WOODY WEED DISPERSAL BY BIRDS, WIND AND EXPLOSIVE DEHISCENCE IN NEW ZEALAND

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ABSTRACT

Age and distance from source were measured in southern New Zealand for plants of lodgepole pine and Darwin's barberry, and for seeds and plants of broom. These species are dispersed by wind, birds and explosive dehiscence, respectively, and annual spread rates of 1200 m, 30 m and 1.2 m were obtained. Broom seeds can be dispersed much further by animals or machinery. Lodgepole pine spreads in the prevailing wind direction, whereas directionality of spread of the other species is controlled by the behaviour of animal vectors. Lodgepole pine and broom seedlings establish only in short vegetation, but barberry can establish in scrub, forest or pasture. All three species produce seeds at four years of age. Control measures should target outlier plants first.

Keywords: weed, seed dispersal, *Pinus contorta*, *Berberis darwinii*, *Cytisus scoparius*.

INTRODUCTION

Three major groups of invasive woody weeds in New Zealand show different dispersal mechanisms. Wind dispersed conifers are invading mountain grasslands, threatening pastoral and nature conservation values. Fleshy-fruited, bird dispersed woody weeds invade several natural ecosystems, and some threaten agricultural land. Two major agricultural weeds, gorse (*Ulex europaeus*) and broom (*Cytisus scoparius*), disperse their seeds by explosive opening of the dry fruit (ballistic dispersal).

Seed production by members of these groups, and the conditions that favour their establishment in the South Island, are relatively well understood (Molloy 1964; Benecke 1967; Allen & Wilson 1992; Allen et al. 1995). In this paper we compare the rate and pattern of spread of examples of each group, and discuss the implications for management.

METHODS

Wind dispersal: lodgepole pine (*Pinus contorta*)

All stems of lodgepole pine were cut close to ground level and their growth rings counted in a triangular area of snow tussock grassland extending from a 35-year-old plantation on Mid Dome (NZMS 260 E43 618043; sample area 2 m wide) eastwards 30 km to the Waikaia River (sample area 8 km wide).

Bird dispersal: Darwin's barberry (*Berberis darwinii*)

Two sites were selected where the age of the original planting of barberry was known and there was a clear limit to the distribution of its progeny: in pasture and native scrub at Mouats Saddle, south-east Otago (grid reference NZMS 260 G47 375035), and in pasture, scattered exotic and native shrubland, and patches of silver beech (*Nothofagus menziesii*) forest in the Argyle Burn, northern Southland (NZMS 260 F44 925885). Several of the largest stems of barberry at its distribution limit at each site were cut at ground level and their growth rings were counted. The stem of the woody plant adjacent to each of 14 (Mouats Saddle) and 16 (Argyle Burn) barberry bushes was also sampled to obtain a comparison of ages.

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Ballistic dispersal: broom (*Cytisus scoparius*)

Broom plants were sampled at several sites in Nelson and Otago (Allen et al. 1995). Isolated broom bushes (up to 14 years old) were aged as for barberry. Soil samples (0-5 cm deep) were taken at random distances out to 3.5 m from the parent stem, and the number of broom seeds in each was counted. The ages and positions of broom seedlings were also recorded.

RESULTS**Lodgepole pine**

Most of the ca 1200 progeny trees sampled were 5-11 years old (Fig. 1). The youngest trees with cones were 4 years old. Stem density declined rapidly beyond about 5 m from the parent plantation (Fig. 2a).

FIGURE 1: Age distribution of lodgepole pine wildlings between Mid Dome and the Waikaia River.

The most distant seedlings located were ca 20 km from the plantation (Fig. 2b). The original trees first produced seedlings in 1973, so the average linear spread rate 1973-1990 was approximately 1.2 km/yr.

Seedlings established within the grassland both under and outside tall tussock canopies, but few were found at the edge or within the base of tussocks.

FIGURE 2: Lodgepole pine wildling densities (plants/ha) on Mid Dome plotted on a log scale. (a) Up to 2000 m from the source plantation. (b) Between 2000 and 22000 m from the source plantation.

Darwin's barberry

At Mouats Saddle, the original plants were 60 years old. Progeny in the catchment were located at a maximum of 1050 m from this source. The oldest was 25 years old (Fig. 3a), giving an approximate linear spread rate of 30 m/yr.

Most (ca 80%) of the barberry plants were established in herbaceous vegetation (rank grasses and dicot weeds) beside or under fence posts, shrubs or trees. The rest were in pasture, but within 50 m of the nearest stands of shrubs or trees. Plants were distributed in no particular direction from the source. Twelve of 14 barberry plants were younger, and only the two oldest were older, than their adjacent woody plant of another species (Fig. 4a). Where the barberry plant was more than 4 years younger than its neighbour, the latter was probably tall enough to provide a perch for birds when the barberry plant established. However, half of the barberry plants sampled established at least several metres from the nearest possible perch.

Barberry was planted at Awatere Station, near the Argyle Burn, at least 90 years ago. Most progeny plants were north of this source, and separated from it by a substantial area of pasture. The oldest plant at the limit of spread (1400 m) from the source was 30 years old. Assuming that this was the first to reach the site, and an age difference of 60 years between this and the source plants, the linear spread rate was approximately 23 m/yr.

(a) Mouats Saddle

(b) Argyle Burn

FIGURE 3: Age distribution of barberry plants sampled at the limit of distribution from the original plants. (a) Mouats Saddle. (b) Argyle Burn.

Barberry ages sampled at the Argyle Burn ranged from seven to 30 years (Fig. 3b), and those of adjacent paired woody plants up to 40 years. Six of the 16 paired plants, mainly *Coprosma propinqua*, gorse, broom and marble leaf (*Carpodetus serratus*), were older than the adjacent barberry stem, and 10 barberry plants were more than five years older than their pair (Fig. 4b). Barberry establishment occurred within several metres of woody vegetation, but not necessarily directly beneath potential perch sites for birds.

Barberry plants can produce seeds at four years old (R.B. Allen, unpubl. data.).

Broom

Most broom seeds were deposited under or close to the canopy of the parent bush. Seed density varied from 2700/m² under the parent canopy to <300/m² at 3.5 m from the parent stem (Allen et al. 1995). Seeds were produced by three-year-old plants, and seedlings could establish from the first seed crop. Seedlings established in ungrazed rough pasture and herbaceous weeds to 3.5 m from the parent stem at densities of up to 2.3/m² by 14 years. The linear spread rate was 1.2 m/yr (Allen et al. 1995).

(a) Mouats Saddle **(b) Argyle Burn**

FIGURE 4: Comparison of the ages of barberry plants and their immediate neighbour woody plant of another species. Paired species names are as follows. (a) Mouats Saddle: a. *Hebe salicifolia*, b. *Weinmannia racemosa*, c. *Griselinia littoralis*, d. *Coprosma parviflora*, e. *Leptospermum scoparium*, f. *Coprosma propinqua*, g. *Coprosma lucida*, h. *Pittosporum eugenioides*, i. *Aristotelia serrata*, j. *Pittosporum tenuifolium*, k. *Coprosma foetidissima*. (b) Argyle Burn: a. *Carpodetus serratus*, b. *Coprosma propinqua*, c. *Cytisus scoparius*, d. *Leptospermum scoparium*, e. *Ulex europaeus*, f. *Olearia lineata*.

DISCUSSION

Lodgepole pine was planted at Mid Dome between 1949 and 1963, and the first few wild seedlings were found up to 8 km from the parent plantations in 1976 (Wardle & Osborne 1983). These were the oldest progeny plants sampled in 1990. Wildlings recorded in 1990 established from seed from either the original plantation or mature progeny plants. Although the average rate of spread was 1.2 km/yr between 1973 and 1990, seeds may disperse to the maximum of 20 km in any year. A seedling located in the Umbrella Mountains (A.P. Perrett, pers. comm.), 45 km from the source, suggests that greater dispersal distances are possible.

Lodgepole pine wildlings were dispersed eastwards by the prevailing westerly winds. Similar directional patterns of conifer spread are seen throughout South Island high country (Ledgard 1988). Lodgepole pine establishment is confined to grassland because seedlings are light-demanding (Allen & Lee 1989). Its seedlings are relatively conspicuous, and can be killed before reaching the age of seed production. Control of conifers should start with outliers, because these have the potential to increase the range of infestation most significantly.

At Mouats Saddle, barberry plants were distributed in all directions because suitable feeding and perching habitat for birds surrounded the source population. At the Argyle Burn most barberry plants were relatively far from the source, because intervening pasture was inhospitable both for frugivorous birds and for barberry establishment. Most were north of the source, in the nearest suitable vegetation. The distance between source and progeny may reflect the clearance of intervening barberry plants, but more likely represents relatively long distance flights by birds after fruit ingestion.

Barberry spread depends on the distance a bird flies between eating and defecating. Blackbirds, thrushes and silvereyes disperse most Darwin's barberry fruits in southern New Zealand (Allen & Lee 1992). The fruits are available December-January, when bird seasonal behaviour restricts movement to within 100 m of ingestion sites (Bull 1953). Many barberry bushes at the study sites were near perches or the boundaries of woody vegetation. However, barberry also established in grazed pasture. Allen (1991) found no barberry establishment in ungrazed rank pasture near Dunedin.

Barberry seedlings are relatively shade tolerant, and can be inconspicuous. Control should be undertaken when the plants are at their most visible (i.e. in flower), and should start at the outer limits of infestations.

The potential spread rate of broom is underestimated here, because broom establishes outlier plants substantial distances from the parent when seeds are transported by animals, machinery, vehicles and water. Broom seedlings tolerate low light levels (10% of full light; Williams 1981), which allows establishment in grassland, but broom plants are intolerant of shading by taller woody vegetation (Williams 1983). Unless grassland is grazed consistently to remove newly-established seedlings before they reach three years of age (Allen et al. 1995), long-lived seeds will accumulate in the soil and broom will occupy the site for more than one generation. Therefore, outlying plants should be targeted first for control, and before they reach three years old. The exclusion of stock and machinery from broom stands would help to limit the potential for spread, and stands could be contained by establishment of dense woody vegetation at their boundaries. Continual removal of broom seedlings as they establish at stand edges is only practicable by consistent hard grazing.

CONCLUSIONS

Wind dispersed seeds, such as those of lodgepole pine, can spread up to several kilometres from the parent plant, but mainly in the direction of the prevailing wind. Disperser behaviour, more than existing plant cover, determines the spread of barberry in southern New Zealand. Although wider dispersal may happen by transport of fruits or seeds eaten by mammals, most seeds fall within a few hundred metres of the parent plant, and in the direction of the nearest perch site rather than towards open land. Most

broom seeds fall within a few metres of the parent plant. Long-range dispersal of broom depends on its seeds being carried by some means.

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