Pest detection surveys on high-risk sites in New Zealand

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Summary

A need for a surveillance system in New Zealand dedicated to early detection of newly-introduced pests has been recognised since the 1950s. Surveys around ports and high-risk sites started in earnest in the 1970s, taking the form of a ‘walk in the park’. It was not until the late 1980s that a formal and structured survey system was developed. Data on the efficacy of pest detection surveys were collected from field trials carried out in 1995 and 1999, and based on the latter study a new surveillance system of intensive surveys in small plots was developed. The need for further development of the system was emphasised with the growth in numbers of import transitional facilities in the mid-2000s that spread biosecurity risk far wider than ports. The improvement process is ongoing.

Keywords: surveillance; detection; risk; surveys; sampling; forest health; pest management; New Zealand

Introduction

New Zealand has a long history of forest health research, dating back to the 1920s when the Forest Service appointed D. Millar and G.H. Cunningham as entomologist and pathologist, respectively (de Gryse 1955). In 1953, de Gryse was commissioned by the New Zealand Forest Service to recommend practices to safeguard New Zealand’s exotic forests from the threat of insect and pathological epidemics. In his report de Gryse recommended a formal forest health surveillance system with the focus on a detection survey. Kershaw (1989) provided an excellent review of the forest health surveillance in New Zealand. He described how in the late 1960s the emphasis of forest health surveys changed from pest population sampling to detecting new forest health problems. In the early to mid-1970s regular surveys of port environs were started. These surveys consisted almost solely of inspecting parks and reserves. Blitz surveys, where teams of inspectors scoured pre-determined sites for new insects and fungi, were carried out from the mid-1970s to the mid-1980s, but ceased in 1987 with the demise of the New Zealand Forest Service.

Developing port environs surveys

It was not until the late 1980s that formal and structured pest detection surveys of high-risk sites were initiated. This system consisted of surveying 22 ports twice a year and 19 ports once a year (Carter 1989). A ‘port’ was defined as a location where it was perceived there was a high risk of an exotic pest entering the country and becoming established. These included airports and sea ports, along with industrial sites where significant quantities of imported material were received. The port survey covered an area with a radius of 5 km, and all parks, reserves and some roadside trees within that area were examined. Systematic sampling was not considered practical, mainly because of difficulties in gaining access to private land and what was assumed to be uneven host distribution (Carter 1989). At that time, it was assumed that each port survey had a 50% probability of detecting any newly introduced pest that happened to be present in the parks or reserves that were inspected. It was also assumed that subsequent surveys would have an equal probability of detection, which gave a cumulative probability of detection in any one year of $P = 1 - (1 - P_e)^n$, where n = number of surveys and P_e = probability of detection from one survey.

1995 efficiency trials

In 1995, a trial was carried out at three parks in Auckland to provide data on the efficiency of pest detection surveys in port environs, the probability of detection associated with carrying out repeat surveys, and the effect of using different surveyors (Bulman *et al.* 1999). Five observers looked for three types of artificial symptoms of new pests (spray-painted foliage; yellow tape attached to branches; and small paper tags placed under the bark of dead or dying trees or stumps). The mean detection rate was 48%, almost identical to that assumed by Carter (1989). There were significant differences between parks and symptoms, with detection rates low for cryptic symptoms and the largest park. Repeat inspections increased detection rate to 65%, lower than that assumed by Carter (1989). There was no discernable difference between surveyors, and also, two inspections by one observer were not significantly different from two single inspections by different observers. This latter finding may have been a result of the training and experience of the surveyors used in the trial and may not be repeatable at an operational level with less skilled surveyors.

1999 hazard site review and efficiency trials

In 1998, it was recognised that surveys suffered from lack of detailed specification, and that movements of goods across the border had changed dramatically since the first port environs surveys started. In order to address those issues, a review was commissioned by the Ministry of Agriculture and Forestry (MAF) (Hosking *et al*. 1999). The review consisted of four parts:

I. Analysis of past pest establishments
- Determine what factors constitute highest risk

II. Hazard site selection
- Develop criteria for determining individual risk sites
- Write a list of prioritised hazard sites

III. Inspection site selection
- Develop criteria for determining where inspections should be carried out
- Determine appropriate sampling method

IV. Survey method
- Determine what should be surveyed in terms of vegetation type
- Recommend best practice for inspection methods and data collection in terms of efficacy and cost
- Evaluate the role and application of blitz surveys.

In part I, a detailed analysis of ten past establishments was undertaken and it was confirmed that risk pathways should be the primary basis of site selection and prioritisation, and that formal surveys should be complemented by encouraging input from the wider community. Part II concluded that the selection of hazard sites for inclusion in the program should be based on a national prioritised list derived from individual site risk profiles, which should be reviewed annually. Part III recommended that inspection sites of 50-ha blocks should involve mandatory inspection of five specific classes of vegetation.

In part IV, a major field trial was carried out in three sites in Auckland, ranging in size from 3 to 7 ha (Hosking *et al.* 1999). Artificial symptoms were applied to trees in a similar manner to the 1995 trial (Bulman *et al.* 1999), except that the symptoms were designed to look like damage caused by biotic agents. Blotches of red or yellow paint were applied to leaves to simulate fungal leaf spots, holes were punches into bark of trees to simulate insect attack, and foliage was sprayed with a contact herbicide to induce wilt and dieback. For each type of 'symptom', half were reasonably to somewhat obvious, and half quite to very cryptic.

Two survey methods were tested. Firstly, extensive surveys were carried out where the entire area was walked and suspicious symptoms recorded. The second method was an intensive survey where all trees within 0.16-ha inspection plots were examined thoroughly. Five plots were placed in Dove-Myer Robinson Park (7 ha in size), and three were placed in Purewa Cemetery (3 ha) and Allright Place (4 ha). Three surveyors were used and they were allowed two hours to inspect each site. They did not know what type of symptom to look for or the number of symptoms placed at each site.

The mean detection rate of the extensive survey was 51%, almost the same as the 1995 trial where non-biotic symptoms were used. The intensive surveys, however, resulted in 77% of symptoms within the 0.16-ha plots being detected. The mean detection rate for one inspection was 77%, increasing to 89% for two inspections, and 94% for three inspections.

The more difficult symptoms were more readily found during the intensive survey. Only 21% of the cryptic paint symptoms were found during the extensive survey, compared with 50% during the intensive surveys; and 36% of cryptic holes were found during the extensive survey compared with 71% during the intensive survey (Table 1).

The 1999 project recommended that hazard sites be divided into 50-ha inspection sites using a grid system with 700 m centres. Within each inspection site two 40 m × 40 m inspection plots should be placed — one randomly and the other selectively to allow for inspectors' intuition and experience. Representatives of five vegetation types (Australian species, native species, *Pinus* spp., conifers other than those from Australia or New Zealand or *Pinus* species, and all other exotic species) had to be inspected in at least every two contiguous 50-ha inspection sites. It was also recommended that blitz surveys of high-risk sites be reinstated. This project was the most influential of all in shaping the high-risk site surveillance system now used.

2002 and 2003 reviews and operational trial

In 2002, an independent review of New Zealand's post-border biosecurity surveillance program concluded that the then current surveillance system was inadequate, and made a large number of recommendations for improvement (Prime 2002). Importantly, it urged that effort be concentrated on high-impact pests and that surveys be focussed on areas around seaports and airports to target high-risk pathways. In response to the 2002 review, MAF released a biosecurity strategy in 2003 (Biosecurity Council

Table 1. Detection rates by symptom type — obvious and cryptic (from Hosking *et al.* 1999)

Symptom type	Extensive survey			Intensive survey		
	No. of symptoms	No. found	Fraction detected (%)	No. of symptoms	No. found	Fraction detected (%)
Wilt obvious	72	56	78a[1]	27	25	93a
Wilt cryptic	72	34	47c	24	18	75 b
Paint obvious	78	50	64b	27	23	85ab
Paint cryptic	75	16	21c	36	18	50c
Holes obvious	78	46	59b	33	32	97a
Holes cryptic	72	26	36c	42	30	71b
Total	447	228	51	189	146	77

[1]Values within a column followed by the same letter are not significantly different at the 5% level of probability as determined by an analysis of deviance

2003) that established expectations for biosecurity surveillance (primarily that biosecurity policies and objectives be consistent across all sectors).

A trial to test the feasibility of implementing the recommendations in the 1999 hazard site review (Hosking *et al.* 1999) in an operational situation was commissioned (Bradbury *et al.* 2003). The trial took place in 2003 in the Auckland Airport environs where a GIS was used to demarcate 50-ha inspection sites. Within each site, one inspection plot was randomly placed, along with one selectively sited after the operational trial started. Inspection plots were either 40 m × 40 m or 80 m × 20 m in size, depending on the location and distribution of vegetation. The trial demonstrated that intensive inspection could be carried out operationally. All five vegetation types were adequately inspected using the specified method. Random plotting reduced inspector bias, but on the other hand increased planning time and thus cost. Four new pest location records and eight new host records were made from 130 specimen collections.

Following on from the Prime review and the biosecurity strategy document, Murphy (2004) circulated a discussion document to the sector and interested parties in June 2004. In that, it was acknowledged that survey specification and method could be improved further. A major discussion point was the change in risk pathways that had occurred recently and quickly. Risk had dispersed from ports to a large number of risk sites, primarily transitional facilities. Also, imported used vehicles posed a real, but undetermined, risk.

A field trial to measure the efficacy of the methods planned (Murphy and Baird 2004) confirmed that the probability of detecting a particular symptom type diminished with decreasing visual obviousness from large to cryptic (Table 2). Results were broadly similar to those from the 1995 and 1999 trials. The trial also demonstrated the feasibility of carrying out transect inspections around transitional facilities.

Biosecurity New Zealand (BNZ), a division of MAF, was formed in November 2004 to lead New Zealand's biosecurity system. Subsequently, in July 2007, MAF Biosecurity New Zealand (MAF-BNZ) was created from the integration of BNZ and the MAF Quarantine Service.

Pest detection surveys in 2007

As a result of submissions and the BNZ review of 2004, a new surveillance program started in November 2005. The focus changed from inspecting a small number of ports to inspecting 7500 transitional facilities along with traditional risk sites. Inspection is prioritised by the volume of imported goods received and by the proximity of 'vegetation-rich zones'. The greater the volume and vegetation diversity, the larger the number of transect plots established in order to achieve a specified detection probability. Transect plots are selectively marked on maps before inspections are carried out. Inspection plots are defined as transects, where a transect cannot be shorter than 20 m nor longer than 100 m, and the width must be between 10 and 30 m. Within the transect all arborescent vegetation has to be closely inspected for suspect organisms or symptoms. Time is also allowed for discretionary inspections, where inspectors may see unusual symptoms outside a predetermined transect. A GIS plays a key role, assisting in determining where plots should be placed, marking plots on maps so they can be found, and for recording information and auditing purposes.

Table 2. Probability of finding a given object type and estimated standard error (from Murphy and Baird 2004)

Object type	Prediction	Standard error
Large	0.752	0.023
Medium	0.578	0.019
Small	0.499	0.016
Cryptic	0.246	0.014

The improvement process is ongoing, and MAF–BNZ is developing a strategy for a cross-sector national biosecurity surveillance system. A review of the current state of the biosecurity surveillance system was circulated in July 2007. Review and development of biosecurity surveillance systems are ongoing and will probably never stop, as trade patterns change and new risks emerge.

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