the primary focus of health surveillance in Tasmania. In more recent years other high-value forest assets have been incorporated in the

health surveillance system. These include commercially valuable thinned native forest and ecologically valuable wildlife habitat strips. The program has also expanded to provide a tailored service to external clients such as Gunns and Timberlands.

Survey methods

The entire plantation estate on state forest is surveyed annually. Other plantation areas on private land are surveyed in accordance with client requirements. The total area surveyed in 2007–2008 is expected to exceed 110 000 ha. A small team of Forest Health Officers, one full-time and two part-time, is responsible for carrying out the surveillance program. These officers generally have a background in botany and or zoology. Specialists in pathology, entomology and nutrition provide further diagnostic support and advice.

The surveillance program requires careful preparation at the start of each season. Details of changes in the plantation estate that have occurred since the previous season are collected and collated. For example, new plantations need to be incorporated in maps, and waypoint lists need updating to include plantations that have become old enough to effectively survey from the air. The primary maps, used for both aerial and ground surveillance, are prepared at a scale of 1:25 000. Aerial navigation within and between forest blocks is aided with the use of maps prepared at a scale of 1:200 000, and of waypoints loaded on a global positioning system (GPS) unit.

Surveillance entails three main survey activities: aerial, drive-through and ground follow-up.

Aerial surveys

Aerial surveillance is the primary method of detecting and mapping problems in compartments older than around 5 y, after which canopy closure restricts visibility from the roadside. Currently around 35 h of flying time are required per annum. This is conducted using a helicopter, usually a Bell Jet Ranger, at an elevation of 300–500 m above ground level. The navigator sits in the front seat of the helicopter with relevant navigation maps, GPS and camera. Maps and the GPS are used to direct the pilot along a pre-planned waypoint route. The sketchmapper sits directly behind the navigator so both can look at the same section of plantation. The sketchmapper has a series of 1:25 000 maps that display a wide range of information, including the mapped extent of problems from the previous surveillance season. Problem areas detected from the air are sketched onto these maps and annotated with details such as damage type and incidence. Waypoints are captured to aid the follow-up inspection of detected problems by hovering above areas with the most severe damage. Significant problems are photographed and a note indicating this is added to the map. Aerial surveillance is very efficient at detecting gross symptoms such as crown death, and can pick up individual dead or dying trees at an incidence of 0.1% (Wardlaw *et al.* 2008). The ability of a helicopter to hover is extremely useful for distinguishing causal agents at closer range. For example, dead tops in *P. radiata* caused by the fungal pathogen *Diplodia pinea* and ringbarking of the upper crown by brushtail possums are indistinguishable from 300 m (Fig. 2). However, a helicopter

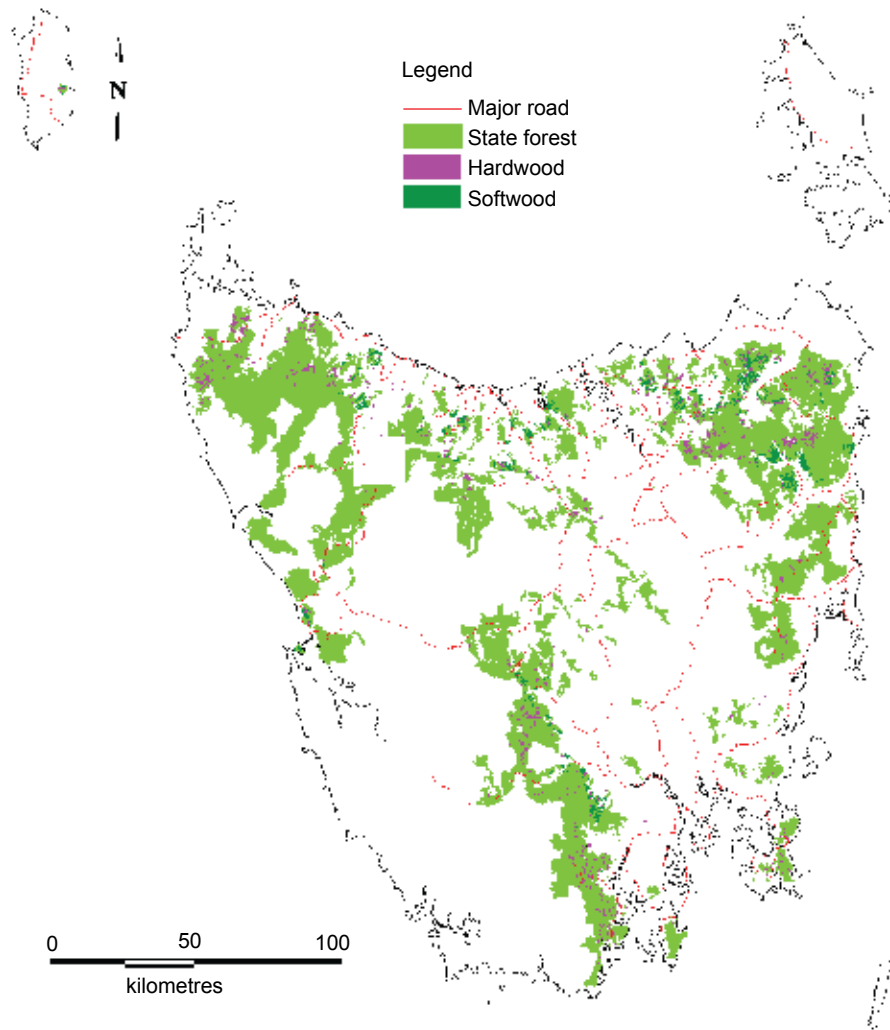


Figure 1. Distribution of softwood and hardwood plantations on state forest in Tasmania



Figure 2. Dead tops in *P. radiata* caused by *Diplodia* (left) and bark stripping by possums (right) detected during aerial surveillance. Causes of such damage are indistinguishable at a distance but can usually be resolved by closer inspection achieved with the helicopter hovering above affected areas.

can get within 20 m of individual crowns from which point any bark stripping damage is usually apparent.

Drive-through surveys

Drive-through surveys involve driving at low speed (10–30 km h⁻¹) along the road network around and within all plantation areas <7 y old. A proportion of the older plantation estate is also examined in this manner, generally on the way to survey younger plantation areas. Surveys are usually conducted with a two-person team: one driver–observer and one navigator–observer–recorder. These surveys are an efficient way to detect and assess non-lethal damage affecting the crown such as defoliation, discolouration and necrotic leaf lesions, particularly when these symptoms occur in the lower crown where they are very difficult to see from the air (Wardlaw *et al.* 2008).

Drive-through surveys are also used to adjust, if necessary, the mapped boundaries of health problems detected during the current season's aerial surveys. All problem areas from the previous season are revisited and details of the shapefiles are updated to reflect any change in status. Further notes are taken to record other features of the compartment that might be having an effect on tree health such as the level and extent of weed competition, areas of poor drainage, etc. In addition, performance and silvicultural issues (e.g. suitability for pruning) are assessed in young (up until the age when pruning is completed, generally <6 y old) hardwood plantations. If these are outside 'satisfactory' guidelines, then approximate average height and MDH (mean dominant height of 50 tallest evenly distributed stems ha⁻¹), height variability and crown size are estimated and recorded.

Ground follow-up surveys

Ground surveys, involving intensive, plot-based assessments that recorded very detailed information of both pest and disease status and tree performance (height and leaf retention) were done during the early years of FHS on state forest. This was because early guidelines for managing plantations for solid-wood products had strict specifications and required detailed information to inform silvicultural decisions (Wardlaw 2008). Such surveys were very expensive and became less of an imperative as specifications for silvicultural prescriptions were relaxed and other assessment tools, particularly pre-pruning surveys, were introduced (Tim Wardlaw, Forestry Tasmania, *pers. comm.*, 2007).

It was thought that ground-based surveys were still required for the early detection of new pest and disease incursions. However, collaborative research conducted with the Queensland Department of Primary Industries and Fisheries showed that such ground surveys are inefficient at detecting cryptic symptoms (often a characteristic of early damage from new incursions) even when they occur at a relatively high incidence (Wardlaw *et al.* 2008). It did, however, show that aerial and roadside surveillance is very efficient at detecting pest and disease damage at operationally relevant levels. This allowed the streamlining of ground surveys to exclusively target problems detected during aerial or roadside surveillance without the need for separate extensive ground detection surveys. The early detection of new incursions of exotic pests and pathogens now primarily relies on a hazard site surveillance program (Bashford 2008; Wylie *et al.* 2008).

The follow-up of problems detected during aerial or drive-through surveillance allows confirmation of the suspected cause or field diagnosis, as well as further investigation of the extent and nature of the problem. Follow-up inspections usually involve a walk-in survey or transect to quantify the incidence and severity of damage. If a field diagnosis cannot be made, samples are collected for later diagnosis by relevant experts.

Timing of surveillance

Spring and autumn are both suitable times for conducting aerial surveillance of *P. radiata* plantations. The major risks are crop loss and damage due to browsing mammals and mortality due to siren wood wasp (*Sirex noctilio*). Browsing damage, particularly bark stripping, tends to peak over winter in the colder, wetter areas of the state (Wotherspoon 2004), and damage symptoms are best picked up during spring. However, *S. noctilio* attacks *P. radiata* during summer and early autumn and foliage discolouration is most noticeable between late summer and the following spring (Elliott and deLittle 1984). Importantly, detection of *S. noctilio* damage at this time of the year allows trap trees to be installed in time for the wasps' flight season the following summer. The best time for aerial surveillance of the eucalypts is late summer and autumn, following the conclusion of the summer management period for chrysomelid leaf beetles, and at a time when symptoms of water stress become apparent. Drive-through and follow-up surveillance should be conducted as soon as possible after flying. However, due to time and budgetary constraints flying can be conducted only once a year. Access restrictions during the breeding season of the wedge-tailed eagle, 1 August to 31 January inclusive (Forest Practices Authority 2006), further constrain aerial surveillance, as does restricted helicopter availability due to fire fighting. Consequently flying is usually delayed until February or later. This compromise allows for the detection of new *S. noctilio* mortality, while trees ringbarked by browsing mammals the previous winter are still apparent. Aerial surveillance augments a separate static trapping program for detecting *S. noctilio*, which now runs between December and February (Bashford 2008). There are also separate operational programs for monitoring leaf beetle populations (conducted between November and January) and damage by browsing mammals (conducted from planting until the plantation has successfully established). These programs inform decisions on the need for control operations when populations or damage exceed certain thresholds.

Drive-through surveys in *P. radiata* plantations are conducted between September and November, which allows for the detection of bark-stripping damage from the previous winter. Drive-through surveys in eucalypt plantations are conducted between January and June. This follows the period of peak environmental stress and the period of main activity of key pests such as leaf beetles and browsing mammals. It allows under-managed areas (where routine operational pest management has delivered sub-optimal results) to be detected, as well as facilitating the detection of stress-related mortality and borer attack. It also allows late-season events, such as developing outbreaks of autumn gum moth, to be detected sufficiently early to initiate control.

Follow-up surveys of both pines and eucalypts are conducted once aerial surveys have been done and are usually combined with the drive-through surveys of the eucalypts.

Information dissemination and communication

The primary means of informing clients of detected health problems is the *Forest Health Notification*. This is a one- or two-page document that includes all relevant details of the problem detected as well as recommendations where appropriate. We aim to produce and disseminate notifications during the week following the detection of problems in the field. If a problem warrants more immediate attention, clients are contacted by phone as soon as possible. Tracking the status of recommended actions is to be enhanced with the introduction of a new corrective action system that uses the Integrum software package (<http://www.integrum.com.au>). Annual meetings are held with district staff, one of the main clients for FHS services, where a review of health problems and associated recommendations is undertaken. This includes revisiting any outstanding issues from the previous surveillance season. At these meetings recommendations are discussed, solutions for any ongoing or outstanding problems are negotiated and responsibilities delegated. Liaison also brings to light the main management issues of concern to district staff over the previous year and these concerns can be fed back to appropriate staff within the Division of Forest Research and Development.

Forest Health data management systems allow the annual production of forest health maps, which delineate all 'moderate', 'severe' (according to standards agreed to by Research Working Group 7, see Stone *et al.* 2003) or potentially threatening problems

across the plantation estate. This information is used to prepare the Tasmanian contribution to the annual pest and disease status report compiled by Research Working Group 7 as well as Forestry Tasmania's annual *Sustainable Forest Management Report*. Client reports produced at the end of each surveillance season outline the most significant problems, the area of the estate affected, new or unusual problems, performance and silvicultural issues and management implications. These reports form the basis for developing research priorities to address new, emerging or under-managed health problems.

Conclusion

Since Forest Health Surveillance was introduced at Forestry Tasmania in 1997 it has undergone constant revision and refinement. As a result the program has become simpler and more cost effective, with a focus on the detection of operationally relevant pest and disease problems (Fig. 3). The program has expanded to incorporate a number of external clients and is flexible enough to tailor solutions to meet these clients' needs. With the exception of detecting incursions of exotic pests and diseases (conducted as a separate hazard-site surveillance program) FHS still largely achieves all its original objectives (Wardlaw 2008). It is expected that FHS will continue to evolve as new technologies, such as digital aerial sketchmapping (Carnegie *et al.* 2008) and remote sensing (Stone *et al.* 2008), become more accessible and affordable; and as industry needs continue to change.

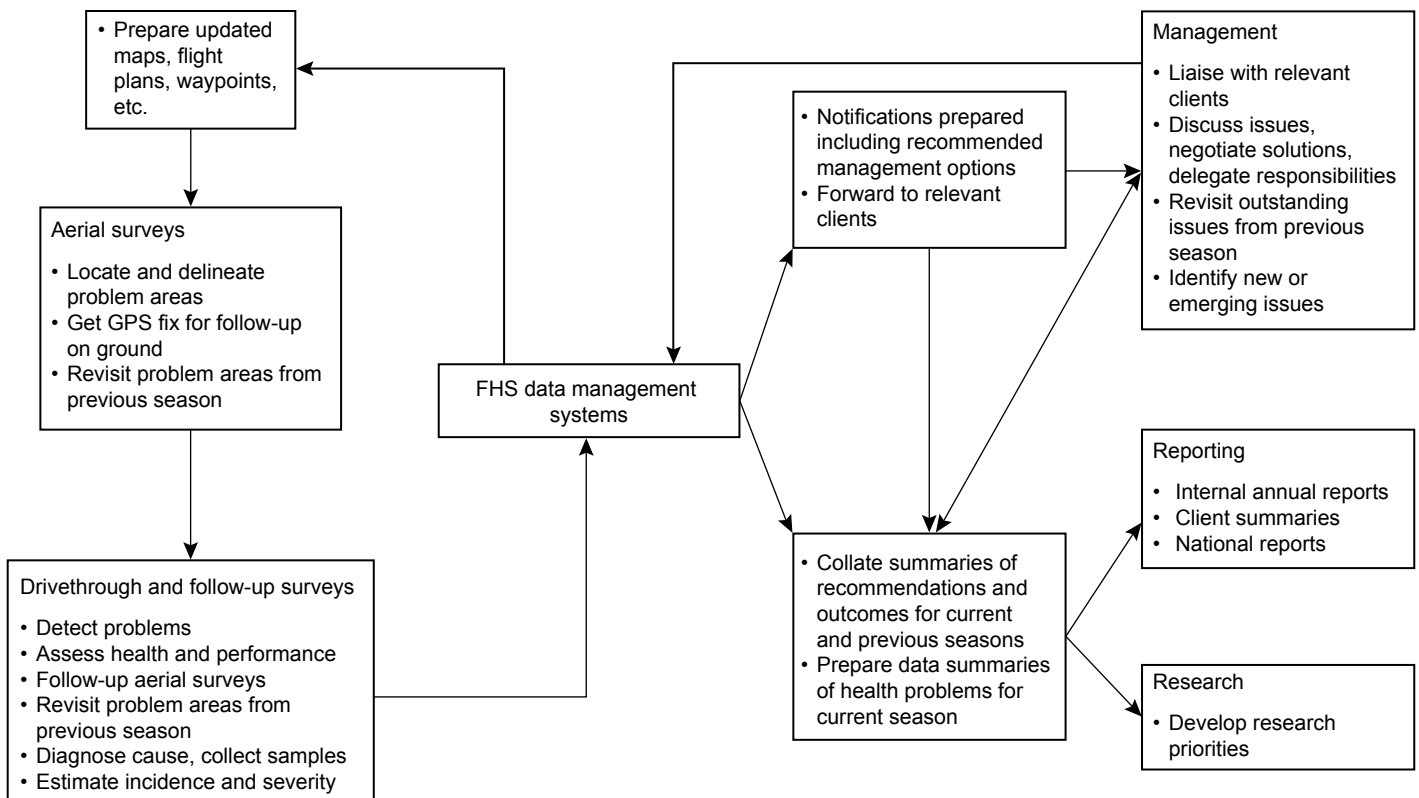


Figure 3. FHS procedures and processes at Forestry Tasmania

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