# SEEING THE FOREST FOR THE TREES – FLORISTIC COMPOSITION IN A TALL, WET *EUCALYPTUS OBLIQUA* FOREST OF SOUTHERN TASMANIA

*Genevieve M. Gates & David A. Ratkowsky*

*Tasmanian Institute of Agriculture, University of Tasmania, Hobart, Tas. 7001, Genevieve.Gates@utas.edu.au & D.Ratkowsky@utas.edu.au*

## ABSTRACT

Mapping the individual trees ≥10 cm diameter in four 50 m x 50 m plots in the tall, wet *Eucalyptus obliqua* dominated forest in southern Tasmania revealed aspects of the fire history of this forest which had not been discernible from the large-scale overview of these plots. In particular, we found that a second fire had occurred in part of one of the four plots 72 years prior to the start of the survey, contradicting a previous assessment that had concluded that the area was uniformly burnt by an earlier fire 108 years before the survey began.

## INTRODUCTION & BACKGROUND

The expression used of someone who "can't see the forest for the trees" describes a person who looks too closely at the details of a problem (i.e., the trees) and thereby misses out on seeing the bigger picture (i.e., the forest). In this work, we turn the meaning of the expression on its head and show that by identifying and mapping the individual trees in a forest plot, one can derive a better idea of how the forest is structured as a whole than by a superficial overview. That is, the attention paid to the fine detail, obtained by measuring the diameters of all trees and plotting the positions of the trees ≥10 cm diameter on a 2-dimensional graph, has its reward in the facts revealed about the plot, especially its previous fire history.

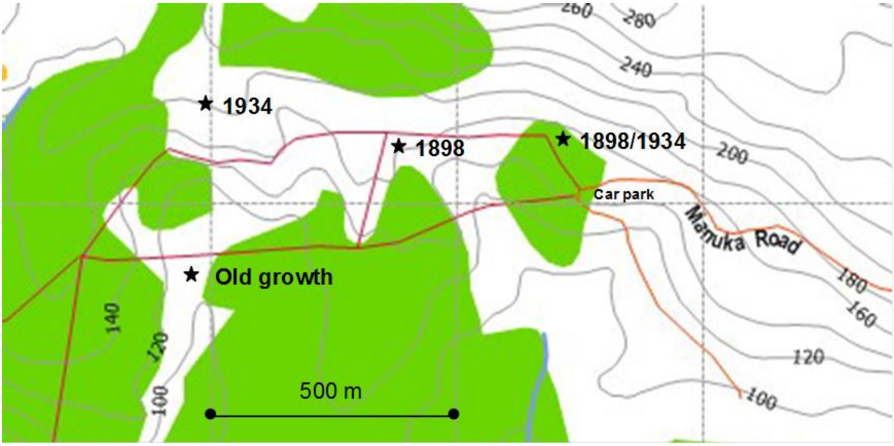


**Figure 1**. Position of the four plots along the 'Bird Track', Warra LTER site.

## MATERIALS & METHODS

All field work was conducted in tall, wet, native *E. obliqua* forest at the Warra LTER (long-term ecological research) site in southern Tasmania, west of Geeveston, an area of 15,900 ha that was designated in 1995 to encourage long-term ecological research and monitoring in wet forests in Tasmania (Brown et al. 2001). The plots used in the study reported here were all situated along a track north of the Huon River known as the 'Bird Track', and accessed from the car park at the western end of Manuka Road (Figure 1). Four plots of presumed known fire history were chosen along this track, the age since fire having previously been determined for the Warra LTER site (Hickey et al. 1999). In general terms, fire ages for these forests were determined by a combination of (1) tree coring to count growth rings, (2) identifying species compositions that correspond to particular fire-free intervals, (3) relating the diameter sizes of trees to age since their fire-stimulated germination and identifying any subsequent fire by their fire scars, (4) identifying species with known germination and life span history, and their responses to different fire intensities, and (5) using existing maps of fire history. The 'Bird Track' site had the advantage that it provided plots within walking distances of each other, with the same south-facing aspect and similar altitude, rainfall, temperature, and forest type. This ensured a high degree of similarity among the plots except for differing wildfire histories that resulted from the natural disturbance of stand-replacing wildfires at different times. Details about the four plots (latitude and longitude, slope, soil pH, soil % total nitrogen and % total phosphorus) can be found in Gates (2009).

The ages of the plots since wildfire had been determined, respectively, as 200-300 years, 108 years, 72 years and a plot that was burnt twice, i.e. it was within a 108 year old forest that was burnt again 36 years later (Turner et al. 2007). The names given to the plots at the time of their establishment in the year 2006, motivated by convenience but which reflected their wildfire history, were 'Old growth', (a forest that had not experienced a wildfire for at least two centuries),'1898' (believed to have been last burnt in the year 1898), '1934' (last burnt in the year 1934) and '1898/1934' (a plot that had been burnt both in 1898 and 1934), respectively.

The size of the plots in each of the wildfire histories was 50m x 50m, divided into 25 10m x 10m subplots using star pickets placed at 10m intervals at two opposite outer boundaries. The remaining corners of each subplot were marked with fibreglass rods, and twine was strung from the star pickets up and down the plot but not across. All vascular plants were identified and named to species level as given in Buchanan (2007). Using a diameter tape, stems of all sizes for all woody species were recorded. Stems ≥10 cm diameter for all species had their positions measured with respect to the plot boundaries so that they could be mapped in each plot. Hence, the final tabulation from each of the four plots contained, for each woody species, the diameters of all trees of all sizes and the coordinates of each tree whose diameter was at least 10 cm. The aim of this article is to show that a map giving the positions of the vascular plants in the forest plot may provide useful additional information about the plot's fire history.

## RESULTS & DISCUSSION

The information obtained about the vascular species present in each of the four 0.25 hectare plots examined in this survey consists of two components, one tabular and one visual. The tabular information appears in Table 1, which enumerates the number of records of each of the species present in the plot and the contribution that they make to the total basal area (BA) of the plot. The visual information appears in Figures 2a–d, which has four parts, one for each plot. As the positions of all woody species ≥10cm diameter are mapped in two dimensions, the exact location of each tree with respect to all other trees in the plot is pinpointed. Differences in tree size are not displayed, as the graphs involve different species of vascular plants which have different size ranges Therefore, the symbols used in Figures 2a–d are all approximately the same size. Also, to avoid clutter, only the nine most commonly occurring species are shown, but these account for almost all of the basal area of each plot. In the following paragraphs, each plot is considered in turn.

**'Old growth'**

There are only two *Eucalyptus obliqua* trees in the 0.25 hectare plot, but they occupy 54% of the basal area (see Table 1), as one of them is 350 cm diameter and the other is 230 cm diameter. These old eucalypts are moribund, and if fire continues to be excluded from this plot, these trees will persist as stags (i.e., standing dead trees) after their death or become part of the coarse woody debris that is present in and around the plot, the volume of which is largely made up of large, dead eucalypts. Aside from these two trees, the only other substantial contributors to the basal area (BA) are the 189 stems of *Nothofagus cunninghamii* ('myrtle') which collectively occupy 24.9% of the BA and the 216 stems of *Atherosperma moschatum* ('sassafras'), which accounts for a further 17.7% of the BA. This leaves only 3.4% BA for the remaining six species, of which the 5 stems of *Acacia melanoxylon* accounts for 3.0% BA. Thus, only four vascular species occupy more than 99% of the BA, highlighting the low diversity of forests that are either rainforests or tending towards becoming rainforests. The 'Old growth' plot closely fits the C-type classification, viz. "*Eucalyptus obliqua* over callidendrous rainforest" as found in the Warra LTER silvicultural systems trials (Neyland, 2001), located a few kilometres to the east of the Bird Track plots. Callidendrous rainforest is one of the types of cool temperate rainforest dominated either by myrtle or by sassafras (Jarman et al., 1984). In 'Old growth', these two species are present in approximately equal numbers irrespective of whether one counts the number of stems or uses BA to make the judgement. Visual examination of Figure 2a shows that these two rainforest species are fairly randomly distributed throughout the 50m x 50 m plot. This is consistent with the pre-existing information that fire has been excluded from this plot for a very long time.

**Table 1. Living tree species in each plot, number of records and %BA (basal area), listed in decreasing order of %BA of the total.**

‘Old growth’:
*Eucalyptus obliqua* (54.0%[1]; 2[2]; 350[3])
*Nothofagus cunninghamii* (24.9%; 189; 110)
*Atherosperma moschatum* (17.7%; 216; 80)
*Acacia melanoxylon* (3.0%; 5; 80)
*Eucryphia lucida* (0.4%; 8; 35)
*Anopterus glandulosus* (<0.1%; 4; 5)
*Coprosma quadrifida* (<0.1%; 5; 6)
*Phyllocladus aspleniifolius*(<0.1%; 1; 1)
*Pimelea drupacea*(<0.1%; 11; 1.5)
*Tasmannia lanceolata*(<0.1%; 1; 1.5)
Total 442 living stems

‘1898’:
*Eucalyptus obliqua* (66.3%; 19; 300)
*Pomaderris apetala* (11.5%; 193; 27.5)
*Nothofagus cunninghamii* (9.3%; 86; 65)
*Atherosperma moschatum* (5.7%; 50; 50)
*Acacia melanoxylon* (3.6%; 10; 60)
*Olearia argophylla* (3.3%; 37; 34)
*Phyllocladus aspleniifolius* (0.2%; 4; 18.5)
*Anopterus glandulosus* (<0.1%; 2; 1.5)
*Coprosma quadrifida* (<0.1%; 5; 4.3)
*Cyathodes glauca* (<0.1%; 1; 1)
*Monotoca glauca* (<0.1%; 2; 7.5)
*Pimelea drupacea* (<0.1%; 8; 1)
*Pittosporum bicolor* (<0.1%; 1; 7)
Total 418 living stems

‘1934’:
*Eucalyptus obliqua* (85.7%; 40; 230)
*Nothofagus cunninghamii* (6.0%; 167; 35)
*Monotoca glauca* (3.5%; 174; 21)
*Acacia melanoxylon* (2.2%; 18; 32.5)
*Acacia dealbata* (0.8%; 5; 31.5)
*Nematolepis squamea* (0.4%; 2; 25.5)
*Phyllocladus aspleniifolius* (0.4%; 22; 15.5)
*Tasmannia lanceolata* (0.3%; 29; 12.5)
*Pittosporum bicolor* (0.2%; 2; 23)
*Cyathodes glauca* (0.1%; 32; 8.5)
*Eucryphia lucida* (0.1%; 3; 18)
*Anopterus glandulosus* (0.1%; 33; 11.5)
*Atherosperma moschatum* (<0.1%; 3; 3)
*Coprosma quadrifida* (<0.1%; 7; 2.5)
*Pimelea drupacea* (<0.1%; 7; 1.5)
Total 544 living stems

‘1898/1934’:
*Eucalyptus obliqua* (73.9%; 39; 250)
*Pomaderris apetala* (17.2%; 832; 25.5)
*Acacia melanoxylon* (3.5%; 13; 70)
*Eucryphia lucida* (2.2%; 78; 36)
*Nothofagus cunninghamii* (1.6%; 155; 33)
*Atherosperma moschatum* (0.5%; 18; 17.5)
*Phyllocladus aspleniifolius* (0.4%; 54; 27)
*Olearia argophylla* (0.3%; 17; 9.5)
*Acacia verticillata* (0.1%; 3; 12)
*Anopterus glandulosus* (0.1%; 29; 10)
*Coprosma quadrifida* (0.1%; 28; 5)
*Cyathodes glauca* (0.1%; 29; 7)
*Aristotelia peduncularis* (<0.1%; 4; 3)
*Monotoca glauca* (<0.1%; 2; 1)
*Pimelea drupacea* (<0.1%; 20; 1)
*Pittosporum bicolor* (<0.1%; 1; 3)
*Tasmannia lanceolata* (<0.1%; 11; 6.5)
Total 1333 living stems

Note: [1]Percent basal area of the total; [2]Number of living stems; [3]Maximum diameter, cm.

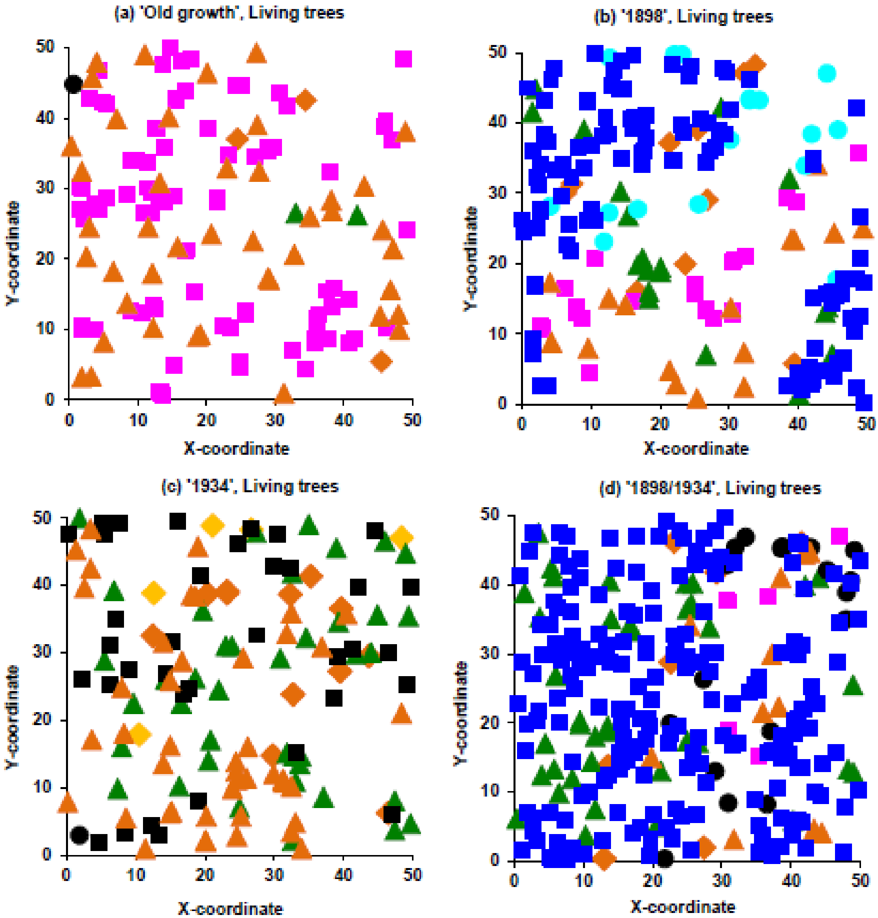


**Figure 2**. Positions of all trees ≥10 cm diameter, (a) 'Old growth' plot, (b) '1898' plot, (c) '1934' plot, (d) '1898/1934' plot. The symbols representing the tree species are as follows: *Acacia dealbata* (◆), *Acacia melanoxylon* (◆), *Atherosperma moschatum* (■), *Eucryphia lucida* (●), *Eucalyptus obliqua* (▲), *Monotoca glauca* (■), *Nothofagus cunninghamii* (▲), *Olearia argophylla* (●), *Pomaderris apetala* (■).

**'1898'**

From the tabular information in Table 1, we see that there are six species that account for more than 99% of the BA. These include the four species that were also prominent in the 'Old growth' plot, to which *Pomaderris apetala* (11.5% BA) and *Olearia argophylla* (3.3% BA) have been added. Although *P. apetala* accounts for only 11.5% of the basal area, its 193 stems make up 46.2% of the number of living trees in the plot. This small tree, the largest of which in this survey had a diameter of 27.5 cm, is an occasional component of eucalypt-dominated wet forests or the margins of rainforest and was a common component of the understorey on high fertility soils in the *Eucalyptus regnans*-dominated forests in the Florentine Valley where there was a moderate fire frequency (1–2 fires per century)(Gilbert 1959). The map of the '1898' plot (Figure 2b) presents an entirely different picture from that presented by the 'Old growth' plot (Figure 2a), due to the presence of *P. apetala* and to a lesser extent *O. argophylla*, and, more particularly, the positions in the plot where they occur. These two species are prominent in a broad area in the upper left-hand corner of the plot and in a narrower area in the lower right-hand corner. Interspersed with these two species are stems of *E. obliqua* and *A. melanoxylon*. The presence of *P. apetala* in these areas contradicts the belief that the '1898' plot had its last fire in 1898, as determined in the preliminary fire assessment of the area at the time of establishment of the research plots (Turner et al. 2007). Core samples (see Gates, 2009, Figure 2.6, p. 26) taken from the '1898' plot showed that the oldest *P. apetala* trees were 72 years old, thereby dating them as having been established in the year 1934. The two major rainforest species *N. cunninghamii* and *A. moschatum* are notably absent from the areas with abundant *P. apetala*. Instead, they occur exclusively in a band extending from the middle upper right-hand corner of the plot to the central lower area and also near to the left-hand boundary of the plot. Therefore, the '1898' plot is not of a single forest type, but consists of at least two portions, the one with abundant *P. apetala* burnt 72 years before the study commenced, and the other portion that had been unburnt for a much longer period of time and which contains all 16 of the *N. cunninghamii* trees and all 27 of the *A. moschatum* trees that are ≥10 cm diameter. Also surviving in this latter region is a cluster of E. obliqua trees, three of which are of large diameter (80, 85 and 120 cm).

**'1934'**

The '1934' plot is very different from the other plots of this study. The tabular listing (Table 1) shows that the most frequently occurring species is *Monotoca glauca*, with 174 stems (32% of the individual trees), although in terms of basal area it accounts for only 3.5% of the total BA, the vast majority of the trees being less than 10 cm diameter. This species is spread out over the whole of the plot (Figure 2c). There is also an almost complete absence of *A. moschatum*, there being only 3 stems, the largest of which is only 3 cm diameter. Although the other main rainforest species, *N. cunninghamii*, is abundant there (167 stems), 73% of these are less than 10 cm diameter. Table 1 shows that the main contributor to the overall basal area is *E. obliqua*, accounting for 85.7% of the BA, which is by far the largest percentage of any of the four plots. Aside from *E. obliqua*, *M. glauca* and *N. cunninghamii*, only *Acacia melanoxylon* and *A. dealbata* contributed more than 0.5% to the BA, as the other 10 tree species collectively add only 1.8% to the overall BA. The main factor differentiating the '1934' plot from the other three plots is that this plot is situated on a sandstone outcrop, whereas the other plots are on dolerite. The forest type that best describes the '1934' plot is WET-OB101 of the Forest Botany Manual (Forest Practices Authority 2005), which is one of the examples of a tall *E. obliqua* forest that occurs at low altitudes on low fertility soils. WET-OB101 contains the floristic community *E. obliqua–N. cunninghamii–Monotoca glauca*, which describes the main components perfectly. This forest type may contain a variety of understorey species. The keys for WET-OB101 in the Forest Botany Manual (Forest Practices Authority 2005) state the following: "leatherwood (*Eucryphia lucida*), celery-top pine (*Phyllocladus aspleniifolius*), horizontal (*Anodopetalum biglandulosum*) and native laurel (*Anopterus glandulosus*) sparse or absent", which was certainly true for the '1934' plot at the start of this study, but these keys also state that "dogwood (*Pomaderris apetala*), musk (*Olearia argophylla*), lancewood (*Nematolepis squamea*) or prickly moses (*Acacia verticillata*)" is common, none of which is true for '1934'. This merely illustrates the great variability of Tasmanian forests, and how vascular species may be present in one representative of a forest type, and replaced by another species in other examples of that forest type. Because soils derived from sandstone are of lower fertility and lower pH (the measured pH of the '1934' plot was 4.3, the lowest of any of the four plots) than soils derived from dolerite, they are not able to support *Pomaderris apetala*, which requires the more fertile soils derived from dolerite (Forest Practices Authority 2005). Transects in the *Eucalyptus regnans*-dominated forests of the Florentine Valley also contained *M. glauca* when soil fertility was low and fire frequency was moderate (Gilbert 1959).

**'1898/1934'**

The fire assessment revealed that the '1898/1934' plot had two fires, the first of which occurred in 1898 (i.e. 108 years before the start of this study) and the second of which occurred in 1934. Figure 2d shows that *Pomaderris apetala*, which appears frequently in wildfire regeneration sites in Tasmania (Hickey 1994), is widespread throughout the plot, the only sparse area for that species being an approximate 10m x 10m square located between the 30 & 40 metre markers in both the X and Y coordinates. In this same area are three sassafras (*A. moschatum*) trees, the largest of which has a diameter of 17.5 cm. This small size compared with the maximum diameter of sassafras in 'Old growth' (80 cm) and in '1898' (50 cm) is consistent with the fact that the more recent fire in 1934 has retarded its establishment and growth, although some degree of secondary regeneration of this rainforest species does occur in Tasmanian mixed forests (Hickey 1994). Similar observations may be made about myrtle (*Nothofagus cunninghamii*), which has 155 stems in the '1898/1934' plot but they tend to be much smaller than those in 'Old growth' or '1898' (Table 1). Along with sassafras, myrtle appears more frequently in the right-hand half of Figure 2d than in the left-hand half. Furthermore, leatherwood (*Eucryphia lucida*), a species that likes high rainfall and low fire frequency, is also more concentrated in the right-hand half of Figure 2d than in the left-hand half. This suggests that either the 1898 fire or the 1934 fire, or both, may have been less intense in the right-hand half of the '1898/1934' plot than in the left-hand half.

## CONCLUSIONS

We have shown here that gathering information on the occurrence, size and location of the vascular plants of a forested area can reveal additional information about the forest's fire history. Of particular interest was the fact that previous assessments of the fire history of the Bird Track plots, based upon earlier maps of the fire history and on fire scars on *E. obliqua* trees, did not discover that there was a second fire in part of the '1898' plot. Although one could count the number of stems of each vascular species present, and list them without mapping them, it is unlikely that a mere listing would reveal the underlying anomalies. The visual impact of the map of the vascular plants also leads to a greater appreciation of how wildfire affects the distribution of the vascular species within the plot and has the potential of revealing further aspects of the fire history. We have seen that the '1898/1934' plot is not homogeneous with respect to its vascular plant composition, and that this probably has its explanation in its fire history, resulting in half of the plot having many more rainforest species than the other half. In the absence of the mapping of the positions of the trees, it is unlikely that this implied difference between the fire intensities in differing portions of the plot would have been detected. Mapping also helps to highlight the erratic nature of a wildfire that is not stand-replacing. Although editors of scientific journals, and their reviewers, like to emphasize the importance of replication in scientific research, the great variability in floristic composition that exists in Tasmanian forests renders it almost impossible to achieve satisfactory replication of plots within a given forest type. Dividing a plot up into subplots is generally frowned upon, as it is rightly considered to be pseudoreplication. However, measurements made on the individual trees within the subplots may reveal major differences among the floristic composition or stand structure at the subplot level. Correlating these differences with other measurements made in the subplots, such as the species richness or diversity of its fungi, mosses or liverworts, for example, is one way of obtaining useful scientific information from forest plots when satisfactory replication of a given forest type is not possible.

REFERENCES

Brown, M.J., Elliott, H.J. & Hickey, J.E. (2001). An overview of the Warra Long-Term Ecological Research Site. *Tasforests* 13(1):1–8.

Buchanan, A.M. (2007). *A Census of the Vascular Plants of Tasmania & Index to The Student's Flora of Tasmania.* Tasmanian Herbarium, Tasmanian Museum & Art Gallery: Hobart, Tasmania.

Forest Practices Authority (2005). *Forest Botany Manual*. Forest Practices Authority, Tasmania.

Gates, G.M. (2009). Coarse woody debris, macrofungal assemblages, and sustainable forest management in a Eucalyptus obliqua forest of southern Tasmania. Ph.D. Thesis, University of Tasmania.

Gilbert, J.M. (1959). Forest succession in the Florentine Valley, Tasmania. *Papers & Proceedings of the Royal Society of Tasmania* 93: 129–151.

Hickey, J.E. (1994). A floristic comparison of vascular species in Tasmanian oldgrowth mixed forest with regeneration resulting from logging and wildfire. *Australian Journal of Botany* 42: 383–404.

Hickey, J.E., Su, W., Rowe, P., Brown, M.J. & Edwards, L. (1999). Fire history of the tall wet eucalypt forests of the Warra ecological research site, Tasmania. *Australian Forestry* 62: 66–71.

Jarman, S.J., Kantvilas, G. & Brown, M.J. (1984). *Rainforest in Tasmania*. National Parks and Wildlife Service, Tasmania. 201 pp.

Neyland, M.G. (2001). Vegetation of the Warra silvicultural systems trial. *Tasforests* 13(2): 183–192.

Turner, P., Grove, S.J. & Airey, C. (2007). *Wildfire chronosequence project establishment report.* Division of Forest Research and Development, Forestry Tasmania.