Is garden waste dumping really a problem?

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Summary The dumping of garden waste is thought to contribute to the spread of environmental weeds, but it is difficult to collect suitable data to confirm or refute this hypothesis. A qualitative model was developed that combined three plant attributes: local growth rate, mean dispersal distance and dispersal curve. This model was used to test the effect of garden waste dumping on the spread of weeds with different characteristics. We found that garden dumping can greatly enhance the spread of weed species with limited natural dispersal. For those weeds that already disperse long distances, by wind or birds, garden dumping makes little difference to the time taken to reach a reserve. The modelling also underlined the difficulty of eliminating infestations of weeds that are wind or bird-dispersed.

Keywords Environmental weeds, weed spread, garden dumping, garden escapes, weed dispersal, stochastic growth and dispersal model.

INTRODUCTION

Two-thirds of New Zealand's 328 environmental weeds were originally cultivated in gardens as ornamentals (Howell 2008). Their abundance in reserves is correlated with proximity to human settlements (Timmins and Williams 1991), and in particular proximity to gardens (Sullivan *et al.* 2004). Garden waste has been observed dumped along roadsides (Sullivan *et al.* 2009) and in bush reserves (Sullivan *et al.* 2005) and it has been reported anecdotally that plants establish from this dumped garden material (Esler 1988). This has been picked up in Weedbuster campaigns, such as the Dirty Weekends, that encourage gardeners to dispose of their garden rubbish appropriately (Weedbusters 2010). But just how common is dumping and how much difference does it make to the spread of environmental weeds across the New Zealand landscape?

We attempted to collect field data to investigate our questions. We visited favoured dump sites along roads and looked along the margins of reserves near towns. As with previous casual observations, we found either a pile of discarded garden waste or an established weed infestation. Rarely did we find the two together to enable a causal link to be drawn. Further, we could not monitor all the potential dumping sites in a region, let alone often enough to observe both dumping and subsequent weed establishment. Also, any such field data would tend to be species or site-specific. So we chose to simulate garden dumping using a simple model to investigate the role garden dumping may play in environmental weeds invading reserves.

METHODS

A simple one dimensional stochastic growth and dispersal model was developed to explore the degree to which garden dumping might contribute to the spread of weeds. The model combined three attributes of weed species: growth rate (the rate at which a weed infestation puts on biomass to occupy a site), mean distance propagules are dispersed, and the shape of the propagule dispersal curve. For most plant species, most propagules land near the parent plant, then progressively fewer propagules with distance from the parent plant (Gaussian or normal distribution). For some plants, while the majority of propagules fall close to the parent plant, a few propagules are dispersed a long (medium-tailed) or very long distance from the parent plant (heavy-tailed dispersal curve) (Baeumer *et al.* 2007).

The model assumed a homogeneous, one-dimensional landscape and predicted the time it would take a weed species to spread naturally from a source area (e.g. a town) to a reserve. The weed was assumed to be able to grow to a fixed carrying capacity at any site in the landscape that it establishes. The model was used to test the effect of dumping a pile of garden waste between the two—does dumping facilitate the weed getting to the reserve much more quickly? Does the effect differ depending on a weed's local growth rate, mean dispersal distance and dispersal curve? Does the effect differ depending on the proximity of the dump to the reserve?

To relate the model to New Zealand's environmental weeds, we categorised all 328 species according to: growth rate and modes of dispersal including birds (260 species), people (105 species), wind (75 species) and water (9 species). For each species we assessed the likelihood of it being dumped in garden waste—a function of how commonly the species is grown in gardens and becomes unruly. We also classified the

weeds for the likelihood of successful establishment from dumped material. This information came from the DOC weeds database and field knowledge among the authors and their colleagues.

RESULTS

Long distance dispersal While the model used weed growth rate, mean dispersal distance and the shape of the propagule dispersal curve, the modelling showed that it is the latter, a weed's capacity for long distance dispersal, that is the greatest determinant of how long it will take for it to invade a reserve.

Thus, we found that a weed species that already disperses a few propagules a long distance gains less spread benefit from being dumped in garden waste. Weeds like this include those that are bird-dispersed, e.g. holly (*Ilex aquifolium* L.), ivy (*Hedera helix* L.) and Japanese honeysuckle (*Lonicera japonica* Thunb.), and particularly those that are wind-dispersed, e.g. pampas grass (*Cortaderia selloana* Asch. et Graebn.) and old man's beard (*Clematis vitalba* L.). In contrast, if a weed species would not otherwise disperse far naturally, movement by garden dumping can make a huge difference to how quickly it can invade a reserve. This is markedly so for species with heavy seeds, such as legumes (e.g. broom *Cytisus scoparius* (L.) Link), or with vegetative reproduction only, e.g. potato vine (*Solanum jasminoides* Paxton) or wandering Jew (*Tradescantia fluminensis* Vell.). Not surprisingly, the time taken for a weed to reach a reserve is further reduced the closer to the reserve that dumping occurs.

Successful dump species Species that are common garden plants and a nuisance, are more likely to be dumped in garden waste than uncommon or tame plants. Having been dumped, weeds that can grow from fragments any time of the year are more likely to establish than species that can only establish from seeds at a specific time of the year. Weeds that have both these features include wandering Jew, agapanthus (*Agapanthus praecox* Willd.), old man's beard (*Clematis vitalba* L.), kahili ginger (*Hedychium gardenerianum* Ker-Gawl.), Cathedral bells (*Cobaea scandens* Cav.), Japanese honeysuckle and Chilean rhubarb (*Gunnera tinctoria* Mirbel).

Table 1 gives examples of weeds with different characteristics of growth rate, dispersal type, likelihood of dumping and establishment. It is the combination of these factors that determine the degree to which garden dumping might facilitate the spread of weeds.

DISCUSSION

For weeds that are bird-dispersed or wind-dispersed, garden dumping makes less difference to the rate of spread than for weeds that otherwise have limited natural dispersal. For species such as wandering Jew that spreads by vegetative reproduction alone, garden dumping can dramatically speed up the spread of the weed. Indeed, it could be the difference between the weed invading or not invading the reserve. While this study has not attempted to quantify the role of garden dumping, it lends support to the belief that the current distribution of weeds such as wandering Jew must have resulted in part from garden dumping or some other human-mediated activity.

A management tool If weeds are moved by garden dumping their pattern of spread is unlikely to follow ecological rules but rather be more idiosyncratic, unexpected or unpredictable. Just as collecting field data on this topic was challenging, so too stopping people dumping garden rubbish in particular places will be difficult, except by raising awareness.

However, the spread of some weeds could be slowed considerably if we could stop them being dumped in garden waste. Species in this camp include wandering Jew and agapanthus, which ordinarily only disperse vegetatively, but readily establish from dumped material. Stopping the dumping of such species would pay dividends. In contrast, there would be less benefit from stopping garden dumping of a species such as old man's beard; it grows from fragments, but it also has abundant wind-dispersed seed. Japanese honeysuckle and kahili ginger have bird-dispersed fruit but their current distributions in New Zealand are likely to have been facilitated in part by garden dumping. Preventing garden dumping of species with these characteristics would be a medium priority.

It is the combination of the three weed factors that determine the importance of garden dumping to their spread: probability of being dumped in garden waste, probability of establishing once dumped, and the facilitation provided by dumping (Table 1). That said, simple messages, like 'don't dump garden rubbish' may be more effective than distinguishing between species.

It is acknowledged that this study has only considered garden dumping. Other human-mediated activities that are likely to move weed propagules across the landscape include road maintenance, soil or gravel movement and movement of propagules attached to stock, people and vehicles (e.g. Lippe and Kowarik 2007). Nor has this study addressed the relative importance of garden dumping or other human-mediated weed spread compared to other

Table 1. Examples of weeds with different characteristics of growth rate, dispersal type, likelihood of dumping and establishment.

Species name	Common name	Growth rate[A]	Dispersal type[B]	Role of dumping[C]	Likelihood of dumping[D]	Likelihood of establishment[E]
Agapanthus praecox	agapanthus	high	vegetative	high	high	high
Hedychium flavescens Roscoe	wild ginger	high	vegetative	high	high	high
Tradescantia fluminensis	wandering Jew	high	vegetative	high	high	high
Cytisus scoparius	broom	med	gravity	high	med	low
Ulex europaeus	gorse	low	gravity	high	low	low
Cotoneaster glaucophyllus	cotoneaster	med	bird	med	high	med
Hedychium gardenerianum	kahili ginger	high	bird	med	high	high
Lonicera japonica	Japanese honeysuckle	high	bird	med	high	high
Tropaeolum speciosum	Chilean flame creeper	med	bird	med	med	med
Clematis vitalba	old man's beard	high	wind	low	high	high
Cortaderia selloana	pampas grass	high	wind	low	med	low
Pennisetum clandestinum	kikuyu grass	high	wind	low	low	low
Acer pseudoplatanus	sycamore	high	wind	low	low	low
Calluna vulgaris	heather	low	wind	low	low	low

[A] Refers to local growth rate— the rate at which a weed infestation puts on biomass to occupy a site.
[B] Wind-dispersed seeds conform to a heavy tailed dispersal curve, while bird-dispersed seeds have a medium tailed curve. Species with gravity-dispersed seeds or only vegetative reproduction have Gaussian (not heavy-tailed) dispersal curves.
[C] The degree to which garden dumping would facilitate the spread of a weed and speed up its invasion into a reserve.
[D] A function of how common and rampant the species is in gardens.
[E] Likelihood that this species would establish and grow were it dumped as garden waste.

factors influencing weed dispersal such as other plant traits or environmental factors of the invaded site. These are jobs for another study.

Beyond garden dumping, the modelling has a message for our weed management in general. It suggests that we should be hesitant to embark on a weed-led control programme on a bird or wind-dispersed wind species, unless the species is very newly established. This is because searching and finding all new plants is critical to the success of eradication attempts (Panetta 2009). Once a weed disperses and establishes even just a few new plants some distance away, the search area becomes increasingly large such that it is less likely that all the outliers will be found and eliminated (Harris and Timmins 2009). The model underlines again the importance of early detection and action.

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REFERENCES

Baeumer, B., Kovacs, M. and Meerschaert, M.M. (2007). Fractional reproduction-dispersal equations and heavy tail dispersal kernels. *Bulletin of Mathematical Biology* 69, 2281-97.

Esler, A.E. (1988). The naturalisation of plants in urban Auckland, New Zealand 4. The nature of

the naturalised species. *New Zealand Journal of Botany* 26, 345-85.

Harris, S. and Timmins, S.M. (2009). Estimating the benefit of early control of all newly naturalized plants. Science for Conservation 292. Department of Conservation, Wellington.

Howell, C. (2008). Consolidated list of environmental weeds in New Zealand. DOC Research and Development series 292. Department of Conservation, Wellington.

Lippe, M.V.D. and Kowarik, I. (2007). Long-distance dispersal of plants by vehicles as a driver of plant invasions. *Conservation Biology* 21, 986-96.

Panetta, F.D. (2009). Weed eradication—an economic perspective. *Invasive Plant Science and Management* 2, 360-8.

Sullivan, J.J., Timmins, S.M. and Williams, P.A. (2005). Movement of exotic plants into coastal native forests from gardens in northern New Zealand. *New Zealand Journal of Ecology* 29 (1), 1-10.

Sullivan, J.J., Williams, P., Cameron, E.K. and Timmins, S.M. (2004). People and time explain the distribution of naturalized plants in New Zealand. *Weed Technology* 18, 1330-3.

Sullivan, J.J., Williams, P.A., Timmins, S.M. and Smale, M.C. (2009). Distribution and spread of environmental weeds along New Zealand roadsides. *New Zealand Journal of Ecology* 33 (2), 190-204

Timmins, S.M. and Williams, P.A. (1991). Weed numbers in New Zealand's forest and scrub reserves. *New Zealand Journal of Ecology* 15 (2), 153-62.

Weedbusters (2010). Weedbusters dirty weekends. http://weedbusters.co.nz/get_involved/dirty_weekends.asp (accessed 5 February 2010).