# Designing a Forest Health Surveillance Program

Tim Wardlaw, Forestry Tasmania
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## 1. Why

It is important when developing a health surveillance program that the purpose for doing surveillance is clearly identified. Establishing the main purpose for doing health surveillance will often determine the type of surveillance best suited for that purpose.

### 1.1. Detect new incursions of exotic pests & pathogens

This may be a high priority where plantations are comprised mainly of exotic species that are largely free of the pests and pathogens at attack them in their natural range.

The priority for detecting new incursions of exotic pests and pathogens can be determined by balancing the value of exotic trees in your country (i) with the risk of exotic pests and pathogens entering the country from overseas (ii – iv).

(i) Significance of exotic species in the estate to be protected;
(ii) Volume of imports able to vector exotic pests and pathogens, particularly imports from countries known to have significant pest or pathogen threats of the main exotic species planted in your country;
(iii) Stringency of import requirements (e.g. treatments and phytosanitary certificates) set by quarantine regulations;
(iv) Intensity of quarantine inspection at the border (port).

If (i) is high and any of (ii – iv) are low then surveillance to detect new incursions of exotic pests and pathogens could be a high priority.

Generally surveillance to detect new incursions are concentrated in high risk areas, such as forests and amenity trees planted around international ports of entry into the country. Such surveillance would usually be co-ordinated by the central or regional government.

### 1.2. Understand and prioritise health risks in new plantations

There is little prior knowledge of the health risks in plantations that are being established in new areas or using species new to an area. Under these circumstances it is clearly important to establish the risk of particular health problems as soon as possible. By doing so actions can be taken to minimise

the area subject to a high risk of unacceptable damage. In new plantation areas, surveillance of species evaluation trials are a valuable source of information of the health risks particular species might experience. However, it is important that the sites of such trials are representative of the wider range of sites planned for planting.

### 1.3. Understand and prioritise health risks in established plantations / forests

In established plantation areas the recurrent threats affecting tree health are usually well known and dealt with by appropriate management. In this situation health problems that develop are often due to agencies (e.g. pest outbreaks, extreme weather events) that occur infrequently. Health surveillance can be a cost-effective tool to detect such events soon enough to allow a management response to limit further losses. Also health surveillance can indicate when management for recurrent pests has been ineffective.

### 1.4. Forest health audits

Increasingly, access to markets for forest products is dependent upon demonstrating sustainable forest management. Most certification schemes for sustainable forest management have criteria related to forest health. Health surveillance provides an objective measure of the health status of forest areas that can satisfy, partly or fully, such criteria. Health audits are also a valuable in situations where the performance of a forest estate (typically plantations) needs to be demonstrated. This situation arises in estates that have been established as an investment by prospectus companies.

Health audits differ from other types of health surveillance in that they generally report on overall health (i.e. healthy and unhealthy trees) rather than health problems detected.

### 1.5. Inform forest management

Health surveillance can be a useful tool in situations where management decisions require some knowledge of the condition of the forest. Knowledge of forest condition gained through health surveillance may be used simply to improve yield estimates and the type of products likely to be harvested. This knowledge may also be used more actively to make decisions on investment in management such as pruning to produce future saw or veneer logs.

# 2. What

## 2.1. Plantations

Fast-growing plantations are typically more valuable for commercial wood production than native forests where growth rates are much lower. As a consequence health surveillance undertaken by organisations managing forests for wood production will usually be concentrated in plantations where a return on the investment in surveillance is more likely to be realised.
Plantations are comparatively easy (compared with native forests) to conduct health surveys because of:

- better and more intensive road networks providing ready access;
- a more uniform forest canopy enabling the crowns of most trees to seen easily from the air or vantage points;
- uniform age allowing areas of poor growth to be more easily differentiated;
- generally better ground access because of more intensive weed control.

### *2.1.1. Industrial estates*

Plantations estates owned by industrial companies are generally large and aggregated. Such estates are usually much cheaper (on an area basis) to conduct using a centralised health surveillance than small, disaggregated plantations. Industrial-scale companies typically have strong lines of communication and well-developed management structures. This allows them to make effective use of the outcomes of health surveillance by responding rapidly and consistently to detected health problems.

### *2.1.2. Small, independently-owned*

Small, independently-owned plantations are generally inefficient to cover using a centralised health surveillance system. This is because the time spent in arranging access and travelling to the plantations will be far greater than the time spent in conducting health surveys. In such situations, it will usually be more efficient for the forest owners themselves to undertake health surveillance of their plantations. For such an approach to be successful requires strong support from a centralised agency to ensure forest owners have sufficient training and access to appropriate reference material. Another challenge is ensuring important information (including samples for diagnosis) arising from health surveillance reaches the appropriate authorities. Extension

networks linking the small, independent growers with centralised agencies employing appropriately trained personnel may fulfil this need.

## 2.2. Native forests

Native forests can form a significant proportion of the forest estate and they can be important for the supply of timber. Typically native forests have other values (conservation, protection, amenity) that can be at least as high as the commercial values. The management of native forests will generally be less intensive than in plantations. This may be because of the lower growth rates not justifying a greater intensity of management, or because of the objective of maintaining natural processes (including native pests and diseases). The intensity of health surveillance should be matched with management intensity. This would generally mean that the optimum level of surveillance in native forests would be low resolution (e.g. aerial inspection or remotely sensed) or low intensity (e.g. limit to native forests that are easily accessible).

## 2.3. Amenity trees

Amenity trees are commonly the target of health surveillance in high risk sites (air and sea ports receiving international freight). This is because high-risk sites are usually within or adjoining urban areas where amenity trees predominate. The intensity of surveillance in amenity situations would generally decrease with increasing distance from high risk sites.

### *2.3.1. General*

Surveillance of trees and shrubs of all taxa in amenity situations will invariably detect the widest range of pests and pathogens. However, such a focus will demand a high level of diagnostic support, not only to identify the pests and pathogens, but also to identify the host plants. It is likely that a high proportion of the detected pests and pathogens would have a low threat status.

### *2.3.2. Commercially / environmentally important species or genera*

Concentrating on commercially or environmentally important taxa will limit the range of pests and pathogens detected. A higher proportion of the detected pests and pathogens will have a moderate – high threat status because of the higher status of the host taxa.

# 3. Where

## 3.1. High risk sites

High-risk sites are those sites that receive significant volumes of imports (including packaging) from overseas destinations or sites used to dispose of dunnage arising from overseas imports. Those sites may be ports that are the first point of entry into the country or depots away from the ports that receive and unpack imported goods for processing or distribution (e.g. container depots).

Surveillance is usually concentrated in the immediate vicinity of high risk sites (within 1 km) although plantations or forests of commercially / environmentally important species within 5 km of high risk sites may justify inspection, albeit at a lower intensity.

## 3.2. Whole estate

Conducting surveillance of the whole forest estate at one time is desirable where resources allow.

## 3.3. Random sample (stratified / unstratified)

Where it is not possible to conduct surveillance of the whole estate at one time it is necessary to restrict coverage to a smaller sample. It is usually more efficient to divide the estate into strata (e.g. species, region, age class) and conduct surveillance in a sample of areas within each stratum class.

## 3.4. Easily accessible areas

Confining health surveillance to easily accessed areas, such as along road edges, improves the efficiency of health surveillance (likelihood of detecting a health problem per unit time) within the accessible areas. However, the effectiveness of surveillance that is concentrated in easily accessed areas is dependent on:

- The proportion of the forest estate that is easily accessed (km of road of track / ha of forest). The effectiveness of surveillance increases as the intensity of road networks increases;

- The density of vegetation (how many metres into the forest can be seen from road edges). The effectiveness of surveillance increases with increasing distance into the forest that can seen from the road edge;
- The representativeness of the easily accessible forest area of the overall forest estate. The effectiveness of surveillance is lower if the easily accessed areas are not representative of the wider forest estate.

## 4. Who

The effectiveness of surveillance is dependent upon the skill of the individuals conducting the survey in recognising health problems. Individuals who are familiar with health problems will have higher detection efficiency than individuals who have little experience in recognising health problems. The focus of the individuals when they are in the forests will also affect the efficiency of surveillance. Those who visit the forest solely to inspect them for health problems will have greater detection efficiency than individuals who are doing other tasks as well as surveillance when they visit the forest. Experience has shown that a very low detection efficiency can be expected if health surveillance is done by individuals visiting the forest primarily for other purposes.

### 4.1. Pest and disease specialists

Pest and disease specialists have the most intimate knowledge of the health problems affecting forests and have a high sensitivity for detecting problems. However, specialists are few in number and are rarely able to devote much time to conducting health surveys because of other duties. Their role will be mainly to provide diagnostic support and training.

### 4.2. Dedicated forest health surveyors

Individuals whose role is dedicated to conducting health surveys are able to detect health problems efficiently. However, the efficiency of using dedicated health surveyors is dependent upon the size and aggregation of the forest estate to be covered. If the estate is not sufficiently large there may be insufficient work to justify employing a dedicated health surveyor. Similarly if the estate is disaggregated the efficiency of using a dedicated health surveyor declines because they spend a high proportion of their time travelling between forest areas.

### 4.3. Trained forestry officers

Forestry officers will usually be quite familiar with the forests in their local area. Forestry officers may visit the forests in their local area regularly to undertake routine forest management tasks. However, where surveillance is not part of their routine duties they will generally be inefficient in detecting health problems. This can be overcome to some extent by training and access to extension material to increase their awareness of health problems. However, unless they are assigned specific responsibility for conducting health surveillance as a part of their normal duties the full benefits of that greater awareness of health problems will not be realised.

### 4.4. Forest owners / custodians

Forest owners / custodians usually have ready access to their forests. They will often be very familiar with the local conditions that may affect the health of their forests. However, they will generally be unfamiliar with pests and diseases and therefore may miss detecting problems in their forests. This can be overcome by providing training and extension material to give them greater familiarity with health problems they might encounter.

Where there are many small forests, each managed by local owners / custodians, it can be challenging to ensure consistency in surveillance and response to detected problems among the various groups. This can be dealt with by having well documented procedures for undertaking surveys and responding to detections. It is also important that the local groups have ready access to forest health specialists through established networks of communication.

## 5. When (and how often)

### 5.1. Irregular, ad hoc

Ad hoc inspections done at irregular intervals are generally not an effective way of conducting health surveys. Such inspections are typically made when forests are visited for other purposes, usually by forestry officers. However, ad hoc inspections can form part of a health surveillance system if the people making the inspections have received training to increase their awareness of forest health problems.

### 5.2. Regular

Inspections done at regular intervals are usually required for an effective health surveillance system. The frequency of inspection is ideally related to the level of risk (of pest or disease) the forest. The higher the risk the more frequent the inspections. For most forest situations annual or biennial inspections are usually done. However, high risk sites surrounding ports that receive large volumes of imports from overseas destinations may justify more regular inspections (2-4 times per year). Surveys involving static trapping are capable of providing continuous detection although the traps need to be visited at regular intervals (typically weekly or fortnightly) to collect samples and provide maintenance.

The timing of inspections depends to a large extent on the periods of the year when peak activity of the greatest range of known pests and diseases can be expected. Where this is not known (e.g. detection of new incursions) it may be necessary to conduct surveys of a particular areas at different times of the year over successive years.

## 6. How

There is a range of ways to inspect forests to detect health problems. Each method will have a characteristic level of coverage (area inspected per unit time) and resolution (capacity to see symptoms). Generally coverage and resolution are negatively correlated. The choice of inspection methods to detect health problems in forests depends on a range of factors including:

- The area of forest needing inspection within a given time period.
- The objectives of the survey. If it is to detect new incursions at an early stage it is necessary to have a high level of resolution. If it is to detect significant damage, say to inform management of the need for intervention, then a lower level of resolution may be sufficient.
- The type of problems that are important for detection. For forests managed to produce veneer or sawlogs, stem quality is paramount and detecting problems that adversely affect stem quality will be a high priority. Such problems would require using an inspection method that has a high resolution.
- The physical characteristics of the forest estate – roading density, density of vegetation, degree of relief (hilliness).

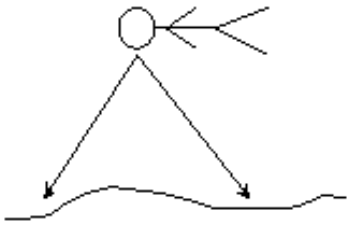
Invariably an optimum health surveillance method will use a mix of inspection methods.

## 6.1. Overview inspection

Overview inspections can cover a large area of forest quickly. They are particularly suitable for detecting health problems that produce highly visible crown symptoms in trees that form the upper canopy of the forest. Overview surveys generally have insufficient resolution to detect problems that produce cryptic symptoms, particularly where those symptoms occur in the stem or on trees that are overtopped.

### *6.1.1. Aerial*

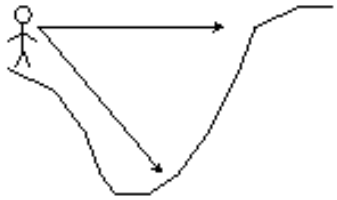
Viewing plantations from the air[1] enables large areas to be quickly scanned for health problems. Aerial inspection is best suited to detecting problems that produce highly visible symptoms (e.g. mortality and foliage discolouration, particularly if patches of trees are affected).



[1.] Using fixed wing aircraft or helicopters flying 200-300 metres above ground.

### *6.1.2. Vantage point*

Viewing from high points in the landscape (e.g. top of hill, side of valley) is another way of quickly scanning plantations for health problems that produce highly visible symptoms. Binoculars can be used to view the crowns of individual trees in greater detail.



## 6.2. Roadside cruise

Roadside cruises[1] suitable for detecting health problems with less visible symptoms, particularly where the symptoms occur on the stem or in the lower crown. Detection efficiency declines with increasing distance from the road (rarely reliable beyond 40 metres) and increasing vegetation density. Older plantations that have been pruned and thinned provide optimum viewing conditions for roadside cruises. The usefulness of roadside cruises also depends upon the density of roading within the plantation estate – the higher the road density the greater the effectiveness of roadside cruises.

1. Driving at speeds not exceeding 15 kph, preferably in a team of two – a driver and an observer.

## 6.3. Ground transect

Ground transects provide a higher level of resolution than overview inspections or roadside cruises. However, they are capable of inspecting only a small area of forest per unit time, compared with overview or roadside inspection. Ground surveys are ideal for detecting problems that have very cryptic symptoms such as sub-lethal attack by stem borers or stem canker diseases.

Because ground surveys are slow to do it is usually necessary to only sample a proportion of the forest. This is usually done by conducting a certain number[1] of fixed length transects (say 100 metre long x 10 metre wide strips) per unit area of forest. The transects should be located in such a way that the widest range of site conditions present in the general area are sampled. Ideally areas distant from access points would be sampled using ground transects. However, invariably trade-offs are made to concentrate transects near access points to reduce the time spent doing these surveys.

1. The capacity to detect health problems increases in proportion with the number of transects per unit area.

## 6.4. Plots

Fixed area plots are rarely used in routine surveillance for detecting forest health problems. However, plots are a useful method for measuring the general health of a forest (e.g. for forest health audits). Fixed area plots allows the proportion of trees affected by a particular health problem to be accurately reported. Temporary plots (single visit) are usually used audit purposes. Permanent plots that are revisited on a regular basis are commonly used in forest health monitoring programs (where the objective is to measure the change in forest health over time).

## 6.5. Static traps

Static traps can be used to provide continuous collection of insect pests[1] . There are a wide range of trap designs available. The choice of trap design depends on the main group of insect pests to be targeted. Traps incorporating pheromone lures can target a very narrow range of insect pests. Sticky traps can be used to indiscriminately capture flying insects or insects that walk up the stems of trees (sticky bands encircling the stem). It is necessary to inspect static traps on a regular basis (weekly or fortnightly) to collect the insects that have been captured and to maintain the traps.

Static traps are mainly used for surveillance of high risk sites such as ports.

[1] Spore traps can detect pathogen spores but are rarely used operationally for surveillance

### 6.6. Blitz surveys

Blitz surveys involve the intensive inspection of all trees in a given area or a set time period. The aim of blitz surveys is to detect low levels of damage or potential insect pests that are present on the trees inspected. The effectiveness of blitz surveys in detecting pests and diseases depends a lot on the size of trees inspected – the larger the trees the less effective the survey, particularly for problems concentrated in the upper crown.

Beating trays may be used on a proportion of the trees sampled to collect all insects present on accessible branches near the ground. This involves holding the beating tray beneath the branch and repeatedly hitting the branch with a stick to dislodge the insects.

Blitz surveys are generally only used in surveys of high-risk areas surrounding ports.