Seeing the forest through the weeds: frugivorous birds and rainforest regeneration in subtropical regrowth dominated by camphor laurel

Wendy Neilan[1], Carla Catterall[2], John Kanowski[2] and Stephen McKenna[2]
[1] Byron Shire Council, PO Box 219, Mullumbimby, New South Wales 2482, Australia
[2] Centre for Innovative Conservation Strategies, Griffith University, Nathan, Queensland 4111, Australia

Summary This paper presents a partial summary of findings presented in Neilan *et al.* (2005 and 2006). Regeneration of rainforest in old agricultural fields in Australia is largely dependent on seeds being dispersed into sites by frugivorous birds moving between remnants of original forest and patches of regrowth within the landscape. In subtropical Australia, regrowth is commonly dominated by camphor laurel, an exotic fleshy-fruited tree species, which is attractive to many frugivores. The spread of camphor laurel in these landscapes has led to considerable debate amongst land managers. Camphor laurel is an undesirable invasive in productive farmland and some native vegetation types, but also provides important food and other resources for forest fauna. The potential for rainforest regeneration in camphor laurel regrowth in northeast New South Wales was investigated by surveying the frugivorous bird assemblage and rainforest plant recruitment in 24 patches of camphor laurel regrowth. Most frugivorous birds associated with subtropical rainforest were recorded and almost half of these (16 of 34) species were considered potential dispersers of rainforest plants. Of the 208 plant species recruited to the camphor patches, 87% were of local rainforest origin. Comparisons between the composition of the adult and recruit tree layers suggest birds have largely facilitated recruitment and later successional species are increasing in abundance over time. With careful and strategic management, regrowth dominated by fleshy-fruited exotics may provide opportunities for broadscale reforestation of degraded rainforest landscapes.

Keywords Frugivore, weed, *Cinnamomum camphora*, camphor laurel, rainforest, restoration.

INTRODUCTION

In extensively cleared tropical and subtropical landscapes, rapid large-scale reforestation is required to reverse the course of ecological degradation that threatens biodiversity (Dobson *et al.* 1997, Parotta *et al.* 1997). Increasing abandonment of marginal lands from agricultural production in these landscapes represents an opportunity for the restoration of forest cover (Young 2000). However the extent to which secondary regrowth can develop naturally on abandoned farmland is limited by the intensity and duration of prior land use (Parotta *et al.* 1997). Due to the rapid depletion of soil seed banks following clearing, regeneration in degraded rainforest landscapes is largely dependent on either deliberate or natural seed dispersal from forest remnants (Wunderle 1997).

Reforestation via plantings is one possible avenue for restoring the density and diversity typical of rainforest to regenerating sites, but this is generally cost prohibitive over large spatial scales (Catterall *et al*. 2004). Large-scale restoration is more likely to be achieved through strategies that use natural regenerative processes such as seed dispersal. Most rainforest plants bear fleshy fruits dispersed by frugivorous vertebrates, particularly birds in Australia (Moran *et al.* 2004). The movement of frugivorous birds between patches of forest across the landscape may facilitate seed dispersal into regrowth areas from remnants (Neilan *et al.* 2006).

The introduction of exotic species often accompanies landscape change due to human activities. Weeds can come to dominate sites and prevent native species establishment. Management is generally focused on containment and eradication, however in some instances exotic species can provide important ecological function where native species are unable to establish or are extinct (Zaveleta *et al.* 2001). Camphor laurel (*Cinnamomum camphora* (L.) Nees & Eberm.) is an exotic, fleshy-fruited, tree species that has naturalised along much of the east coast of Australia (Firth 1979). Considered an undesirable invasive plant in productive farmland and some native vegetation types, camphor also provides habitat for forest fauna and is an important winter food resource for many frugivores (Scanlon *et al.* 2000, Neilan *et al.* 2006).

This paper describes some of the findings detailed in Neilan *et al.* (2006). The study assessed the potential for rainforest regeneration in regrowth patches dominated by camphor laurel in the landscape once occupied by the Big Scrub subtropical rainforest in northeast NSW. Once the largest tract of subtropical rainforest in Australia, the Big Scrub was reduced by clearing for agriculture to scattered remnants

covering less than 1% of its former range. A recent decline in the dairy and banana industries in the region has resulted in areas abandoned from production reverting to regrowth, largely dominated by camphor laurel (Firth 1979). The study, detailed in Neilan *et al*. (2006), assessed the extent of rainforest plant recruitment in camphor laurel regrowth patches and the use of these patches by frugivorous birds that are capable of dispersing rainforest plants.

The questions, previously addressed in Neilan *et al.* (2006) and also examined in this paper, are: 1) To what extent are patches of camphor laurel regrowth in the Big Scrub region frequented by frugivorous birds capable of dispersing rainforest plants and does this vary with distance from remnant forest? 2) How much rainforest plant regeneration is occurring within these regrowth patches? The results are discussed here in terms of the role of fleshy-fruited exotics and frugivore-mediated seed dispersal in the regeneration of forests in extensively cleared landscapes.

MATERIALS AND METHODS

Twenty-four camphor patches were surveyed in the former 'Big Scrub' landscape stratified by three zones of distance from major rainforest remnants in the Nightcap Range: 'close' (seven sites; <1 km distant); 'mid' (eight sites; 3–15 km); and 'far' (nine sites; 20–30 km). Study sites were regrowth patches with a well developed tree stratum dominated by camphor laurel (>50%), at least 20 years old, on land that had once been cleared of rainforest followed by an intervening agricultural phase.

Four 'summer' and three 'winter' bird surveys were conducted at each site. A bird survey consisted of a 45 minute search of a 0.6 ha plot during which all birds seen or heard were recorded. Summer and winter surveys were conducted by different observers. Frugivorous birds were grouped based on their seed dispersal potential (high, medium or low: adapted from Moran *et al.* 2004). This classification was based on the proportion of fruit in the diet, gape width, and the likelihood of dispersing viable seed (Neilan *et al.* 2006).

All vascular plants >0.5 m tall were surveyed in five, evenly spaced, 50 m transects at each site. Transect width was 2 m for plants <2.5 cm d.b.h. (diameter 1.3 m above ground), 4 m for plants 2.5–10 cm d.b.h., and 10 m for plants >10 cm d.b.h. Plant species were classified by origin, dispersal mode, and life form. Tree species were further categorised by successional stage according to Kooyman (1996) and diaspore size. Tree recruits were defined as individuals >0.5 m tall and <2.5 cm d.b.h. (Neilan *et al.* 2006).

RESULTS

Frugivorous birds Thirty-four species of frugivorous birds were recorded: ten with high, six with medium, and eighteen with low potential to disperse fleshy-fruited seeds. Of the sixteen species, considered of medium to high potential to disperse seeds, half occurred at most sites and seven were rare to uncommon. More species and individuals of high and medium seed dispersal potential were recorded in winter than in summer. More species of frugivores of high seed dispersal potential were recorded in sites close to the major rainforest remnants. Frugivores with medium seed dispersal potential did not vary with distance from the major Big Scrub remnants. More individuals and species of frugivores with a low potential to disperse seeds were recorded in close sites (Neilan *et al.* 2005, 2006).

Plant recruitment Overall, 181 plant species of local rainforest origin, four species of local non-rainforest origin and 23 exotic species were recorded. In small-sized (>0.5 m high, <2.5 cm d.b.h.) plants, the three most common species were the exotic shrub, small-leaved privet (*Ligustrum sinense* Lour.), and the exotic trees, large-leaved privet (*L. lucidum* Aiton) and camphor laurel (Neilan *et al.* 2006). Exotic small-sized plants were more abundant in mid distance sites than close or far sites. Overall, small-sized native plants did not vary in abundance or species richness with distance from remnants. When native plants were considered on the basis of life form and dispersal mode the only variation with distance occurred in bird-dispersed tree recruits. There were more species of bird-dispersed native tree recruits recorded in close sites but the number of individuals did not vary with distance from remnants.

For both species and individuals natives comprised a greater proportion of the young recruit trees compared to the proportion of adults that were native (Neilan *et al.* 2006). In the adult trees native early successional species were the most abundant, whereas, many of the relatively abundant recruits were later successional species, which were rare or absent in the adult tree layer (Neilan *et al.* 2006). Bird-dispersed native tree species, especially later successional species, tended to be proportionally more abundant in the recruit cohort than the adult cohort (Neilan *et al.* 2006).

DISCUSSION

A diverse assemblage of rainforest plants has recruited to patches of camphor laurel regrowth in the Big Scrub landscape. Patterns in recruitment suggest the relative abundance and diversity of rainforest plants is

increasing over time (Neilan *et al.* 2006). The results of this study suggest that patches of camphor laurel regrowth have ecological attributes that may assist rainforest regeneration. Firstly, camphor laurel attracts frugivorous birds that are the main dispersers of rainforest plants in Australia. Secondly, the patches of camphor laurel regrowth surveyed had developed relatively complex forest structure (Neilan *et al.* 2006). The development of a moderately dense canopy cover and litter layer can suppress the growth of competitive pasture grasses and other herbaceous cover and create a microclimate suitable for the germination and establishment of rainforest plants (Kooyman 1996, Kanowski *et al.* 2003).

Given the widespread clearing of lowland rainforests, camphor laurel regrowth is recognised as an important winter food resource for frugivorous birds in subtropical Australia (Date *et al.* 1991). Most frugivorous birds associated with subtropical rainforest in Australia (Moran *et al.* 2004) were recorded using camphor laurel regrowth (Neilan *et al.* 2006). Frugivorous birds were most abundant in camphor laurel regrowth in winter, but many with potential to disperse rainforest seeds were also recorded during summer. This may be particularly important for seed dispersal into regrowth from remnants as many rainforest plants fruit during summer months (Neilan *et al.* 2006).

Regardless of origin, woody vegetation in cleared landscapes can catalyse development of diverse secondary forests by providing habitat structure attractive to vertebrate seed-dispersers. Regrowth dominated by fleshy-fruited species is likely to attract more frugivores over longer distances given the food resource available to offset costs of long distance movement (Wunderle 1997). This study found only moderate variation in frugivore abundance and native plant recruitment in camphor laurel regrowth regardless of distance to major rainforest remnants. This is a useful phenomenon where native vegetation is mainly fleshy-fruited, but may increase risk of invasion by fleshy-fruited species in dry-fruited forests. Management, therefore, needs to be context-specific and consider the multiple ecological functions fleshy-fruited exotics may perform in extensively cleared landscapes (Neilan *et al.* 2006).

Due to the extent of disturbance in human-dominated landscapes, it is unlikely that forest restored to large areas will closely resemble historic species-abundance patterns (Catterall *et al.* 2004). In the Big Scrub region, the recruitment of rainforest plants into camphor laurel regrowth appears to be increasing over time and to be largely facilitated by frugivorous birds. However, the trajectory and rate of rainforest succession in these regrowth patches is unknown (Neilan *et al.* 2006). Preservation of original forest remnants is critical for conservation, but may be insufficient to maintain biodiversity across some landscapes. The emergence of multi-species complexes, incorporating both native and exotic plant species, over large spatial scales, presents new opportunities and challenges for ecological restoration and weed management (Neilan *et al.* 2006).

ACKNOWLEDGMENTS

Hank Bower and Cath Moran conducted two of the bird surveys. We acknowledge the assistance of Scott Piper, Terry Reis, Peter Benson, Naima Fine and landholders, Landcare groups and local authorities of the Big Scrub. The project was supported by the Rainforest Co-operative Research Centre, Griffith University Patience Thoms Honours Scholarship and the Norman Wettenhall Foundation.

REFERENCES

Catterall, C.P., Kanowski, J., Wardell-Johnson, G.W., Proctor, H., Reis, T., Harrison, D. and Tucker, N.I.J. (2004). Quantifying the biodiversity values of reforestation: perspectives, design issues and outcomes in Australian rainforest landscapes. *In* 'Conservation of Australia's forest fauna', eds D. Lunney, pp. 359-93. (Royal Zoological Society of New South Wales, Sydney).

Date, E.M., Ford, H.A. and Recher, H.F. (1991). Frugivorous pigeons, stepping stones, and weeds in northern New South Wales. *In* 'Nature conservation 2: the role of corridors', eds D.A. Saunders and R.J. Hobbs, pp. 241-5. (Surrey Beatty and Sons, Chipping Norton).

Dobson, A.P., Bradshaw, A.D. and Baker, A.J.M. (1997). Hopes for the future: restoration ecology and conservation biology. *Science* 277, 515-22.

Firth, D.J. (1979). Ecology of *Cinnamomum camphora* (L.) Nees and Eberm (camphor laurel) in the Richmond-Tweed region of north-eastern New South Wales. PhD thesis, University of New England, Armidale.

Kanowski, J., Catterall, C.P., Wardell-Johnson, G.W., Proctor, H. and Reis, T. (2003). Development of forest structure on cleared rainforest land in eastern Australia under different styles of reforestation. *Forest Ecology and Management* 183, 265-80.

Kooyman, R. (1996). 'Growing rainforest: rainforest restoration and regeneration'. (Greening Australia Queensland Inc., Brisbane).

Moran, C., Catterall, C.P., Green, R.J. and Olsen, M.F. (2004). Functional variation among frugivorous birds: implications for rainforest seed dispersal

in a fragmented subtropical landscape. *Oecologia* 141, 584-95.

Neilan, W., Catterall, C.P., Kanowski, J. and McKenna, S. (2005). A new role for weeds in rainforest restoration? Issues in tropical forest landscapes. Issue 4 September 2005. (Rainforest Co-operative Research Centre. http://www.rainforest-crc.jcu.edu.au/publications/issueSeries/issuesSeries.htm. Accessed March 2006).

Neilan, W., Catterall, C.P., Kanowski, J. and McKenna, S. (2006). Do frugivorous birds assist rainforest succession in weed dominated old-field regrowth of subtropical Australia? *Biological Conservation* 129, 393-407.

Parotta, J.A., Turnbull, J.W. and Jones, N. (1997). Catalyzing native forest regeneration on degraded tropical lands. *Forest Ecology and Management* 99, 1-7.

Scanlon, T. and the Camphor Laurel Taskforce (2000). Camphor laurel kit. North Coast Weed Advisory Committee. http://www.northcoastweeds.org.au/camphorkit.htm. Accessed 8 November 2005.

Wunderle, J.M. (1997). The role of animal seed dispersal in accelerating native forest regeneration on degraded tropical lands. *Forest Ecology and Management* 99, 223-35.

Young, T.P. (2000). Restoration ecology and conservation biology. *Biological Conservation* 92, 73-83.

Zavaleta, E.S., Hobbs, R.J. and Mooney, H.A. (2001). Viewing invasive species removal in a whole-ecosystem context. *Trends in Ecology and Evolution* 16, 454-9.