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Seed production in jarrah forest

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Background

An adequate seed supply is one important component for regenerating jarrah forest after timber harvesting or disturbances such as high intensity bushfires and severe storms. Harvested jarrah forest is regenerated by managing the innate regeneration capacity of jarrah (*Eucalyptus marginata*) – the tree's ability to develop from seed, lignotuberous seedlings to ground coppice, and also to coppice from stumps. Where the stocking of ground coppice and saplings is inadequate to re-establish a stand after harvesting, suitable trees are retained in a shelterwood to provide seed and maintain other forest values while the regeneration develops. Shelterwood stands are burnt after harvesting to promote seed-fall, to develop a receptive seed-bed for seedling establishment, and to stimulate growth of lignotuberous seedlings. A substantial crop of seed in the tree crowns contributes to successful shelterwood regeneration. Stand basal area, the cross-sectional area of the tree boles on a stand, affects the growth of trees and associated attributes such as leaf area, biomass and seed production. The trees retained in a shelterwood provide a stand basal area of 8 to 10 m^2/ha in the intermediate to high rainfall zones (> 900 mm/yr) and 6 m^2/ha in the low rainfall zone (< 900 mm/yr).

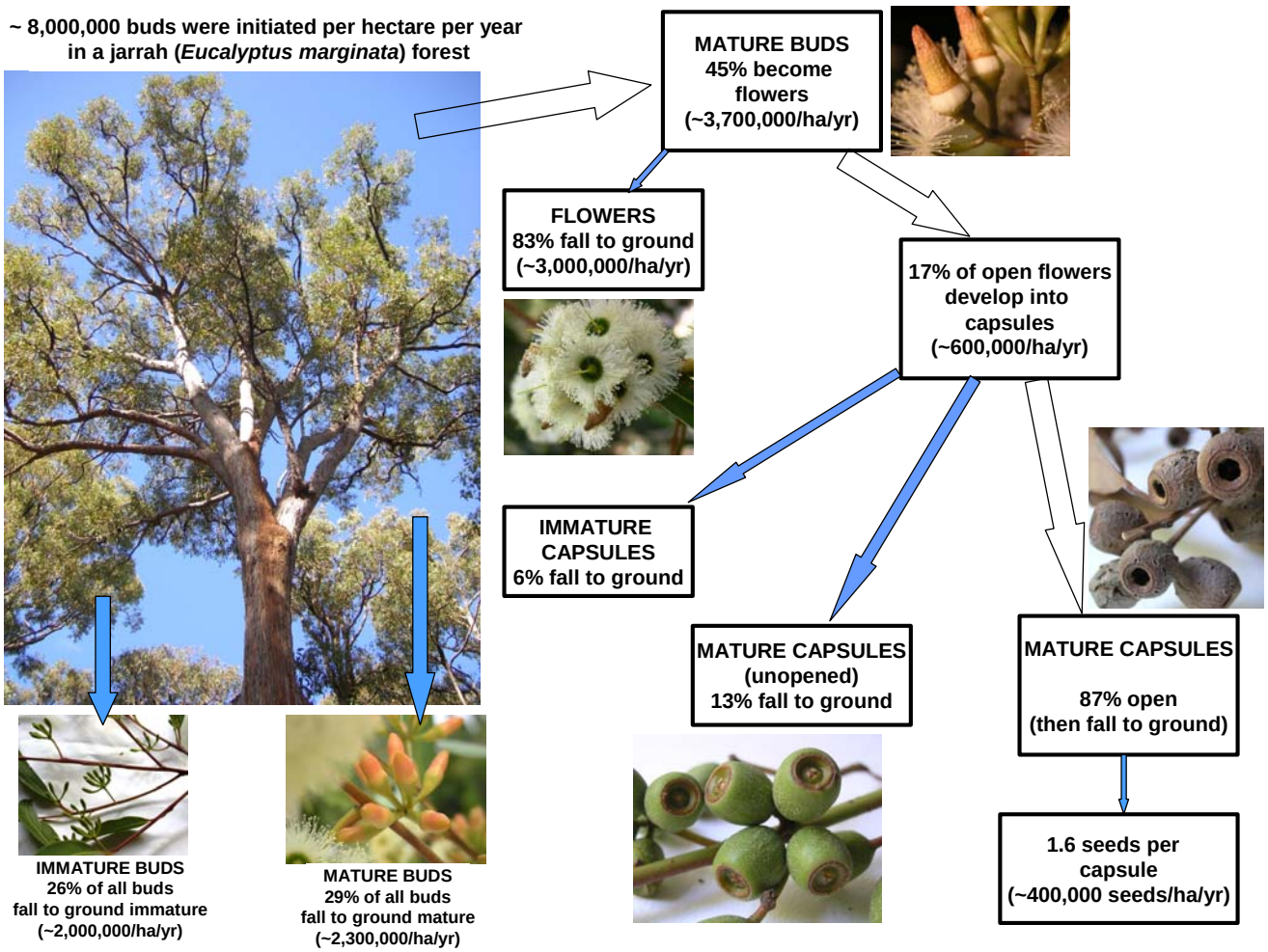
We studied the fall of the reproductive parts, from bud initiation through to seed-fall, in order to better understand the effect that stand density has on seed production and to identify the best times to predict the size of the future seed crop. Flower buds, flowers, opercula, capsules and seed that fell into 90 seed traps in the jarrah forest near Dwellingup were collected, sorted, counted and weighed each month from February 1994 to July 1997.

Findings

The cycle of jarrah seed production begins in summer to early autumn when new flower buds are initiated along branches from the current and previous season's growth. Flower buds then open late in the next spring and the following summer. Once flowers are pollinated, seed capsules then develop and ripen over early winter. Seed fall commences about one year after flowering, i.e. 21 months after the flower buds first appeared. Good seed crops do not occur every year and it is thought that it is four to seven years between major seeding years in jarrah.

The mean annual fall of reproductive parts on the study site was 423 kilograms per hectare per year, which is approximately six per cent of the estimated total annual biomass production, and 10 per cent of the estimated total litterfall. Only four kilograms (about one per cent) of this was jarrah seed. As jarrah seed are light, weighing around nine milligrams each, the average production of jarrah seed was 429,000 seeds per hectare per year.

Although the fall of opercula, flowers and seed followed a regular seasonal pattern with seed-fall peaking between November and February, there were massive losses of reproductive parts through the earlier developmental stages. While an average of 3.7 million flowers opened per hectare, 55 per cent of jarrah flower buds fell before they had a chance to flower, leaving only 45 per cent of the flower buds to complete their development. High levels of bud abortion have also been observed in karri (75 per cent) and eastern states Eucalypts *(E. sieberi,* 44 per cent; *E. globoidea*, 67 per cent; *E. regnans,* 50 per cent). For jarrah, losses through the early development stages mean that only seven per cent of buds that were initiated completed development to set seed. These losses complicate estimation of the future seed crop. Because losses through the early development stages are so variable, the final seed crop can only be accurately estimated once the capsules have begun to form.



Observations of the mean fall of various reproductive parts at one site in the northern jarrah forest showed that massive losses occur through the seed production cycle. Only seven per cent of buds open and flower and complete the cycle to develop and set seed (All photographs, other than the jarrah tree, by Linda Manning).

Seed production on jarrah forest stands was not greatly affected by stand basal area. Seedfall was reduced at very low stand basal areas and increased rapidly up to a basal area of 10 m^2/ha (in the intermediate rainfall zone). Seedfall reached 99 per cent of the maximum seed-fall at a basal area over bark of 13 m^2/ha; further increases in basal area did not substantially increase in seed production.

Management Implications

Seed crops can be reliably estimated after flowering, once seed capsules have begun to form. Predictions of future seed crops made during the bud development and flowering stages will be unreliable because of the potentially high losses that occur between these stages and the final seed-fall. Seed forecasting can be undertaken with relative confidence in the later stages of flowering (typically February), or with a high level of confidence once capsules have begun to form shortly after flowering (typically February to March) and then through to commencement of the new seed-fall (typically September).

The high rates of jarrah seed production found in this study (on average > 400,000 seed per hectare per year), even at relatively low stand basal areas of 13 m^2/ha of basal area over bark, and the potentially high rates of germination and emergence under favourable conditions, indicate that following a good seed year, survival and growth of seedlings are likely to be the factors determining regeneration success. Consequently low to moderate stand densities (on the particular stands we studied 9 to 18 m^2/ha of basal area over bark) would be prescribed for shelterwood cut areas.

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