Dispersal and establishment of bird-dispersed weed and native species in early successional subtropical habitats

Eve White, Anna Barnes and Gabrielle Vivian-Smith
Alan Fletcher Research Station, Biosecurity Queensland, DPI and F and CRC for Australian Weed Management, PO Box 36, Sherwood, Queensland 4075, Australia
Email: eve.white@dpi.qld.gov.au

Summary This study investigated patterns of dispersal and establishment of bird-dispersed weeds and native species in early successional habitats in northern New South Wales. Patterns varied among growth forms, between native species and weeds, and among vegetation types. Results indicate that seed rain is not necessarily a good predictor of recruitment; post-dispersal factors, such as microsite characteristics, may be more important influences on seedling recruitment. This knowledge will assist with designing management strategies for bird-dispersed weeds in natural areas.

Keywords Frugivory, seed dispersal, recruitment, seedling establishment.

INTRODUCTION

Bird-dispersed weeds pose a unique problem to land managers owing to the complexity of interactions between multiple frugivore species and multiple weed and native species. The manipulation of dispersal of bird-dispersed weeds has been suggested as part of an integrated weed management strategy (Gosper *et al*. 2005). Since the aim of land management in natural areas is usually to reduce weeds whilst facilitating establishment of native species (which are likely to be dispersed by the same suite of frugivores as the weeds), it is vital to take dispersal and establishment patterns of native, as well as weed species, into account when designing such management and restoration strategies. This study aims to improve our knowledge of dispersal and establishment processes for bird-dispersed weed and native species in subtropical eastern Australia. Specifically our aims were to determine: (1) whether dispersal patterns differ between weeds and native species and among early successional subtropical habitats, and (2) the degree to which recruitment can be predicted by seed rain composition for bird dispersed weeds and native species.

MATERIALS AND METHODS

Study sites Sampling was conducted in nine study sites, i.e. three replicates representing each of three common early successional habitat types in the former 'Big Scrub' region of Northern New South Wales: (1) Tree regrowth: areas in which a mixture of native and exotic tree species (particularly *Cinnamomum camphora* (camphor laurel)) have established autogenically since the mid-1900s following land clearing. Each site was at least 2 ha in size. (2) Shrub regrowth: Shrubby vegetation dominated by exotic *Solanum mauritianum* (wild tobacco), on previously cleared land. This vegetation typically occurs on roadsides and as edge habitat adjacent to tree regrowth. Each site was linear and <1 ha in size. (3) Native plantings: Native restoration plantings were comprised of a mixture of native tree and shrub species which were planted six to 10 years prior to sampling, on previously cleared land. One replicate was <1 ha in area whilst the others each covered ~2 ha.

All sites were adjacent to farmland and were within 1.5 km of a remnant rainforest patch.

Methods Seedling surveys and seed trapping were conducted at sampling stations beneath the canopy of dominant bird-dispersed species at each site. Each tree regrowth site had 24 sampling stations, 12 beneath *C. camphora* trees, and 12 beneath the canopy of native *Guioa semiglauca* (Guioa). Twelve sampling stations were set up in each shrub regrowth site, beneath the canopy of *S. mauritianum* shrubs. The number of stations in native plantings ranged between 13 and 23, and stations were positioned beneath the canopy of the two dominant bird-dispersed native species within each site; these species varied among sites.

This study focused on dispersal and establishment of a subset of species found in the area: the 10 most common bird-dispersed exotic species, including trees: *C. camphora* and *Ligustrum lucidum* (large leaf privet), shrubs: *S. mauritianum*, *Ligustrum sinense* (small leaf privet), *Lantana camara* (lantana), and *Phytolacca octandra* (inkweed), and vines: *Asparagus plumosus* (asparagus fern), *Passiflora subpeltata* (white passionflower) and *Passiflora suberosa* (corky passionflower), and the 15 most common bird-dispersed native species, namely, trees: *Acacia melanoxylon*, *Mallotus philippensis*, *G. semiglauca*, *Alphitonia excelsa*, *Commersonia bartramia* and *Ficus* spp. (largely *Ficus coronata*), shrubs: *Omolanthus populifolius*, *Pittosporum undulatum*, *Rubus rosifolius*, *Aphananthe philippinensis*, *Trema aspera* and *Alpinia caerulea*, vines: *Stephania japonica*, *Cissus antarctica*, *Maclura cochinchinensis* and *Gietonoplesium cymosum*.

At each sampling station, we recorded the number of seedlings and saplings of the species listed above within two 1 m × 1 m quadrats.

Seed traps constructed from seedling trays were placed at each station. We sampled a total area of 0.53 m^2 per station in tree regrowth sites and 0.36 m^2 per station in other habitats. Traps were emptied monthly. All seeds without flesh were assumed to have been deposited by frugivores, and were identified and counted. Here we present results based on the first six months' data collection as part of an ongoing study. Data presented were collected between March and August 2007, coinciding with the fruiting season for most bird-dispersed weeds in the region.

Data analysis Analyses were performed in Systat v. 11. We pooled all monthly seed rain data and excluded from analysis records of seeds and recruits of conspecifics of the canopy species under which each sampling station was positioned. Species were assigned to the following categories: Exotic tree, native tree, exotic shrub, native shrub, exotic vine, and native vine. For each species category we performed Kruskal-Wallis tests to determine whether differences existed among habitats for the following variables: (1) mean density per 0.25 m^2 for (a) seed rain and (b) recruits, and (2) mean species richness per 0.25 m^2 for (a) seed rain and (b) recruits (species richness is briefly discussed but data are not presented in a figure). No statistical results are presented, but significant differences (at the 0.05 level) are indicated by letters in Figure 1.

We compare existing recruit composition to current seed rain, thereby making the assumption that seed rain is similar between years.

RESULTS

Exotic trees Tree regrowth sites received greater numbers of exotic tree seeds than did other habitats. Shrub regrowth and native plantings received similar numbers of exotic tree seeds (Figure 1a). Seed rain species richness was similar among habitats. Recruits showed a different pattern (Figure 1b): both density and species richness of recruits were similar between tree regrowth and native plantings. Recruit density and species richness were lowest in shrub regrowth sites.

Native trees Native tree seeds were dispersed in higher numbers (and with higher species richness) within native plantings than other habitats. Seed rain density (Figure 1a) and species richness was similar between shrub and tree regrowth habitats. The highest density and species richness of recruits, however, was recorded in tree regrowth sites (Figure 1b). Density and species richness of native tree recruits were similar between native plantings and shrub regrowth sites.

Exotic shrubs Plantings and shrub regrowth sites received similar numbers and species richness of exotic shrub seeds. Tree regrowth sites received significantly fewer seeds (and had a lower species richness) than other habitats (Figure 1a). However, recruitment for this group was similar (both in terms of density and species richness) among tree regrowth and shrub regrowth sites. Lowest recruit densities (Figure 1b) and species richness occurred in native plantings.

Native shrubs A lower number and species richness of native shrub seeds were deposited within shrub regrowth sites than in other habitats (Figure 1a). The highest species richness for native shrub seeds was recorded in native plantings. However, recruits occurred in similar densities (Figure 1b), and with similar species richness in all habitats.

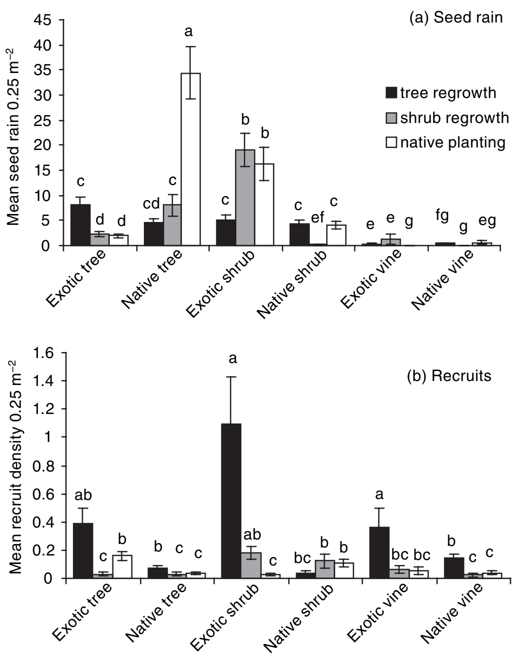

Figure 1. Mean density of (a) seed rain and (b) recruits per 0.25 m^2 (± SE) for different growth forms of native species and weeds in early successional habitats. Bars with the same letter are not significantly different from one another (at the 0.05 level).

Exotic vines Native plantings received lower numbers and species richness of exotic vine seeds than did other habitats. Density (Figure 1a) and species richness of seed rain were similar among tree and shrub regrowth sites, but tree regrowth had the highest density and species richness of recruits. Neither recruit density (Figure 1b) nor species richness varied between plantings and shrub regrowth sites.

Native vines Density and species richness of native vine seed rain in shrub regrowth sites did not differ from those recorded in tree regrowth or planted sites. Planted sites had both higher seed rain density (Figure 1a) and species richness than tree regrowth sites. Tree regrowth habitat, in contrast, had the highest recruit density and species richness. Recruit density (Figure 1b) and species richness were similar between shrub regrowth and planted sites.

DISCUSSION

Patterns of dispersal and establishment differed among growth forms. Seed rain composition did not appear to be a good predictor of recruit composition, with microsite factors potentially having a strong influence on species establishment in these early successional habitats.

Although fewer exotic tree seeds arrived in native plantings than in tree regrowth sites, similar densities of recruits were recorded between these habitats, suggesting that recently established restoration plantings provide a particularly suitable microenvironment for the establishment of this group of weeds, particularly *C. camphora*. This may be due to the sparse ground cover and high light availability in this vegetation. Furthermore, our results indicate that this vegetation type is less suitable for native tree and vine recruitment than older, autogenic (albeit weed-dominated) tree regrowth areas: although native tree and vine seeds were dispersed to native plantings in greater densities (and species richness) than to tree regrowth sites, both density and species richness of native tree recruits were lower in planted sites. Native plantings, however, appear to be less susceptible to invasion by weedy bird-dispersed shrubs than the other vegetation types. This may be due to microenvironment factors since seed rain was similar to or higher than, that recorded in other habitats.

Of the early successional systems we sampled, shrub regrowth sites were the most resistant to invasion by bird-dispersed exotic trees. This is probably partly due to lower seed rain (compared with tree regrowth sites). However, seed rain was similar to that observed in native plantings, yet recruitment was lower, indicating that microsite factors – perhaps the dense herbaceous layer in this habitat - are also playing a role in suppressing establishment of exotic trees. Surprisingly, the density and species richness of native tree recruits in shrub regrowth were similar to those in native plantings, despite far fewer seeds arriving within these sites.

Recruitment of exotic bird-dispersed shrubs and vines in tree regrowth habitat was higher than expected based on seed rain density, indicating that tree regrowth may provide a particularly suitable microenvironment for the establishment of these groups of weeds (especially shrubs *L. sinense*, and vines *A. plumosus* and *Passiflora* spp.). However, tree regrowth conditions are also more conducive than either native plantings or shrub regrowth to the establishment of native trees and vines.

This study focused only on a subset of the most common bird-dispersed species. It is likely that if the entire suite of species occurring in study sites were included, native species richness and density (particularly for tree seeds and recruits) would be far higher for tree regrowth sites than for shrub regrowth and native plantings, owing to more frequent records of less common species in this habitat (authors' unpublished data).

Different early successional or disturbed habitats will require different management approaches in order to promote the establishment of 'desirable' native species and reduce weed invasion. We are collecting further data to determine the effect on recruitment of herbaceous layer, canopy openness and distance to seed source. Identifying characteristics that either reduce weed seed rain or seedling establishment, will give us the opportunity to incorporate manipulation of the dispersal and establishment phases into management plans for bird-dispersed weeds in natural areas.

ACKNOWLEDGMENTS

Thanks to W. Neilan for advice, T. Roberts, R. Woodford, and D. Bailey for advice and assistance with plant identification, S. Harvey, J. McCarthy and A. Dimmock for technical assistance, Rous Water and private landholders for granting access to their properties.

REFERENCES

Gosper, C.R., Stansbury, C.D. and Vivian-Smith, G. (2005) Seed dispersal of fleshy-fruited invasive plants by birds: contributing factors and management options. *Diversity and Distributions* 11(6), 549-58.