Applied Geography 62 (2015) 97–106

Contents lists available at ScienceDirect

Applied Geography

journal homepage: www.elsevier.com/locate/apgeog

Spatial and environmental patterns of off-road vehicle recreation in a semi-arid woodland

Fiona Westcott, Margaret E. Andrew*

School of Veterinary and Life Sciences, Murdoch University, Murdoch, Western Australia, Australia

A R T I C L E I N F O

Article history:
Available online

Keywords:
Cultural ecosystem services
Great Western Woodlands, Western Australia
GoogleEarth
Maximum entropy (MaxEnt)
Motorized recreation
Recreation planning

A B S T R A C T

Outdoor recreation is a widely recognized cultural ecosystem service. Ensuring that appropriate, high quality recreation opportunities are available requires, among other factors, knowledge of the environmental preferences of recreation users and spatial indicators of where those environmental features exist on the landscape and offer the potential to meet recreation goals. Diverse types of outdoor recreation exist, and different forms of recreation may be associated with different environmental features. The focus of this study is off-road vehicle (ORV) recreation. We demonstrate how readily available spatial environmental datasets, including high resolution image data provided within GoogleEarth, can be used to develop a cost-effective, objective indicator of ORV recreation across a landscape, which can inform management to provide desired recreation opportunities while protecting ecologically sensitive areas.

ORV recreational tracks were delineated from GoogleEarth imagery throughout our study area in the Great Western Woodlands of Western Australia. In this region, ORV use is a popular recreation activity and a growing concern of conservation organizations, but is not yet actively managed. Most recreational ORV tracks in the study area are informal and user-created. Mapped ORV recreation tracks were used to model and map the environmental associations of ORV recreation. The pattern of existing tracks indicated associations between recreation and noteworthy environmental amenities in the study area such as the shores of salt lakes and rock outcrops with high ecological and cultural value. However, one of the most important determinants of ORV track presence was accessibility, especially proximity to a road. Access infrastructure, such as proximity to roads, is often used to proxy demand and use in expert-based spatial assessments of ecosystem services. The results of our empirical model underscore the importance of incorporating patterns of both supply (i.e., desired natural amenities) and demand (i.e., access) into ecosystem service assessments. In addition, when integrated with maps of environmental sensitivity and more detailed information about human use, the predictive map of areas providing potential recreation experiences can be used for comprehensive spatial planning of sustainable ORV recreation. One possibility suggested by our results is that careful planning and management of access routes may be an effective means to achieve sustainable ORV recreation.

Introduction

Ecosystem services are expanding the range of motivations and funding sources for conservation (Goldman & Tallis, 2009) and highlight the importance of integrated land use planning (e.g., Goldstein et al., 2012). Ecosystem services are the benefits that species and the environment provide to human societies, including the supply of such entities as natural resources, cultural resources, and fresh air and water (Millennium Ecosystem Assessment, 2005). Of these benefits, cultural ecosystem services are readily identifiable by the broader public because they involve direct engagement with the environment (e.g., Raymond et al., 2009). Despite this conceptual advantage, the complexity of social systems and cultural preferences has caused them to receive relatively less study to date than other, more tangible ecosystem services, and has limited the development of spatial indicators of cultural services for use in planning and management (Balmford et al., 2008; Daniel et al., 2012; Hernández-Morcillo, Plieninger, & Bieling, 2013; Martínez-Harms & Balvanera, 2012).

* Corresponding author. School of Veterinary and Life Sciences, Murdoch University, 90 South St., Murdoch, WA 6150, Australia. Tel.: +61 8 9360 6121.
E-mail address: m.andrew@murdoch.edu.au (M.E. Andrew).

http://dx.doi.org/10.1016/j.apgeog.2015.04.011
0143-6228/

Spatial indicators of recreation services

Recreation and tourism are among the most studied and operational cultural ecosystem services (Hernández-Morcillo et al., 2013; Martínez-Harms & Balvanera, 2012; Plieninger, Dijks, Oteros-Rozas, & Bieling, 2013; Seppelt, Dormann, Eppink, Lautenbach, & Schmidt, 2011). Nevertheless, there is substantial need for continued research into the spatial distribution of recreation services and the environmental features that meet recreation goals. Although many protected areas monitor aggregate visitor numbers, less is known about the specific locations of recreational activities (Buckley, 2003; Buckley, Robinson, Carmody, & King, 2008; Hadwen, Hill, & Pickering, 2007) or impacts (Cole, 2004; Ouren et al., 2007). Instead, spatial planning exercises typically rely on expert judgment to relate recreation values to environmental variables and map the distribution of recreation services (e.g., Chan, Shaw, Cameron, Underwood, & Daily, 2006; Haines-Young, Watkins, Wale, & Murdock, 2006; Lautenbach, Kugel, Lausch, & Seppelt, 2011; van Oudenhoven, Petz, Alkemade, Hein, & de Groot, 2012; Willemen, Verburg, Hein, & van Mensvoort, 2008). Yet expert-based maps are essentially untested hypotheses of the environmental associations of the ecosystem service of interest (Carpenter et al., 2009; de Groot, Alkemade, Braat, Hein, & Willemen, 2010; Haines-Young, Potschin, & Kienast, 2012). Further, this practice has been criticized because it does not explicitly consider actual recreation use preferences (Kliskey, 2000). Indeed, participatory exercises have revealed that expert and user groups differ in their identification of the relative importance of various environmental contributors to recreation value and the resulting maps of recreation services (Nahuelhual, Carmona, Lozada, Jaramillo, & Aguayo, 2013).

Alternatively, environmental preferences of recreationists can be directly determined with user surveys or participatory research methods. Such preferences may be linked to spatial data layers to map recreation preferences across a landscape (e.g., Albritton & Stein, 2011; Goossen & Langers, 2000; Kliskey, 2000; Oishi, 2013; Snyder, Whitmore, Schneider, & Becker, 2008). This type of research may demonstrate that recreation preferences may not be accommodated by the existing opportunities (Oishi, 2013), which may lead to reduced visitor satisfaction (Boers & Cottrell, 2007) or problematic unmanaged recreation (Brooks & Champ, 2006; Snyder et al., 2008; Turton, 2005; Wimpey & Marion, 2011).

Finally, recreation services have been empirically modeled by relating observed patterns of visitor use to spatial environmental variables. Locations of recreation activities can be determined from surveys (Bateman, Lovett, & Brainard, 1999; Termansen, McClean, & Jensen, 2013), participatory mapping (Sherrouse, Clement, & Semmens, 2011), or evidence of free-ranging recreation activities such as tracks or informal trails (Braunisch, Patthey, & Arlettaz, 2011; Coppes & Braunisch, 2013; Matchett et al., 2004; Wimpey & Marion, 2011). Empirical recreation indicators avoid uncertainties in how to represent user preferences or expert opinion with existing spatial data layers and explicitly test relationships between environmental characteristics and recreation occurrences. However, they are correlative models of the environmental associations of recreation and do not explicitly determine causal mechanisms such as personal recreation preferences.

Off-road vehicle recreation

Another reason for the incompleteness of our understanding of recreation services is the heterogeneity of recreation activities that are possible, with correspondingly diverse preferences (Albritton & Stein, 2011; Bagstad, Villa, Johnson, & Voigt, 2011; Goossen & Langers, 2000; Sherrouse et al., 2011). Consequently, different forms of recreation are unlikely to be well represented by a collective recreation indicator. Such heterogeneity continues to grow as new technologies stimulate novel forms of outdoor recreation (Burgin & Hardiman, 2012). One relatively recently developed recreation activity that continues to grow in popularity is off-road vehicle (ORV) use (Burgin & Hardiman, 2012; Cordell et al., 2005). Much of the existing research of ORV recreation is restricted both geographically and environmentally (Buckley, 2004; Stokowski & LaPointe, 2000) to desert (Ouren et al., 2007) and coastal (Priskin, 2003) settings. Considerable basic research remains to be done on the preferences, patterns, and impacts of ORV recreation (Monz, Cole, Leung, & Marion, 2010; Pickering & Hill, 2007). Given the potential for social and environmental conflicts in areas where ORV recreation overlaps with other types of recreational use or with ecologically sensitive areas (Brooks & Champ, 2006; Shilling, Boggs, & Reed, 2012), a spatial perspective should be brought to the planning, monitoring, and management of ORV recreation. Rigorous spatial indicators of ORV recreation can also contribute to our understanding of the environmental preferences of recreationists.

This study characterizes the spatial and environmental patterns of recreational ORV tracks in a semi-arid woodland of Western Australia where ORV recreation is largely unmanaged and occurs on informal tracks created by the recreation users. The objectives of this project were to (1) develop a spatial inventory of ORV tracks throughout the study area and (2) use predictive modeling to identify the environmental associations of ORV recreation and to map other locations of potential recreation opportunities. Because much of the ORV recreation in this region occurs on informal tracks created by the recreation users themselves, it is assumed that they occur in environments that provide desired recreation experiences (Coppes & Braunisch, 2013; Wimpey & Marion, 2011). Thus, the modeled environmental associations can suggest inferences into the environmental preferences of ORV recreationists and these and the resulting maps of observed and predicted recreation occurrence can inform effective management to balance recreational use and conservation.

Methods

Study area

The study area is a 1700 km^2 area surrounding Lake Johnston within the Great Western Woodlands (GWW) of Western Australia (32.3°S, 120.8°E; Fig. 1). The GWW is a remnant of formerly widespread semi-arid woodlands and is considered to be the largest intact Mediterranean-type climate woodland in the world (Department of Environment and Conservation, 2010). Notable environmental features of the GWW include numerous rock outcrops and ephemeral salt lake playas. The rock outcrops have high conservation and cultural value (Main, 1997, 2000). ORV recreation is popular in Western Australian woodlands but has not yet been researched in these systems (Buckley, 2004).

The study area is ~100 km from the nearest settlement (Norseman). It contains two maintained roads, several tourist facilities, and a network of tracks normally only accessible by four-wheel drive. These tracks are used for transportation, mineral exploration, recreation, or a combination of uses. There is no comprehensive inventory of tracks in the study area; few are included in regional maps (typically the longest tracks that provide shortcuts to surrounding roads). The study area is representative of the large tracts of unallocated crown lands in the GWW. It is monitored but not actively managed by the Department of Parks and Wildlife and portions of it have been proposed for protection (Department of Conservation and Land Management, 1991). There are concerns that rock outcrops are subject to degradation by unmanaged ORV recreation in this area.