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The distribution and status of alien plants in a small South African town

P. McLean [a,b,*], J.R.U. Wilson [a,b], M. Gaertner [a,c], S. Kritzinger-Klopper [a], D.M. Richardson [a]

[a] Centre for Invasion Biology, Department of Botany & Zoology, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa
[b] South African National Biodiversity Institute, Kirstenbosch National Botanical Gardens, Private Bag X7, Claremont 7735, South Africa
[c] Nürtingen-Geislingen University of Applied Sciences (HFWU), Schelmenwasen 4-8, 72622 Nürtingen, Germany

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A B S T R A C T

1. The invasion of alien plants into natural ecosystems in South Africa is a substantial conservation concern. The primary reason for the introduction of alien plants has been ornamental horticulture, and urban centres are the main sources of invasions. Small towns have high edge: area ratios which favour the launching of invasions into surrounding areas. There is, however, a shortage of information at the global and local scale on the occurrence, distribution, and status of alien plants in an urban context.
2. We surveyed all alien plants in the small town of Riebeek Kasteel in the Western Cape, South Africa, to gain insights on where to find alien plant species, and to assist with future studies and the management of alien floras in small towns.
3. We surveyed publically accessible land, recording the abundance of all alien plant species every 10 m of road. A species accumulation curve was compiled to show the rate at which new species were encountered. This approach was used to test the efficacy of different sampling strategies.
4. Two hundred and ninety eight alien plant taxa were recorded in five land-use types. Half of the alien plant species recorded were naturalised within the town, while a third were invasive in the region (the Berg River catchment). 95% of the taxa, including many invasive species, occurred in gardens or adjoining road-sides, highlighting the invasion risk posed by ornamental horticulture. The most efficient way of collecting data on alien plant distribution for this town would have been to survey roads in the town centre first, rather than urban-edge roads and industrial areas.
5. Synthesis and applications: The gardens of small towns in South Africa harbour a high diversity of alien plants, many of which are already invasive or are potentially invasive. As the alien flora differs markedly between gardens, it is difficult to extrapolate generalised rules of thumb on where to survey. This means that compiling accurate inventories of alien plants in urban areas requires substantial search effort and taxonomic expertise.

1. Introduction

Alien plant invasions are a major conservation concern in many parts of the world (Mack et al., 2000), including South Africa (Richardson et al., 2011a). Urban areas are hotspots for the introduction of alien species (Vitousek et al., 1997; Pyšek, 1998), particularly of plants used for ornamental horticulture (Reichard and White, 2001; Sanz-Elorza et al., 2008; Marco et al., 2010; Asmus and Rapson, 2014). It is therefore not surprising that there is a strong correlation between human population density and alien plant species richness (Spear et al., 2013; Aronson et al., 2014a, 2014b). Urbanisation is increasing in all regions of the world, and more than half of the global human population now live in cities and towns (United Nations, 2016). This trend is likely to increase into the future (Grimm et al., 2008). While increasing urbanisation is likely to exacerbate problems associated with cities as sources of alien propagules, historical patterns and processes mean that there is already a large invasion debt: even without further introductions, many species that are already introduced will become invasive over time (Rouget et al., 2016).

Despite these findings and the obvious risks, few studies have examined the structure and patterns of alien plants within urban spaces. Those that have been done have focussed on large cities (e.g. Alston and Richardson, 2006; Lambdon et al., 2008; Botham et al., 2009; Garcillán, 2014; Lenda et al., 2014; Aronson et al., 2014b). While large cities typically have more alien species than small rural towns and villages, and are often the first places in a country to which a plant is introduced, smaller towns typically have a relatively larger urban-wildland interface (a notable exception is the City of Cape Town with the Table Mountain National Park embedded within its boundaries). A large urban-wildlife interface means that established urban alien plant species with expanding populations only need to cover a relatively small geographical distance before reaching surrounding natural areas

* Corresponding author at: Centre for Invasion Biology, Department of Botany & Zoology, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa.
E-mail address: fynbosphil@yahoo.com (P. McLean).

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(Moreira-Arce et al., 2014). This effect was also noted by Marco et al. (2010) who observed that species planted on garden margins were more likely to escape into adjacent areas. Smaller towns are also much more numerous than big cities and so collectively represent a higher risk of contributing invasive propagules into the surrounding areas.

South Africa has enacted national legislation aimed at controlling invasive species which has implications for the urban environment (Box 1).

However, most municipalities do not have the capacity to service the requirements of NEM:BA (Irlich et al., 2017). While some information is available at a broad environmental scale on the existence and general location of alien plant species outside of cultivation that will assist municipalities in compiling their plans (Henderson and Wilson, 2017), there is very little information on the location, identity, and distribution of alien plants in the urban spaces in the country.

Our aims were thus to systematically map the occurrence and abundance of alien plants in a small town in South Africa, and, based on the data collected, to propose a strategic approach to guide future surveys of alien plants in small towns in South Africa. The survey strategy developed here could be used to help municipalities to meet their regulatory requirement to report on the occurrence of invasive species in urban areas. We also aimed to determine the introduction status of alien plants captured in our survey. Such information can assist managers in the identification and prioritisation of invasive species within the urban context.

2. Methods

2.1. Site description

Riebeek Kasteel is a small town of 6.9 km^2 situated within the Swartland Municipality (part of the West Coast District Municipality) in the Western Cape, South Africa (Fig. 1). The town was established in the 1860s and it currently has a population of 1144 people at a density of 179 persons/km^2 (StatsSA, 2016). The town has a mixture of residential, industrial, commercial and agricultural land uses and is bordered mainly by agricultural land (primarily vineyards) and in the west by natural vegetation of the Riebeek Kasteel Mountain and the Kasteelberg Nature Reserve. Its relatively long history and diversity of land-use types makes Riebeek Kasteel an ideal subject to investigate the patterns of distributions of alien plants in a small urban centre. In terms of its size and complement of alien plants, Riebeek Kasteel is typical of towns in the Breede River catchment (McLean et al., 2017).

Box 1
South African legislatory requirements for municipalities to manage invasive species.

The National Environmental Management: Biodiversity Act (DEA, 2014; NEM:BA, Act 10 of 2004) compels "all organs of state in all spheres of government", including municipalities, to deal with invasive species by "preparing an invasive species monitoring, control and eradication plan for land under their control" (NEM:BA 2004). This plan must be compiled according to Section 76.(2)(a) of NEM:BA and should form part of each municipality's integrated development plan. Such a plan must include [76(4)(a–f)]:

a) detailed lists and descriptions of listed invasives;
b) a description of the parts of land infested;
c) an assessment of the extent of each infestation;
d) a status report on the efficacy of (any) previous control measures;
e) current measures to monitor, control and eradicate invasives;
f) measurable indicators of progress and success of above control measures (including a timeline of projected completion).

Plans must include the land under urban settlement within each municipality's jurisdiction.

2.2. Field-survey

We treated roads in the town as transects for our survey and sampled all publically accessible roads in the town. While we covered all such roads over the course of the study, we were not prescriptive in our choice of routes that we took during the survey (i.e. roads were not selected strategically, but haphazardly). This survey was undertaken by the same two observers (PM and SK-K) over eleven non-consecutive days in the spring of 2015 (August–October). While it is possible that a few additional plants might have been found if we had sampled in other seasons, the vast majority of plants in the area flower and/or have foliage in spring. We walked each public road taking a GPS waypoint every 10 m. This was done for both sides of each road because it was not feasible to accurately identify or count individuals on the far side of roads given the distance and the increased potential of obstructions between the viewer and the specimens. At each waypoint we recorded the identity and number of each alien plant species visible within three observation zones. The observation zones were: 1) within 1 m of the observer; 2) within a radius of 10 m (until the next observation point or into a garden/property up until the view was obstructed by a tall building); 3) plants appearing above or behind visual obstructions like buildings which would not likely be captured from another street (the datasheet used for this survey is shown in Supplementary Table 1). Species recorded at one waypoint were not included at the next waypoint to avoid double counting. This methodology enabled us to extend the sampling range of each point to capture information on plants which may be located relatively far from the road (e.g. back gardens).

Numbers of individuals of all taxa observed were calculated as number of stems for large, woody species, and as the canopy cover (in m^2) for herbaceous or spreading/creeping species.

We also noted points where no species could be observed (for example when standing on a paved driveway and where anything visible in Zones 2 or 3 would be captured by the next or previous observation waypoint). The growth stage of individuals was recorded at each waypoint as either 'adult' (ideally there was evidence of flowering or fruiting, but occasionally plants were coded as adults simply on the basis of their size), or 'seedling' or 'young, non-reproductive individual'. A measure of the degree of cultivation at each sampling point was taken as either high (well-tended gardens and mowed open areas like parks and playgrounds); medium (less-well maintained gardens and public open spaces); or low (obviously unmanaged areas). Whether an individual was purposefully planted or naturally recruiting was noted and we attempted to determine whether the species had the opportunity to recruit at each sampling point (was it on open, fertile ground, or embedded within paving, for example) and whether there was evidence of recruitment (i.e. the presence of unplanted propagules in the vicinity). The land-use type was also recorded at each waypoint for each observation zone according to five categories: Agricultural Areas; Garden; Curbs (i.e. roadsides bordering gardens or agricultural land); Urban Green Space (we used an adaptation of the definition used by Cilliers et al. (2012) which includes publically accessible spaces within the town, whether formally gardened or not including parks, churches and open plots); and Industrial Areas (including sites of heavy industry, warehouses, commercial space and the waste water treatment works). Lastly, we included field-notes, e.g. that some roadside plants appeared to have grown from dumped garden waste.

While we limited our survey to publically accessible roads, most properties in the town had either no perimeter walls or only low ones, which effectively gave visual access to most species growing in private gardens.