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# Tourism and recreation listed as a threat for a wide diversity of vascular plants: A continental scale review

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ABSTRACT

Tourism and recreation are diverse and popular activities. They may also contribute to the risk of extinction for some plants because of the range and severity of their impacts, including in protected areas: but which species, where and how? To evaluate the extent to which tourism and recreation may be threatening process for plants, we conducted a continental level review of listed threats to endangered vascular plants using data from Australia. Of the 659 vascular plant species listed as critically endangered or endangered by the Australian Government, tourism and recreation were listed as a threat(s) for 42%. This is more than those listed as threatened by climate change (26%) and close to the proportion listed as threatened by altered fire regimes (47%). There are plant species with tourism and recreation listed threats in all States and Territories and from all but one bioregion in Australia. Although more than 45 plant families have species with tourism and recreation listed as threats, orchids were the most common species listed as at risk from these threats (90 species). The most common types of threats listed were visitors collecting plants in protected areas (113 species), trampling by hikers and others (84 species), damage from recreational vehicles (59 species) and road infrastructure (39 species). Despite the frequency with which tourism and recreation were listed as threats in Australia, research quantifying these threats and methods to ameliorate their impacts are still limited. Although this lack of information contributes to the challenge of managing tourism and recreation, impacts from visitors will often be easier to manage within natural areas than those from larger scale threats such as altered fire regimes and climate change.



## 1. Introduction

Globally, biodiversity is experiencing a sixth wave of mass extinction, nearly entirely due to human activities (Smith et al., 1993; Stork, 2010; Barnosky et al., 2011). As a result, there are 9829 species of plants listed as threatened on the International Union for the Conservation of Nature (IUCN) Red List, 1.3% of which are Australian (IUCN, 2013). The Australian flora is particularly vulnerable due to the large number of endemic species. There are approximately 21,000 species of plants in Australia, 93.3% of which are endemic to the continent (Chapman, 2009). Australian flowering plants account for 15.2% of the world's threatened flowering plants (Chapman, 2009; Cork et al., 2011) with common threats including land clearing, feral animals, weeds, pathogens, altered fire regimes, salination and climate change (Burgman et al., 2007; Mackey et al., 2008; Cork et al., 2011).

A major mechanism for the conservation of biodiversity is the creation and maintenance of protected areas whose primary purposes are conserving native flora, fauna and ecosystems (Mackey et al., 2008; Australian Government, 2013a). This protection, however, does not exclude or mitigate many of the impacts of tourism and recreation which are amongst the few human activities permitted in many protected areas (Pickering and Hill, 2007; Monz et al., 2010; Newsome et al., 2013). Nature-based tourism is increasing and diversifying globally and in Australia, with a wide range of activities and areas utilized (Pickering and Hill, 2007; Newsome et al., 2013). For example, nature-based tourism accounts for an estimated 84 million visits per year to Australian protected areas (Newsome et al., 2013). In addition there are a range of impacts of tourism and recreation on rare plants outside protected areas including from the construction of tourism infrastructure (Pickering and Hill, 2007; Ballantyne and Pickering, 2012).

Unfortunately tourism and recreation, including nature-based tourism, have a diverse range of negative environmental impacts

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that can increase the extinction risk for already threatened plants (Hercock, 1999; Kelly et al., 2003; Obst, 2005: Pickering and Hill, 2007; Monz et al., 2010; Ballantyne and Pickering, 2012; Newsome et al., 2013). Impacts range from those associated with the building and maintenance of infrastructure, including in protected areas, to the recreational activities themselves, such as horse riding, hiking and camping (Liddle, 1997; Hercock, 1999; Kelly et al., 2003; Obst, 2005: Pickering and Hill, 2007; Monz et al., 2010; Ballantyne and Pickering, 2012). Environmental impacts from tourism and recreation activities can result from trampling, collecting, alteration to soil nutrients and hydrology, and changes in vegetation structure, as well as indirect impacts including those from the spread of weeds and pathogens and habitat fragmentation (Liddle, 1997; Hercock, 1999; Kelly et al., 2003; Obst, 2005: Pickering and Hill, 2007; Monz et al., 2010; Pickering et al., 2012; Ballantyne et al., 2014).

Despite the scale and diversity of tourism and recreation in Australia, the extent to which they threaten Australian biodiversity is not well recognised or researched (Kelly et al., 2003; Pickering and Hill, 2007; Ballantyne and Pickering, 2012). Assessing how, where and why these processes are considered threats to plants at risk of extinction is important for the managers of protected areas and for conservation goals in general. It can also provide insights about the importance of the issue including for particular regions with high levels of biodiversity, endemism and tourism-recreational use. One approach to this issue is assessing how frequently tourism and recreation are listed as threatening processes within systematic databases of endangared species as has been done for plants in Europe (Ballantyne and Pickering, 2013), all species in the Pacific (Morrison, 2012) and birds globally (Steven and Castley, 2013). Similar approaches have also been used to compare the frequency with which different threatening process affect endangered plants in Australia previously (Burgman et al., 2007; Evans et al., 2011), and in global studies assessing the benefits of tourism for the conservation of critically endangered mammals (Buckley et al., 2012), frogs (Morrison et al., 2012) and birds (Steven and Castley, 2013).

The process for listing species and their threats in international databases such as the International Union for the Conservation of Nature Red List or national databases such as that maintained by the Australian Government, involves the input of and review by a range of experts and advisory committees and hence does not require the same level of evidence as found in experimental research. As a result, there can be debate about the importance of different threatening processes, particularly for high profile species and controversial threats (Possingham et al., 2002). Despite these imitations, however, these databases remain one of best available sources of information for prioritizing conservation efforts (Rodrigues et al., 2006; Schatz, 2009). The databases often list more than one threatening process for individual species without ranking them in terms of severity. As a result, it is not possible to use them to evaluate the severity of different types of threats, but they can be used to assess the frequency with which different types of threats are listed (Burgman et al., 2007; Evans et al., 2011).

This study used data from the list of critically endangered (129 species) or endangered (530 species) plants maintained by the Australian Government. Specifically it determines: 1) for how many of these species are tourism and recreation listed as threat(s)? 2) how are tourism and recreation considered a threat?, 3) where are these species?, 4) which types of plants are they?, 5) how frequently are tourism and recreation listed as a threat compared to fire and climate change, two key threatening process in Australia?, and 6) what are the implications for tourism and recreation and plant conservation? By providing a continental-scale case study, we highlight the potential importance of tourism and recreation as global threatening processes for plants.

## 2. Methods

### 2.1. Data collection

This analysis uses similar methods to those in previous studies comparing the frequency of different types of threatening process for the Australian flora (Burgman et al., 2007; Evans et al., 2011), and the methods used to assess tourism impacts for plants in Europe (Ballantyne and Pickering, 2013), and birds globally (Steven and Castley, 2013). The Australian Government list of threatened species was used as there is a relatively consistent set of listing criteria and it provides information for different types of threats at a continental scale (Australian Government, 2013b). There were 659 species and subspecies of plants listed as either critically endangered (129) or endangered (530) under the Australian Government's *Environmental Protection and Biodiversity Conservation Act 1999* (EBPC Act) in August 2013. Individual State or Territory level listings within Australia were not used as the latter: 1) report on many species that may be considered threatened in one State or Territory but are present and not threatened in another, 2) the criteria used for listings are not identical among States, and 3) do not cover as broad a range of habitats as the Australian Government list.

The term Australia was used in this study to refer to all the States and territories associated with the mainland continent as well the external island territories of Norfolk, Macquarie, Christmas, Cocos-Keeling, Bathurst, Lord Howe, Heard and MacDonald, Ashmore and Cartier and Coral Sea Islands.

For each species identified in the Australian Government list, information was entered into a specific database for the study: this included information on scientific and common names as well as synonyms, the date the species was listed, taxonomic family, conservation status, growth form, State and/or Territory where it is found, whether it is endemic to a State or Territory, whether it is endemic to Australia, which of the eight bioregion/s in Australia it occurs in, its current distribution, growth form and preferred habitat. The eight bioregions in Australia are: 1) tropical and subtropical moist broadleaf forests, 2) temperate broadleaf and mixed forests, 3) tropical and subtropical grasslands, savannahs and shrublands, 4) temperate grasslands, savannahs and shrublands, 5) montane grasslands and shrublands, 6) Mediterranean forests, woodlands and shrublands, 7) deserts and xeric shrublands and 8) tundra (Australian Government, 2013c).

Information on all threats to these species was reviewed to assess if tourism and recreation were considered important threatening processes. This included assessing if the terms tourism and/or recreation were explicitly stated as threats, and/or if tourism and/or recreation infrastructure or activities were listed as threats for these plants. Plant collecting was included as a tourism and recreation threat only if the listing stated that plants were collected from plant populations in protected areas by visitors. To provide a basis for comparing the frequency of different types of threats, information about whether inappropriate fire regimes and/or climate change were listed threats was also included for all species.

### 2.2. Data analysis

The total number of species threatened by tourism and/or recreation was calculated for each State and Territory, the eight bioregions and for Australia overall. The number of species affected by specific activities or impacts of tourism and recreation were calculated for each government region and bioregion. Chi-squared tests were used to determine whether threatened species with