2. MONITORING TOOLBOX

Use this part when you are ready to start some fieldwork.

It contains a series of monitoring instructions and field forms but these are only a few of the monitoring methods that you could use.

Part 4 contains a more complete list of useful forest ecosystem indicators and ways to measure them.

Quick reference list to monitoring methods listed in protocol

Monitoring Plan
General Surveillance Checklist for Forest Ecosystems
Ground Photography to Monitor Forest Canopy Cover
Quick Plot Method for Vegetation Assessment
20m x 20m Permanent Vegetation Plots
RECCE – For Vegetation Description
Foliar Browse Index for Possum-Related Damage
Epicormic Shoot Counts
Cylinder Intercept Assessment of Forest Structure
Point Intercept – For Forest Ground Cover Assessment
Flowering and Fruiting Observation Record
Ground Plot Monitoring of Seed and Fruit-Fall
Forest Bird Slow Walk Transects
Weed Map Monitoring
Possum Percentage Trap Catch
Tracking Tunnels for Rodents and Stoats
Rodent 'Gnaw Block' Bait Interference

RECORDING AND MEASUREMENT STANDARDS FOR USE WITH THE TOOLBOX

Many of the instructions in this toolbox require recording of similar background information such as location, or plant species. The list below provides some general standards for recording this information. Additional specific definitions are provided in the individual instructions.

Location name

This is the name of the specific area where the monitoring is being undertaken. It must be a widely used location name. Ideally it should be location that is published on a topographical map. For example Kaitawa Reserve, Wainui Stream, etc.

Grid reference

The six figure grid reference from an NZMS 260, 1:50,000 topographical map. This gives a grid reference estimated to the nearest 100m. The grid reference is preceded by the map sheet number. Instructions for giving grid references are provided on New Zealand 1:50,000 topographical maps. For example the grid reference for Mt Mathews on sheet R27 is given as R27 785819.

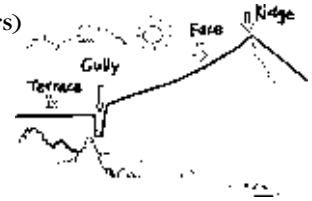
Fieldworker names

Record the names of people who undertook the monitoring that is being recorded. Where more than one person is involved, identify the individual that was recording information, and the individuals undertaking measurements.

Landscape unit

Where there is reference to 'Landscape', or 'Landscape unit', the position where the monitoring is being undertaken should be recorded in one of the following four classes:

- Ridge (including spurs)
- Face
- Gully
- Terrace



Altitude

Height above sea level in metres. This can be estimated off a 1:50,000 topographical map, or measured using an altimeter.

Aspect

The predominant direction that the area faces. Measured by pointing a compass in that direction and recording the magnetic bearing.

Drainage

Recorded in one of the following categories:

- *Poor:* swampy sites where water stands for long periods.
- *Medium:* runoff may be slow, with water accumulating in hollows for a day or two after rain.
- *Good:* water runs off site rapidly.

Diameter at breast height (DBH)

Tree diameter is measured in centimetres to one decimal place, e.g. 23.6cm, at 1.35m above ground level on the uphill side of the stem. This height is chosen as it is used in 20x20 m permanent vegetation plots (Allen 1993). Diameter is measured using a diameter tape which allows diameter to be read directly from a tape wrapped around the stem.

Plant names

The standard for plant names is to record the shortened scientific (latin) name using a six letter code, in capital letters. This code is made up of the first three letters of the Genus (first word in the scientific name) and first three letters of the species, (second word in the scientific name). For example *Elaeocarpus dentatus* (hinau) is recorded ELADEN, *Dacrycarpus dacrydioides* (kahikatea) is recorded as DACDAC. If you do not know the scientific name, record a well accepted common name, during fieldwork, and replace this with the six letter code later.

Sources of measurement equipment & materials

- Length measurement tapes and diameter tapes can be obtained from survey or forestry supply companies. These companies include… Geosystems Ltd (phone 03 343 2333), Trig Surveying Instrument Co, phone 04 473 7935
- Aluminium rod for making stakes can be obtained from metal suppliers such as Mico Metals in your area.

MONITORING PLAN

Purpose

The Monitoring Plan provides a structure to help you ensure that important aspects of design are considered and recorded.

Introduction

This form allows you to work through the important components of designing your monitoring programme, to make sure you consider all the important points and come up with an effective monitoring design.

Recording the reasons for monitoring (your objective and monitoring questions) and the way the monitoring project will be implemented is essential. It will ensure monitoring is done in a consistent way. It will allow the project, once under way, to be checked against what was planned. It will allow people repeating the monitoring in future to re-measure in a consistent way, using the same indicators and measurement methods.

Completing the monitoring plan form

Work through each section of the monitoring form as set out below. Refer to later sections of this publication and ask experts about completing this form.

- *Why do you want to monitor?* The reasons for monitoring and your specific monitoring questions need to be defined (*see* 'Why do you want to monitor', p.86 and 'What is the monitoring question?' p.87).
- *What level of precision is required?* Identify what broad level of precision is necessary to answer your questions. For example, do you need to pick up small changes over a year or two, or are you only interested in major changes over several years, *see* 'What sort of difference … ?' and 'Design monitoring …', p.88.
- *Indicators and Measurement:* Select the most appropriate indicator or indicators, relevant to your questions. Also identify the measurement methods you will use to match the precision you require, and your skills and resources. Identify the specific measurement instructions you will use. See 'What will you measure', p.89, 'Selected measurement methods' p.89 and 'Using marked or unmarked measurements' p.92.
- *Design:* Decide how you will design your monitoring to answer your questions. How will you design it to compare differences between areas or, if relevant, change after a management operation. See 'Design monitoring …', p.88.
- *Fieldwork:* Develop a plan for efficiently carrying out the fieldwork (*see* 'General notes on undertaking fieldwork', p.102). This will include considering points such as: When will it be undertaken? What people and equipment are needed? Are there any particular training requirements?
- *Data analysis and storage:* Identify how you will analyse the data that is collected. This may include specifying what will be calculated, such as calculating mean tracking frequency for different areas from tracking tunnels, or percentage vegetation cover from digital analysis of photographs. Identify how data will be stored. For example, where will the hardcopy field sheets be stored? Will a computer data file be created? See 'Analysis of data', p.104 and 'Records …' p.108.

Records

The Monitoring Plan form should be stored with the data collected under this plan. It may form the cover sheet on a series of data sheets.

MONITORING PLAN

Forest areas involved: Kaitawa Scenic Reserve

Plan prepared by: James Hannah **Date:** 12.11.99

Why do you want to monitor?

Broad objective: (general surveillance, specific surveillance, conservation outcome, operational monitoring)
Examine the conservation outcome of Goat Control

Monitoring questions
What impact has reducing the numbers of goats had on species in the understorey that goats eat.

Precision required
Need to pick up moderate changes occurring over a 3–5 year period

Indicators and measurement

Indicators
understorey abundance, species composition and diversity, abundance of indicator species.

Measurement methods
Assessment of understorey density, composition and epicormic shoots

Measurement protocol Quickplot, Epicormic shoot counts

Design

How will change be examined? (BAC (before after control impact), treatment and non-treatment areas etc)
Areas in the same catchment and forest type where no control has been undertaken will also be measured.

Marked or unmarked plots?
marked

Sample size. Attached calculations show 35 Quickplots will be required in the reserve area and a similar number in the areas with no goat control.

Sample selection (systematic, random, stratification, etc explain field layout)
Transects will be run out on a bearing of 160°(magnetic) from the road. Transect starts randomly located. Quickplots at 75m spacing along transects.

Field trial of design
Will be trialed on 10.12.99. One transect will be established.

Fieldwork

Fieldwork
Will require measurement in accordance with Quickplot and Epicormic shoot count methods.

Timing
17.1.00 — 31.3.00

Resources
One team of two people, measurement tapes etc. See method checklists.

Particular requirements
None

Analysis and data storage

Proposed analysis: Comparison of changes in density and composition of browse preferred species over time, and between the area with goat control and without goat control. Advice is being obtained on statistical tests.

Proposed storage of records
Daily storage in paper file.

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

GENERAL SURVEILLANCE CHECKLIST FOR FOREST ECOSYSTEMS

Purpose

To identify any immediate threats or issues about the general forest condition that may require management input.

Summary

Indicators
- Canopy cover
- Understorey abundance
- Ground cover
- Bird relative abundance
- Abundance of weeds
- Abundance of large vertebrate pests
- Abundance of possums

Skills
- General knowledge of the assessment of forest values and threats
- Ability to identify main native plant and weed species
- Ability to identify conspicuous sign of animal pests

Time

0.5-1 hour per sheet

Sampling
- Needs to be determined when planning monitoring
- One checklist completed for one similar area of forest ecosystem
- In small reserves, one sheet per reserve may be adequate
- In larger forest areas, use sheets for different areas

Equipment and people
- 1-2 fieldworkers
- Map
- Aerial photograph
- Pencils
- Surveillance checklist
- Clipboard
- Camera and film (to photograph important features or issues)
- Plastic bags and labels, to collect any important plant specimens

Strengths
- Simple to undertake without special skills or equipment
- Provides a good initial identification of key threats and issues
- Examines a wide range of indicators at one time

Weaknesses
- Relies on visual assessments so precise changes cannot be examined
- Subjective assessments – may vary between observers

Introduction

This method is broadly based and intended to provide an indication of the current important management issues for a forest area. It may identify where more monitoring and management input are required. It can be used to examine big differences between areas or over time, but it should not be used for more detailed studies.

Its main use is as part of a regular inspection of a forest area by field staff.

Sampling

One checklist (*see* page 23 and 24) is completed for a particular, similar area of forest. For a small reserve, one checklist would be completed for the whole reserve. For larger areas, or where there are distinctly different parts of a forest area, several checklists may be completed.

Each checklist should relate to an area that can be walked through and visually assessed by one person, for example, a small catchment area, or a defined area of an important vegetation type.

Method

Define the forest and area that the checklist is for.

- This may be a whole forest area, or one part, such as a small stream catchment, a defined area along a forest edge, etc. It is important to define where you walked in assessing the area, for example, did you follow an existing track, or walk systematically through the whole area.
- Fill out the header information.
- Walk through the whole area being assessed; referring to the checklist as you go to make sure all the important indicators are noted.
- Tick the appropriate description for each indicator that is closest to the state of the area assessed.
- If you are not sure about the assessment of a particular aspect of forest condition, record this in the notes.
- Add any additional notes about key points or important work that needs to be done. For example, is there a break in a fence that needs fixing?

Records

File the completed checklists and any associated notes and maps.

Analysis and presentation

Because of the relatively crude nature of the data collected, involved analysis is not warranted. Some approaches to using the information are as follows:

- Compare the estimates (1-4 on the checklist) for each indicator between different areas, and different assessment periods to identify any big differences. Individual indicators should be compared rather than an overall combined rating.
- Identification of high-risk combinations. If certain combinations of indicators are identified, this should 'ring alarm bells' and result in a more thorough examination of the area. Important combinations may include:
  - ~ Poor canopy condition and high possum populations.
  - ~ Poor canopy condition, poor understorey condition and high goat or deer populations.
  - ~ Poor canopy condition and high weed populations.
- Identify and note follow-up of management needs.

Frequency of re-measurement

The frequency of re-assessment will depend factors such as:

- The importance of the area – does it have particular significance in terms of rare species or communities?
- Issues and actions raised at the last assessment – if there are important actions to follow up on, re-assessment may be sooner.
- Is the area under threat, for example, close to an urban area or road, meaning introduction of new threats is likely?

A generalist monitoring checksheet is suitable for a regular annual or two-yearly field check of an area.

FOREST GENERAL SURVEILLANCE CHECKLIST

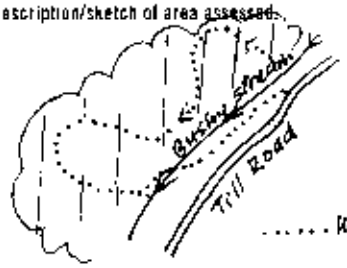
Location name: Bushy Hill Reserve **Grid reference:** R26555884 **Date:** 27-3-00

Fieldworker names: David Jones, William Burns **Weather:** Overcast

Landscape unit: Face **Altitude:** 130m

Aspect: 260° **Drainage:** Good

Description/sketch of area assessed:



Special species or communities:
(rare, threatened, unusual distribution etc)
None identified.

Forest canopy composition:
Underline dominant species.
Kohekohe, mahoe, tawa

Indicator	Rating	Estimate (Tick appropriate level)	Notes (Species etc)
Birds	1	☐ Very few birds and only 1-2 species.	
	2	☑ Occasional birds and 3-4 species	tui, kereru, blackbird, grey warbler
	3	☐ Common birds, and 5-10 species	
	4	☐ Abundant birds, and >10 species.	
Canopy condition	1	☐ Very sparse foliage, many large holes. dieback > 20% of tree crowns.	
	2	☐ Foliage sparse in some areas, canopy holes common Some dieback.	
	3	☑ Foliage mostly dense, only occasional sparse areas. canopy holes rare, very occasional dieback	
	4	☐ Abundant dense foliage over whole canopy. no canopy holes or dieback	
Understorey	1	☐ No browse palatable species 45cm-1.35m understorey bare	
	2	☐ Very few browse palatable species 45cm-1.35m Scattered seedlings of less palatable species	
	3	☑ Moderate browse palatable species 45cm-1.35m Other species relatively abundant.	
	4	☐ Abundant browse palatable species and other species present	
Ground cover	1	☐ Bare soil, rock/gravel > 20% of forest floor. Ground vegetation (ferns, moss, seedlings etc < 45cm tall) absent or very uncommon. Leaf litter or remainder of forest floor.	Some steep rocky areas.
	2	☑ Scattered bare soil and rock. Ground vegetation (ferns, moss, seedlings etc < 45cm tall) < 20% Leaf litter on remainder of forest floor	
	3	☐ Bare soil, rock absent or very uncommon. Ground vegetation (ferns, moss, seedlings etc < 45cm tall: 20%-50%. Leaf litter on remainder of forest floor	
	4	☐ No bare soil, rock, or eroding soil. Ground vegetation (ferns, moss, seedlings etc < 45cm tall), abundant. 50%-100%. Leaf litter on remainder of forest floor	
Vine Weeds	1	☐ Very common, > 50% canopy cover	none in main reserve, but present on margins.
	2	☐ Common, 10%-50% canopy cover.	
	3	☐ Occasional up to 10% canopy cover	
	4	☑ None present.	
Shrub / Tree Weeds	1	☐ Very common, > 50% understorey or canopy cover	Holly present in some areas.
	2	☐ Common 10%-50% understorey or canopy cover.	
	3	☑ Occasional up to 10% understorey or canopy cover	
	4	☐ None present.	

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

Indicator	Rating	Estimate (Tick appropriate level)		Notes (Species etc)
Ground cover weeds	1	☐	Very common, cover > 50% ground area.	Tradescantia present in some areas. Appears to be spreading.
	2	☐	Common. 10% - 50% ground area	
	3	☑	Occasional, up to 10% ground area.	
	4	☐	None present.	
Possums	1	☐	Abundant fresh sign (droppings, pad runs, bark scratching and biting)	
	2	☐	Common fresh sign but sometimes scattered	
	3	☑	Sign uncommon, often quite old.	
	4	☐	No sign.	
Deer	1	☐	Abundant fresh sign (droppings, major tracks and hoof prints). Occasional deer may be disturbed	
	2	☐	Common fresh sign but sometimes scattered Sightings of deer uncommon	
	3	☐	Sign uncommon. Sign is often old	
	4	☑	No sign.	
Goats	1	☐	Abundant fresh sign (droppings, major tracks and hoof prints, bedding areas) Goats commonly heard, seen, or smelt.	Some goats heard outside the reserve.
	2	☐	Common fresh sign but sometimes scattered Occasional goats heard, seen, or smelt	
	3	☑	Sign uncommon. Sign is often old	
	4	☐	No sign	
Pigs	1	☐	Abundant fresh sign (rooting, droppings and hoof prints). Pigs commonly seen, or heard nearby.	
	2	☐	Common fresh sign but sometimes scattered.	
	3	☐	Sign uncommon. Sign is often old.	
	4	☑	No sign.	
Stock	1	☐	Abundant fresh sign (droppings, major tracks and hoof prints). Stock heard or seen throughout area	
	2	☐	Common fresh sign but sometimes scattered Occasional stock heard or seen, generally confined to scattered areas on edge.	
	3	☐	Sign uncommon. Sign is often old. Only near edges.	
	4	☑	No sign	
Fencing	1	☐	No fencing	
	2	☐	Some fencing, for example one side, or fence poorly maintained with large breaks.	Whole boundary not checked. Looks O.K.
	3	☑	Most of boundary fenced, includes all areas where stock access likely. Some small recent breaks	
	4	☐	Secure, intact fencing around whole area	
Human Visitors	1	☐	Widespread trampling, and other damage throughout area	
	2	☐	Common tramping and damage but limited to certain areas.	Some dumping of rubbish from road.
	3	☑	Occasional localised minor damage.	
	4	☐	No damage.	

Management needs/actions	By whom	By when
Examine feasibility of removing holly.	O.J	30·4·00
Trial control on areas of tradescantia.	W.B.	30·11·00
Contact neighbour about goats.	O.J.	30·4·00

Page 2 of 2

GROUND PHOTOGRAPHY TO MONITOR FOREST CANOPY COVER

Purpose

To determine levels of foliage cover and canopy condition using photographs taken from the ground.

Summary

Indicators
- Canopy cover and condition

Skills
- Basic understanding of photography
- Ability to identify key canopy species

Time
- 0.5 hr per photopoint to establish, less to re-photograph

Sampling
- Needs to be determined when planning
- For careful repeat monitoring of individual trees, 10-20 trees may be sufficient

Equipment and people
- 1 fieldworker
- Topographical map
- Pencil and eraser
- Instruction sheet
- Photopoint record sheet
- Clipboard
- Camera (preferably with a fixed focal length lens)
- Film
- Tripod and cable release – essential for telephoto and low-light photographs.
- UV filter
- Polarising filter (optional but can improve monitoring result)
- Aluminium stakes, permolat (venetian blind), and nails for marking photopoints

Strengths
- Can be done with standard camera equipment
- Photographs are available for future re-examination
- Can provide good precision, particularly if computer image analysis used

Weaknesses
- Care required to get good quality photographs for comparison

PHOTO: ROBIN BLAKE

Introduction

Three general types of canopy photographs are identified that are useful for monitoring.

Uplooking

These are photographs taken looking vertically upwards into the forest canopy from the forest floor.

Side view single tree/emergent

Photographs showing the entire crown of a single tree that is usually emergent above the forest canopy, for example, northern rata. These photographs are taken from the side.

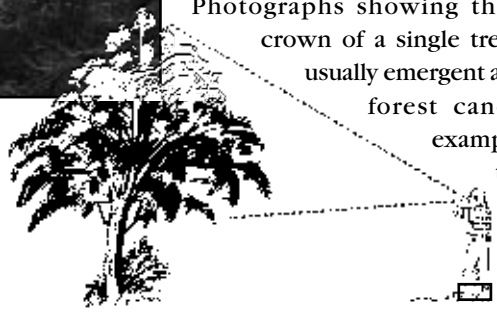


PHOTO: ROBIN BLAKE

Panorama

Photograph of an area of forest canopy viewed from the outside from some vantage point. For example, a forest covered face across a narrow valley from an access road.

Sampling

When photographing the canopies of a sample of trees through an area, trees should be located in some random or systematic way, to avoid bias. This may involve identifying trees along some pre-defined transect, such as is set out in the instruction for epicormic shoot counts. Also, refer to 'Sampling', p.95.

Sometimes photographs may be selected subjectively to monitor particular sites of interest. When monitoring large emergent species such as northern rata, it may be possible to photograph all the visible trees in an area.

When selecting sites as photopoints, make sure the view from the photopoint will not be obscured by vegetation growth over the monitoring period.

Uplooking

- Each photograph, which forms an individual sample point, is taken looking vertically upward into the crown of an individual tree. If the impact of possum browse is being assessed, canopy species are chosen that are likely to be browsed by possums. Trees photographed must have at least part of their canopy clearly visible against the sky when viewed from directly underneath.

Side view – emergent

- Side-view photographs of individual tree crowns form the sample points. The easiest analysis is achieved where crowns can be photographed silhouetted against the sky so, where possible, choose trees that can be photographed in this way. Trees can also be photographed against a bush background, but extra care must be taken with the photography (*see* table on p.29).

Panorama

- Each section of the forest canopy photographed from the outside vantage point forms a sample point. Availability of vantage points allowing a view of the canopy will limit the number of available sample points.

Method

Establishing a photopoint and photoframe

- *Photopoint:* a specific, referenced and relocatable site where a camera is set up and photographs taken.
- *Photoframe:* the exact direction, focus and variables of photographs taken from the photopoint. Many photoframes can be established at a photopoint.

Guidelines for the establishment of photopoints and photoframes are provided by Elwood (1997).

Photography

Specific guidelines for canopy photography are set out in the table on page 29.

Timing

Photographs should be taken at the same time of year to allow realistic comparison. For this reason, it is important to record details of date and time on photopoint sheets.

Leaf growth generally occurs from spring until mid summer each year. Photography during this period should be avoided if possible, because small changes in the timing of leaf growth, and of photography during this period may affect the results. Repeat photographs should be taken at a similar time of day and under similar light conditions to minimise variation.

Records

Maps, aerial photographs and other location information.

Standard photopoint record sheets. *See* page 30.

Analysis and presentation

The photographs obtained with this method may be used in several ways depending on the objectives of the study.

FIGURE 6: Example photo and digital image analysis of area in circle.

PHOTO: ROBIN BLAKE

Computer image analysis

Photographs are analysed using computer image analysis software to identify vegetation cover. With high quality side-view and panorama photos, the amount of dieback present can also be determined. A fixed area within the photograph is analysed.

Changes occurring between repeat photographs from the same photopoints can be tested for statistical significance.

Manual analysis

A measure of canopy cover can be obtained by placing a standard dot grid over the photograph, and then counting the number of dots falling on vegetation or open space. This measure is tedious and will have a lower level of precision than that obtained by computer image analysis.

Subjective presentation

Sometimes photographs are only required to provide a visual demonstration of the change that has occurred. Wherever possible, this should be combined with one of the above measures to provide more objective results.

Frequency of re-measurement

The frequency will depend on growth rate of the species and area photographed, and how easy it is to re-photograph the photopoints. In some cases, annual photography may be possible, otherwise re-measurement every two to three years will be acceptable. As discussed above, photographs should be taken at the same time of year and similar time of day.

FOREST CANOPY COVER PHOTOGRAPHY REQUIREMENTS				
Photo	**Image characteristics**		**Suitable photographic technique**	
	Avoid	*Achieve*	*Conditions*	*Equipment*
Upward Looking	• Sun on canopy • Overexposure 'washing out' fine leaves around canopy holes and gaps	• Sharp focus • Crisp exposure out to fine leaves • Photo of the identical area of tree crown if taking repeat photos. This can be achieved by taking the previous image into the field, and putting a permanent peg in the ground showing position and orientation of the camera • The area of interest centred in the photo	• Overcast or shaded by topography – no sun on tree canopy • Sufficiently still conditions that sharp image can be obtained	• Good quality camera with a lens of focal length in the 28-55mm range. The same focal length should be used for repeat photographs • Colour print film with a speed of 200-400 ASA • Polarising filter useful, but not essential • Tripod • Minimum resolution of 1,200,000 pixels if using digital photography
Side View Emergent	• Areas of light and shade on the crown • Over or underexposure • Small, distant images • Trees against a bush background. These images can still be analysed but are more difficult and less reliable	• Sharp focus over the whole tree crown • Crisp exposure out to fine leaves • The tree silhouetted against sky, if possible • Even light over the whole part of the tree being photographed • Photograph from an identical location if taking repeat photos. This can be achieved by taking the previous image into the field, and putting a permanent peg in the ground showing position and orientation of the camera	• Full sun shining directly on to the side of the tree being photographed • Where trees are photographed in silhouette, overcast sky or shading by topography can be suitable • Sufficiently still conditions that sharp image can be obtained	• Good quality camera with a lens of suitable focal length to allow a large image of the tree. The lens required will depend how far the photopoint is from the tree. Use the same focal length for repeat photographs • Colour print film with a speed of around 200 ASA • A polarising filter is strongly advised • Tripod – particularly if a longer focal length lens, or slow shutter speed is used • Minimum resolution of 1,200,000 pixels if using digital photography
Panorama	• Areas of light and shade on the canopy • Over or underexposure • Low intensity light	• Sharp focus over the whole picture • Crisp exposure out to fine leaves • Even, bright, light over the whole photograph • Photograph from an identical location if taking repeat photos. This can be achieved by taking the previous image into the field, and putting a permanent peg in the ground showing position and orientation of the camera	• Full sun shining directly onto the area being photographed • Sufficiently still conditions that sharp image can be obtained	• Good quality camera with a lens of suitable focal length to allow a large image of the area photographed. The lens required will depend how far the photo point is from the area, and how large an area is being photographed. The same focal length should be used for repeat photographs. Colour print film with a speed of around 200 ASA. A polarising filter is strongly advised • Tripod – particularly if a longer focal length lens, or slow shutter speed is used • Minimum resolution of 1,200,000 pixels if using digital photography

PHOTOPOINT SHEET

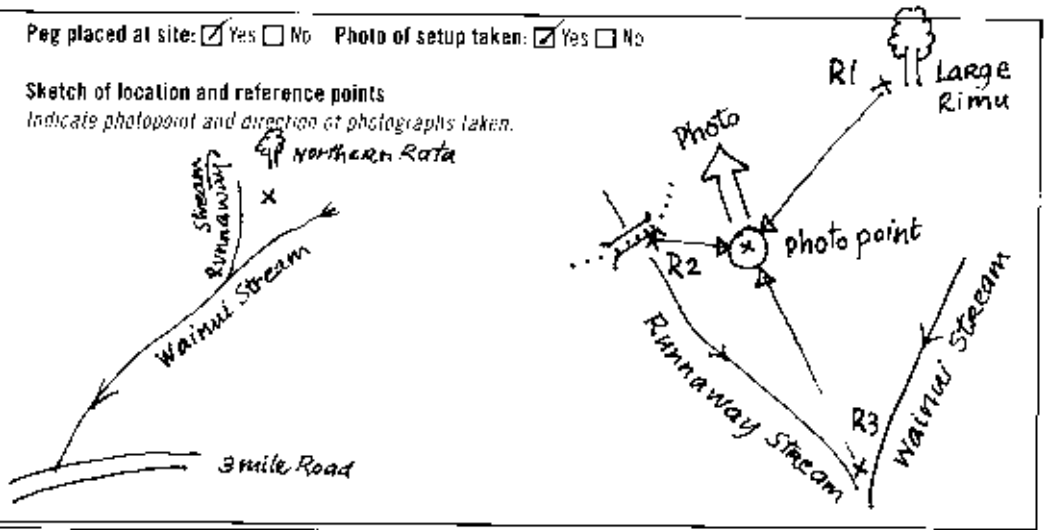
Photopoint location

Location name: Angle Gully	Photosite number: 2.1
Landscape unit: Terrace	Grid reference: R 27 723 926
Date established: 17-5-00	Fieldworker names: David Sims

Peg placed at site: ☑ Yes ☐ No Photo of setup taken: ☑ Yes ☐ No

Sketch of location and reference points

Indicate photopoint and direction of photographs taken.



Reference point 1:	Reference point 2:	Reference point 3:
Object: Large Rimu tree	Object: Foot Bridge	Object: Fork in Stream
Distance to photopoint: 25 m.	Distance to photopoint: 10 m	Distance to photopoint: 30 m
Bearing to photopoint: 40°	Bearing to photopoint: 288°	Bearing to photopoint: 130°

Photoframe data

Photo No	Description	Date	Time	Weather (sunny etc)	Film Brand	Film ASA	Frame no	Focal length	Shutter speed	Aperture
1	Northern Rata	17-5-00	1340	overcast	Fuji	200	7	50mm	1/125	f8

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

QUICK PLOT METHOD FOR VEGETATION ASSESSMENT

Purpose

To assess the abundance of various plant species in the forest understorey.

Summary

Indicators
- Understorey abundance
- Species composition/diversity
- Abundance of 'indicator' species
- Population structure

Skills
- Good knowledge of native and introduced plant species

Time
- 0.5 hr per plot

Sampling
- Depends on feature such as variability and precision required
- Needs to be determined when planning monitoring

Equipment and people
- 2 fieldworkers
- Topographical map
- Pencil and eraser
- Instruction sheet
- Quick plot field form
- Camera and film (to photograph important features or issues)
- Plastic bags and labels (to collect plant specimens for identification)
- 20m measuring tape.
- Hip chain or long (50-100m) tape, for locating plots.
- 2m pole, marked at 0.5m intervals, with additional marks at 0.15m from one end (the bottom) and 0.45m and 1.35m from the same end.
- A diameter tape
- Compass
- Plant identification references (if necessary)
- Aluminium stakes and permolat (venetian blind)
- Numbered tree tags

Strengths
- Relatively quick to measure compared to other plot methods
- Provides precise stem count data
- Provides information for use in the study of a several different vegetation indicators

Weaknesses
- Can be difficult to assess less common species
- Considerable number of plots can be required to get good data

Introduction

These plots are relatively quick and easy to establish.They are most effective at obtaining data on the understorey, but also collect data on larger canopy trees. Measurement methods and height tier distinctions have been designed to be compatible with the well established 20mx20m plot protocol (Allen 1993).This allows broad comparison of results with data from any existing long-term 20mx20m plots.

The cylinder intercept method of examining forest structure (*see* 'Cylinder intercept assessment …', p.49), and the point intercept method for ground cover (*see* 'Point intercept … ', p.53) can be easily combined with the standard quick plot.

Sampling

Plot location and layout

Each plot forms a sample point. Plots will normally be located in a systematic or systematic random way using transects running through the forest area.

Transects should run in the same direction as an environmental gradient. In many cases, the main gradient will be in altitude, in which case, transects should run up or down the slope. Individual plots on a transect should all be run out on the same bearing, at right angles to the

transect bearing (*see* Figure 7). This should ensure that most plots are run out along the contour to minimise the effect of slope.

The transect and plot bearing should be selected before starting fieldwork to remove any chance of bias.

Plot size

Plot size must be kept the same for each block (*see* 'Breaking areas into blocks …', p.97) that is sampled. At the start of a survey, different plot size can be set for the tree, sapling, tree fern and ground fern tiers. But these plot sizes must be maintained in all plots in the sample.

The standard plot length is 20m, though this can be increased if necessary, providing this change is well documented and is applied to all plots in the sample.

When choosing plot size for the various tiers follow the following process:

- Walk through and examine the general density in the forest area you will be monitoring.
- Choose one of the plot sizes listed in Figure 6 for each tier, so that on average, about 20 individual plants will be counted in that tier. If the understorey is very sparse, this may mean using the maximum plot size (4m wide) even though fewer than 20 individuals are included.
- It is suggested that you quickly lay out 4-5 plots in the area to check if the plot sizes you have selected are right. If you get many more than 20 stems in a tier (say, more than 30), try a smaller plot size for that tier to get closer to 20 stems. If you get many fewer than 20 stems (say, fewer than 12), try a larger plot size to get closer to 20 stems.

FIGURE 6: Diagram with six different plot sizes and required layout.

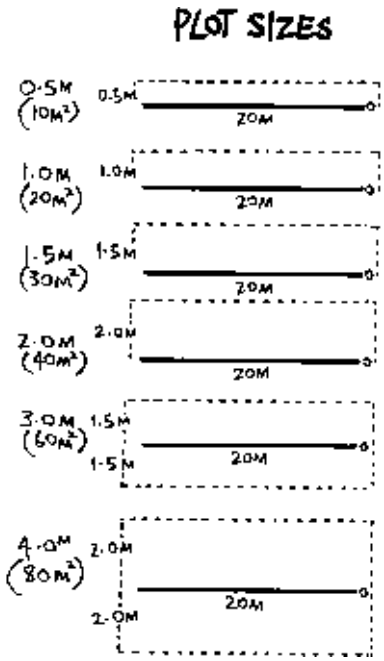
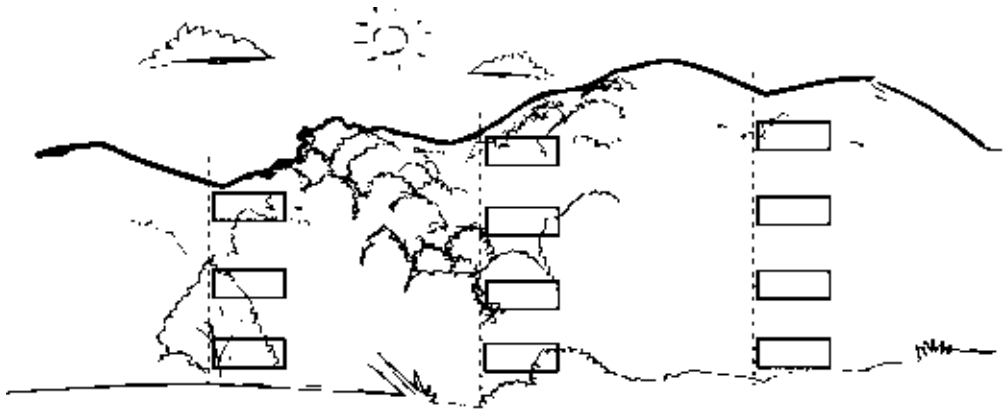


FIGURE 7: Individual plots can be run out at right angles, at set intervals along a transect.



As a rough guide, consider the following:

A good tree cover of moderate-sized trees, but a sparse understorey with very few seedlings or ferns	A 4m-wide plot for all tiers will probably be appropriate
A good tree cover of moderate-sized trees, and seedlings and saplings are common enough that you are brushing past one every 3-4m	A 4m-wide plot for trees and tree ferns, and a 2m-wide plot size for all other tiers
A good tree cover of moderate sized trees. Saplings are common enough that you are brushing past one every 3-4m. Seedlings and ground ferns are extremely abundant, and you are almost constantly brushing past them	A 4m-wide plot for trees and tree ferns, a 2m-wide plot size for saplings, and a 0.5m-wide plot for seedlings and ground ferns

Plots of 2m or less in width are searched only on one side of the tape. On sloping ground, always search on the uphill side of the tape. On flat ground, search on the right-hand side of the tape, as you face from the start toward 20m. Always record the side (left or right facing from the start) that was searched.

Method

- Run a 20m tape along the bearing selected (at right angles to the survey transect).
- As you run the tape out, put aluminium pegs with venetian blind markers (*see* Figure 8) in the ground at 0, 5m, 10m, 15m and 20m and put the tape through these markers (*see* Figure 8) to hold it in place. Wind the tape around the last marker to hold it tight.
- Take care during plot layout and measurement not to step on or damage seedlings because this can affect your future measurements.
- Use a 2m pole marked in 0.5m intervals, with additional marks 0.15 m, 0.45 m and 1.35m from one end, to assess the plot width, and measure height tiers (*see* Figure 9).

FIGURE 8: Tape is run through pegs to hold it in position.

PHOTO: PETER HANDFORD

- It is important to assess the plot by moving consistently along the plot from the start (0m), recording all stems in each tier as you go.This prevents confusion over what part of the plot has already been assessed.
- In most cases, plots will be permanently marked so they can be re-measured. If this is the case, attach a numbered aluminium tree tag to each tree stem, at 1.35m above ground on the uphill side. Leave the nail head 1-2cm out from the stem to allow for growth.
- For each tier, record, on the plot sheet on page 39:
  - ~ The width of the transect. This is the width of plot assessed in that tier (either the chosen width or full 4m).
  - ~ The species of each stem.This can be recorded as a shortened scientific name using a six letter code.This code is made up of the first three letters of the Genus (first word in the scientific name) and first three letters of the species, (second word in the scientific name). Information on using plant names is provided in Measurement Standards.
  - ~ Number of stems.The count of stems for that species in the tier.This applies to sapling, seedling, tree fern and ground fern tiers. Trees are recorded individually with their diameter.
  - ~ DBH (diameter at breast height – 1.35m) of tree stems in the plot.
- Record all vine species present in a 4m-wide transect in broad abundance classes of:
  - ~ Occasional – a small number, 1-5 vines in the plot.
  - ~ Common – vines common, with possibly 5-20 along the plot, but they do not affect your movement in the plot area.
  - ~ Abundant – vines throughout the plot area and restricting your movement over parts of the plot.
- Record all woody epiphyte species present in the tree plot.

Definitions

Tree

- Greater than or equal to 3cm in diameter at breast height (1.35m).
- Any stem forking below breast height (1.35m) is a separate tree stem. However, it is bracketed on the data sheet to link it to its companion stems.

FIGURE 9: A 2m pole is used to measure the boundary of the plot for each tier, as well as the height of seedling tiers.

PHOTO: PETER HANDFORD

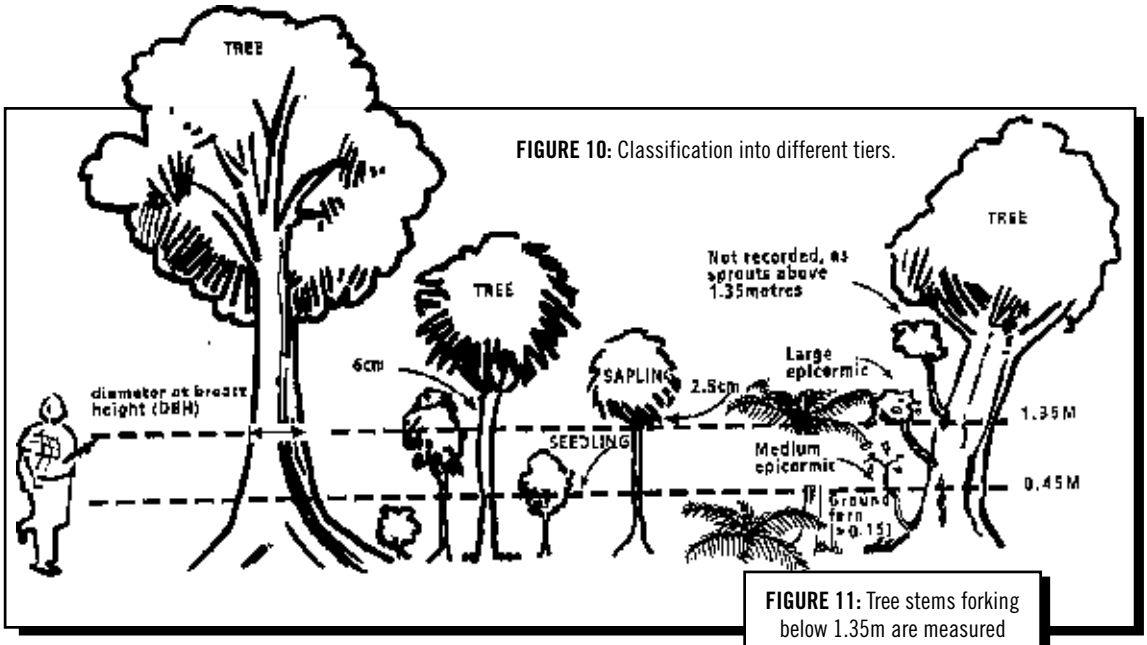


FIGURE 10: Classification into different tiers.

Sapling

- Greater than 1.35m in height but less than 3cm in DBH.
- Any stem forking below breast height (1.35m) is a separate stem. However, it is bracketed on the data sheet to link it to its companion stems.

Seedlings

- Greater than 0.45m, but less than 1.35m in height.
- Count groups of stems from the same plant that fork visibly above ground level as one stem.

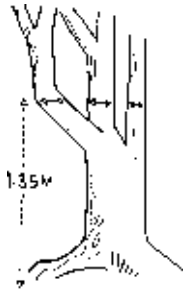


FIGURE 11: Tree stems forking below 1.35m are measured separately.

Small-medium epicormic

- Shoot from a tree stem that is within the plot.
- Must sprout from below 1.35m on the tree stem.
- Must be longer than 0.15m from the tree stem to the tip of the shoot.
- Height from ground to top of shoot must be less than 1.35m.

Large epicormic

- Shoot from a tree stem that is within the plot.

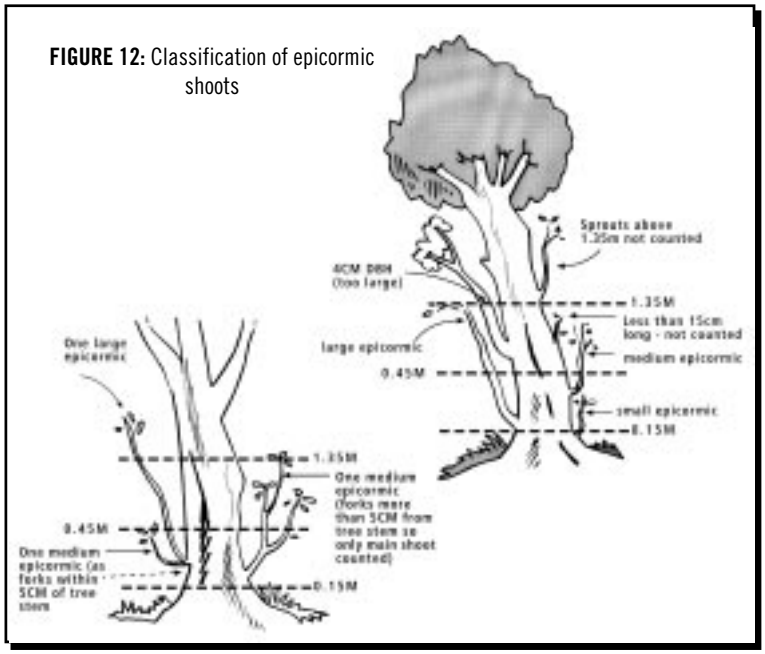


FIGURE 12: Classification of epicormic shoots

- Must sprout from below 1.35m on the tree stem.
- Must be longer than 0.15m from the tree stem to the tip of the shoot.
- Height from ground to top of shoot must be greater than 1.35m.
- Diameter of shoot at 1.35m from ground must be less than 3cm.

Tree ferns

- Have a distinct trunk.
- Must be tree fern species.
- If less than 1.35m in height, record as a ground fern.

Vines

- Greater than 0.45m in height.

Ground ferns

- Greater than 0.15m (15cm) in height.
- Must be fern species that form a single 'plant', and not spreading species on rhizomes.

Woody epicormics

Woody plants that are rooted in tree or tree fern stems above ground level.

- *Height:* Measured vertically from ground level, immediately adjacent on the uphill side of the stem.
- *DBH (Diameter at breast height):* Measured at 1.35m height, on the uphill side of stem. This 1.35 m convention is the same as that used in the established 20x20m plot method. Where stems have fallen over and are lying horizontally, DBH is measured 1.35m along the stem from the base.
- *Diameter of multiple stems:* Where trees in the plot have multiple stems, forking below 1.35 m, they are treated as separate stems, and their diameter is measured separately (*see* Figure 11). The stems are shown as linked on the field form.

Records

These should include:

- Objectives and monitoring plan.
- Details on the monitoring method, any changes, etc.
- Field data sheets.
- Location information, including maps of survey lines, transect locations, etc.
- Any general notes on the monitoring.

Analysis and presentation

A wide range of analysis of plant abundance, composition, population structure can be undertaken (*see* 'Species composition and diversity', p.124, 'Abundance of indicator species', p.127 and '– Population structure', p.136).

Frequency of re-measurement

This will depend on the monitoring question and the growth rate of the vegetation being monitored, and any other change likely to be occurring. Re-measurement after two to three years may be appropriate to examine changes in the understorey.

Example

A manager is undertaking monitoring of the forest understorey in a reserve area where there is a good forest canopy cover, and moderately common seedlings and saplings. They undertake trial measurement of a small number of plots and decide that they will use a 4m wide plot for tree stems, and tree ferns, and a 2m wide plot for all other tiers. They measure 10 plots. They then calculate the mean number of plants in each tier from the 10 plots (*see* 'Datapoints and means … ', p.104). The results for some of the major species in the tree, sapling, and seedling tiers are presented below.

Species		**Trees** *Measured in a 4m wide plot (80m²)*			**Saplings** *Measured in a 4m wide plot (80m²)*			**Seedlings** *Measured in a 2m wide plot (40m²)*		
Scientific code	*Common name*	*no*	*No/m² **	*No/ha ***	*no*	*No/m² **	*No/ha ***	*no*	*No/m² **	*No/ha ****
DYSSPE	kohekohe	3	0.0375	375	12	0.15	1500	4	0.1	1000
HEDARB	pigeonwood	1	0.0125	125	8	0.1	1000	6	0.15	1500
MELRAM	mahoe	2	0.025	250	2	0.025	250	7	0.175	1750

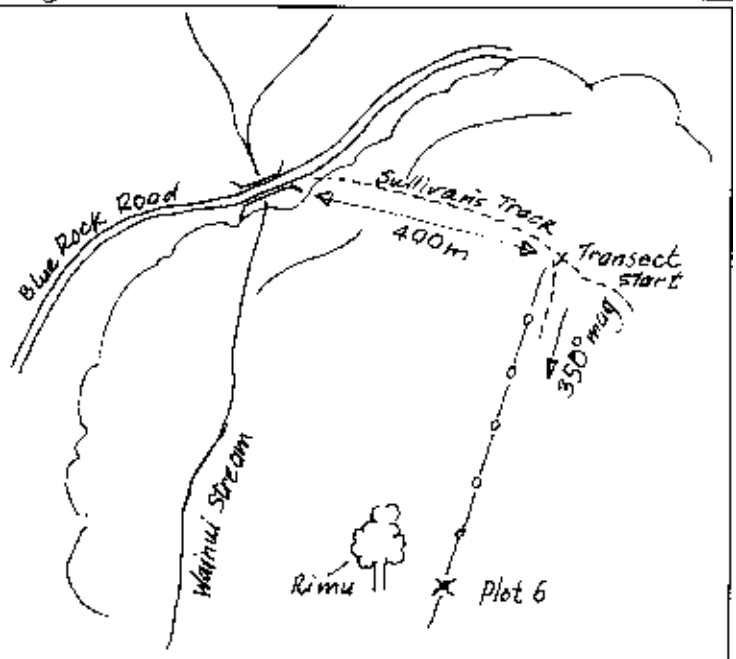
* no / 80, i.e number of stems divided by the plot area
** no X 10,000, i.e one hectare = 10,000m².
*** no / 40, i.e number of stems divided by the plot area.

QUICK PLOT

Location

Date: 18-11-99	Plot no: 6
Recorded by: John Hansen	Measured by: Duncan Jones
Location name: Blue Gully Reserve	Grid reference: R27 535942

Location diagram/notes:



Approach: From the road walk up Sullivans Track for 400m to transect start. Transect runs on bearing of 350° magnetic. Plots are at 100m intervals along the transect. Plot 6 is 600m from the transect start and just above the large Rimu tree

Notes:

Canopy is open in some areas around the plot.

Understorey quite dense compared to nearby areas

Site

Landscape: Face	Aspect: 160°	Altitude: 180m	Drainage: Good

Page 1 of 2

QUICK PLOT

Transect Widths (m)	Trees	4	Saplings	4	Seedlings	2
	Tree ferns	4	Ground ferns	2		

Note: If any widths are 2m or less, which side of the centre line (facing from start) was measured? left (right)

Tree Stems and Epicormic Shoots

Species	Stem 1 Tag	Stem 1 DBH	Stem 2 Tag	Stem 2 DBH	Stem 3 Tag	Stem 3 DBH	Stem 4 Tag	Stem 4 DBH	Stem 5 Tag	Stem 5 DBH	Count of epicormic shoots: Small-Med Epicormic (<1.35m <4cm DBH)	Count of epicormic shoots: Large Epicormic (>1.35m >4cm DBH)
MELRAM	1254	32·7	1255	4·7	1256	34·5					3	4
HEDARB	1257	23·2									—	3
BEITAW	1258	36·9									—	—

*note ∩ = stems joined below 1.35m

Understorey

Species	Stem counts: Saplings (>1.35m <5cm DBH)	Seedlings (>0.45m <1.35m)	Tree Ferns (>1.35m Distinct trunks)	Ground Ferns (>15cm <1.35m distinct crowns, no rhizome)	Vines: Occasional (O) Common (C) Abundant (A)
CYADEA			4		
ASPBUL				5	
CYASMI			7	7	
PSEAXI	5	1			
DICSQU			2	1	
ELADEN	1	2			
KNIEVC	3	8			
POLVES				3	
CARSER	2	2			
RIPSCA					O

Epiphytes – list all species present within the tree plot boundary.

COPGRA, WEIRAC, ASPBUL

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

20M X 20M PERMANENT VEGETATION PLOTS

Purpose

To monitor detailed changes in abundance, population structure and composition of forest vegetation. This is an overview only – see Allen 1993 for the full method.

Summary

Indicators
- Canopy condition (indirectly)
- Understorey abundance
- Species composition and diversity
- Abundance of indicator species
- Population structure

Skills
- Good plant identification knowledge

Time
- 3-6 hours per plot

Sampling
- Depends on features such as variability
- Needs to be determined when planning monitoring

Equipment and people
- 2 fieldworkers
- Map
- Aerial photograph
- Pencils
- Stem diameter sheet
- Understorey subplot sheet
- Clipboard
- Aluminium pegs
- 20m tapes (4)
- 20m nylon cords
- Diameter tape
- Plant identification books

Strengths
- Provides good data for examining long-term changes in forest
- Widely used, so comparative data, and experience available

Weaknesses
- Relatively time-consuming to establish. This can result in the number of plots established being small, giving less statistically reliable results
- Less cost effective for examining short-term changes in forest understorey

Introduction

This method has been widely used in New Zealand and produces fairly reliable results, particularly for tree stems. The full method is described in *A permanent plot method for monitoring changes in indigenous forests,* R B Allen, published by Landcare Research Ltd, Christchurch NZ, 1993 (Allen 1993). You will need this publication if you are going to use this method.

Sampling

The number of plots established will depend on aspects such as variability in the forest and the precision required (*see* 'Design monitoring …' p.88 and 'Sampling' p.95). Several plots will usually be required to provide useful information.

Method

Square 20m by 20m plots are laid out, and all tree stems tagged and measured. Various counts of understorey stems are also undertaken. The full method is provided in Allen 1993.

Records

Standard plot sheets provide hard copy records, in addition to maps and other information (*see* Allen 1993).

Analysis and presentation

Data can be used to examine a wide range of indicators such as plant abundance, composition, population structure and biomass.

Landcare Research NZ Ltd has several standard computer programmes for initial analysis of data.

RECCE – FOR VEGETATION DESCRIPTION

Purpose

To describe vegetation communities and examine differences in the composition and diversity of forest vegetation, often in relation to environmental differences between areas. This is an overview only – see Allen 1992 for the full method.

Summary

Indicators
- Species composition and diversity
- Relative abundance of indicator species

Skills
- Good plant identification knowledge

Time
- 0.5 hours-2 hours per description

Sampling
- Depends on features such as variability
- Needs to be determined when planning monitoring

Equipment and people
- 1-2 fieldworkers
- Map
- Aerial photograph
- Pencils
- Eraser
- Compass
- Altimeter
- Hand held level or other device to measure slope
- RECCE description sheet
- Soil probe (aluminium or steel stake)
- Clipboard
- Aluminium pegs
- Plastic bags (for plant specimens)
- Labels for specimens
- Plant identification books

Strengths
- Provides a relatively quick and consistent approach to describing vegetation
- Useful in analysis of vegetation composition and differences in composition between forest communities

Weaknesses
- Involves visual estimation of variables related to abundance, leading to differences between observers and surveys
- Not designed to pick up changes in abundance. Only very broad changes in communities can be detected.

Introduction

This method has been widely used in New Zealand. It has been used for purposes such as describing the species and communities present in particular reserves, and identifying differences in species composition between different forest communities. The full method is described in *RECCE – An Inventory Method for Describing New Zealand Vegetation*, R B Allen, published by Landcare Research Ltd, Christchurch NZ, 1992 (Allen 1992). You will need this publication if you are going to use this method.

Sampling

The approach to sampling and the locations where descriptions are undertaken will depend on the particular monitoring questions (*see* 'Design monitoring …' p.88 and 'Sampling' p.95). Designing ways to use the RECCE method is discussed in Allen 1992.

Method

A standard description sheet is filled in for a particular area. Plant species present in tiers from emergent trees down to the forest floor, are recorded. The abundance of species is estimated in percentage cover classes. A variety of other information such as soil depth is recorded. A full description of the method is provided in Allen 1992.

Records

Standard description sheets provide hard copy records, in addition to maps and other information (*see* Allen 1992).

Analysis and presentation

Species present and their relative abundance in different areas can be examined. Some computer programs can be used to group similar descriptions to identify forest communities.

Frequency of re-measurement

RECCE descriptions are often a one-off survey to describe vegetation.Any re-measurement to examine big changes in communities would need to occur over an extended period of years.

FOLIAR BROWSE INDEX FOR POSSUM-RELATED DAMAGE

Purpose

To assess aspects of the condition of individual tree canopies of certain indicator species that have been damaged by possums.This is an overview only – see Payton et al 1999 for the full method.

Summary

Indicators
- Canopy cover and condition
- Fruiting and flowering of key species
- Vegetation mortality

Skills
- Identification of all main tree species

Time
- 5-15 trees per hour

Sampling
- Depends on features such as variability
- Needs to be determined when planning monitoring
- About 50 individual trees of a particular species may need to be assessed to pick up useful changes

Equipment and people
- 2 fieldworkers
- Map
- Aerial photograph
- Pencils
- Eraser
- Compass
- Altimeter
- Binoculars
- Hand held level or other device to measure slope.
- Foliar browse index plot sheet.
- Clipboard
- Foliage cover scale
- Indicator species assessment sheet
- Tape – 20m
- Nylon cord – 50m
- Numbered tree tags
- Nails – flathead, galvanised
- Hammer
- Flagging (permolat)

Strengths
- Focused directly on assessing aspects of forest condition likely to be impacted by possums
- Relatively straightforward method, requiring little equipment

Weaknesses
- All variables are estimated visually, resulting in relatively low levels of precision
- Variation between observers is large
- Method can be difficult in complex, multi-tiered forests, due to difficulty in observing trees

Introduction

This method has been used in New Zealand since about the mid 1990s to assess the impacts of possums on the forest canopy. The full method is described in *Foliar Browse Index: A Method for Monitoring Possum (Trichosurus vulpecula) Damage to Plant Species And Forest Communities,* Payton et al 1999.You will need this publication if you are going to use this method.

Sampling

The exact approach to sampling and the location of plots where trees are assessed by the Foliar Browse Index (FBI) will depend on the particular monitoring questions (*see* 'Design monitoring …' p.88 and 'Sampling' p.95). Sampling in relation to the FBI is discussed in Payton et al 1999. It is suggested that assessment of about 50 individuals of a particular species is likely to be required to detect changes of around 10 percent in estimated foliage cover.Assessing this number of trees of a particular species can be difficult in practice.

Method

The method involves visually assessing the following:

- Foliage cover
- Dieback
- Conspicuous recovery (regrowth after damage)
- Possum browsed leaves
- Possum use of the trunk or stem
- Presence or abundance of flowers or fruit

Each of these is estimated in abundance classes. The full method is described in Payton et al 1999.

Records

Standard Foliar Browse Index plot sheets provide hard copy records, in addition to any maps or other location information (*see* Payton et al 1999).

Analysis and presentation

Relative abundance of the different variables listed under the method above can be reported for different species. Changes between measurements in these different variables between assessments of the same trees can be examined.

Frequency of re-measurement

Trees are likely to be assessed every one to three years. Re-assessment should always take place at the same time of year because of seasonal changes.

EPICORMIC SHOOT COUNTS

Purpose

To monitor changes in the abundance of shoots from the trunk of particular tree species likely to be impacted by browsing animals.

Summary

Indicators
- Understorey abundance
- Abundance of indicator species

Skills
- Ability to identify key indicator tree species used
- Identification of animal browse on shoots

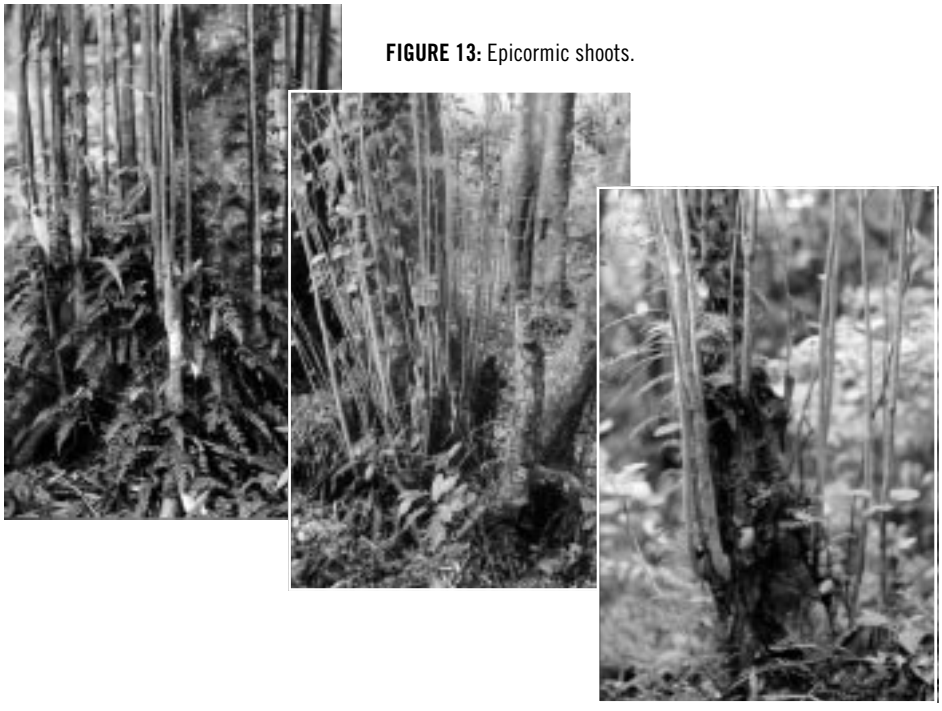
Time
- 10-20 trees / hour, depending on how common the target tree species is.

Sampling
- Depends on features such as variability, and tree density
- Needs to be determined when planning monitoring
- Likely to need around 20-50 trees of each species studied

Equipment and people
- 1-2 fieldworkers
- Map
- Aerial photograph
- Pencils
- Standard field sheet
- Clipboard
- Hip chain and cotton
- Aluminium tree tags (consecutively numbered)
- 5m nylon cord with a peg on one end
- Diameter tape

Strengths
- Easy to assess
- Potential rapid response on key species

Weaknesses
- Not widely trialled and used in NZ
- Only provides information on species that produce epicormic shoots



PHOTOS: PETER HANDFORD

FIGURE 13: Epicormic shoots.

Introduction

This method has not been widely used, but it offers considerable potential to pick up rapid changes on key species. Epicormic shoots are defined as shoots less than 3cm in diameter sprouting from below 1.35m in height on the trunk.These shoots grow from existing trees so they do not rely on a seed source, or good seed production and germination conditions to grow. They can respond rapidly over a year. Only certain tree species produce epicormic shoots. Some species producing epicormic shoots, such as kamahi (*Weinmannia racemosa*), pigeonwood (*Hedycarya arborea*), mahoe (*Melicytus ramiflorus*) and broadleaf (*Griselinia littoralis*), are also browsed heavily by deer and goats. Shoots from these species can respond quickly to a reduction in browsing.

Sampling

Transects are run out from a random or systematically selected start point (*see* 'How to select the sample', p.95) using a compass and a hip chain.

The number of transects established, and trees measured, will depend on aspects such as variability in the forest and the precision required (*see* 'Design monitoring …', p.88 and 'Sampling', p.95). It is likely that 20-50 trees of each species will need to be assessed.

Transects where these trees are assessed should cover the range of forest habitat in the area being studied.

Method

- From the transect start point, walk along the transect line, looking for target tree species >=10 cm in diameter, within 5 m either side of the line.
- Check trees close to the 5m distance by pushing a peg into the ground on the transect line and running a 5m cord out at right angles to the line. If the cord reaches past the centre of the stem at ground level, then it is included.
- Measure the diameter at breast height of the tree stem. If the tree consists of multiple stems (*see* the definition in the Quick plot method … p.31), measure the diameter of each stem.
- Tag the stem by nailing a numbered aluminium tree marker tag to it. Trees should be numbered consecutively from the start of the transect. If a tree consists of multiple stems, tag the largest stem.
- Count the number of shoots that sprout from the tree below 1.35m from the ground, and are less than 3cm in diameter (measured at 1.35m above ground level). The number of shoots are counted in three height classes, 0.15m-0.45m, 0.45m-1.35m, > 1.35m.
- Count the number of shoots in each class that have either fresh or old animal browse (*see* definitions below).
- Record the distance measured on the hip chain from the transect start to the point on the transect line adjacent to the tree.
- Once each tree is assessed, continue along the transect until the next tree within 5m is encountered, and repeat the assessment.

Definitions

- Epicormic shoot:A live shoot arising from the tree stem below 1.35m height, that is less than 3cm in diameter at a point 1.35m above the ground.The shoot length from where it arises from the stem to green tip must be greater than 0.15m (15cm). Note that if the shoot is dead from its base to tip, it is not recorded.

- Dealing with forked shoots: Epicormic shoots may often fork to form a number of growing points. Only shoots that are separately attached to the tree stem, or fork from another shoot within 5 cm of the tree stem are counted as separate epicormic shoots.
- Shoots from multiple stem trees: Where a tree forks below 1.35 m to give two or more stems, the DBH (diameter at breast height – 1.35 m) is recorded for each stem, but they are identified as linked on the data sheet. Epicormic shoots are then counted as the total for the group of stems.
- Height measurement: Height is measured from ground level on the uphill side of the tree stem. This applies for all height measurement, such as measuring the height of shoots, or the height for diameter measurement. Shoot heights are measured from ground level to the highest live point on the shoot.
- Shoot height classes: The following classes are used.
  >0.15m and <= 0.45
  >0.45m and <=1.35m
  >1.35m and < 3.0 cm in diameter at 1.35m
- Animal browse: Browse damage to the leaves or shoot stem that is caused by vertebrate pests such as deer, goats or possum.

Records

- Maps, location data and descriptions for the transects.
- Location of trees along the transects.
- Standard field sheets provide hard copy records of assessments.

Analysis and presentation

Examine the number of shoots in each height class, and the number of browsed shoots in each height class.

The mean number of shoots per tree in each height class and the mean number browsed can be examined.

Changes between assessments can be examined and tested for statistically significant difference.

Frequency of re-measurement

Trees are likely to be reassessed at one to two year intervals.

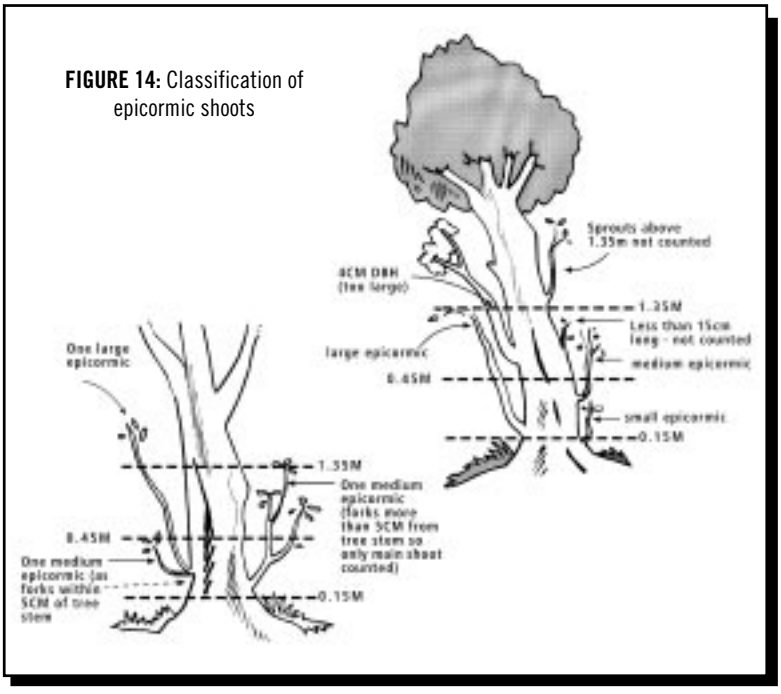


FIGURE 14: Classification of epicormic shoots

EPICORMIC SHOOTS

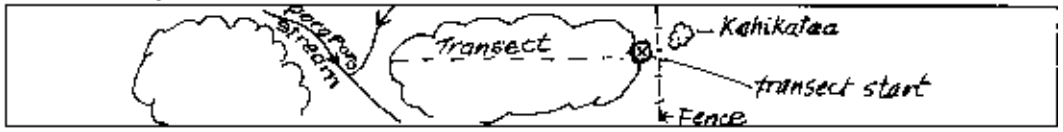
Location name: Poroporo Bush **Date:** 17-2-00

Fieldworker names: John Hammond, Bill Syme

Transect origin

Grid reference: S25 918 433 Bearing: 280°

Location diagram



Shoot counts

Species	Distance from start of transect (m)	Tree tag no.	DBH (cm)	Epicormic shoots (count the total number of all shoots in each size class)			Number of shoots with browse		
				Small epicormic (>15cm long, tip >45cm & <135cm from ground)	Medium epicormic (>15cm long, tip >45cm & <135cm from ground)	Large epicormic (>15cm long, tip >135cm from ground and >3cm diameter at 135cm)	Record the number of browsed shoots in class for each size		
				No.	No.	No.	Sm	Med	Lge
MELRAM	10	1891	32·4	–	7	2	–	2	–
HEDARB	16	1892	20·5	–	–	2	–	–	–
WEIRAC	23	1893	46·2	5	8	–	3	5	–
MELRAM	28	1894	15·3	3	6	3	–	3	–
MELRAM	28	1895	32·7	)					
MELRAM	28	1896	21·3						
HEDARB	42	1897	15·6	–	–	–	–	–	–
WEIRAC	51	1898	35·1	–	–	–	–	–	–
MELRAM	64	1899	40·6	–	5	1	–	1	–
MELRAM	64	1900	18·3	)					
WEIRAC	80	1901	27·8	2	3	–	1	1	–
HEDARB	117	1902	15·9	–	–	–	–	–	–
HEDARB	127	1903	22·7	)					
MELRAM	152	1904	35·7	–	2	–	–	–	–

) = Stems joined

Shoots must be:

- >15 cm long from point attached to stem to end of live growing tip
- <3cm in diameter at breast height (1.35m above ground).
- Alive – dead shoots not counted
- Attached to stems 10cm or greater in diameter at breast height
- Either:
  - Separately attached to the main stem or
  - Forking from another shoot less than 5 cm from its point of attachment to the main stem

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

CYLINDER INTERCEPT ASSESSMENT OF FOREST STRUCTURE

Purpose

To assess the vertical structure of a forest and allow comparison of structural diversity.

Summary

Indicators
- Vertical vegetation structure
- Species diversity/composition (particularly of subcanopy and canopy layers)

Skills
- Ability to identify main plant species

Time
- 20-40 points per hour

Sampling
- Depends on feature such as variability and precision required
- Needs to be determined when planning monitoring
- Points can be combined with Quick plot, with assessment at 0m, 5m, 10m, 15m and 20m along the plot

Equipment and people
- 1-2 fieldworkers
- Topographical map
- Pencil and eraser
- Clipboard
- Instruction sheet
- Tape measure or hip chain for locating points.
- 2m height pole
- Field form
- Plastic bags and labels (to collect plant specimens for identification)
- Aluminium stakes and permolat (venetian blind) – if points are to be permanently marked
- Plant identification books

Strengths
- Can be done without special skills or equipment
- Provides information on forest structure and composition

Weaknesses
- Relies on visual assessments so measurement precision is not high
- Results are sometimes difficult to interpret

Introduction

This method provides a simple approach to achieve an indication of structural diversity. Other methods are available to provide greater detail (*see* 'Vertical and horizontal vegetation structure', p.121).

Assessment of structural diversity in this way may be useful for comparing the structural diversity of different forest areas on a broad scale. This method is unlikely to be useful in identifying changes in vertical structure occurring in the short term.

Sampling

Each individual point at which overhead vegetation structure is assessed forms a sample point. These sample points can be located in conjunction with a vegetation plot technique. The points can be easily undertaken in conjunction with the quick plot monitoring method, by assessing points at 0m, 5m, 10m, 15m and 20m marks along the plot.

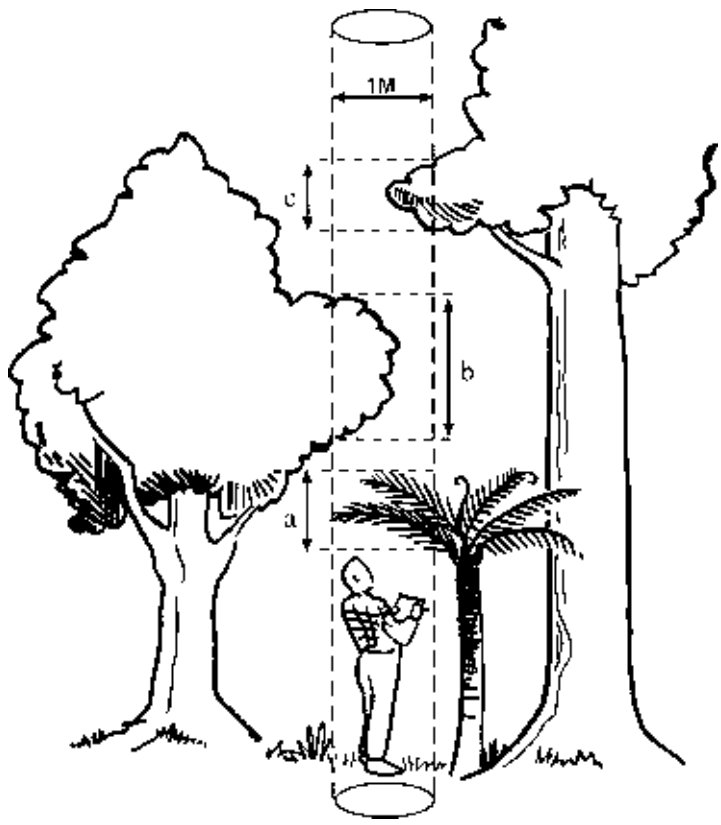
Measurement points may be located at fixed intervals along a survey line. For example, a line could be run out on a fixed bearing (*see* 'Sampling', p. 95), and the vertical structure assessed using this method at 5m or 10m intervals along the line.

The number of survey lines and points that are assessed will need to be determined depending on the precision you require and the amount of time you have. The points measured should cover the full variety of the forest area you are assessing.

Method

- Visualise a 1m diameter vertical cylinder, centred on the assessment point (*see* Figure 15).
- Identify each point at which a 'vegetation layer' intercepts the cylinder.
- Layers must be greater than 2m above ground.
- Vegetation includes any live plant material, for example, foliage, branch, stem.
- They must be from a separate plant, that is, the same individual plant cannot be counted more than once per point. Note that there may be more than one individual of the same species present so the same species may occur more than once at a point.
- Record the species and estimate the height of range of each 'layer'. Recording the lower height (H1) and the upper height (H2) in metres. Where a single branch enters the cylinder, H1 and H2 may be the same.
- If points are being permanently marked for future re-measurement. This can be done using an aluminium stake and 'permolat'.

FIGURE 15: Cylinder intercept assessment.



Records

An example of a format for recording cylinder intercept data is given on the cylinder intercept form on page 52. For each data point, ensure that the following is recorded:

- Header information, including:
  - ~ location: description, diagram, and grid reference
  - ~ date
  - ~ observer: record who was doing the assessment, and who recorded the information
- Species and estimated height (to nearest 0.5m) of each layer intercepting at the point in ascending order (*see* Figure 15).

Analysis and presentation

Depending on the monitoring question, information from this method can be analysed and presented in several ways, including:

- Structural diversity: This could be broadly examined by considering the number of plant intercepts recorded for each point. An area with a larger number of intercepts may have greater structural diversity. The presence of absence of intercepts within height classes can be considered. For example, examine the data for each point against the following sequence of height classes: 2m-5m, 5m-10m, 10m-15m, 15m-20m, 20m-25m, >25m. Identify the number of these height ranges that had vegetation present at each point. An area with intercepts present in a greater number of height classes may have greater structural diversity.
- Examine diversity in relation to the number or species detected at each point, and over the sample as a whole. The number of species within certain height ranges, as described in the above point, could also be examined.
- For a particular plant species, the number of points at which the species occurs can be examined.

Frequency of re-measurement

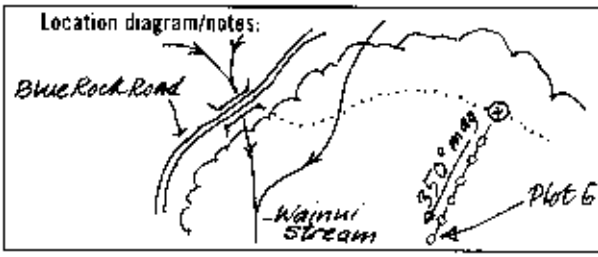
Changes in forest structure will normally only occur over a relatively long period. Depending on the objectives of monitoring, and the amount of change occurring, re-measurement every five to 10 years may be appropriate.

CYLINDER INTERCEPT – FOR FOREST STRUCTURE

Location

Date: 18-11-99	Plot no: 6
Recorded by: John Hansen	Measured by: Duncan Jones
Location name: Blue Gully Reserve	Grid reference: R 27 535 942

Location diagram/notes:



- Transect starts from 400m from start of Sullivans Track.
- Transect on bearing of 350°.
- Plot 6, 600m along transect.
- Assessed at 5m intervals on 20m 'quick plot'

Site

Landscape: Face	Aspect: 160°	Altitude: 180m	Drainage: Good

Cylinder Intercept Assessments

Point	Species		Species		Species		Species		Species		Species		Species		Species	
0m	CYADEA		MELRAM													
	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
	3·5	4·0	7·0	9·0												
5m	CYADEA		ELADEN		DACCUP											
	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
	4·5	5·0	9·0	12·0	25·0	30·0										
10m	MELRAM		ELADEN		DACCUP											
	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
	5·0	6·0	10·0	12·0	25·0	30·0										
15m	CYASM1		MELRAM													
	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
	6·0	6·0	7·0	8·0												
20m	CYADEA		ELADEN													
	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
	3·5	4·0	6·5	7·5												

H1 = lower height limit H2 = upper height limit

Notes

- Tree ferns throughout area.

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

POINT INTERCEPT – FOR FOREST GROUND COVER ASSESSMENT

Purpose

To assess the proportion of the forest floor in classes of cover.

Summary

Indicators
- Ground cover

Skills
- Ability to identify main plant species

Time
- 100-200 points per hour

Sampling
- Each series of points assessed along a line forms an individual sample unit
- The number of lines in a sample depends on features such as variability and precision required
- Needs to be determined when planning monitoring
- Points can be combined with Quick plot, with assessment at 1m or 0.5m intervals along the plot

Equipment and people
- 1-2 fieldworkers
- Topographical map
- Pencil and eraser
- Instruction sheet
- Clipboard
- Tape measure for locating points
- Hip chain or long tape for locating plots
- Compass
- Field form
- Plastic bags and labels (to collect plant specimens for identification)
- Aluminium stakes and permolat (venetian blind) – if lines are being permanently marked
- Plant identification books

Strengths
- Simple to undertake without special skills or equipment
- Data is easy to interpret
- Quick and easy to measure

Weaknesses
- Only provides information on one indicator
- Considerable number of plots may be required to provide good results

Introduction

This method is used to assess the percentage of different types of ground cover on a forest floor. It may commonly be used in conjunction with the quick plot or other vegetation plot method.

Sampling

If your monitoring questions mean that you need to establish vegetation plots, establish point intercept measurements in conjunction with the quick plot or other vegetation plot. If it is undertaken in conjunction with the quick plot, point intercept can be assessed at 1m intervals along the 20m plot.

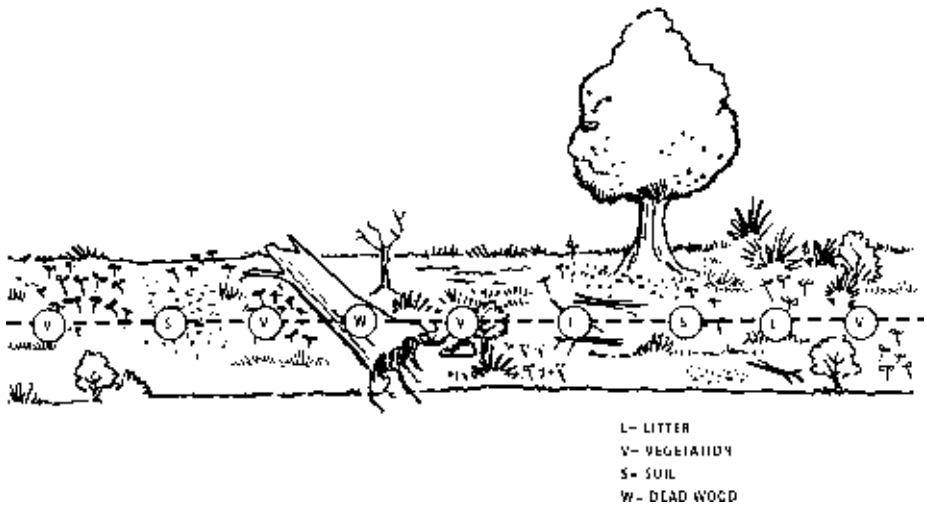
Point intercept can be assessed separately from other monitoring, at fixed intervals along a tape measure or other survey line. A 20m measuring tape can be run out, and then ground cover assessed at the point under each 1m interval of the tape. This series of point intercepts forms an individual sample. A number of these sample measurements are then undertaken through the area being assessed, up to the required sample size, for example, a sample of 20 lines might be assessed.

For information on identifying sample size, refer to 'What size sample?', p.98.

Method

- Run out a measuring tape on the set bearing. If used in conjunction with the quick plot, this tape will be 20m long.
- Record the ground cover, including low stature vegetation <15cm high, which is covered by the width of the tape at each metre mark using appropriate standard classifications, such as:
  - ~ *Vegetation (V):* Any vegetation less than 15cm in height other than moss or ferns. Includes woody seedlings, herbaceous vegetation, and grasses. It does not include live tree roots and trunks.
  - ~ *Root (T):* Live tree roots.
  - ~ *Moss (M)*
  - ~ *Fern (F):* Any ferns less than 15cm in height.
  - ~ *Leaf Litter (L):* Including dead sticks < 3cm in diameter.
  - ~ *Wood (W):* Dead wood, branches and logs, >= 3cm in diameter.
  - ~ *Soil (S):* Bare exposed soil where the litter layer has been removed.
  - ~ *Rock (R):* Exposed bare rock or gravel.
- Only one classification can be recorded at each point. *See* Figure 16 below.
- Where vegetation or fern is present, also record the species. If you are unable to identify the species, record it by type of vegetation, that is, grass, fern, woody seedling or herb.
- If the measurement plot is being permanently marked, aluminium pegs can be placed at 5m intervals along the tape. This allows the tape to be laid out in the same location for re-measurement.

FIGURE 16: Point intercept assessment undertaken at fixed intervals along a tape.



Records

An example of a format for recording point intercept field data is given on page 56. For each sample plot where point intercept data is collected, ensure that the following is recorded:

- Header information including:
  - ~ location: Description, diagram, and grid reference
  - ~ date
  - ~ observer: record who was doing the assessment, and who recorded the information
- The ground cover classification at each point
- Identification of each point, for example, its distance along a 20m measuring tape

Analysis and presentation

The percentage of ground cover in each of the ground cover classes for the study area is presented. This can be simply turned into a graph as a pie chart.

Changes in the proportion of ground cover in different classes can be examined. Differences between different areas can also be examined (*see* 'Examining difference' p.106).

Frequency of re-measurement

This will depend on the nature of the study, and the amount of change likely to be occurring. Re-measurement after two years may be appropriate where a moderate level of change is likely.

FIGURE 17: Tape on forest floor for point intercept assessment. The point in the middle of this photo would be classified as fern.

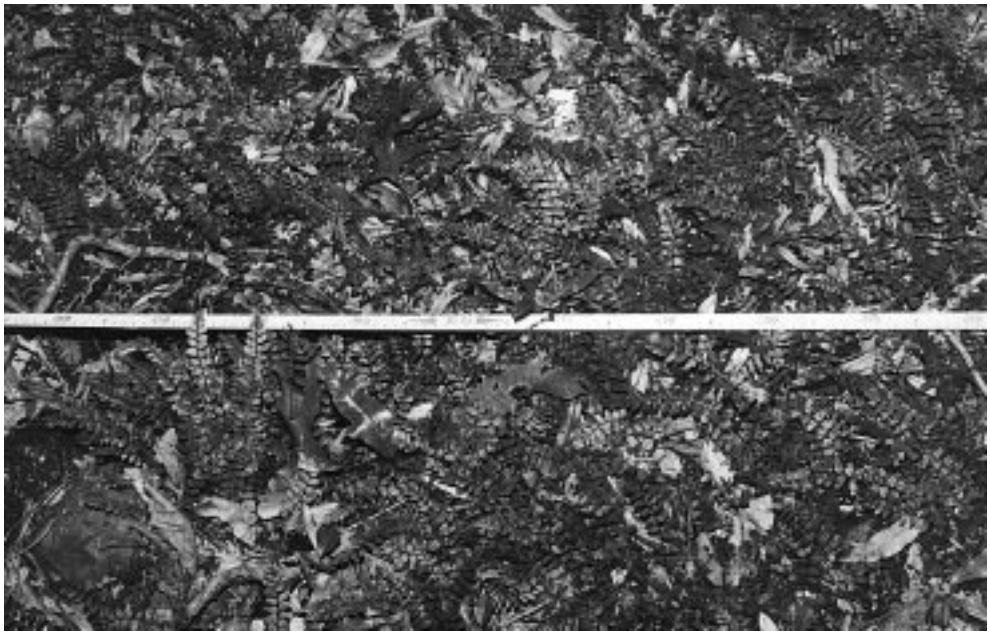


PHOTO: PETER HANDFORD

POINT INTERCEPT – FOR FOREST GROUND COVER

Location

Date: 18/11/99	Plot no: 6
Recorded by: John Hansen	Measured by: Duncan Jones
Location name: Blue Reserve Gully	Grid reference: R27 535 942

Location diagram/notes

Site

Landscape: Face	Aspect: 160°	Altitude: 180m	Drainage: Good

Point Intercept Assessments

Point (m)	Ground Cover Class	Plant Species (if ground cover is V or F)
0	L	
1	L	
2	L	
3	L	
4	L	
5	F	BLECHA
6	F	BLECHA
7	L	
8	L	
9	L	
10	R	
11	S	
12	L	
13	L	
14	L	
15	L	
16	L	
17	L	
18	L	
19	L	
20	L	

Notes

Generally thick litter under tree fern and hinau. One deer track runs across area.

Ground Cover Classes

Fern (F): Any fern less than 15cm in height
Leaf Litter (L): Dead leaves and twigs, including branches up to 3cm in diameter
Moss (M)
Rock (R): Exposed bare rock or gravel
Root (T): Live tree roots
Soil (S): Bare, exposed soil where the litter layer has been removed
Vegetation (V). Any vegetation, other than mosses or ferns, less than 15 cm in height
Wood (W): Dead wood, branches and logs, > 3 cm in diameter
Note: Only one classification can be recorded at each point.

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

FLOWERING AND FRUITING OBSERVATION RECORD

Purpose

To provide records of the timing of fruiting and flowering of key species, and identify peak fruiting and flowering years.

Summary

Indicators
- Fruiting and flowering

Skills
- Ability to identify main plant species

Time
- Depends on size of area assessed

Sampling
- Can be assessed in relation to individual marked trees, or as the average of the fruiting or flowering present along a track or transect. Can also be assessed in this general way across a small reserve area
- The assessment should aim to cover a range of individual plants and trees of each species studied, which is likely to include the usual variation in the area
- Examine up to 10 key species. These species should be important, for example, major canopy trees, important source of bird food (*see* appendix 2) etc

Equipment and people
- 1 fieldworker
- Topographical map
- Aerial photograph
- Clipboard
- Instruction sheet
- Fruiting and flowering record form
- Camera and film for photographing levels of fruiting and flowering
- Numbered aluminium tree tags and permolat (venetian blind) – if individual trees are being permanently marked
- Plant identification books

Strengths
- Can be undertaken without special skills or equipment
- Provides useful information to examine relationships to other indicators.
- Gives a simple record

Weaknesses
- Estimating flowering and fruiting levels can be difficult
- Visual estimates are used so detailed comparisons of fruiting and flowering levels are difficult
- Needs ongoing commitment so regular records are kept

FIGURE 18: Records are kept of the timing and intensity of fruiting and flowering.

PHOTOS: DOC

PHOTO: PETER HANDFORD

Introduction

This method provides a standard form for keeping records of observations of fruiting and flowering for selected species. It identifies the timing of important events such as flowering and fruiting, and allows levels of flowering and fruiting to be compared between years.

There can be difficulties with observations of fruiting and flowering and other aspects of phenology (i.e the timing of various recurring plant growth phases). These should be considered before you undertake this type of study.

- Make sure you can clearly identify different stages, for example, flower buds, flowers, ripe and unripe fruit.
- Be aware that birds and animal pests can remove large quantities of fruit between observations. Record any signs of this occurring.
- As the abundance of flowering and fruiting varies greatly between years, take photographs that represent maximum abundance occurring that year. This helps you to identify high and low flowering and fruiting years.

Sampling

This record system can potentially be used in a variety of ways:

- Tagging of individual trees. Where a detailed study is being undertaken, records can be kept for individual marked trees.
- Assessment along a transect. This may be the same transect that was used to assess birds ('Forest bird slow walk transects'. p.68), or a track or walkway. Each month, fruiting and flowering of the species of interest along the 'transect' is assessed as the average of all the individuals present.
- General assessment of a forest area, for example, a reserve or park area. Again, a general monthly assessment of the area is undertaken in a similar way to that for the 'transect' approach.

Timing

A quick assessment of flowering, fruiting, and other growth phases should be recorded monthly, at a similar time each month.

Method

- Decide which of the sampling approaches above will be used. In many cases this will involve assessment along a transect or general assessment of a defined area.
- If individual tree results are being recorded, tag individual trees and record location details.
- For assessment of transects or area, define the location of the area assessed.
- Decide on the species to be monitored. These should be species that are:
  - ~ Relatively important or common in the forest area, for example, an important canopy tree, or relatively abundant subcanopy tree or shrub.
  - ~ Known to be sources of bird food (*see* appendix 3) in the area, and possibly important to pest animals.
  - ~ Possibly important because of their limited numbers.
- Using the attached form, examine these species in the study area once a month, and record the following:
  - ~ Date of assessment.
  - ~ Species being assessed.

~ Relative abundance of the different phenology characteristics (*see* definitions below).
~ Notes: include any general observations on the level of fruiting, flowering, etc, presence of any birds or other animals feeding on flowers or fruit.

Definitions

Abundance

Record abundance in the classes given below: Take photographs of the levels of abundance you have assessed. Record the date of the photograph and the abundance category you assigned. This allows your records to be re-examined in future, and the abundance classes corrected if future levels suggest that you over or underestimated.

Abundance is recorded in the following categories:

Class	Description	% of canopy covered
0 None	None	0%
1 Rare	Few visible, often only in part of canopy	<5%
2 Occasional	Sparse throughout the canopy	5%-25%
3 Common	Common throughout the canopy	25%-50%
4 Abundant	Heavy and highly visible throughout the canopy	50%-75%
5 Very Abundant	Tree canopy covered in flowers or fruit, branches weighed down with an unusually large amount of fruit or flowers	75%-100%

Characteristics

The following characteristics and definitions are used:

- New leaf buds: green live buds that are not open.
- New leaves or shoots: expanding leaves or shoots that have not yet reached full size.
- Flower buds: unopened flower buds, including developing cones or ovules in the podocarps.
- Flowers: Open flowers or fully mature ovules and male cones.
- Immature/unripe fruit: Not yet mature, colour, etc.
- Ripe fruit: Fruit has reached full size, colour and ripeness.

Records

Records should be maintained and include the information in the following phenology observation field form.

Analysis and presentation

Records can be presented in various ways, including:

- Graphs showing the monthly abundance scores for different phenology characteristics , such as flowering and fruiting, for a particular species. This will identify the timing of stages such as fruiting or flowering.
- Annual summaries of abundance scores for a species. This will identify years of maximum or close to maximum abundance of flowering or fruiting for different species. For example, show the major fruiting years for kahikatea.

Frequency of re-measurement

Simple records such as this are most useful if kept as an ongoing monthly sequence.

FLOWERING, FRUITING & GENERAL PHENOLOGY RECORD: JANUARY – JUNE

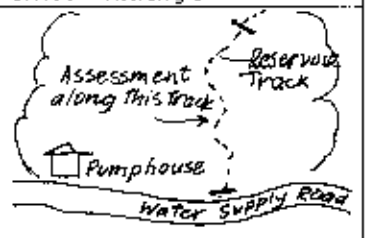
Year: 1999

Location name: Reservoir Track

Grid Reference: S25 045563

Species: 1 WEI RAC; 2 BEITAW; 3 4 5 6 7 8 9 10

Locat on notes/diagram



		1	2	3	4	5	6	7	8	9	10
Jan	New leaf buds	1	2								
	New leaves or shoots	2	3								
	Flower buds	0	1								
	Open flowers	1	2								
	Immature fruit	3	4								
	Mature/ripe fruit	2	2								

Date of check: 10·1·99
Fieldworker: Dave Wilson
Notes: Tawa has much green fruit.

		1	2	3	4	5	6	7	8	9	10
Feb	New leaf buds	1	2								
	New leaves or shoots	2	3								
	Flower buds	0	0								
	Open flowers	0	1								
	Immature fruit	3	3								
	Mature/ripe fruit	3	4								

Date of check: 12·2·99
Fieldworker: Dave Wilson
Notes: Tawa fruit becoming ripe.

		1	2	3	4	5	6	7	8	9	10
Mar	New leaf buds	1	1								
	New leaves or shoots	2	2								
	Flower buds	0	0								
	Open flowers	0	0								
	Immature fruit	1	2								
	Mature/ripe fruit	3	4								

Date of check: 15·3·99
Fieldworker: Sarah Wilson
Notes: Tawa fruit mostly ripe. Several Kereru feeding on fruit in the area.

		1	2	3	4	5	6	7	8	9	10
April	New leaf buds	0	0								
	New leaves or shoots	1	1								
	Flower buds	0	0								
	Open flowers	0	0								
	Immature fruit	0	0								
	Mature/ripe fruit	2	2								

Date of check: 9·4·99
Fieldworker: Dave Wilson
Notes:

		1	2	3	4	5	6	7	8	9	10
May	New leaf buds	0	0								
	New leaves or shoots	0	0								
	Flower buds	0	0								
	Open flowers	0	0								
	Immature fruit	0	0								
	Mature/ripe fruit	0	0								

Date of check: 7·5·99
Fieldworker: Dave Wilson
Notes: No new growth or flowers

		1	2	3	4	5	6	7	8	9	10
June	New leaf buds	0	0								
	New leaves or shoots	0	0								
	Flower buds	0	0								
	Open flowers	0	0								
	Immature fruit	0	0								
	Mature/ripe fruit	0	0								

Date of check: 11·6·99
Fieldworker: Dave Wilson
Notes: no new growth or flowers

Classes: 0–none 1–rare, 2–occasional, 3–common 4–abundant, 5=very abundant

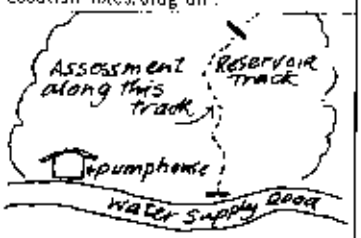
Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

FLOWERING, FRUITING & GENERAL PHENOLOGY RECORD: JULY – DECEMBER

Year: 1999
Location name: Reservoir Track
Grid Reference: S25 045563

Species: 1 2 3 4 5 6 7 8 9 10

Location notes/diagram:



		1	2	3	4	5	6	7	8	9	10
July	New leaf buds	0	0								
	New leaves or shoots	0	0								
	Flower buds	0	0								
	Open flowers	0	0								
	Immature fruit	0	0								
	Mature/ripe fruit	0	0								

Date of check: 15·7·99
Fieldworker: Dave Wilson
Notes:

		1	2	3	4	5	6	7	8	9	10
Aug	New leaf buds	0	0								
	New leaves or shoots	0	0								
	Flower buds	0	0								
	Open flowers	0	0								
	Immature fruit	0	0								
	Mature/ripe fruit	0	0								

Date of check: 18-8-99
Fieldworker: Dave Wilson
Notes:

		1	2	3	4	5	6	7	8	9	10
Sept	New leaf buds	2	0								
	New leaves or shoots	0	2								
	Flower buds	0	1								
	Open flowers	0	0								
	Immature fruit	0	0								
	Mature/ripe fruit	0	0								

Date of check: 10-9-99
Fieldworker: Dave Wilson
Notes:
Tawa leaf buds developing

		1	2	3	4	5	6	7	8	9	10
Oct	New leaf buds	3	0								
	New leaves or shoots	1	3								
	Flower buds	0	1								
	Open flowers	0	0								
	Immature fruit	0	1								
	Mature/ripe fruit	0	0								

Date of check: 12-10-99
Fieldworker: Dave Wilson
Notes:

		1	2	3	4	5	6	7	8	9	10
Nov	New leaf buds	3	3								
	New leaves or shoots	4	4								
	Flower buds	1	1								
	Open flowers	0	1								
	Immature fruit	0	1								
	Mature/ripe fruit	0	0								

Date of check: 15-11-99
Fieldworker: Dave Wilson
Notes:
Very few flowers on Tawa

		1	2	3	4	5	6	7	8	9	10
Dec	New leaf buds	1	2								
	New leaves or shoots	3	3								
	Flower buds	1	1								
	Open flowers	2	2								
	Immature fruit	2	1								
	Mature/ripe fruit	1	0								

Date of check: 17·12·99
Fieldworker: Dave Wilson
Notes: Only small amounts of fruit on flowers on Tawa

Classes: 0=none, 1=rare, 2=occasional, 3=common, 4=abundant, 5=very abundant

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

GROUND PLOT MONITORING OF SEED AND FRUIT-FALL

Purpose

To monitor annual fruit and seed production by key tree species and assess levels of damage to fallen fruit by predators.

Summary

Indicators
- Fruiting and flowering

Skills
- Ability to identify main plant species
- Ability to identify different types of animal damage

Time
- 1-3 trees per hour when establishing and measuring
- 2-6 trees per hour when re-measuring

Sampling
- The number of trees in a sample depends on features such as variability and precision required
- Needs to be determined when planning monitoring
- Trees need to be selected for examination throughout the area
- Initial results suggest assessment of 10- 20 trees may be enough in many cases

Equipment and people
- 1-2 fieldworkers
- Topographical map
- Aerial photograph
- Clipboard
- Instruction sheet
- Fruit-fall plot form
- Numbered aluminium tree tags and permolat (venetian blind) for marking trees
- Aluminium stakes and permolat (venetian blind) for marking plot centres
- Nylon cord with a loop on one end, and a knot 0.5m from the loop end
- Compass
- Tape measure for locating plots around the tree
- Long tape or hip chain for locating trees
- Random number tables (*see* appendix 6)
- Last year's location records (if re-measuring)
- Sorting tray (a plastic cutlery tray with different compartments is good)

Strengths
- Can be undertaken without special skills or equipment
- Provides a precise, objective measure of fruiting for key species
- Simple to assess and analyse
- Can provide information on fruit predation as well as level of fruiting

Weaknesses
- Care is required in classifying different types of damage to fruit
- Can be influenced by birds feeding on fruit

Introduction

This method sets out an approach to monitoring fruit-fall and predation of fruit for tree species with large edible fruits such as tawa and hinau.

Many native species vary in the amount of fruit they produce each year. Relationships between fruiting and the abundance of native bird species, browsers and predators have been found in some areas.This method allows simple quantitative monitoring of the level of fruiting, by counting fruit on the ground.

Sampling

- A sample of individual trees of the species is selected within the study area.This sample should include the range of tree sizes and growing sites present in the study area.
- Initial work suggests a minimum of 10 trees should be sampled.
- In small forest areas, where the numbers of the species are very limited, it may be appropriate to sample all trees, otherwise some form of sampling, as set out in 'Sampling', p.95, will be required.

Timing

- Measurement must occur at the end of the fruiting period. See appendix 4 for an indication of timing of the fruiting period, but you will need to identify the best time for your area.
- If it is your first year of measurement, ideally you should establish the measurement plots before the start of fruit-fall, and clear them of any old fruit or seeds present from the previous year. If this is not done, the first year's results may be inflated.
- For species such as tawa, where possums are eating the whole kernel before the fruit is ripe, and only leaving a thin husk, it is important to assess seed-fall twice in a season. One measurement should be made at the start of the period when ripe fruit is available, followed by another measurement at the end of the fruiting period. The data from the two measurements for each tree is added together to give the year's measurement.

Species

The following is a list of species suitable to assess using this monitoring method. The method may also be used to assess other species.

SPECIES KNOWN TO BE SUITABLE FOR ASSESSMENT			
Scientific name	**Common name**	**Approx fruit size (mm)**	**Ripe fruit colour**
Beilschmiedia tarairi	tarairi	20-30	Purple
Beilschmiedia tawa	tawa	20-30	Purple
Corynocarpus laevigatus	karaka	20-30	Orange
Elaeocarpus dentatus	hinau	10-15	Purple
Prumnopitys ferruginea	miro	15-20	Orange
OTHER SPECIES THAT MAY BE SUITABLE			
Scientific name	**Common name**	**Approx fruit size (mm)**	**Ripe fruit colour**
Nestegis lanceolata	white maire	10	Red
Vitex lucens	puriri	15-20	Red
Alectryon excelsus	titoki	10-15	Red
Dysoxylum spectabile	kohekohe	8-15	Orange
Hedycarya arborea	pigeonwood	10-15	Red

FIGURE 19: Searching plots for fruit.

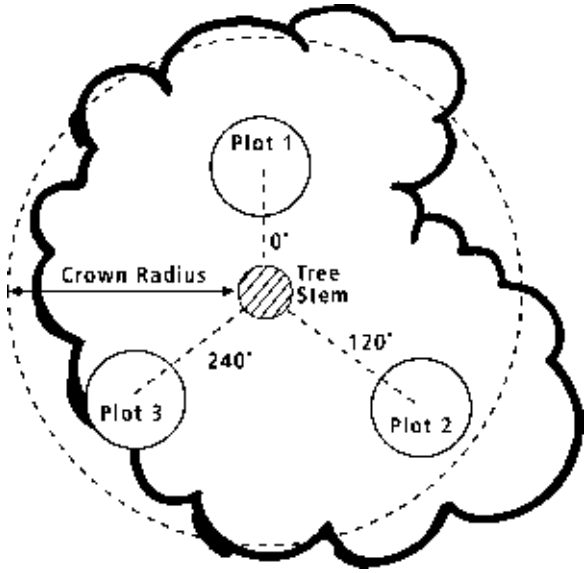
PHOTO: PETER HANDFORD

Method

Measurement

- Tag or uniquely identify each tree being assessed.
- Provide enough location information for each tree so someone else could easily locate it. This will include giving bearing and distance from easily identifiable points to each sample point. A good way to do this, if trees are not too distant from each other, is to locate the first tree using a bearing and distance from a known, well marked point, and then locate each subsequent tree by a bearing and distance from the previous one.
- Measure the diameter at breast height (1.35m).
- Measure the distance from the trunk to the dripline (outer limits of the tree crown). To do this, look up at the tree crown and stand at a position where you are on the average edge of the tree's live crown (*see* Figure 20). Measure the distance from that position to the outside of the tree stem.
- Use random-number tables in appendix 6 to select three, two-digit random distances between 0.5m and the outer limit of the crown. For example, if the distance to dripline was 3.0m, move along a line in the random number table, looking at each two digits and select the first three to be between 05 and 30. For example, moving along the first row of random numbers in the table of random numbers, the first three, two digit numbers between 05 and 30 are 30, 23, and 13. These equate to distances of 3.0 m, 2.3 m, and 1.3 m.
- Take bearings from the centre of the tree trunk at 0, 120, and 240 degrees (magnetic).
- Measure the random distance from the outer surface of the tree trunk on each of the three bearings and put a stake in the ground to mark each plot centre permanently. Number each plot from 1 to 3, with 1 being the plot at 0 degrees, 2=120 degrees, and 3=240 degrees (*see* Figure 20).

FIGURE 20: Layout of seed-fall plots under a tree. Distance from tree stem to each plot centre is selected from random number tables, but must be a number between 0.5 and the crown radius.



- If the plot centre falls on a tree trunk or a large log, select the next random number distance in the series that misses this obstruction.
- Count all fallen fruit of the tree species being monitored within a 0.5m radius of each plot centre.
  - ~ Search through fresh litter down to the top of the humus layer (*see* Figure 19).
  - ~ Count whole and damaged fruit.
  - ~ Do not count part fruit if it is less than half a full fruit (this avoids double counting the two halves).
- Classify each fruit into the fruit classes (defined below) on the attached field form. A plastic cutlery tray is useful so fruit classes can be sorted into the different compartments as they are collected.
- Place counted fruit well clear of the plot so it is not re-counted accidentally.
- Record all recognisable possum faecal pellets. If several pellets are clumped together in one group obviously deposited at the same time, record the whole group as one pellet.

Definitions

Fruit Classes

- *Immature:* Usually predominantly green, hard and not ripe.
- *Ripe:* Well coloured (for example, tawa = purple / black, hinau = purplish) and soft.
- *Withered/Dry:* Flesh has gone and husk is dry and brown/black.
- *Possum damaged:* Tawa = whole outer skin removed in large cuts leaving portions of the husk, or the whole husk with the centre cleanly scooped out.
- *Rat damaged:* Many ragged edges with signs of small teeth marks. Often part of the kernel remains. Rats tend to attack ripe fruit on the ground.
- *Insect damaged:* Generally one or more small entry holes about the size of a pencil lead. Normally only present in fully mature fruit that are starting to dry out or rot. Inner kernel is eaten out, commonly leaving just the husk, which when squeezed has nothing inside. Husk is full of frass (powdery or granular insect chewed material).
- *Rotten:* Mature fruit is soft and rotten when squeezed and does not contain any insect frass, or insect entry holes.

PHOTOS: PETER HANDFORD

Ripe, undamaged tawa fruit

Possum damaged tawa fruit

Rat damaged tawa fruit

Definitions for searching

- Fresh litter: This consists of all loose whole or largely intact leaves that have not significantly broken down. The layer is loose and can be relatively easily moved by picking up large pieces and moving the side of the hand lightly across the ground.
- Humus layer: A more compact dark layer under the litter with many well broken down plant fragments.

Records

- Maps and other location information identifying how to find the survey trees.
- Record details of the counts, as set out on attached form

Analysis and presentation

Information can include:

- Fruit density (fruit/m^2) for each tree and average for the sample in each year. The 0.5m radius plots give a search area of about 0.8m^2 each. Histograms can be provided for each tree and for the average of the whole sample. These can show the total seed-fall as the cumulative total of the different fruit classes. This can be used to identify higher and lower-than-usual fruiting years. It can also show differences in the impact of fruit predators between years and areas of forest.
- The percentage of fruit damaged by different predators from year to year to study the ongoing impact of different fruit predators.

Frequency of re-measurement

Measurement should occur every year at the same time, at the end of the fruiting season. Appendix 4 provides an indication of the fruiting seasons for some important species.

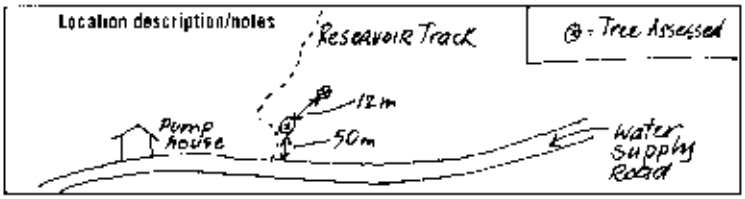
FRUITFALL PLOT FORM

Date: 10 - 5 - 99

Location name: RESERVOIR TRACK

Grid reference: S25 045563

Location description/notes



Fieldworkers: John Symes , Sam Harvey

Tree Location	Plot Information					Fruit Fall																
						Immature							Ripe						Withered / dry				
							Damaged						Damaged						Damaged				
	Tree No.	Crown radius (m)	Plot	Bearing (mag. from tree)	Distance (m)	Whole	Possum	Bigfoot	Insect	Rot	Unidentified	Whole	Possum	Bigfoot	Insect	Rot	Unidentified	Whole	Possum	Bigfoot	Insect	Rot	Unidentified
BEI TAW Adjacent to track 50m from road	164	5·5	632	1	0	1·0	0	3	0	0	0	0	7	0	1	0	0	3	35	12	2	21	8	4
				2	120	3·7	1	2	0	0	0	0	3	0	2	0	0	1	16	8	1	6	1	2
				3	240	0·6	0	4	0	0	0	0	6	0	1	0	0	2	21	11	1	32	7	3
BEI TAW 12m on 200° mag from 164	165	5	0	830	1	0	1·4	0	0	0	0	0	2	0	0	0	0	0	5	8	0	2	0	0
				2	120	3·4	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
				3	240	4·7	0	0	0	0	0	0	1	0	0	0	0	0	4	0	0	1	0	0

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

FOREST BIRD SLOW WALK TRANSECTS

Purpose

To assess relative abundance of different bird species.

Summary

Indicators
- Bird relative abundance
- Bird species composition & diversity

Skills
- Ability to identify bird species, both visually and from their calls. As a minimum, observers must be able to reliably identify the species they are intending to study
- Good hearing and eyesight

Time
- 1 hour per transect when establishing it for the first time
- 20 minutes per transect when re-measuring

Sampling
- The number of transects will depend on features such as variability and precision required
- Bird data commonly has a lot of variation, which can make it difficult to achieve good levels of precision
- Transects are assessed several (5-15) times at the same time each year

Equipment and people
- 1 fieldworker
- Topographical map
- Aerial photograph
- Clipboard
- Instruction sheet
- Bird transect form
- Binoculars
- 20m measuring tape (for measuring 10m from the transect – to calibrate your estimates)
- Hip chain or long measuring tape when setting up the transect for the first time
- Wristwatch to record start and finish times
- Aluminium permolat (venetian blind) for marking out the transect centre line
- Flagging tape to occasionally mark 10m distance either side of transect
- Hammer
- Nails
- Bird identification books.

Strengths
- A large proportion of birds can be identified by sight
- A fixed area is assessed, giving an indication of density

Weaknesses
- Has the usual bird assessment difficulties, resulting from variation in conspicuousness between species, time of day, and time of year
- Requires good bird knowledge

Introduction

This protocol provides a standard method for assessing bird presence and abundance along a walking transect.

Assessment of bird abundance can be difficult because observers need to be able to recognise different bird species by sight and from their calls. There is also seasonal variation in the amount of birdcalls and activity. All these need to be taken into account when designing monitoring of birds.

The method presented here is a reasonable compromise, balancing the level of skill required and the ability to provide an indication of abundance.

Sampling

As discussed above, seasonal fluctuations in bird records can occur. Birds may be active and vocal during the early breeding season, but be secretive during moulting. The abundance of a certain species in one area will vary greatly depending on the availability of seasonal food sources such as nectar and fruit from particular plant species.

Fluctuations during the day also occur – from peaks during early morning (dawn chorus) to much reduced activity in the heat of midday.

If longer term trends need to be examined, these fluctuations must be removed as much as possible through design of sampling. The following points should be considered:

Timing

- Most birds are most conspicuous from early September to late November. During these months, numbers are less likely to be influenced by new fledglings, which may not be a stable part of the population, so this is the best time to assess.
- Try to survey between flowering periods of key species, for example, in a northern coastal area after the kowhai has finished flowering but before the pohutukawa comes into flower. This will avoid you hitting a peak in numbers one year because of birds flocking to a food source, then missing it in another year. If you do strike a peak flowering period – record this and try to repeat conditions next time you measure.
- Undertake a series of measurements of the survey transects over perhaps a month, rather than intensively over a few days. This will help reduce the chance of short-term influences on numbers affecting the result.
- Do not assess the same transect twice in the same day because these assessments are not 'independent'. That is, the same birds may still be present at the same locations on the transect when it is quickly re-assessed. It is better to set up other transects than to re-measure the same transect again.
- Assess transects on calm fine days.
- Assess transects between one hour after dawn and midday.

Transect establishment

- Identify a site where a transect of about 500m in length can be run across an area. If there are many possible locations, see the sampling section ('Sampling', p.95) to decide how to select a location.
- Where multiple transects are being established, there should be sufficient separation between them. If transects are running approximately parallel, they should stay about 200m apart. However, it is acceptable for one transect to lead almost directly into another when they are running in the same direction, such as along a track or route.
- Ensure this transect is well marked so you can follow the same path each time and will be able to relocate it in subsequent years.
- Measure out the transect with a hip chain or measuring tape, and mark each 100m point.
- At occasional intervals, about 50m to 100m, where convenient, mark points that are 10m either side of the transect. This will ensure that observers are frequently able to calibrate their estimates of 10m from the transect.

Intensity

- The number of transects you establish will depend on sampling requirements (*see* 'Sampling', p.95), and on your resources. It is often better to have a small number (even one) of transects that you measure every year than many transects that are only very infrequently assessed.
- For each period of measurement – for example, each year, assess each transect five to 15 times. If you have a small number of transects, it will be important to assess them a greater number of times.
- For a more detailed discussion of sample size, see 'What size sample?', p.98.

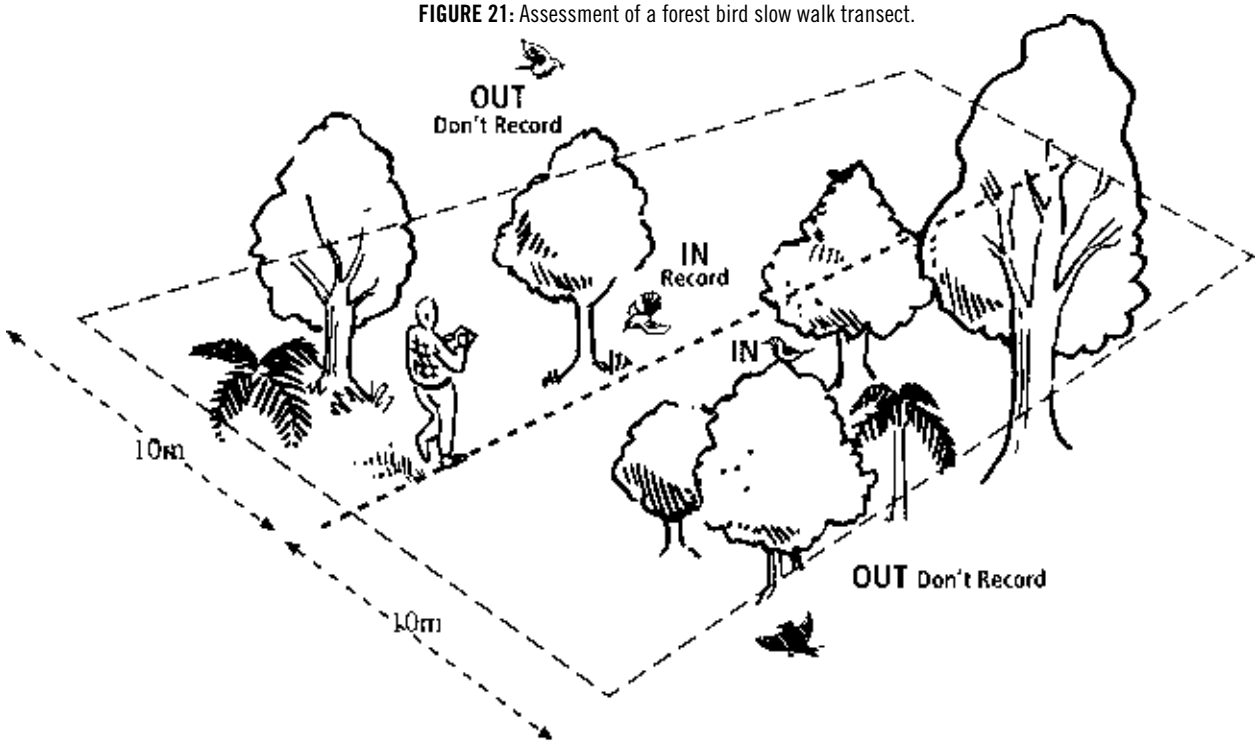
Method

- Walk slowly along the transect, recording all birds seen and heard within 10m either side of the transect on a 'moving front' as you travel along the transect (*see* Figure 21).
- Birds that are seen clearly to move into the transect area in front or behind you, within 20m of your current position, are included.
- It should take about 20 minutes to assess the transect.
- Use binoculars to identify birds if necessary.
- It is often most efficient to walk a transect in one direction, then reassess walking back along the transect so two assessments are obtained in the same visit. However, as discussed above, these assessments are not statistically independent. It is more beneficial to increase the number of transects by, for example, creating a loop containing several transects that can be measured consecutively.
- Record birds as seen or heard. If a bird is seen and heard – record it only as seen.
- Never knowingly record an individual bird more than once. For example, if a bird moves in and out of the transect a number of times, only record it once.
- If you are uncertain of identification of birds, concentrate on the species you can positively identify, and record descriptive notes about other species, for example: 'striped plumage, call: a repeat note trailing off at end'.
- It is often difficult to distinguish bellbird and tui calls. If you are uncertain record as bellbird/tui.

Records

- Record number of birds of each species seen or heard on the form shown on page 72.
- Record all additional climate and other information on the form.

FIGURE 21: Assessment of a forest bird slow walk transect.



Analysis and presentation

The following options are available:

- List the total number of species recorded.
- Plot mean total number of birds for each transect and combined transect data for each year. (*see* 'Data points and means, … ', p.104)
- Examine differences between mean totals for each year (*see* 'Comparison of datasets', p.105).
- Undertake the above two steps individually for the more common species.

Frequency of re-measurement

Transects should ideally be measured once a year, under the guidelines relating to timing discussed under sampling above.

BIRD TRANSECT RECORD

Location name: Reservoir Track	Grid reference: 525 045563	Date: 7-10-99	Fieldworker: Dave Wilson
Transect: 2	Start time: 0905	Finish time: 0925	

Species	Tally: Seen*	Tally: Heard*	Total Number
Grey Warbler	1		1
Silver Eye	8	2	10
Tomtit	1		1
Kereru	1		1
Riflemen		1	1
Fantail	2		2
Chaffinch		2	2
Blackbird		1	1

* if seen and heard, record it only as seen

Notes: (eg. uncommon species observed outside the transect)
Several black swans in reservoir lake

Temperature *(circle appropriate number)*

1	Freezing	<0 C
2	Cold	0-5 C
3	Cool	5-11 C
(4)	Mild	11-16 C
5	Warm	16-22 C
6	Hot	>22 C

Rain: Mist (M), Rain (R), Hail (H), Snow (S) *(Circle one – and grade on following scale)*

(0)	None
1	Dripping foliage
2	Drizzle
3	Light
4	Moderate – *abandon assessment*
5	Heavy – *abandon assessment*

Wind *(circle appropriate number)*

0	Leaves still or move without noise (Beaufort 0 & 1)
(1)	Leaves rustle (Beaufort 2)
2	Leaves and branches in constant motion (Beaufort 3 & 4) – *abandon assessment*
3	Branches or trees sway (Beaufort 5, 6 & 7) – *abandon assessment*

Flowering, fruiting – *record details*

Plant species	Fruit or flowers	Rare, occasional, common, abundant, or very abundant	Notes

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

WEED MAP MONITORING

Purpose

To examine and describe the distribution of particular weeds, and monitor changes in distribution.

Summary

Indicators
- Distribution of weeds

Skills
- Ability to identify important weed species

Time
- Depends on size of area assessed

Sampling
- For small areas, search the entire area
- In larger areas, or if resources are limited, concentrate effort where weed invasions are most likely (eg, edges of reserves, along roads and railways, along waterways)

Equipment and people
- 1-2 fieldworkers
- Topographical map
- Aerial photograph
- Pencil and eraser (including a Chinagraph pencil if marks need to be made directly on to an aerial photo)
- Clipboard
- Instruction sheet
- Pest plant infestation record.
- Camera and film for photographing infestations.
- Plastic bags and labels (to collect weed specimens for identification)
- Aluminium stakes and permolat (venetian blind) or other permanent marker pegs – if small areas of infestation are being permanently marked
- Weed identification references

Strengths
- Easy to understand
- Simple to undertake without special skills or equipment
- Can identify issues quickly – for management action

Weaknesses
- Comparing changes over time can be difficult due to differences in search intensity
- Use of visual estimates of abundance etc also makes precise monitoring of changes difficult

Introduction

Weeds are invasive species that threaten to spread through areas of native forest and potentially out-compete native plant species. Maintaining records of their distribution and picking up any new occurrences allow effective targeting of control.

This monitoring instruction presents a standard approach for recording the distribution and qualitative information on weeds, and for ensuring new weed sightings are recorded. Contact your local regional council and Department of Conservation experts for more information on weeds in your area.

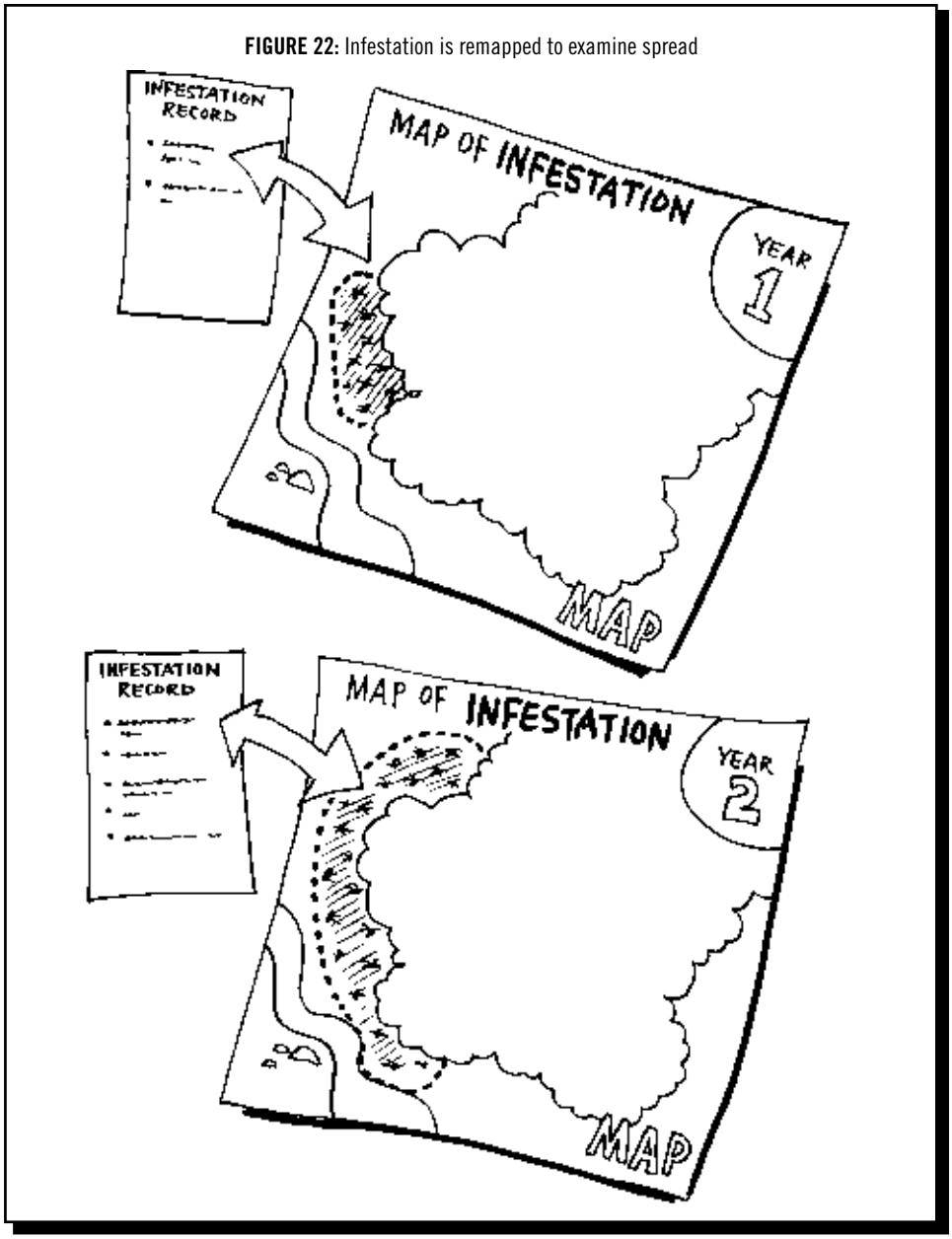
Sampling

Approach will depend on size and nature of forest area. In small forest reserves it may be possible to examine the whole area thoroughly. In large areas, when resources are limited, effort should be concentrated in the following ways:

- Focus on looking for weeds known to be the most significant, and potentially damaging. Information on the relative importance of weeds can be found in Owen (1997), and talk to experts.

- Focus on places where weed invasions are most likely (DOC 1999):
  - ~ The edges of reserves – particularly when near to settlement.
  - ~ Along roads and railways.
  - ~ Near any areas of rubbish dumping.
  - ~ Where there are areas of low or disturbed vegetation.
  - ~ Along waterways – rivers and streams, lakes and the coast.
  - ~ On slips or cliffs.
- Focus on areas that have a high conservation status or are potentially vulnerable to weed invasions.

FIGURE 22: Infestation is remapped to examine spread



Method

- If possible, obtain a large-scale aerial photograph of the area being examined at a scale of 1:10,000 or 1:5000.
- If this is not possible, a less accurate approach is to obtain a copy of a 1:50,000 map and enlarge it on a photocopier.
- Walk the boundary and any likely weed spread areas such as roads and riverbeds.
- Mark the general extent of different weed species on the photo or map.
- Fill out a "pest plant infestation record" for each distinct infestation. If a species is scattered around and through the whole area, just fill out one record per species. The infestation record notes the presence of mature and immature plants. This can provide early indications of whether the weed is spreading.
- Mark on the map the infestation identified in the infestation record form, if it relates to a distinct infestation, and cross-reference this to a number on the record.
- When undertaking surveillance, consider carrying a small grubber or similar to remove individual rare weed plants (after you have recorded them). Make brief notes on plants that are removed.

Records

Photo or map with details written on it and any associated key or explanation.
Plant pest infestation records (*see* form on page 76).

Analysis and presentation

The information collected can be presented in several ways:

- Basic summary information, giving the number of reserve areas containing particular weed species may be useful. Weed infestation information (such as size and distribution of the infestation) from the infestation record form can be presented in a table comparing the different reserves.
- Summary maps showing weed locations throughout the area.
- Visual comparisons of current and past distribution maps for a particular reserve to identify any spread.

Frequency of re-measurement

Areas with high conservation values and a high risk of weed spread or new places with introductions will need to be re-assessed most frequently. Weed species that have been recently introduced, or have potential to spread, will also need to be assessed most frequently.

PEST PLANT INFESTATION RECORD

Completed by: Sam Jones	**Date:** 17 – 2 – 2000
Location name: Scots Creek Reserve	**Grid reference:** S25 062551

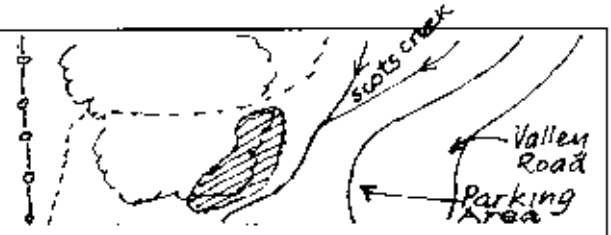
Pest Plant

Common name: Wandering Jew	Tentative name:
Scientific name: Tradescantia fluminensis	Sample taken:

Infestation

Description/Sketch of infestation location:

Adjacent to parking area beside Scots Creek



Vegetation description (predominant species in the area) Tawa, Kohekohe, Titoki

Feature	Rating estimate *(tick appropriate level or write estimate)*	Notes
Size of infestation	Estimate size in m² or hectares 100 m²	
Distribution of infestation	1 ☑ One small patch 2 ☐ Locally scattered 3 ☐ Local patches 4 ☐ Scattered throughout 5 ☐ Patches throughout 6 ☐ Common throughout	
Adult/Juvenile ratio	% Juvenile NA % Adult NA	
Presence of flowers seeds or propagules	Flowers ☐Y ☑N Seeds ☐Y ☑N Propagules (suckers, runners etc) ☑Y ☐N	
Access to the site	1 ☐ Difficult access, several kilometres from roads, no easy helicopter landing sites 2 ☐ Several kilometres by road, but good helicopter landing site 3 ☑ Short walk to road suitable for two-wheel drive 4 ☐ Vehicle access right to the site	Close to road, but must cross Scots Creek
Likely mechanism of arrival	1 ☐ Unknown 5 ☐ Carried downstream 2 ☐ Wind 6 ☐ Intentional introduction by humans 3 ☐ Birds 7 ☐ Accidental introduction by humans 4 ☑ Rubbish dumping 8 ☐ Other (specify in notes)	
Likelihood of spread	What is the likelihood the plant pest will spread: 1 ☐ None 2 ☐ Low 3 ☐ Moderate 4 ☑ High 5 ☐ Unknown	
Likelihood of re-invasion	What is the likelihood the plant pest will re-invade if removed 1 ☐ None 2 ☑ Low 3 ☐ Moderate 4 ☐ High 5 ☐ Unknown	chance of reintroduction by dumping

Notes: Possible Control, etc Control appears feasible if done now

Blank copies of these forms can be obtained at www.fronz.net.nz or under SMF project 5073 at www.smf.govt.nz

POSSUM PERCENTAGE TRAP CATCH

Purpose

To monitor changes in possum relative abundance. This is an overview only – see NPCA 2000 for the full method.

Summary

Indicators
- Possum abundance

Skills
- Possum trapping experience

Time
- 2 – 4 hours/line to establish, much less to check

Sampling
- Sampling designs are provided in trap catch design protocol (NPCA 2000)

Equipment and people
- 1-2 fieldworkers
- Map – with line locations
- Aerial photograph
- Pencils
- Eraser
- Compass
- Standard trap catch record sheets
- Clipboard
- Possum leg hold traps (Victor No 1 unpadded, or Bridger traps)
- Staples
- Wire
- Hammer
- Lure (*see* recipe below)

Strengths
- Provides a relatively precise and consistent approach to assessing changes in possum populations
- Is widely used and has published protocols
- Considerable data is available for comparison

Weaknesses
- Considerable work in establishing and running traplines
- May not be a safe and acceptable monitoring method in and around urban areas
- Can have impacts on non-target species

Introduction

This method is widely used in New Zealand to assess the effectiveness of possum control operations. It is the main form of monitoring the effectiveness of both aerial and ground control operations.A detailed specification for the method can be obtained from the National Possum Control Agencies (NPCA) PO Box 11461 Wellington, phone 04 499 7559.This is in three parts.

- The protocol for designers includes details about selecting the number of traplines to achieve a required level of precision, and issues such as stratification and line location.
- The protocol for planners includes details about planning the field operation.
- The protocol for field operatives covers specific trapline establishment and assessment requirements.

Sampling

The approach to sampling and the locations where descriptions are undertaken will depend on the particular monitoring questions (*see* 'Design monitoring … ', p.88 and 'Sampling', p.95). Detailed information on sampling design is provided in the NPCA protocol for designers.

The standard approach is to use lines of 20 traps spaced at 20m intervals. Samples of 10-15 lines are used in blocks of 500-2000 ha in size. In areas of less than 50ha, it is recommended that trapping be used as the control method.The level of kill is then assessed from the reduction in catch resulting from the control trapping.

Method

- Trapline starting points are randomly selected, and all traplines run out on the same bearing (often 0 degrees magnetic).
- The first trap is placed 20m from the starting point and, thereafter, traps are placed at 20m intervals.
- Victor No 1 unpadded traps or Bridger traps are used. If other makes of leg hold trap are used, they should be used consistently in all monitoring.
- The trap is set against the nearest tree or fence post that will hold a fence staple. Where species such as ponga are present that will not hold a staple, wire can be used to attach the trap.
- Traps are lured with a mixture of plain white flour and icing sugar (10kg flour to 2kg of icing sugar). No flavours are added. Lure is spread up the trunk behind the trap from 10cm to 50cm high.
- Traps are run for three fine nights, and must be checked every day.

Records

- Maps and location data for the traplines.
- Trap-catch monitoring protocols contain standard record sheets.
- The possums caught in each trap over the three nights are recorded. Their sex and maturity are recorded. Traps sprung and empty, or with evidence of a possum escape, are recorded. Non-target species caught are also recorded.

Analysis and presentation

The mean trap catch for each line is calculated over the three nights. The process for doing this and calculating percentage kill are in the NPCA protocol for designers.

The process is broadly:

1. For each line, calculate the total number of possums by adding the number of possums caught and the number of possum escapes.
2. For each line, calculate the number of trap-nights by removing one half trap-night for each non-target catch and sprung but empty trap.
3. Divide the total number of possums on each line (step 1) by the number of trap-nights on the line (step 2). This will give you the mean number of possums captured per trap-night.

Frequency of re-measurement

The same traplines are not usually assessed over time because the removal of possums by the traplines will impact on subsequent assessments. Instead different, randomly located lines are used in the same area when assessing change over time.

When assessing control operations, monitoring occurs immediately before, and immediately after the control operation.

Possums can often return to their pre control abundance in around four to six years after control. Frequency of re-measurement will depend on your monitoring objectives and questions.

TRACKING TUNNELS FOR RODENTS AND STOATS

Purpose

To assess the relative abundance of rodents and stoats.

Summary

Indicators
- Rodent abundance
- Stoat abundance

Skills
- Identification of different animal foot prints

Time
- 0.5 – 1 hr per line to check once established.

Sampling
- Depends on particular study design
- Needs to be determined when planning monitoring
- A monitoring design for large areas involves 10 tunnel lines in both the treatment and non-treatment areas; 10 tunnels on each line at 50m spacing

Equipment and people
- 1-2 fieldworkers
- Map
- Aerial photograph
- Pencils
- Eraser
- Standard forms or notebook
- Clipboard
- Tracking tunnels (*see* design below)
- Food colouring
- Small hand held garden sprayer for applying food colouring
- Tracking papers
- Peanut butter
- Hammer
- Flagging (permolat)

Strengths
- Does not directly influence the population, eg, by killing individuals
- Can deal with several species at once, eg, rats, mice and stoats
- Tracking papers can be retained for re-analysis
- Safe, harmless method – will not impact non-target species

Weaknesses
- It can be difficult to identify differences between footprints of similar sized animal species
- Requires construction of tracking tunnels (possibly around $5-$10 each)
- Considerable work can be involved installing and using tunnels
- Effective sampling unlikely to be possible in small forest areas

Introduction

This method has been used in a variety of scientific studies since the 1980s and is now being used more widely for general monitoring. A tracking tunnel is simply a run-through tunnel with a paper bed on each side of a central sponge which is soaked in food colouring. As an animal passes through, it picks up the food colouring on its feet and transfers it to the paper, leaving footprints. The paper can then be removed and the animal identified from its footprints.

Sampling

A suggested sampling design uses 10 lines of 10 tracking tunnels in the treatment area where you are applying some management or study and another 10 lines in the non-treatment area for comparison. The tracking tunnels should be spaced at 50m intervals along the lines for sampling rodents, or at 100m spacing for stoats. If lines are being used to assess stoat abundance, they need to be at least 1km apart.

The location of each line should be selected in some random or systematic way to minimise bias (*see* 'How to select the sample', p.95). The approach that is to be taken needs to be decided before you start setting out the lines, and then be used for all lines. One simple way of doing this is to identify on a map the start points at regular intervals along some easy access such as a track, the forest edge or river valley. The compass bearing on which the line will run is then selected by rolling a six-sided die, as follows.

Die Roll	Angle of tunnel line (magnetic)
1	285, or 105
2	315, or 135
3	345, or 165
4	15, or 195
5	45, or 225
6	75, or 255

Two bearings are possible for each die throw. If it is clear that only one of these is appropriate then this is selected. For example, one may head into open farmland from a forest edge, or across a river from the valley bottom, and not be suitable for measurement. If either bearing is possible, the die is rolled and if an even number is rolled, the first bearing is taken, if odd, the second.

PHOTO: T LILLEBY, DOC

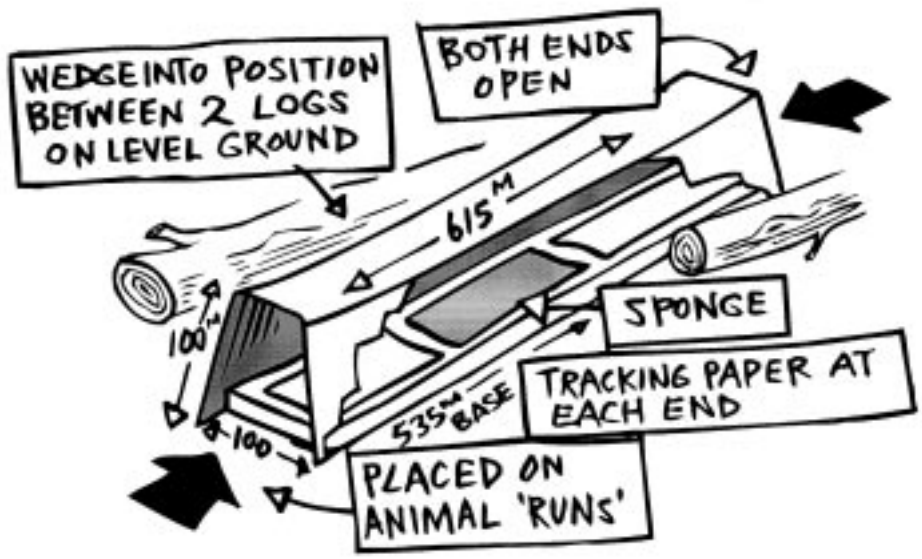
FIGURE 23: The presence of tracks of rats, stoats or mice is identified.

Method

- Each tunnel is set in the best practical spot within 5m of the planned location (for example, the 50m mark on the tunnel line). If there is an obvious place within this 5m radius, place the tunnel there.
- Tunnels should be set out level and secure, with both ends free of obstruction.
- Tunnels should ideally be set out for about three weeks before the first sampling and be left in place between samplings. This ensures animals are familiar with them, and less likely to avoid them.
- For rodents:
  - ~ Tunnels are run for one fine night.
  - ~ Each tunnel is baited with a small (1-2cm) blob of peanut butter smeared on the wooden base at each end of the tunnel.
  - ~ Fresh tracking papers are installed, and 'ink' applied to the sponge. The date, number of the tracking tunnel, and the direction of the closest tunnel entrance are marked, one for each tracking paper.
- For stoats:
  - ~ Bait each tunnel with a small (2-3 cm^3) chunk of skinned rabbit meat placed in the centre of the tracking sponge. Placing this on a 3cm x 3cm square of polythene keeps maggots out.
  - ~ Fresh tracking papers are installed, and 'ink' applied to the sponge. The date, number of the tracking tunnel, and the direction of the closest tunnel entrance are marked, one for each tracking paper.
  - ~ Once baited, tunnels are left for three fine nights before the tracking papers are collected.
- Combining rodent and stoat sampling.

  Install tunnels at 50m intervals as for rodents, and do the one-night rodent sample. Then clear the tunnels and in every second tunnel install new papers and re-bait for stoats. Tunnels are then left for the three-night stoat sample.

FIGURE 24: Tracking tunnel design



Tunnel construction details (*see* Figure 24 above)

- Wooden base of 25mm thick plywood or rough sawn pine. Base is 100mm wide x 535mm long.
- Black plastic 'corflute' cover, stapled or nailed to base. This should be 615mm long to allow for an overhang at each end of the wooden base. Internal clearance height in the tunnel should be 100mm.
- Polycarbonate tray (that slides in on the wooden base), 520mm long x 95mm wide. The tray has partitions, dividing it equally into three 173mm-long sections. These trays can be obtained from Jurgen Fielder Plastics (Rotorua), phone 07-347 5542.
- Papers and sponge fit into the partitioned areas of the polycarbonate tray, and are cut to fit the size of these sections. Papers should be sufficiently absorbent to retain the food colouring animal prints. Heavy brown wrapping paper, such as 110 g 'Sandow' wrapping paper, seems to work well.
- Tracking 'ink' is made of liquid food colouring at 1:4 dilution in water. If freezing may be a problem, use the food colouring without dilution. In extremely dry conditions, mix the food colouring and water with 20 percent polyethelene glycol. The tracking ink is best applied to sponges in the field using a small handheld garden sprayer bottle.

Records

- Maps, location data and descriptions for the tunnel lines and individual tunnels.
- Tracking papers for each tunnel should be stored with the data.
- Record of the date, species identified for each tracking tunnel, and people undertaking the fieldwork.

Analysis and presentation

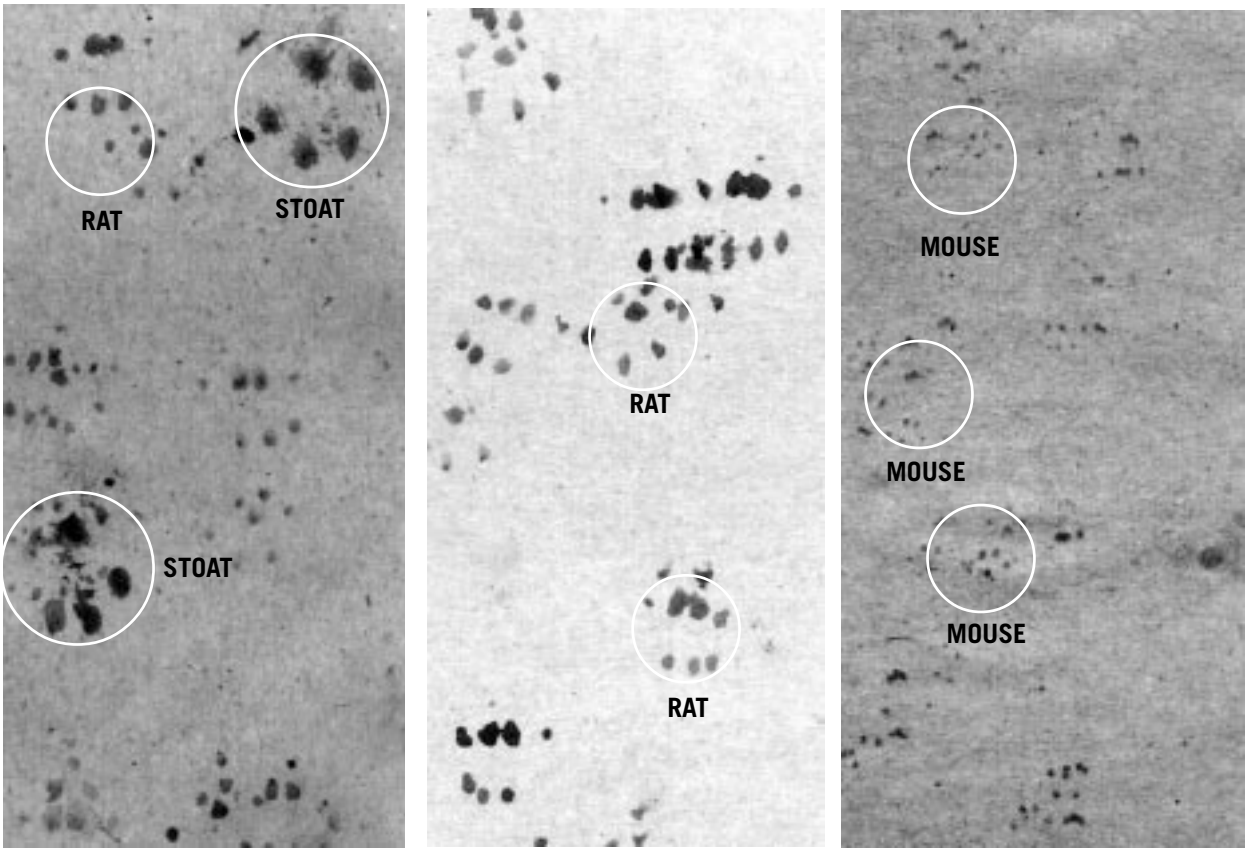
- The number of tunnels tracked by each species on each line is identified.
- If tunnels are badly disturbed (for example, by possums) and are unlikely to have been accessible to the target animals, they should be removed from the analysis.
- The mean percentage of tunnels tracked per line can be presented and changes examined over time.
- Statistical comparisons of change over time and differences between the treatment and non-treatment area can be undertaken.

Frequency of re-measurement

The abundance and habits of these animals change greatly through the year so tunnels need to be run several times a year.

As a minimum, tunnels should be sampled four times a year in February, May, August and November. If it is not possible to run tunnels more than once a year, great care is needed to run them at the same time of year when populations are at a similar stage of their annual cycle. Population levels are likely to be highest around February.

FIGURE 25: Animal tracks, left stoat and rat, centre rat, right mouse.



RALPH POWLESLAND, DOC

RODENT 'GNAW BLOCK' BAIT INTERFERENCE

Purpose

To assess the presence and relative abundance of different rodent species.

Summary

Indicators
- Rodent abundance

Skills
- Identification of different animal gnaw marks

Time
- 1-2 hours / line

Sampling
- Depends on particular study design
- Needs to be determined when planning monitoring
- A common design involves five lines of 40 blocks at 10m intervals

Equipment and people
- 1-2 fieldworkers
- Map
- Aerial photograph
- Pencils
- Eraser
- Standard forms or notebook
- Clipboard
- Wax gnaw blocks (*see* recipe below)
- Temporary flagging – tape
- Hammer
- Flagging (permolat)

Strengths
- Does not directly influence the population, eg, by killing individuals
- Can deal with rats and mice
- Safe, harmless method – will not impact non-target species

Weaknesses
- It can be difficult to identify differences between tooth marks of rats and mice
- Some biases can occur due to animals visiting several baits or following lines of baits

Introduction

Various forms of this method have been used in several areas in New Zealand. It has been mainly used on rodent-free islands to detect re-infestation. It can also provide a simple indication of relative rodent numbers. However, there can be some complications due to rodents visiting several baits, and problems in remembering the location of baits.

Sampling

As with all sampling, consideration should be given to the particular monitoring questions, and the precision required (*see* 'Design monitoring … ' p.88 and 'Sampling' p.95).
A suggested sampling scenario involves:

- Lay 5-10 lines of 40 blocks, with blocks spaced at 10m intervals on the lines. Lines should ideally be at least 200m apart.
- Leave blocks out for two fine nights.
- Check blocks daily and replace any chewed blocks.

The location of each line should be selected in some random or systematic way to minimise bias (*see* 'How to select the sample?' p.95). The approach needs to be decided before setting out the lines so it can be used for all lines. A simple way of doing this is to identify on a map the start points at regular intervals along some easy access such as a track, the forest edge or river valley. The compass bearing on which the line will run is then selected by rolling a six-sided die, as follows:

Die Roll	Angle of Tunnel Line (magnetic)
1	285, or 105
2	315, or 135
3	345, or 165
4	15, or 195
5	45, or 225
6	75, or 255

Two bearings are possible for each die throw. If it is clear that only one of these is appropriate then this is selected. For example, one may head into open farmland from a forest edge, or across a river from the valley bottom, and not be suitable for measurement. If either bearing is possible, the die is rolled and if an even number is rolled, the first bearing is taken, if odd, the second.

Method

- Place the wax blocks at 10m intervals on the line. Temporarily flagging the location with marking tape is useful to allow relocation.
- Run the lines for two fine nights.
- Check the blocks daily and record all blocks that are chewed. Identify the toothmarks using the following guide:
  - ~ Possum – two grooves, each about 3mm wide.
  - ~ Rat – two grooves with a total width of about 3mm.
  - ~ Mouse – two grooves that fit into one rat groove.
- Replace chewed blocks with fresh blocks.

Making wax gnaw sticks/blocks

- Melt candle wax (paraffin wax) and add red food colouring and rose oil.
- Poor the wax mixture into iceblock trays, and add an iceblock stick to each one.
- The iceblock stick is pushed into the ground when laying out the gnaw blocks.

Records

- Maps, location data and descriptions for the lines.
- For each of the two nights, record which blocks were chewed or unchewed on the different lines.
- Record of the date, species identified for each chewed block, and the people undertaking the fieldwork.

Analysis and presentation

- The number of blocks chewed by each species on each line over the two nights is identified.
- The mean percentage of blocks chewed per 'block night' for each line can then be presented and changes examined over time.
- Statistical comparisons of change over time and differences between the treatment and non-treatment area can be undertaken.

Frequency of re-measurement

The abundance and habits of these animals change greatly through the year so, ideally, blocks should be laid out several times a year. Setting blocks on the same lines, four times a year in February, May, August and November is suggested.

If it is only possible to set blocks once a year this should be done at the same time of year when re-measuring. In this case, it is suggested that blocks are run in March when rodent numbers are likely to be close to their peak.