Invasive alien species (IAS) are one of the major threats to biodiversity in protected areas and pose a significant management challenge (see Allen, Brown & Stohlgren 2009; Pyšek, Jarošík & Kučera 2002). One of the first steps towards managing IAS in protected areas is establishing which alien species are present, followed by ongoing surveillance and prevention efforts to combat new introductions (Foxcroft et al. 2009). Information on the identity and traits of alien species is needed for conducting risk assessments and prioritising species for control, as well as for monitoring management effectiveness in preventing new introductions (McGeoch et al. 2010). It also provides a first step towards monitoring the extent of occurrence of alien species in national parks.

The online checklist that accompanies this summary provides a taxonomic list of alien plant and animal species for South Africa’s 19 national parks (including marine protected areas). An online index with common names is also provided. The checklist is intended to serve, (1) as a baseline against which future improvements in knowledge of the alien fauna and flora in South African National Parks (SANParks) may be compared and (2) for future monitoring of the success of alien species prevention and control (Foxcroft 2009; McGeoch et al. 2011).

The checklist was compiled using a range of information sources, including scientific publications, reference books, the Working for Water Information System (WIMS), the Birds in Reserves Project database (http://birk.adu.org.za/), SANParks Invasive Species Control Unit biocontrol database, park management, lower level and operational plans, Kimberley SANParks Herbarium (KSAN) records, species listed for monitoring with handheld computers loaded with CyberTracker software (http://www.cybertracker.org; hereafter referred to as CyberTracker data) and communication from specialists and SANParks staff. Sources for literature searches included content pages of Koedoe (initially the research journal of SANParks, published since 1958; see http://www.koedoe.co.za) and ISI Web of Science and Google Scholar searches using the names of national parks and the search terms ‘alien’, ‘introduced’ and ‘exotic’. CyberTracker data (256 records) were obtained for the Addo Elephant, Agulhas, Augrabies Falls, Camdeboo, Golden Gate Highlands, Kalahari Gemsbok, Karoo, Mapungubwe, Marakele, Mokala, Mountain Zebra, Namaqua and Richtersveld National Parks (currently held at the Geographic Information System Laboratory at Skukuza). Thirty-three records were obtained from the KSAN for nine parks.

In addition to contributions from the authors, data were obtained from seven specialists (on plants, mammals, the Harlequin ladybird, Painted reed frog and invertebrates). Data were also obtained from at least 20 in situ national parks staff in 15 of the national parks, largely via email. Plant species names were checked for validity using http://www.biolib.cz Plant species names were checked using a number of databases, including http://www.gbif.org/, http://www.itis.gov/, http://www.fishwise.co.za and http://www.theplantlist.org. Information on the identity and traits of alien species is needed for conducting risk assessments and prioritising species for control, as well as for monitoring management effectiveness in preventing new introductions (McGeoch et al. 2010). It also provides a first step towards monitoring the extent of occurrence of alien species in national parks.

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Alien species here refer to species that occur outside their historical distribution ranges. Literature and online database searches were conducted to determine indigenous ranges of species and to designate species as alien. The alien species listed include, (1) domestic and livestock animals (see Campos et al. 2007 for predation by cats and dogs), (2) extralimital species, that is species that are indigenous to South Africa but that have been introduced into national parks outside their historical ranges (see Spear & Chown 2009a, 2009b for ungulates and their impacts), (3) bird species that have expanded their geographic ranges in response to human modified habitats, for example Hadaed ibis, Bostrychia hagedash (Macdonald, Richardson & Powrie 1986) and (4) biological control agents released to control invasive alien plants.

A substantial number of records (54%) were obtained from sources other than primary literature, such as from databases, specialists, park management plans, park management staff and rangers (Figure 1). Alien plants, freshwater fish, marine organisms and snails are the best studied taxa
in national parks (based on the number of publications) and some national parks have been relatively well studied compared with others (Table 1; Online checklist). Plants contribute most to alien species richness in national parks and a similar dominance of alien species lists by plants has been shown globally (Delivering Alien Invasive Species Inventory for Europe 2009; McGeoch et al. 2010).

There are particular taxa that are considered most likely to be under-represented on these lists (see Table 2 for representation of taxonomic groups). Commensal species (species benefiting from human habitation and food) associated with buildings and dwellings in national parks are one such group, such as cockroaches (these are reported for Kruger National Park but not for other national parks) and mice and rats (Mus musculus and Rattus rattus are reported for only three national parks) (Online checklist). Domestic animals (e.g. cats, Felis catus and dogs, Canis familiaris) and livestock are also likely to be in the vicinity of most national parks and, if they are not resident in national parks, may be transient visitors. National parks that are surrounded by game farms are also likely to be subject to extralimital and alien game species intrusions (Spear & Chown 2009a) and these mammal species may be missing from lists for some national parks.

FIGURE 1: Percentage of species records from different data sources, namely peer-reviewed publications and reference books (publication), park management plans and lower level alien and rehabilitation plans (man. plan.), Working for Water Information Management System (WIMS), ex-situ specialists and SANParks herbarium (experts), and SANParks in situ staff and CyberTracker data (staff).

TABLE 1: Number of alien species records per national park for different taxa, as collated from peer-reviewed publications.

<table>
<thead>
<tr>
<th>Park</th>
<th>Plants</th>
<th>Fish</th>
<th>Mammals</th>
<th>Marine organisms</th>
<th>Birds</th>
<th>Reptiles</th>
<th>Snails</th>
<th>Arthropods</th>
<th>Bacteria</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>KR</td>
<td>348 (2)</td>
<td>1†</td>
<td>2†</td>
<td></td>
<td>1†</td>
<td></td>
<td>5 (3)</td>
<td>2 (2)</td>
<td>1†</td>
<td>378 (8)</td>
</tr>
<tr>
<td>AD</td>
<td>65 (1)</td>
<td>-</td>
<td>-</td>
<td>1(1)</td>
<td>-</td>
<td>1(1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>67 (3)</td>
</tr>
<tr>
<td>MZ</td>
<td>49 (2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>49 (2)</td>
</tr>
<tr>
<td>TM</td>
<td>37 (1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1(1)</td>
<td>-</td>
<td>-</td>
<td>8 (2)</td>
<td>-</td>
<td>45 (3)</td>
</tr>
<tr>
<td>CA</td>
<td>37 (1)</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>37 (1)</td>
</tr>
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<td>-</td>
<td>-</td>
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</tr>
<tr>
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<td>7 (1)</td>
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<td>-</td>
<td>12 (5)</td>
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<td>-</td>
<td>8 (4)</td>
<td>-</td>
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<td>-</td>
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<td>8 (4)</td>
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<td>-</td>
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</tr>
<tr>
<td>GR</td>
<td>-</td>
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<td>5 (1)</td>
<td>1 (1)</td>
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<td>-</td>
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<td>9 (5)</td>
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<tr>
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<td>4 (1)</td>
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<tr>
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<td>-</td>
<td>-</td>
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<tr>
<td>RI</td>
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<td>1 (1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1 (1)</td>
</tr>
</tbody>
</table>

Note: The number of publications is in brackets.
†, Paper with a variety of taxa.
There are likely to be many more alien invertebrates (e.g. insects, springtails and earthworms) in SANParks than recorded here. The insect taxa currently listed are largely biological control agents, with little record of other alien insects. Insects that may be present but yet unrecorded in some national parks include the European wasp, *Vespa germanica*, the Harlequin ladybug, *Harmonia axyridis* and the Argentine ant, *Linepithema humile*. *Vespa germanica* is found in Table Mountain National Park and could be in other national parks in the Western Cape Province (see Tribe & Richardson 1994), whereas *Harmonia axyridis* has been recorded in the vicinity of Addo Elephant, Bontebok, Mountain Zebra and West Coast National Parks (Lambert Smith pers. comm.). Other groups that are likely to be underrepresented on alien species lists for SANParks include grasses (Milton 2004), garden plants (although well studied for the Kruger National Park; Foxcroft, Richardson & Wilson 2008) and marine organisms (Griffiths et al. 2010).

As with most alien species lists, those provided here are thus almost certainly incomplete (see Pyšek et al. 2008) and may also include inaccuracies as a result of one or more of the following factors, (1) inadequate surveys, inventories and knowledge, (2) taxonomic uncertainty and species misidentification (including cryptogenic species), (3) outdated historical records that may no longer be accurate, (4) unpublished or grey literature information is not always accessible and (5) inadequate information on species historical ranges. Nonetheless, over time and with the planned increase in research, surveillance and monitoring of IAS in national parks (McGeoch et al. 2011), the list accuracy and completeness may be incrementally improved. The publication of these baseline lists will also contribute to future assessments of the relative contribution of increased knowledge versus new invasions and extirpations (see Costello & Solow 2003) to the status of, and trends in, alien species in SANParks.

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### Supporting information

Additional supporting information may be found in the online version of this article, namely:

- **Online checklist**: Lists of alien plant and animal taxa in South Africa’s 19 national parks.
- **Online index**: Lists of animal and plant species and their common names.

### References


