

**NECTRIA REGIONAL SURVEY 2004 –  
WHERE DID WE GO WRONG AND  
IMPROVEMENTS FOR THE FUTURE.**

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**Nectria regional survey 2004 – where did we go wrong and improvements for the future.**

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## EXECUTIVE SUMMARY

### Objective

A disease incidence and severity survey for *Nectria fuckeliana* was carried out in Otago and Southland from January to April 2004. A field audit of selected plots showed that at the plot level there were significant errors and the original data were not suitable for detailed analysis.

The FHRC commissioned an evaluation of survey methods in order to identify errors and recognise deficiencies so that these are not repeated in future surveys. This report recommends procedures to ensure best practice for forest disease surveys.

### Key Results

Good survey procedure involves detailed planning and practice. Four steps for good survey practice involve quality management, quality assurance, quality control and quality evaluation.

- It is vital to determine clear objectives
- Assessment methods must be developed in the field and tested on a wide range of host types
- Reference material, in particular photographic standards, should be used in conjunction with clear and precise written documentation
- Training is critical step and needs to be carried out in a structured manner
- One experienced assessor needs to visit and calibrate other assessors and audit data recording and method
- A pilot assessment under field operational conditions, and using staff who will be involved in delivering the full survey, is valuable in identifying any inherent weaknesses before committing to the full survey.

### Application of Results

Recommendations will be applicable for any forest disease survey.

### Further Work

The disease survey for *Nectria fuckeliana* will be repeated following the recommendations presented here. A checklist based on recommendations in this report could be developed for use in other surveys.

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# INTRODUCTION

A disease incidence and severity survey for *Nectria fuckeliana* was carried out in Otago and Southland from January to April 2004. The aim of the survey was to:

- Determine the distribution, incidence and severity of *Nectria* disease in the southern region of New Zealand.
- Determine any relationships between disease and other features such as host age, silviculture, topography, altitude, and aspect.

The survey followed certain steps.

1. Objectives of the survey were discussed and developed.
2. Forests and stands were selected for assessment, and stratified with regard to the objectives developed in step 1. Forest owners were consulted and selections were modified and refined.
3. Assessment methods were developed and a workplan written.
4. A field visit was made, during which assessment methods were modified and refined.
5. Field assessors were trained.
6. Assessments were carried out.
7. Data were sent to the researcher and entered.
8. Errors were identified and forest staff were asked to remedy, if possible.
9. Preliminary data analysis and reporting was done.

It was during steps 8 and 9 that potentially serious problems were identified. A field audit of selected plots showed that at the plot level there were significant errors and the original data were not suitable for detailed analysis.

The FHRC commissioned an evaluation of survey methods in order to identify errors and recognise deficiencies so that these are not repeated in future surveys. This report discusses the *Nectria* regional incidence survey step-by-step with regard to the methods followed and recommends procedures to ensure best practice for forest disease surveys. This will ensure data are collected in the most efficient and accurate manner.

## METHOD USED FOR THE REGIONAL INCIDENCE SURVEY

### ***Survey objectives***

The objectives were discussed among researchers and forest owners via the *Nectria* Focus Group and the FBRC. Objectives were clearly stated in strategy documents distributed to the NFG, in documentation presented to the FBRC, and in the workplan itself.

Developing clear objectives is a critical step when planning surveys because they will influence how data are collected, what is assessed, and what is sampled. Using the *Nectria* survey as an example, it was known that pruning was likely to play a role in disease intensity, as was tree age. The survey objectives were to determine effects of site, age, and silviculture along with determining the incidence and severity of the disease throughout the region. Therefore sampling was stratified, as much as was possible, to get good regional coverage and an even allocation of plots within age classes and silvicultural treatment.

### ***Deficiencies***

No deficiencies or recommendations for improvement were identified in this process.

## ***Plot selection***

For forest health surveys the target population **must** be characterised and explicitly defined relative to the survey objective. A target population may be restricted to a group of trees, a stand, or a forest. Once the target is defined the sampling design can be determined. The design can be stratified, systematic, random, or combinations of each. Each design has application depending on the distribution of the target.

The Nectria survey was a forest-level survey where the target population was several stands spread over the geographical extent of the forest, but with restrictions on age and time since last silvicultural treatment. Therefore a stratified random design was taken.

The plot selection process was time consuming and difficult. Firstly, forest owners were asked to provide stand records in electronic format so that stands could be selected on criteria identified as important during the determining survey objectives stage. Stand records were interrogated and plots selected based on regional distribution, ownership distribution, silvicultural treatment, and stand age. Lists of selected plots were then sent to forest owners who then either approved the selection or sent suggestions for inclusions or deletions.

### ***Deficiencies***

No deficiencies or recommendations for improvement were identified in this process.

## ***Development of assessment methods and documentation***

Assessment methods can be resolved by asking three questions:

1. What is assessed?
2. How is the target assessed?
3. What and how is assessment data captured?

These are addressed by considering the objectives. The primary objective of the Nectria survey was to relate disease to environment, so the assessment had to provide an accurate indication of disease incidence (percentage of trees affected, or more simply: were symptoms present on trees assessed) and disease severity (the amount of damage on trees where symptoms were present).

In order to do this, it was decided to assess the target (in this case fluting on stems) by using two methods:

- a. Assessment of the entire pruned stem for fluting
- b. Assessment of fluting on individual stubs on two whorls per tree

The second method was based on that used for assessing fluting associated with individual stubs in a major silvicultural trial that had been going for over nine months. This had benefits and drawbacks. The benefits were that assessment methods did not have to be developed from scratch and methods used had been tested operationally. The drawbacks were that researchers were biased towards using that method and did not consider new or different methods as rigorously as they might have if they were developing a system from new.

A difficulty arose when it was attempted to define the severity of fluting. For the silvicultural trial flutes were classified as low, medium, or severe depending on their length, depth, and width. For this survey, the initial definition classified severity of flutes by length only, in an attempt to keep things simple.

Another problem became apparent after survey data had been collected. The detailed assessment of individual stubs was time consuming, difficult, and sometimes not representative of what was occurring on the remainder of the stem.

A workplan documenting methods was written and distributed to forest owners for comment. Feedback indicated that the fluting definitions were not sufficiently refined and several versions of the workplan were sent for comment before the final version was accepted. A copy is appended. However, the assessment

system was considerably more complex than what was originally proposed. There were two different assessment types – a brief evaluation and a detailed evaluation, and within each of those types there were different methods for old and young trees. An overall stem assessment and a detailed stub assessment were made for younger trees as well. Documentation contained photographs of flutes of varying severities to use as assessment standards. However the photographs were limited, and should have showed a wider range of fluting types.

A field visit was made to confirm the assessment method and carry out training. The assessment method was revised during the first day, and the following day surveyors were trained.

Data capture was considered and because each surveyor was doing a reasonably small number of plots it was not economically feasible to collect data electronically. The time taken to set up the hardware would have easily outweighed any potential savings in data capture in the field and subsequent data entry in the office.

### ***Deficiencies***

There were a number of deficiencies with this process.

1. Not all assessment methods were evaluated thoroughly enough. The silvicultural trial assessments on which survey methods were based were carried out on young trees that had just received their first pruning. The difficulties associated with assessing old trees and their occluded stubs were not considered.
2. The assessment process was developed and workplan written from the office without looking at diseased trees. Assessment methods were not tested rigorously enough in the field.
3. The final assessment method development in the field and training were undertaken too close together so there was no opportunity to fully test the method and revise the workplan before training was done.
4. Data initially thought worthwhile proved to be not useful. In particular the detailed stub-by-stub assessments was extremely time consuming and did not provide representative data.
5. Use of visual aids was not fully exploited through the provision of photographs of showing a full range of fluting categories.

### ***Training***

It was decided early on that a number of surveyors would be used. This was despite reservations that the use of more than one surveyor would result in increased variation and data error. The use of a number of surveyors was driven in part by cost considerations, allowing NFG members to provide assessment as an in-kind contribution. It is well recognised that use of different assessors can result in decreased precision of the assessments, and problems can arise when assessments from different assessors in different regions are compared. These problems can be resolved through rigorous training and using a standardised set of procedures and assessment methods.

Not all surveyors were familiar with disease assessment and few were used to collecting data during a scientific survey. In order to overcome these problems a training day was held immediately after the assessment methods had been finalised.

The training consisted of an outline of the survey objectives and plot types, a description of the types of flutes likely to be seen, definitions of fluting severity and the data collected, and guidance on how plot sheets were to be filled out. After presentations and discussion, the group of surveyors assessed a number of young trees using the methods described in the brief evaluation. A question and answer session was held afterwards. A similar process was followed for detailed evaluations of younger trees and evaluations of older trees. The training session took one day.

## **Deficiencies**

There were a number of deficiencies with this process.

1. Ideally, one skilled assessor should have been used. Training would have been easier and simpler and using one assessor eliminated between assessor variance.
2. Training was not carried out in a fully structured manner. Improved methods are discussed in the following section.
3. Not enough time was devoted to training. One day was not long enough to cover the different assessment methods **and** reinforce and test good practice.
4. Training was not continued once the survey was underway – there was no quality control process.
5. In summary, surveyors not used to conducting scientific surveys were used after insufficient training.

## **Data collection, transfer, entry and verification**

All surveyors were provided a copy of the workplan, data recording sheets for each of the various assessment methods, list of stands to be surveyed, and maps. They were sent out in the field to assess the pre-selected plots. The data sheets were completed by hand. Plot locations were marked on the maps provided and numbered with the plot number. Individual assessment trees were marked with paint, in case reassessment was needed. Assessors worked alone, and were thus responsible for assessments and data recording.

Once all plots were finished the completed data sheets were sent to the respective forest owner who then forwarded them to the researcher for data entry, data checking, and analysis. Data sheets were either posted to the researcher or, in some cases, hand delivered.

Data were entered and verification started. Verification comprised initially looking for missing data. One surveyor did not do an overall stem assessment. There was no reason for omitting this important assessment value other than carelessness on the part of the surveyor. Then, stand details recorded on data sheets were compared with stand details provided by forest staff during the plot selection phase. All plot numbers and location details shown on data sheets were compared with what was recorded on maps. Once the data verification process was completed (over 4 days' work for 459 plots) forest owners were sent requests to provide data to fill in gaps where survey data were missing. During the verification process it became apparent that one batch of survey sheets were missing from one surveyor. Data from that specific forest owner were hand delivered therefore data sheets did not go missing in the mail. Other data sheets from that surveyor and owner were received.

The undertaking of a full scale pilot survey followed by a careful review of the results may have identified some of the deficiencies outlined below before the full survey was undertaken.

## **Deficiencies**

There were serious deficiencies with this process.

1. Most significantly, quality control or evaluation was not done while the surveys were underway. The surveyors were provided reference material and asked to complete their task. Their assessment technique and results were not checked by an experienced assessor during the survey period.
2. Likewise, their data entry was not checked. Interpretation of the workplan was likely to vary between assessors but this was not checked and thus errors were not identified and corrected. No attempt at surveyor calibration was made.
3. Some important assessments were not done.
4. One batch of data sheets was not delivered.

## ***Data analysis and reporting***

Data analysis was carried out in the standard manner, where data were tabulated and summary statistics produced. It was during this stage that it became apparent that there may have been significant variation between surveyors. It was concluded that there was a large variation in disease incidence between plots at various locations, and at that stage the reasons for such variation had not been established (Bulman 2004a). It was also stated that results were provisional and a full statistical analysis needed to be carried out before any real trends could be identified.

### ***Deficiencies***

No deficiencies or recommendations for improvement were identified in this process.

## ***Results from the audit***

In response to the provisional findings, and high between-surveyor variation, an audit of a selected number of plots was carried out by one experienced assessor. This audit of the regional Nectria survey was undertaken in late July 2004 by Paul Cox of Forest Tech Services (Cox 2004). Twenty plots in total covering four forest owners' estates were assessed.

The audit findings were as predicted. Of the 370 trees individually audited, Cox found that 162 (44%) were incorrectly assessed by the original surveyor. Bulman (2004b) carried out further evaluation of Cox's raw data and concluded that at the overall regional level, disease incidence calculated from the original assessments conformed reasonably well with the audit results. However, at the plot level, significant errors were found and it was recommended that the original data were not suitable for detailed analysis. There were also instances of missing data. As stated previously, one assessor did not record overall fluting assessments. Another assessor often recorded incorrect plot numbers and there were instances of other missing or obviously incorrect plot details. It was concluded that error was attributable to specifications written in the workplan for younger trees not being followed, and with difficulty in interpreting specifications written for older trees. However, instances of inexplicably poor data recording were also noted (Bulman 2004b).

# RECOMMENDATIONS FOR IMPROVED METHODS

## *Survey objectives and plot selection*

It is critical to develop and agree on survey objectives before anything else is started. This process has been termed “quality management” (Cline & Burkman 1989). It incorporates proper survey design, definition of data quality requirements, and documentation. It ensures that appropriate data are collected in an appropriate way. Ferretti (1997) states that the objective(s) of the assessment and monitoring program should be carefully identified, including the target entity to be monitored, and therefore the identification of the relevant assessment questions and assessment end points.

Once the survey objectives have been determined and documented a sampling system can be designed and plot selection can take place. Time spent during this stage is critical to the ultimate success of the survey and it is false economy to try to reduce effort here.

## *Development of assessment methods and documentation*

The assessment method can be developed once the sampling system has been designed. There are many assessment methods for forest surveys of biological targets. Generally, accuracy and precision are inversely proportional to the economy of the survey. An increase in one will result in a decrease in the other.

For instance, in order to determine the incidence and severity of *Nectria* as evidenced by stem fluting, one could carry out a stub-by-stub assessment of the entire pruned stem and count, record and assess the severity of every flute seen. This would be the most accurate way to determine the amount of fluting on individual trees, but it would certainly not be the most efficient or economical. The between-tree variation in fluting will determine the number of trees to be assessed, regardless of how accurate an assessment of an individual tree is. It is often possible to revise the assessment method so that individual tree assessment is faster and therefore more efficient, thus enabling more trees to be assessed at reduced cost.

Assessment methods **must** be developed and tested rigorously in the field under different conditions in different stand types, and preferably by more than one assessor.

Methods must be documented and then peer reviewed. Documentation should be tested in the field by people independent of the method development and documentation processes in order to pick up inconsistencies and ambiguities. This process will also identify if people have differing interpretations of instructions and assessment methods. One approach to the method evaluation process is to apply the agreed methodology, including data collection, to a pilot assessment designed such that if it meets the required standard it will contribute directly to the full assessment. The pilot assessment can be critically evaluated against all relevant standards before proceeding to the full population assessment.

Standards (photographs of disease symptoms at various severities) should be used if at all possible.

## *Training*

Training is absolutely critical. Insufficient or poor training will markedly increase the odds of receiving inaccurate, and probably incorrect, data. There are several standard procedures that should be followed when training assessors for disease surveys.

Firstly, assessors should be given documentation some time before the training sessions start. This will prepare them for the training, particularly with regard to the purpose and objective of the survey. It will also avoid people being distracted by reading documentation while the training course is being run. Assessors should come to the training session well prepared.

The trainer needs to be an effective communicator and experienced and skilled at the assessment method to be taught. The objectives of the survey need to be clearly stated and the relationships with

assessment method pointed out. Questions should be encouraged at this stage. For a major or complex survey this process could possibly take one half day, with material provided in the office and in the field.

The assessment methods then need to be fully explained and described step-by-step. Questions and discussion should be encouraged again. Assessors need to be clear on what they have to do and why they have to do it.

Once the theoretical processes have been covered practical training may start. Practical assessments should be carried out in a group situation firstly, with the trainer demonstrating how assessments are carried out while assessing trees. The assessor should assess 4-5 trees and tell the group what the assessment value of each was and why. After that the trainer and the group should discuss and debate the individual assessment values and come to agreement on them. This process is then repeated but this time the assessor involves individuals in the group and asks them to provide an assessment value. This process should continue for some time, until people in the group are feeling reasonably comfortable about assessing trees.

After the above has been done, the intensive training should be started. About 30-50 trees should be pre-selected and numbered with paint. Assessors are asked to assess and record each tree, independent of other assessors. The trainer also assesses all trees. When everyone is finished, all assessments are tabulated and shown to the group. Trees with large variation in assessments are identified and the group inspects those trees. Assessors who gave the tree below average scores are asked to give their reasons for doing so, as are those who scored the tree higher than average. These discussions reinforce the documented methods and can identify differences in interpretation between assessors. This process is repeated again for another set of trees.

The following day, the process is repeated again, this time with assessments starting at the highest numbered tree and working back. The process of carrying out repeated assessments followed by discussion reinforces correct method and gives assessors practice. Finally, a new set of trees is assessed by all independently and scores compared. Trainee assessors are ready to start surveying when group assessments are uniform, i.e. all scores are within a predetermined level of error.

The next and final stage of training is quality control and quality evaluation. The experienced assessor should visit all assessors while they are carrying out the survey to ensure that individuals are not deviating markedly from documented methods and that their scores are within acceptable range. Data recording should be checked. It is important that this stage is undertaken soon after the surveys start.

The trainer needs to recognise and identify any fundamental problems in applying the assessment technique, and discuss them directly with the project manager.

## ***Data protocols***

Data collection can be made either by writing or electronic entry. Electronic entry is often more expensive due to set up costs and data entry time (particularly if long textual strings need to be entered). However, data errors can be minimised by setting field validation rules. Hardware and software has advanced markedly and shows no sign of slowing. The pros and cons of paper versus electronic vary depending on the survey and need to be considered on a case-by-case basis.

Survey data are valuable and care needs to be taken that they are not lost. Copies of paper forms should be made before they are sent by post. Electronic data should be backed up.

Before analysis of trends and main effects is carried out, assessment precision determinations need to be done if more than one assessor is used. This will identify bias and/or imprecise assessments and clarify if regional differences in disease are real or merely due to poor assessment or misinterpretation of standards. Nearly always, between-stand variation should be higher than within-stand variation.

## SUMMARY

Good survey procedure involves detailed planning and practice. Four steps for good survey practise involve quality management, quality assurance, quality control and quality evaluation.

- It is vital to determine clear objectives from which survey design, methodology, and documentation can be designed and developed (quality management)
- Assessment methods must be developed in the field and tested on a wide range of hosts displaying a wide range of disease levels (quality management)
- Reference material, in particular photographic standards, should be used in conjunction with clear and precise written documentation (quality assurance)
- Training is a critical step and needs to be carried out in a structured manner with sufficient time as is needed to ensure that all surveyors' assessments are within an acceptable range (quality control)
- One experienced assessor needs to visit and calibrate other assessors (quality control) and audit data recording and method (quality evaluation)
- A pilot assessment using a subset of the whole population and carried out under full operational conditions helps to identify any inherent weaknesses before the methodology is applied to the full population.

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