Vegetation: Foliar Browse Index

Version 1.0

This specification was prepared by Richard Clayton in February 2016.

Contents

Inventory and monitoring toolbox: vegetation

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Department of Conservation
Te Papa Atawhai

Synopsis

Negative impacts of brushtail possums (*Trichosurus vulpecula*) on native biodiversity have been widely observed in New Zealand. Possums are responsible for the dieback of forest canopies and local elimination of sub-canopy species and large-leaved mistletoe species. Possums have now colonised nearly all of New Zealand's forests, and pest control is often undertaken to prevent (or minimise) ongoing possum impacts on vulnerable indigenous plant and avifauna species.

The Foliar Browse Index (FBI) assesses possum impacts in forests by repeated measurements of foliar condition on tagged 'indicator' trees and/or mistletoes. The FBI method monitors canopy condition by assessing foliar cover and possum browse on representative individuals of 'indicator species' known to be palatable to possums. Individual trees or mistletoes are monitored within plots that are located along transects in a study area.

Monitoring the effects of pest control on forest canopies benefits greatly from having a treatment and non-treatment comparison to compare FBI results between sites and with changes in possum abundance, e.g. after possum control operations.

The Foliar Browse Index Field Manual was reviewed and updated in 2014, and is available online (http://www.doc.govt.nz/Documents/conservation/threats-and-impacts/animal-pests/foliar-browse-index-field-manual.pdf).

Other methods such as hemispherical photography, photopoints, permanent plots or aerial canopy surveys can assess canopies at large scales but lack detailed data on changes in canopy condition and/or foliar cover.

Some questions that an FBI study can answer are:

- What level of pest control is needed to protect the forest canopy, or a particular species?
- Is possum control improving the condition of the canopy?
- Where are possum impacts occurring and where are they most severe?

Assumptions

- The individual trees selected to monitor are representative of the entire study area.
- Possum browse is the dominant pressure that is influencing canopy condition.
- Changes to canopy condition between measurement years is not an artefact of different observers being used between measurements.

Advantages

- The FBI method is suitable for monitoring in both the short and medium term (5–20 years).
- Data collection is straightforward and reasonably quick to carry out once monitoring is established and observers are trained.
- Sampling plots on multiple transects is an efficient and statistically robust way of measuring many trees over large areas.
- The FBI method is widely used in New Zealand with a considerable resource of published studies that can help with reporting and interpreting of results.
- The method can be applied to a wide range of species in New Zealand, including common ones such as māhoe (*Melicytus ramiflorus*) fuchsia (*Fuchsia excorticata*), kāmahi (*Weinmannia racemosa*) and rātā (*Metrosideros robusta, M. umbellata*) and to large-leaved mistletoe, which are a very sensitive indicator of possum damage.

Disadvantages

- The FBI method requires subjective assessments. If observers consistently score trees differently, results will be biased and could lead to erroneous conclusions.
- Species with smaller leaves, particularly those which are emergent or canopy forming (e.g. rātā, kāmahi), can be difficult to assess.
- Possum browse can be confused with other herbivorous browse such as insect browse.
- Some parameters are affected by natural seasonal fluctuations, e.g. deciduousness or a flush of spring growth, so surveys need to take place at a particular time of year.
- Obtaining sufficient sample size can be difficult when indicator species are sparse, clumped or unevenly distributed across the landscape.
- There is a time lag between effective control of possums and observable changes in foliar cover, and this can vary substantially between indicator species.
- The FBI method is focused on indices of canopy and sub-canopy condition and does not monitor wider forest processes that will influence forest composition, e.g. tree mortality and recruitment.
- The FBI method is particularly impractical in heavy rain.
- Initial setup costs for programmes can be prohibitive.

Suitability for inventory

The FBI method is not suitable for one-off assessments, although observers can make useful observations during field work on the health of a site (e.g. signs of vegetation browse) and evidence of other pests (e.g. faecal pellets).

Suitability for monitoring

FBI monitoring is a useful method to monitor changes to the condition of forest canopies. To maximise effectiveness, plots and transects should be established according to the sampling protocols detailed in 'Full details of technique and best practice', and monitoring should be established in both treatment and non-treatment sites. If this is not possible, then establish FBI monitoring prior to pest control being undertaken at a site. FBI results are best interpreted in conjunction with possum abundance data (e.g. residual trap catch index,[1] wax tag index[2]).

Resources

Standard field equipment includes:

- Topographic maps with line locations and treatment boundaries
- GPS and spare batteries
- FBI data sheets
- Laminated indicator species assessment sheet and foliar cover scale
- Pencils
- Clipboard
- Compass
- Digital camera (for mistletoe photos)
- Good quality waterproof binoculars (8 × 32 or 10 × 40)
- 20 m measuring tape
- Numbered tree tags
- Nails
- Hammer
- Diameter at breast height (DBH) tape
- Flagging tape
- Permalat for marking lines and behind tree tags
- 8 m builder's tape for estimating height and size of mistletoe

This method requires a minimum of two trained observers who can identify indicator species, accurately score and record possum browse etc. on those species, and who have good navigational and general bushcraft skills**.**

[1] See 'Animal pests: residual trap catch index for possums' (http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-animal-pests-residual-trap-catch-index-possums.pdf)

[2] http://www.npca.org.nz/index.php/news/84-general/263-new-possum-population-monitoring-protocol

Minimum attributes

The attributes below are the minimum required for correct implementation of the method. Other attributes may be added, depending on the monitoring objectives. For more information refer to 'Full details of technique and best practice'.

DOC staff must complete a 'Standard inventory and monitoring project plan' (doccm-146272).

The following data sheets are available online:

- FBI transect and plot data sheet[3]
- FBI indicator species data sheet[4]
- FBI mistletoe data sheet[5]
- Foliage cover scale[6]

Minimum attributes to record:

- Transect data: survey details, forest type, transect origin and bearing, location diagram, approach and notes
- Plot data: location, altitude, aspect, slope, physiography, non-possum browse and dominant species of the surrounding canopy
- Indicator species data: transect and plot number, direction of tree from plot centre, species, tag number, stem diameter, living status, tier, % foliar cover, browse, dieback and any notes
- For mistletoe FBI, record additional data on the host species, viewing location, and the size of plants in three dimensions

FBI on large-leaved mistletoe

Mistletoe can be assessed with the standard FBI parameters used for trees, with the addition of extra data collected on host tree details, size of the mistletoe and viewing distance and direction.

Mistletoes require specific host tree species and tend to be more abundant in high light conditions such as forest margins, open ridges, fragments and tracks. As such, they are unlikely to be present in all plots unless a restricted sampling plan is used. Consult a statistician prior to undertaking any sampling in this case.

[3] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/transect-and-plot-datasheet.pdf

[4] http://www.doc.govt.nz/Documents/conservation/threats-and-impacts/animal-pests/foliar-browse-index-indicator-species-datasheet.pdf

[5] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/mistletoe-datasheet.pdf

[6] http://www.doc.govt.nz/Documents/conservation/threats-and-impacts/animal-pests/foliar-browse-index-foliage-cover-score-sheet.pdf

Data storage

Forward copies of completed FBI survey sheets to the survey administrator, and enter data as soon as possible. Store all survey data in an organised system upon returning from fieldwork. Storage tools should use both manual and electronic systems. Backup all data, whether electronic, data sheets, metadata or site access descriptions, preferably offline if the primary storage location is part of a networked system.

Data should be entered into a standard data entry template in Excel,[7] which can also be saved as a .csv file for analysis using a statistical analysis package such as R. Before completing the data entry process, check for missing information and errors, and ensure metadata are recorded. Pivot tables and filters can be used in an Excel spreadsheet to help with this process.

Analysis, interpretation and reporting

Before undertaking statistical analysis, explore the data to see patterns (and help identify any problems with the data). Depending on sampling objectives and design, data analyses can range from very simple summary graphs to complex spatial and demographic models. Only summary statistics should be performed in Excel and a dedicated statistical package such as R should be used for any further, robust analyses. Modelling approaches can be used to compare all aspects of the data, including changes in foliar cover, condition and mortality between treatment and non-treatment areas over time (see Nugent et al. 2010).

Most repeated measures analyses will require support from a statistician.

Case study A

Case study A: diets and impacts of brushtail possum populations across an invasion front in South Westland, New Zealand

Synopsis

The impact of brushtail possums was measured across an ‘invasion front’, i.e. areas where they had been present for 10, 20 or 30 years. The authors measured possum abundance, fecundity, diet, and the condition of indicator species using the FBI method. Canopy condition declined with increasing length of possum occupation, as did the presence of highly preferred food species. Possum densities and fecundity were also related to impacts and length of occupation.

[7] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/fbi-data-entry.xls

Objectives

The authors of this paper were interested in measuring the *severity* and *timing* of impacts of possums colonising a forest in South Westland.

Sampling design and methods

Three study sites were chosen, representing differing lengths of time since first known possum presence. Within each study site, a single transect was established, with plots located at distances along them ranging from 150–300 m. The condition of indicator trees was assessed using the earlier version of the FBI method (Payton et al. 1999) for eight species, all known to be palatable to possums.

Results

Almost no browse was recorded in the 10-year site, but was present on a large proportion of trees for most species at the 20-year and 30-year sites. Foliage cover generally decreased and dieback increased with increasing time since possum colonisation. Possum gut contents confirmed which species were most palatable and largely reflected their presence (or absence) in the local environment.

Limitations and points to consider

The authors concluded that foliage canopy condition of selected indicator species decreased markedly with increasing time since possum colonisation. Possums were clearly responsible for the decline, as evidenced by large increases in possum density and direct evidence from stomach samples and food preferences.

The study was constrained by a lack of replication at the site level. However, the authors were able to make strong conclusions based on sound logic and lack of evidence to suggest anything other than possums were responsible for the observed effects.

References for case study A

Payton, I.J.; Pekelharing, C.J.; Frampton, C.M. 1999: Foliar Browse Index: a method for monitoring possum (*Trichosurus vulpecula*) damage to plant species and forest communities. Manaaki Whenua—Landcare Research, Lincoln. 62 p.

Sweetapple, P.J.; Fraser, K.W.; Knightbridge, P.I. 2004: Diets and impacts of brushtail possum populations across an invasion front in South Westland, New Zealand. *New Zealand Journal of Ecology 28(1)*: 19–33.

Case study B

Case study B: effect of one-hit control on the density of possums (*Trichosurus vulpecula*) and their impacts on native forest

Synopsis

This study was designed (in part) to determine if, and for how long, forest canopies recover after a 'one hit' possum control operation. Reduction in possum numbers caused canopies to improve and continue doing so even when possum populations had recovered quite rapidly.

Objectives

- To determine how forests responded over 6–8 years after a single possum control event and what level of control is needed to protect common canopy species.

Sampling design and methods

At four sites, possums were poisoned using aerial 1080, with three further sites left unpoisoned and used as a non-treatment comparison. Changes in possum abundance were measured using the residual trap catch (RTC) index and compared to the forest condition, as determined by the FBI.

Results

At the treatment sites, browse pressure decreased; mortality was reduced; and canopy foliar cover increased over the period of monitoring when compared to non-treatment sites.

In this study, a single possum control operation was sufficient to allow forests to recover for a period of up to eight years, even when possum numbers had recovered quickly.

Limitations and points to consider

The authors note that the interactions between possums and their food supply are complex, but were able to provide evidence of reduced possum browse leading to reduced mortality of preferred species. The most important conclusion was that a reduction in possum density by 60% was sufficient to protect common canopy species.

Obtaining data on possum density was critical to interpreting the other results in this study, as was having a non-treatment comparison.

References for case study B

Nugent, G.; Whitford, J.; Sweetapple, P.; Duncan, R.; Holland, P. 2010: Effect of one-hit control on the density of possums (*Trichosurus vulpecula*) and their impacts on native forest. *Science for Conservation 304*. Department of Conservation, Wellington. 66 p.

Full details of technique and best practice

To representatively sample a site it is necessary to apply the standard FBI transect and plot protocols, and if possible, do this in both the site receiving pest control (treatment) and a similar site where pest control is not occurring (non-treatment). If a non-treatment site is not available then establish FBI lines before pest control is undertaken to get a 'baseline' of forest canopy condition. Also collect possum abundance data before and after possum control in both areas, because FBI data are most useful when compared to changes in possum abundance.

For each site, choose indicator species based on their: a) availability in the study area, b) suitability for monitoring, and c) palatability to possums. *The Foliar Browse Index Field Manual* provides guidance on the suitability and palatability of indicator species. Refine species choices from local knowledge or a pilot study.

Sometimes, it may be necessary to stratify site(s) into vegetation classes, ecosystem types or altitudinal bands and establish FBI monitoring only in these areas. Consult a statistician prior to undertaking fieldwork in these cases.

Establish 5 to 15 sample plots along randomly located transects in the study area(s) or vegetation type within the study area(s). Ideally, aim for 50 individuals of each species over the study area(s). Locate plots at regular intervals (usually 100m spacing) along transects and tag and monitor one stem of each indicator species by selecting the closest, observable individual closest to the plot centre. Guidance on selecting appropriate individuals to minimise bias are explained in *The Foliar Browse Index Field Manual* (DOC 2014).

Record data about each transect, plot and individual tree. Evaluate the condition of the canopy of each stem by assessing the thickness of foliage cover (using a foliar cover scale), possum browse and canopy die-back, as described in *The Foliar Browse Index Field Manual* (DOC 2014).

Additional information is collected on the location of mistletoe plants on host trees so they can be easily relocated. The size of individual plants is also measured.

References and further reading

DOC. 2014: The Foliar Browse Index field manual. An update of a method for monitoring possum (*Trichosurus vulpecula*) damage to forest communities. Department of Conservation, Christchurch, New Zealand. http://www.doc.govt.nz/Documents/conservation/threats-and-impacts/animal-pests/foliar-browse-index-field-manual.pdf

Nugent, G.; Whitford, J.; Sweetapple, P.; Duncan, R.; Holland, P. 2010: Effect of one-hit control on the density of possums (*Trichosurus vulpecula*) and their impacts on native forest. *Science for Conservation 304*. Department of Conservation, Wellington. 66 p.

Payton, I.J.; Pekelharing, C.J.; Frampton, C.M. 1999: Foliar Browse Index: a method for monitoring possum (*Trichosurus vulpecula*) damage to plant species and forest communities. Manaaki Whenua—Landcare Research, Lincoln. 62 p.

Appendix A

The following Department of Conservation documents are referred to in this method:

doccm-146272	Standard inventory and monitoring project plan