

Weed hygiene: what do we do with seeds we find on our clothing?

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Summary Weeds are a major threat to biodiversity globally including in protected areas. Visiting natural areas is popular with approximately 1.4 million people visiting terrestrial reserves in Australia each year. These visitors may be unintentionally spreading weed seeds, but do they know what weeds are, and what do they do if they find seeds on their clothing? When we surveyed 114 visitors to D'Aguilar National Park in south-east Queensland, we found that visitors could define a weed, with 75% identifying weeds as 'Plants that grow where they are not wanted'. We also found that they may be unintentionally transporting seeds, with 63% having found seeds attached to their clothing. When asked what they do with these seeds, the most common responses included: removing and leaving the seeds when they first noticed them; placing seeds in bins; brushing them off at the car park; dumping them in the backyard garden; or washing them together with the clothing. Therefore, although visitors know about weeds, they can transport, and in some cases deposit seeds from clothing in parks. Since propagule pressure is an important predictor of plant invasion, we discuss how different hygiene practices could help reduce the risk of park visitors spreading weed seeds.

Keywords Human-mediated dispersal, biological invasion, weed management.

INTRODUCTION

Weeds are a major threat to biodiversity globally including in protected areas (Williams and West 2000, Groves *et al.* 2005). They can replace native plants and alter biodiversity (Groves *et al.* 2005). They also increase management costs and reduced ecosystem services provided by protected areas (Sinden *et al.* 2004).

The risk of visitors to protected areas unintentionally introducing weed seeds is growing, with increasing movement of nature based tourists between different habitats on local, national, regional, and transcontinental scales (Pickering and Mount 2010, Chown *et al.* 2012). Protected areas in some regions experience high levels of visitation with around 1.4 million people visiting terrestrial reserves in Australia each year (Director of National Parks 2011). Many visitors to protected areas may carry weeds seed on their clothing, vehicles, and weed seeds can germinate

from the dung of horses ridden in parks (Pickering and Mount 2010). When we completed state-of-knowledge reviews of these three types of seed dispersal mechanisms we found that: seeds from 626 species have been collected from vehicles of which 96% are weeds (Ansong and Pickering 2013a); seeds from 449 species have been found on clothing, of which 87% are weeds (Ansong and Pickering 2014); and that seeds from 249 species of plants (99% weeds) can germinate from horse dung (Ansong and Pickering 2013b).

It is generally agreed that efforts to increase visitor's awareness of the risks associated with unintentional seed dispersal is important (Newsome *et al.* 2013). However, so far, the few studies that looked at these types of seed dispersal mechanism have focused on ecological aspects with little attention to the social dimension of this important topic. To contribute to addressing this important knowledge gap, we assessed visitor's understanding and knowledge of weeds, their behaviour including visitation patterns, and how they dispose of any seeds they find on their clothing, and their perception about human mediated seed dispersal and weed management. We anticipate that the results of this study will contribute to more effective management of weeds for policy makers, park managers, weed researchers and the general public.

MATERIALS AND METHODS

Visitor attitudes and behaviour in relation to seed dispersal and weeds was assessed in a popular peri-urban park. Specifically the research involved structured surveys of visitors to D'Aguilar National Park in South East Queensland. The Park is large (36,000 ha) and close to centre of the capital city of Queensland, Brisbane. It protects sclerophyll forest, eucalypt woodland and subtropical rainforest. The Park is popular for a wide range of recreational activities, with bushwalking, running and mountain biking, the most popular (Rossi *et al.* 2013). Two high use sites in the Park, at the start of popular hiking and running tracks were selected for the survey (Gold Creek and Maila).

The survey was done during periods of high usage over two weekends (14–15 December and 21–22 December 2013) and followed Griffith University health and safety procedures, as well as having obtained ethics approval. The structured interview was conducted when visitors arrived at the Park. The questionnaire

collected data on: actual Park usage; environmental behaviour; knowledge about weeds; and general demographic data. Data was entered into SPSS and Excel and then analysed using a combination of descriptive and inferential statistics such as cross tabulation, to answer the objectives of the research.

RESULTS

Who visits the Park? Most of the visitors approached participated in the survey resulting in a response rate of over 70%. Of the 112 visitors who completed the survey, more than half (57%) were hikers/bushwalkers, 17% were runners/joggers with a few wildlife viewers (6%) and 20% engaged in other recreational activities. Most visitors had been to the Park before, with more than one-third (41%) visiting the Park a few times per year or a few times per month (14%). Some were even more regular Park visitors coming either several times a week (13%) or daily (2%). Over one quarter (29%), however, were first time visitors.

Almost two-third (65%) of the visitors were male, and nearly all visitors were highly educated, with 80% having completed university/tertiary education, while only 2% had only completed primary or some secondary school. Visitors varied in age, with the majority between 35–44 years (26%) and 45–54 years (21%). There were, however, only 3% younger (<18 years) and 3% older (≥ 65 years) respondents, and almost equal number of them in the age class 55–64 years (17%), 25–34 years (16%) and 18–24 years (14%).

Almost all visitors (86%) came to the Park by car, with only 8% arriving on foot and the rest by other means, mostly on bikes. For those who came by car, the majority (43%) travelled between 15–30 minutes, with 24% travelling for 30–45 minutes, 21% for 45–60 minutes, 8% for less than 15 minutes, and 4% for between 60–120 minutes. Over two third (67%) of those who came by foot, travelled <15 minutes while 22% and 11% of those on foot travelled between 15–30 minutes and 30–45 minutes respectively.

Do they know what a weed is, and how concerned are they about weeds in the Park? Most of the visitors were able to effectively define a weed when given several options with 75% identifying weeds as ‘Plants that grow where they are not wanted’. Some others (10%) provided their own, often quite sophisticated, definitions of weeds, including: ‘unwanted plants’, ‘a plant growing outside its natural environment’, ‘plants that grow aggressively and are hard to control’, ‘plants not native to their environment’, ‘non-indigenous plant species in context, that may be invasive in a particular ecosystem’, ‘plants growing in areas where they do not

occur naturally but are well suited to conditions and multiply rapidly’, ‘invasive species’, ‘a species that has grown at the expense of other flora and fauna’, ‘a plant which causes a detrimental effect to the local ecosystem’, ‘introduced species, be it regional country of origin’ and ‘plants which cause negative environmental or economic impacts that are not native to a location’. When asked whether they agree or disagree with the statement ‘weeds in this Park are of concern to me’, 40% agreed, 19% disagreed while 40% were neutral about this issue.

Do they have seeds on their clothing and how do they dispose of any seeds they find? When asked about seeds on their clothing, 63% reported having found seeds attached to their clothing (footwear, socks, skirt, trouser, etc) before, during, or after walking through the Park. When asked an open question about what they do with these seeds, there was a variety of responses, which we grouped into four categories (Figure 1).

The most common response was indiscriminately brushing off the seeds including removing seeds from clothing and leaving the seeds on the ground in the Park or where ever they were when they first noticed the seeds. The next most common method was disposing of the seeds in a bin, which were mostly domestic bins at their homes. Other visitors preferred removing the seeds by washing their clothing in a washing machine or brushing the clothing over a sink. Some

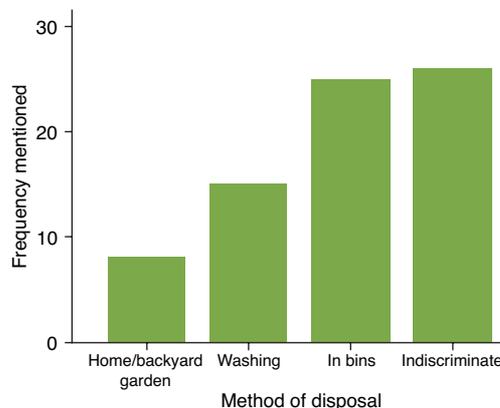


Figure 1. Categorisation of the methods visitors’ used to dispose of seeds they found attached to their clothing before, during or after walking through a park. The categories were aggregated from responses to an open ended question. Some of the respondents provided more than one method for seed disposal.

respondents, however, removed seeds and left them in their backyard garden or house.

Visitors' perception on human-mediated seed dispersal Most (75%) visitors think that visitors do unintentionally introduce seeds into parks (Table 1), which is consistent with how many of them also recorded finding seeds on their own clothing in the Park. Just under half support the idea of visitors cleaning their clothing before entering the Park while a further 30% neutral about this issue. Almost two-thirds support spending money to control/eradicate weeds in the Park (Table 1).

DISCUSSION

Nearly all visitors, at least to this Park, appear to know what weeds are, and support spending money controlling weeds in the Park. Most have also found seed on their own clothing, and agree that visitors can unintentionally disperse weed seeds. Unfortunately, many of them dispose of seeds they find on their clothing in ways that may actually increase the spread of weed seeds including in the Park.

These results indicate that there may be support for education messages about weed, as awareness is key requirement for implementing behavioural change (Hills 2004). Therefore strategies to educate visitors about how they could minimise the chance of them carrying weed seeds when they enter parks, and appropriately disposing of any seeds they find on their clothing in parks would be useful (Andreu *et al.* 2009, Vanderhoeven *et al.* 2011). Information could be provided in a range of forms including: in visual material such as posters, notices or brochures at visitor centres, Park entry points, and other locations within parks as well as in information guides including internet based materials (Wittenberg and Cock 2001, Whinam *et al.* 2005). The strategies could include encouraging visitors to check if they have seeds on their clothing before leaving and entering new destinations, and

avoid walking through weedy roadsides before entering parks (Wittenberg and Cock 2001, Whinam *et al.* 2005, Vanderhoeven *et al.* 2011).

Recommendations could also be made regarding types of clothing, including covering socks with trousers or gaiters (Mount and Pickering 2009). Education about not removing seeds from clothing when sitting down to rest or lunch, or at the end of a hike, may also prevent spread of weeds (Mount and Pickering 2009).

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Table 1. Visitors' perceptions about human mediated seed dispersal and level of support for weed management. Values are the % of visitors that agree, are neutral or disagree with the four statements, while N is the number of respondents who responded to the statement.

Statement	Disagree	Neutral	Agree	N
Visitors do deliberately introduce seeds into this and/or other parks	63	23.4	13.5	111
Visitors do unintentionally introduce plant seeds in parks	9.1	15.5	75.4	110
I will support cleaning of visitor's clothing before entering parks	20.5	30.4	49.1	112
Money should be spent to control/eradicate weeds in the Park	11.6	23.2	65.2	112

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