Seedfall of *Eucalyptus obliqua* at two sites within the Forestier silvicultural systems trial, Tasmania

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Abstract

Seedfall data are presented for Eucalyptus obliqua *from over a seven-year period from two sites within the Forestier Peninsula silvicultural systems trial in south-eastern Tasmania. The data are gross seedfall, being the sum of free seed and seed that fell in capsules. There was a significant difference in the gross annual seedfall of the two* E. obliqua *populations studied, with greater seedfall occurring on the ridge than in the nearby gully. There was no correlation between the seedfall at the two sites, nor could any relationship between the local climate and the pattern of seedfall be determined. While this is thought to be the longest eucalypt seedfall study reported, one of significantly longer duration would be required to determine the major influences on patterns of seed production and seedfall in* E. obliqua.

Introduction

Eucalyptus obliqua L'Hérit. (brown-top stringybark) is widely distributed in the cooler, southern parts of eastern Australia and is one of the most important hardwoods of Australia (Boland *et al*. 1984). Tasmania has 425 000 ha of tall *E. obliqua* forest and 164 000 of dry *E. obliqua* forest (Public Land Use Commission 1996). The silvicultural system applied to tall wet forest in Tasmania, including tall *E. obliqua* forest, is clearfell, burn and sow (Hickey and Wilkinson 1999), although alternative systems based on partial harvesting and natural seedfall are being trialled (Hickey *et al.* 1999; Neyland *et al.* 1999; Bassett *et al.* 2000). In dry *E. obliqua* forest, partial harvesting systems, including advance growth and seed tree retention, are more commonly applied (Hickey and Wilkinson 1999).

Most published material concerning eucalypt seedfall is based on *E. regnans* and to a lesser degree, *E. delegatensis,* but some parallels may be, and often are, drawn for *E. obliqua*. Mann (1955) found that seed in *E. regnans* and *E. obliqua*/*E. radiata* stands was shed in two main periods: from September through to December and from March through to May. Gilbert (1958) reported a general biennial pattern of heavy and light seed years for Tasmanian *E. regnans* forests. Cremer (1966) and Campbell *et al.* (1990) found that natural seedfall from *E. regnans* is greatest following hot, dry periods in late summer and autumn. Cunningham (1957) reported a definite seasonal peak of seedfall in regrowth *E. obliqua* forests for the hottest months (January and February) of both 1953 and 1954. Cunningham (1957) also reported a sequence of highly variable heavy and light seed years. All the above studies were based on short (less than three years) sampling periods. Wide variation in the amount of seedfall in different years from other eucalypt species has also been reported (Bassett 1995).

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The Forestier silvicultural systems trial (Neyland *et al.* 1999) was established in 1987. At the completion of harvesting (April 1989), seed traps were established in two sites, a dry *E. obliqua* forest on a ridge top and a wet *E. obliqua* forest in a nearby gully. The two sites are separated by about 600 m. This study examined variation in the relative amounts and periodicity of seedfall from the two sites over a seven-year period. The aim was to better understand the likelihood of adequate natural seedfall for regeneration establishment in partial harvesting systems in wet and dry *E. obliqua* forests.

Methods

Study site

The study site is located in coupe FT002D on the Forestier Peninsula (Figure 1) in south-eastern Tasmania. The site lies within the humid warm / moist subhumid warm climatic zones as defined by Gentilli (1972). It has an annual rainfall of approximately 900 mm and an altitudinal range between 200 and 270 m.

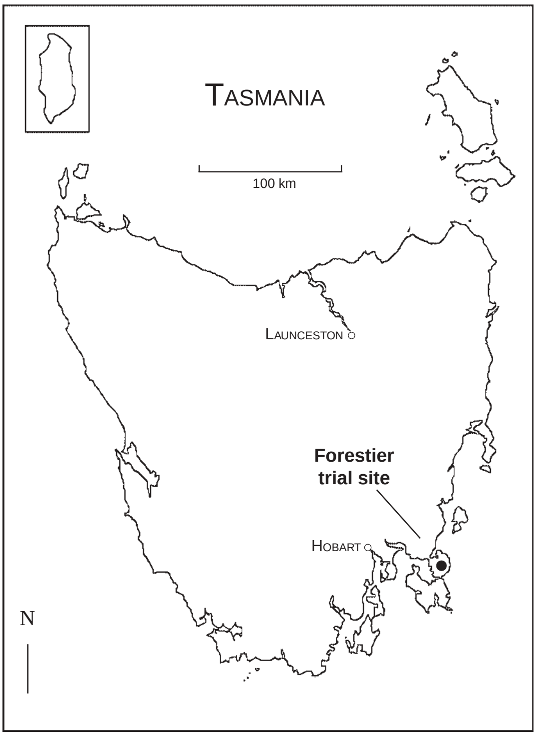

Figure 1. Location of the Forestier trial site in south-eastern Tasmania.

The forest is predominantly 60- to 80-year-old regrowth arising from selective logging and wildfires between 1900 and 1920. Scattered oldgrowth trees are also present. The forest has an average height of between 27 and 41 m. The ridge population is a shrubby *E. obliqua* community (Duncan and Brown 1985) with large open-crowned *Eucalyptus obliqua* and *E. amygdalina,* with a short, open scrub understorey of *Lomatia tinctoria, Epacris impressa, Goodenia ovata* and *Pteridium esculentum*. The gully population, about 600 m away, is *E. obliqua – Acacia dealbata – Olearia argophylla* wet sclerophyll forest (Kirkpatrick *et al.* 1988), with dense, tall *E. obliqua,* typically with small crowns, and an understorey of *Pomaderris apetala, Acacia verticillata, Olearia argophylla, Dicksonia antarctica* and occasional *Acacia melanoxylon* and *Atherosperma moschatum*.

Seed traps

Four sets of paired 1 m^2 traps were located in both the ridge and gully populations, with traps numbered 1–8 and 9–16 respectively (Figure 2). The first trap of each pair was established immediately under one or more large crowns. The second trap was placed about four metres away. The traps were subjectively located beneath large crowns to ensure enough seed was trapped for trends and patterns to emerge; it was recognised that this approach was not appropriate for determining average seedfall per hectare. As the traps were placed deliberately beneath large *E. obliqua* crowns and well away from trees of other *Eucalyptus* species, it is considered unlikely that seed of the other eucalypts present on the site was captured by the traps.

The funnel-shaped traps (Photo 1) were made of lightweight reinforced PVC fabric, with 0.6 mm mesh in the bottom of the trap to allow rainwater, but not seed, to escape. This funnel was hung over a 10 mm steel-

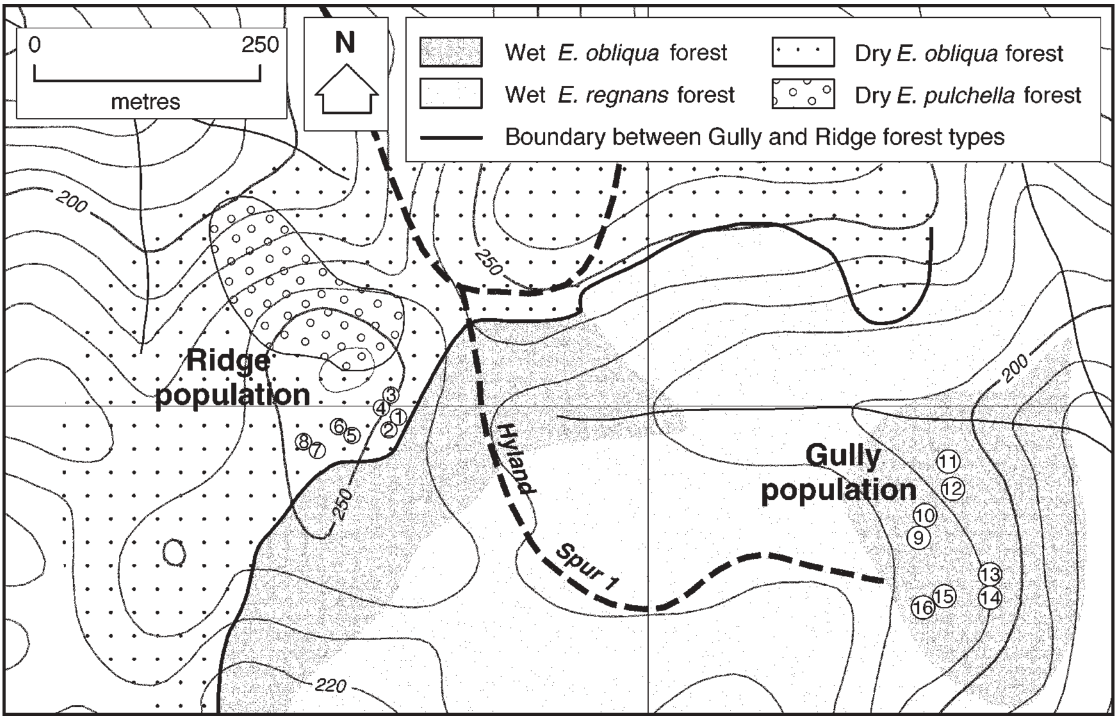

Figure 2. Location of the seed traps within the ridge and gully populations.

rod ring. The frame was supported by three 10 mm steel-rod legs buried 20 cm into the ground. The traps were lightweight, cheap to construct, had no moving parts and were easy to empty and repair.

The trap contents were collected into brown paper bags every two months, so each collection actually represents the seedfall for the two months prior to the sampling time (i.e. the January collection includes seedfall from December and January). This period is referred to as a bimonth in this study. Because sampling commenced at the end of July and the sample represented seedfall for June and July, a collecting year in this study extends from the start of June to the end of May. The sorting process began in the field, where large twigs were rejected. The bags were air dried for a month and then leaves and dust were sieved from the seed-bearing material. A count of capsules was taken at the sorting stage and any seed enclosed was removed from the capsule and added to the chaff mix. Therefore, the data presented

Photo 1. Vinyl seed traps being established at Forestier.

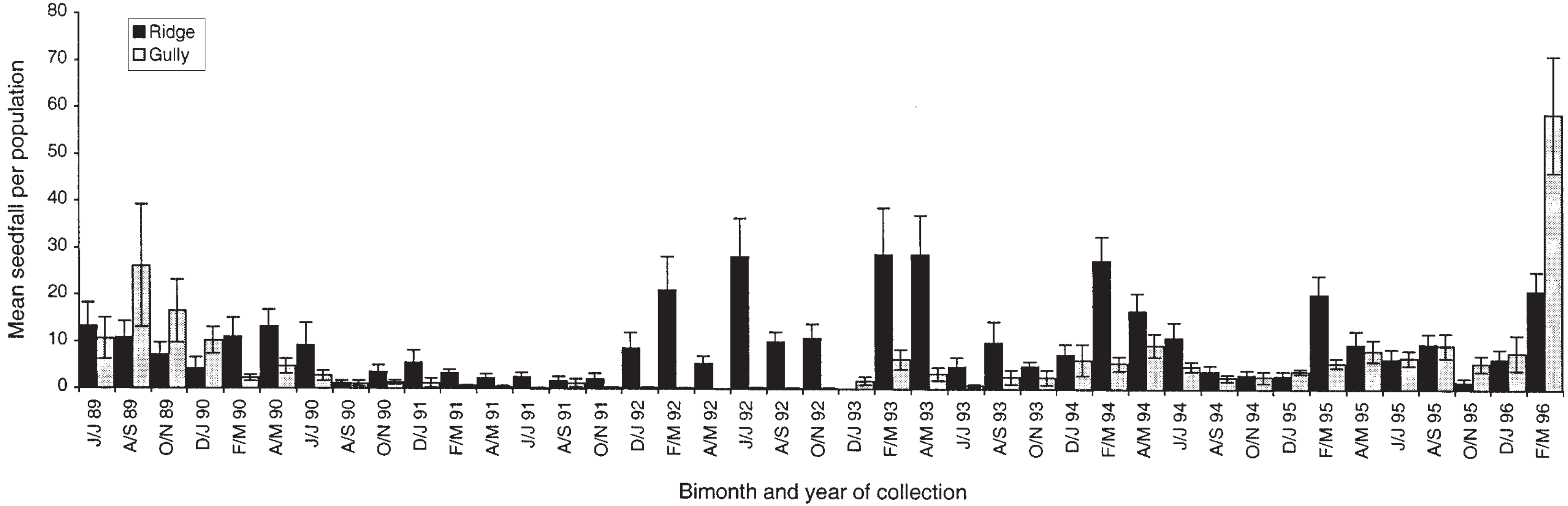

Figure 3. Mean bimonthly seedfall by population (error bars show ± one standard error).

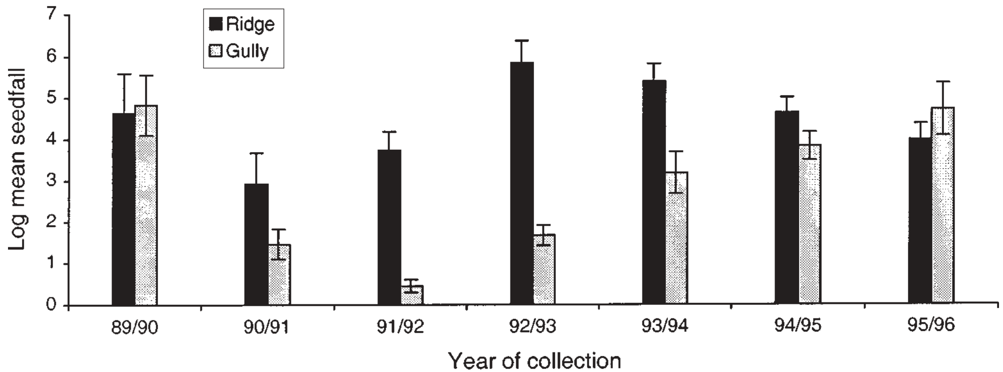

Figure 4. Mean annual seedfall by population (log-transformed; error bars show ± one standard error).

in this paper represent gross seedfall (i.e. seed that fell freely and seed that fell within capsules). It is estimated that less than 2% of the gross seedfall came from seed that fell within capsules.

The chaff mix was set out in large trays, moistened and stratified for two weeks at approximately 2ºC. The trays were then placed in a germination chamber at approximately 18ºC, under a 24-hour light regime. Germination of most of the viable seed occurred within seven days and was 95% complete after 21 days. Germinants were counted and results recorded. The final dataset comprises the number of viable seeds collected from each trap over each two-month sampling period (bimonth).

Data analysis

The mean and standard error of the mean, of the seedfall for each population (each set of eight traps) was calculated for each bimonth and for each year of collection. To reduce the influence of outliers in the sample, log-transformed values were used to compare the seedfall between the two populations for each year of collection. Standard errors, where calculated, were based on the raw data from each of the eight traps within each population and are not pooled estimates as used in ANOVA.

Relationships between seedfall and local and regional climate were explored using on-site rainfall and temperature records and meteorological data for Orford (40 km north of the Forestier site), Bream Creek (20 km N), Copping (20 km N) and Dunalley (10 km north-west).

Results

Amount of seedfall

The mean bimonthly seedfall for both the ridge and gully populations is shown in Figure 3. There was very little seedfall in the gully population for the period from 1990 to 1992, but otherwise there was always some seed falling in both populations. The ridge population had well-defined seedfall peaks in autumn, particularly in years 1992 through to 1996. Seedfall in the gully population was insufficient to show any seasonal trends. Seedfall from the ridge population was higher than that from the gully population for most bimonths. Over the whole collection period the ridge averaged 57 viable seeds per trap per annum compared to 34 for the gully. At the final collection from the trial, the gully population seedfall far exceeded the seedfall of any prior collection, suggesting that a major flowering event had taken place in the summer of 93/94. Whether or not this last seedfall heralded a major seedfall across the trial site is unknown as, unfortunately, no further collections were made.

Annual seedfall variation and correlation between the two sites

The mean annual seedfall for each population is shown in Figure 4. In five of the seven years sampled, the seedfall on the ridge was higher than the seedfall in the gully. There is no correlation between the bimonthly seedfall at the two sites.

Climatic effects

Seedfall variation was tested against rainfall and temperature records from the site and from each of four stations (Orford, Bream Creek, Copping, Dunalley) but no clear correlation was found between climate and seedfall trends. Initiation of flowering precedes seedfall by four or five years in *E. obliqua*, so seedfall in one year could be related to climate patterns from four or five years earlier. The data were searched extensively for such patterns but none were discerned.

Discussion

Eucalypt seed is not released (regardless of maturity) until the capsule has died and completely dried out (Cremer 1962). Under normal conditions, this is a result of an abscission layer forming across the base of the peduncle or pedicel, which cuts off the sap stream to the capsule, causing the capsule to ripen. Once the sap stream is blocked, the capsule dries out in a relatively short period of time (Cremer 1962). This takes several days in summer and a few weeks in winter. Therefore, the main pattern of seedfall is determined by the pattern of abscission layer production and dieback of branchlets. The desiccated capsule is most likely to drop seed in seasonally warm / dry periods (Cremer 1962), which correspond to the summer months in south-eastern Australia.

Climate may affect both the number of inflorescence primordia which are initiated and the developing seed crop (Florence 1996). No correlation was found here between climatic trends (maximum temperatures and rainfall) and seedfall patterns. Other factors must also be involved. Grose (1960) suggests that crown class is one of the most important factors. Dominants and co-dominants produce 80% of the seed in a forest stand (Grose 1960; Campbell *et al.* 1990). Intermediate and suppressed crowns, as present in the fully stocked, dense gully stand at the Forestier site, contribute only a small percentage of the overall seed crop. The ridge trees had larger crowns and are therefore potentially capable of producing a higher number of flowers and therefore seed. The absence of a correlation between the seedfall at the two sites, which are only 600 m apart, also suggests that other factors must be involved in determining seedfall. If recent climate was a key factor, then some correlation between the two sites would be expected.

The data suggest that seedfall in the ridge population may be more consistent from year to year than seedfall in the gully, which appeared to be at very low levels throughout the trial, with the notable exception of the final measurement, at which time a massive amount of seed fell.

Conclusion

The amount of seedfall per unit area (hectare) could not be accurately calculated from the data collected during this study. Owing to the subjectivity of the seed-trap locations, any seedfall estimate would be grossly overestimated. However, it appears that the volume of seedfall in the ridge population is sufficiently consistent to allow satisfactory regeneration from natural seedfall in most years, whereas natural seedfall from the gully population may be inadequate in some years. Local assessments of the standing seed crop remain important where regeneration is dependent on retention of seed trees.

This trial was run for a seven-year period, which is longer than any other known study of seedfall in *Eucalyptus obliqua* or *E. regnans*. However, Figure 3 indicates that the largest seedfall to occur over the life of the trial was occurring as the trial ended. This, and the lack of a discernible relationship between seedfall and climatic patterns, suggests that elucidation of any relationship between climate patterns and seedfall would require a study of much longer duration.

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