INTRODUCTION

Native forests and monitoring are important

Native forests are important to all New Zealanders in different ways. They are extremely important reservoirs of plant and animal biodiversity. Many species of native birds have become extinct in the past 200 years because of pressures from forest clearance and the introduction of new predators. Native forests also provide other values such as the maintenance of high water quality, the protection of soils from erosion and a high-quality visual landscape, which is important to recreation, tourism and leisure.

Native forests are continually changing. They are exposed to threats such as browsing and predation by introduced animals, human development and changes in climate.

Whether you are managing native forests, have a native forest area on your farm, are in a community group that looks after a forest area or are interested in native forests for other reasons, monitoring the condition of the forest is important. Without monitoring, native forests can become degraded and remedial action may be too late to be of use. Monitoring also provides ways of checking if the current management systems are working – is the possum control worthwhile? – is goat hunting keeping numbers down?

This publication aims to provide information so forest owners, managers, community groups and individuals can effectively monitor New Zealand's native forests.

HOW THIS PUBLICATION WORKS

The publication is split into four parts:

1. **Monitoring Outline**: *everyone should read this*!
   This gives a brief summary of the important considerations in native forest monitoring.
2. **Monitoring Toolbox**: *read this when you are ready to do some fieldwork.*
   This provides specific instructions on monitoring methods.
3. **Understanding Native Forest Monitoring**: *use this when you are planning monitoring, or dealing with results.*
   This gives more detailed explanations of the important aspects of native forest monitoring, including design, sampling, fieldwork, analysis and data storage.
4. **Forest Ecosystem Indicators and Monitoring**: *use this to identify what to measure and how.*
   This is a listing of possible native forest indicators and ways to measure them. Use this to design your monitoring programme, to help you identify what you should measure and how you should measure it. Seek out more detail on the measurement methods once you have found them in this part, either from the Monitoring Toolbox or references listed.

The publication is structured so you use it at a level that suits you. If you have a small area of forest and want to begin monitoring, read the Monitoring Outline, then select a method from the Monitoring Toolbox to try. Refer to the other parts of the publication if you strike problems. If you are involved in managing a variety of areas of forest and need to design a robust monitoring programme, you will need to use the entire publication.

If you are unsure about your monitoring – seek advice. Staff from organizations such as the Department of Conservation, regional councils and universities may be able to assist you. Commercial organizations such as ecological consultants, Landcare Research Ltd, and others can also provide assistance.

1. MONITORING OUTLINE

What is monitoring?

Monitoring is the assessment of change in specific characteristics, over time or between areas.
We are dealing with native forest ecosystems. Therefore, we are interested in changes in characteristics such as canopy condition, the abundance of plant species in the understorey, the abundance of bird species or the abundance of particular pests.

What are indicators?

Indicators are specific characteristics of a forest ecosystem that can be assessed to give indications of its condition.
Forest ecosystems are complex so there are many indicators. Figure 1 and Table 1 identify some of these.

Why monitor native forest ecosystems? (*see* also 'Why do you want to monitor?' p.86)

Monitoring to identify changes over time or between areas is important because native forests are exposed to a wide range of threats, including introduced plant and animal pests and human development.
We need to identify if management programmes such as animal or weed control are required to stop forests being further degraded. Monitoring can also help us learn the benefits of any management, and how we can come up with better management. Reasons for monitoring can be summarised as:

- Generalist surveillance monitoring: To check if there are any immediate threats to the forest, requiring intervention.
- Specialist surveillance monitoring: To check on a specific forest indicator or group of indicators. You may want to set a baseline and then understand how things are changing.
- Conservation outcome monitoring: To see the impacts of your operations (for example, animal control) on forest condition.
- Operational monitoring: To check the effectiveness of your operations, for example, did you really kill 90 percent of the possums.

What to monitor? (*see* also 'Design monitoring …', p.88)

Many different indicators can be examined to assess aspects of forest condition (*see* Figure 1 and Table 1).

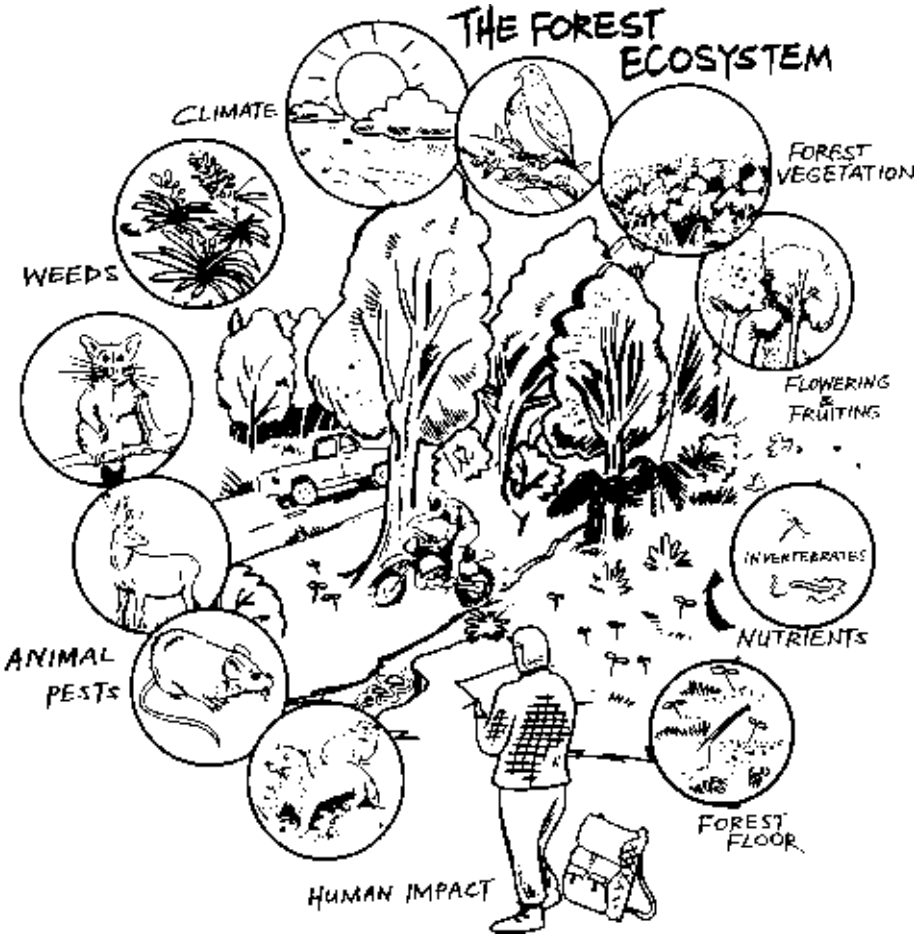
What you measure will depend on your objectives and questions. Once these are determined, you can select relevant indicators to measure.

Examples of monitoring questions are: "What impact will reducing possum numbers have on species that possums eat in the forest canopy?" and "Where is the weed-climbing asparagus distributed through the forest area, and is it spreading?"

If you are uncertain what you should be monitoring, talk to experts, and do some quick generalist surveillance monitoring first. This will help identify any issues you need to look at.

Monitoring is a complex subject described here in a simplified form. Always seek advice if you are unsure – this can save you wasted effort and money.

FIGURE 1: The forest ecosystem involves interactions between many different components. Different parts of the ecosystem, and interactions between them, can be used as indicators of ecosystem condition.



When to monitor (*see* also 'Design monitoring …', p.88)

If you want to examine the results of a management programme or some other operation, such as determining the number of possums after a poison operation, or if there is greater foliage density in the canopy or more seedlings, it is important to monitor before and after the programme.

Many things to be measured will change naturally during the year. For example, birds will be more active in spring, plant species will fruit at certain times of the year, rodent numbers will be higher in summer than winter. Changes also occur depending on the weather and time of day, particularly when monitoring animals. If it is likely these sorts of natural changes will occur, try to be consistent about when you undertake monitoring, bearing in mind:

- Time of year – season.
- Time of day.
- Weather conditions.

Where to monitor

As well as monitoring the area of forest you are interested in, it is important to monitor other areas for comparison at the same time.

Monitoring other areas as well as the area of interest will show you:

- How the area of interest differs from other areas
- How changes in the area of interest compare with changes in other areas. You will need to do this if you want to look at changes in relation to some management operation. For example, you may wish to look at improvements in the abundance of mahoe seedlings in the understorey in response to a goat-control programme. You would need to also look at changes in other areas where goats were not controlled. If mahoe seedlings increase in the area where goats were controlled but not in the other areas, you can show that goat control has had a positive benefit. If you only measure the area where goats were controlled, you won't know if seedlings would have increased naturally without the control programme.

If you need to show conclusive changes scientifically, the way you design your monitoring to compare different areas is important. You are likely to need advice on how to set up your monitoring to compare different areas.

Precision (*see* also 'What is precision?', p.96)

When measuring forest indicators, it is not usually possible to measure every tree canopy, count every bird, or every understorey seedling in the forest. Instead, we have to select a small number of them from the whole forest, measure them and use these measurements to estimate the situation for the whole forest.

TABLE 1: Forest Ecosystem Indicators		
CHARACTERISTIC OF INTEREST	**INDICATOR** *See Part 4 for explanation of indicators*	**RELEVANT METHODS IN MONITORING TOOLBOX** *See Part 4 for other methods*
Vegetation Condition	Canopy cover and condition	Forest general surveillance checklist Ground photography to monitor forest canopycover Foliar browse index
	Understorey plant abundance	20m x 20m permanent vegetation plots Quick plot method for vegetation assessment
	Vertical and horizontal vegetation structure	Recce – for vegetation description Point/cylinder intercept assessment of forest structure
	Species composition and diversity	Recce – for vegetation description 20m x 20m permanent vegetation plots Quick plot method for vegetation assessment
	Abundance of indicator species	Quick plot method for vegetation assessment Recce – for vegetation description 20m x 20m permanent vegetation plots Epicormic shoot counts
	Distribution of key/uncommon species	*See Part 4 for possible methods*
	Fruiting and flowering of key species	Fruiting and flowering observation record Ground plot monitoring of seed and fruit-fall
	Plant species population structure	Quick plot method for vegetation assessment 20m x 20m permanent vegetation plots
	Plant species mortality	*See Part 4 for possible methods*
	Litterfall	*See Part 4 for possible methods*
Weeds	Distribution of weeds	Weed map monitoring
	Abundance of weeds	Quick plot method for vegetation assessment 20m x 20m permanent vegetation plots
	Population structure of weeds	Quick plot method for vegetation assessment 20m x 20m permanent vegetation plots
	Mortality of weeds	*See Part 4 for possible methods*
Ground Cover/ Disturbance	Ground cover	Point intercept assessment of forest ground cover
Birds	Distribution of bird species	*See Part 4 for possible methods*
	Abundance of bird species	Forest bird slow walk transect
	Species composition and diversity	Forest bird slow walk transect
	Bird species population structure	*See Part 4 for possible methods*
Invertebrates	Abundance and species composition/ diversity (may be separate)	*See Part 4 for possible methods*
Large Vertebrate Pests – deer, goats, pigs	Distribution of particular species	*See Part 4 for possible methods*
	Abundance of particular species	*See Part 4 for possible methods*
	Population structure of particular species	*See Part 4 for possible methods*
Possums	Distribution	*See Part 4 for possible methods*
	Abundance	Possum percentage trap catch
	Population structure	*See Part 4 for possible methods*
Rodents	Distribution of particular species	*See Part 4 for possible methods*
	Abundance of particular species	Tracking tunnels for rodents and stoats Rodent 'gnaw stick' bait interference
	Population structure of particular species	*See Part 4 for possible methods*
Stoats	Abundance	Tracking tunnels for rodents and stoats
Cats	Abundance	*See Part 4 for possible methods*
Drainage	Drainage condition (height of water table, surface water)	*See Part 4 for possible methods*
Climate	Records of important climate measures (monthly max and min temp, salt laden storms, wind storms, monthly rainfall)	*See Part 4 for possible methods*

How reliable these estimates are as a measure of the true situation for the whole forest is the *precision of the estimate*. Precision can vary from:

- Low precision – an educated guess. For example, results suggest there may be between 500 and 900 tawa stems per hectare in the forest.
- Good precision – 95 percent confidence. For example, there are 450-550 tawa stems per hectare in the forest.
- Extreme precision – 100 percent confidence, the whole population has been assessed. For example, there are a total of 5022 stems in the 10-hectare forest, or 502 per hectare.

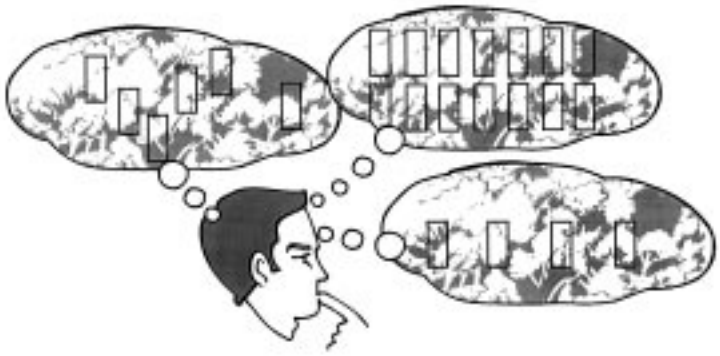
Monitoring should be designed so the level of precision is adequate to answer your monitoring questions. Low precision may be good enough to pick up big changes over long periods. Good precision will be necessary when looking at small changes over shorter periods. Extreme precision is seldom practical or necessary.

Sampling (*see* also 'Sampling', p.95)

Monitoring forests almost always involves picking a selection or 'sample' from the forest to measure and draw conclusions about the whole forest. The size of this sample and the way it is selected are extremely important in determining precision.

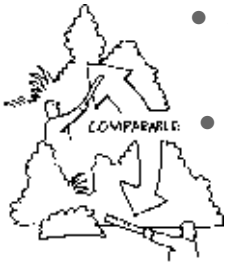
It is important to decide how you will sample – expert advice may be useful. Information on sampling is also provided in 'Sampling', p.95.

FIGURE 2: The way you select samples is very important. Seek advice if you are unsure.

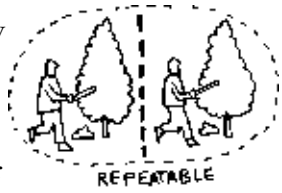


Fieldwork – taking measurements in the forest (*see* also 'General notes …', p.102)

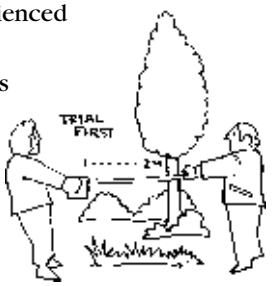
The care with which fieldwork is planned and carried out will determine if the information collected is useful and reliable, or virtually worthless. When planning and undertaking fieldwork, always make sure fieldwork has the following features:



- *Repeatable:* Always record enough information about how the measurement was taken so others can easily re-measure in future.
- *Comparable:* Measurement should be undertaken in a standard and consistent way so it is comparable with other similar studies.



- *Relocatable:* In most cases measurements will be repeated at fixed points. Make sure the locations are well marked and recorded so they can easily be relocated.
- *Knowledge and skills:* Ensure people doing the measurements have enough knowledge and skills. Ways of improving knowledge and skills include reference books, or training from experts and other experienced people.
- *Works in practice:* Do a quick trial of your measurement methods before the main monitoring. Ask questions if you are not sure, and make sure things are working before you do too much.
- *Standard forms:* Use standard field forms where possible. These should stop you forgetting to record important information.
- *Notes on measurements:* Record anything different or unusual about a particular site or measurement. This may be useful when the data is being analysed, or the site is re-measured.



Data analysis and presentation (*see* also 'Analysis of data', p.104)

Analysis can examine:

- Change over time.
- Difference between areas.
- Relationships between different indicators.

Analysis needs to be carefully planned and linked to good sampling and other aspects of monitoring design. Always keep analysis simple and use graphs wherever possible. They help give you a feel if there are differences, changes or relationships. Seek advice to make sure your analysis is scientifically valid.

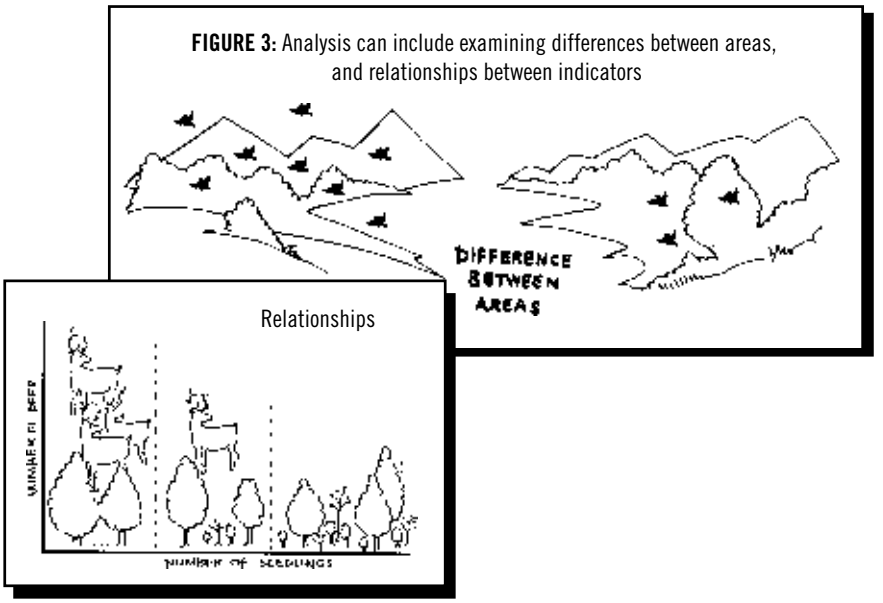


FIGURE 3: Analysis can include examining differences between areas, and relationships between indicators

Data storage (*see* also 'Records, …', p.108)

The data that your monitoring collects will be important in future to allow comparisons and to track changes. It must:

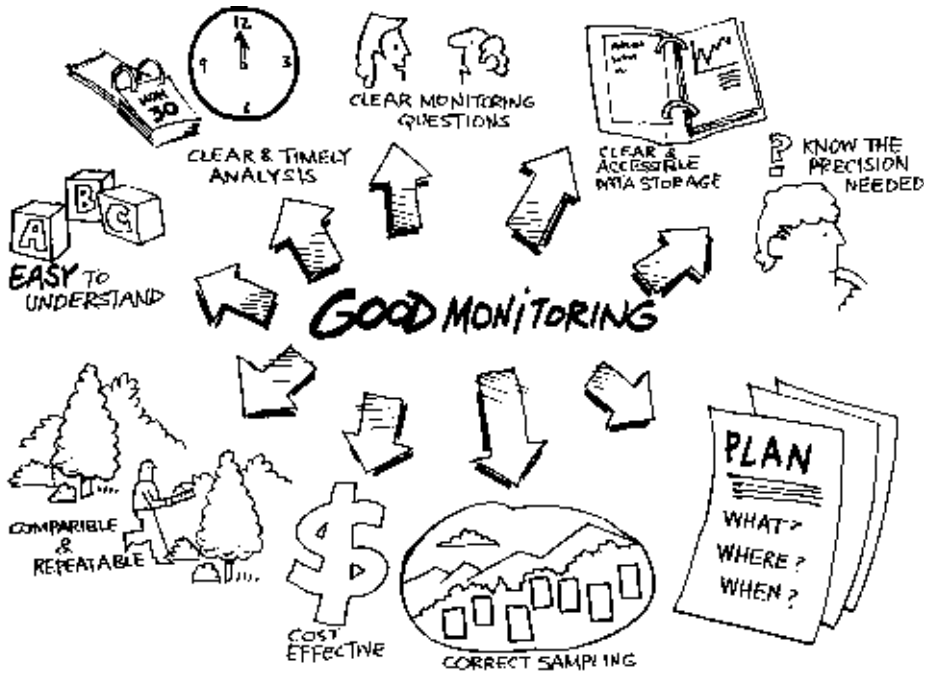
- *Contain all relevant information:* Store the data and information on where and how it was collected. Make sure there is enough information so people can re-measure to get comparable new data. Keeping the data and background information together in a ring binder folder is a good idea.
- *Be accessible:* Make sure other people know the data exists and can get hold of a copy of it. It may be valuable to other people doing similar monitoring who wish to compare results.
- *Be secure:* Make sure the data is safe from damage or loss. Keep at least two copies stored in different locations.

A good monitoring system

Good monitoring has the following elements:

- Clear reasons for monitoring and specific monitoring questions.
- Knowing how precise your results need to be to answer your questions.
- A plan of what, where, and when to monitor to answer these questions.
- Well-planned sampling and measurement methods to give the level of precision you need.
- Is cost-effective and affordable.
- Comparable and repeatable fieldwork.
- Is easy to understand – both monitoring methods and analysis.
- Clear and timely analysis.
- Safe and accessible data storage.

FIGURE 4: Features of good monitoring



Indicators and measurement methods (*see* also Part 4)

Table 1 (page 12) provides a summary of some common indicators for managers of native forests. It also lists monitoring methods provided in the Monitoring Toolbox which could be used to measure some of these indicators.

This is only an introductory list and it may not provide the best approach. Many methods are listed in Part 4.

The steps in a good monitoring system are set out in the following flow chart.

FIGURE 5:
DECIDE WHY YOU WANT TO MONITOR