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The use of public participation GIS (PPGIS) for park visitor management: A case study of mountain biking

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HIGHLIGHTS

- We evaluated the utility of public participation GIS (PPGIS) in park tourism planning.
- Our method was effective for engaging mountain bikers in complex spatial planning.
- Insights were gained on rider distributions, underlying reasons and management actions.
- We used GPS tracking to validate and surveys to complement PPGIS mapping data.
- We discuss the benefits of mixed PPGIS delivery modes (field vs. online data).

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ABSTRACT

Spatially-explicit participatory planning is a relatively new approach for managing visitors to protected areas. In this study we used public participation geographic information systems (PPGIS) mapping and global positioning system (GPS) tracking to monitor mountain bikers frequenting national parks for tourism and recreation in Northern Sydney, Australia. PPGIS was implemented using both an internet application and with hardcopy maps in the field. Our research addressed two fundamental questions for park planning: (1) What is the spatial distribution of visitor activities and location-specific reasons for riding; and (2) What location-specific actions are needed to improve riding experiences? The spatial distributions of riding activities generated in PPGIS showed strong correlation with the GPS tracking results, with riding locations being related to the reasons for track selection. Riders proposed a broad range of management actions to improve riding experiences. PPGIS mapping provides a cost-effective approach to facilitate spatial decision making, allowing park agencies to prioritise future visitor management actions. We discuss the strengths and limitations of these research methods.

1. Introduction

Providing quality tourism and recreation experiences is essential for national parks and other public lands to cultivate social support for their protection. Developing national park experiences that promote short and long-term benefits for visitors (Driver, 2008; Wolf, Stricker, & Hagenloh, 2015) may assist in conserving the natural and cultural values of parks (Weiler, Moore, & Moyle, 2013). To create a diverse and high-quality range of experiences, park managers need to understand the potentially conflicting demands of different visitor groups.

Visitors typically favour specific park locations and times along with supporting facilities that best provide for their preferred activity. These choices are reflected in visitors' spatio-temporal usage patterns of tourism and recreation areas (Wolf, Stricker, & Hagenloh, 2013; Wolf & Wohlfart, 2014). Parks need to supply experiences and facilities consistent with demand to satisfy visitor expectations and to protect natural resources from oversupply (Buhalis, 2000). Popular activity groups in parks around urban centres, such as mountain bikers, require tracks with distinct properties to achieve a desired experience for different styles of

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riding and trip motivations (Newsome & Davies, 2009; Symmonds, Hammitt, & Quisenberry, 2000). Hence, park tourism and recreation management requires critical information on the frequencies and spatial patterns of park use as a predictor of demand (Eagles, 2014), and the underlying visitor motivations that inform management actions to improve visitor experiences. Spatially-explicit information is also needed to better manage crowded areas and conflicts, and to foresee the partitioning of resources between visitor groups (Ostermann, 2009). However, for most parks there is very little information available on the spatio-temporal distributions of visitors and their location-specific needs (van Schaick, 2010).

While the use of detailed spatial data on the ecology, infrastructure, and other attributes of the landscape is common, social data at a similar spatial scale are much rarer, limiting visitor activity management and planning in parks. This issue is aggravated where the activity extends beyond park boundaries across land tenures managed by multiple agencies with variable approaches to visitor data collection and sharing. Mountain biking, for example, occurs on a range of public land tenures as well as on private lands such as commercial mountain bike parks. This demonstrates the need to increase the spatial extent of visitor monitoring efforts beyond park boundaries.

Spatially explicit social data on management processes of public lands can be collected from stakeholders through participatory planning processes. Growing attention has been given to the importance of engaging people for tourism and recreation planning across single and multiple land tenures. Public participation can enhance the quality and acceptance of decisions with spatial implications and alleviate concerns of the community when altering their environment (Raymond et al., 2009). Public participation geographic information systems (PPGIS) use geospatial technology to inform planning processes with public knowledge by inviting participants to provide geospatial information about perceived attributes of place (Sieber, 2006). This has relevance for tourism and recreation areas where visitors have particular needs regarding specific precincts and facilities such as tracks used for mountain biking. Brown and Weber (2011) described PPGIS as " … *the practice of GIS and mapping at local levels to produce knowledge of place*". This methodology finds application in many research areas such as socio-ecological hotspot mapping (Alessa, Kliskey, & Brown, 2008), identification of ecosystem services (Brown, Montag, & Lyon, 2012; Brown & Raymond, 2014; Raymond et al., 2009), land use conflicts (Brown & Raymond, 2014), forest planning (Brown & Donovan, 2013; Brown & Reed, 2012), tourism management (Brown, 2006; Marzuki, Hay, & James, 2012), public land management (Brown, Weber, & de Bie, 2014), and a growing list of other applications (see Brown & Kyttä, 2014 for a recent review). Further, Brown and Weber (2011) consider PPGIS to have great potential to advance national park planning of visitor experiences while there is a growing trend in the use of spatial information in park and protected areas management (Beeco & Brown, 2013). In PPGIS mapping, information is solicited by requesting participants to identify and mark locations on a map about perceived place attributes. PPGIS mapping may be administered in the field (e.g., private homes, park visitor centres) through mail surveys (Brown, 2004), stakeholder workshops (Donovan et al., 2009) or personal interviews and surveys (Donovan et al., 2009; Raymond et al., 2009) that typically use a hardcopy form of data collection. In contrast, internet-based implementations of PPGIS mapping, as advertised through mass media, email lists or online panels have numerous advantages (as reviewed by Pocewicz, Nielsen-Pincus, Brown, & Schnitzer, 2012) especially in the reduction of costs and the increased efficiency of data collection and entry (Couper & Miller, 2008). It is useful to compare the results achieved with both field- and internet-based PPGIS mapping to determine the representativeness of the recruited sample population and to identify other potential biases resulting from the data collection (Olsen, 2009). Outcomes that may vary with the mode of the PPGIS application include the participation rate, and the number and spatial distribution of mapped attributes of place. For example, Pocewicz et al. (2012) found that field-based PPGIS resulted in higher participation rates and greater numbers of mapped attributes.

PPGIS mapping provides insights into spatial distributions of attributes such as the locations people report to visit, and possibly the frequency of visitation, but not the exact time spent at specific facilities and attractions. In contrast, GPS tracking data presents actual (vs. reported) spatio-temporal distributions of visitors and captures entire travel routes (vs. singular locations) of visitors (Orellana, Bregt, Ligtenberg, & Wachowicz, 2012; Wolf, Hagenloh, & Croft, 2012). Typically this information is collected from visitors equipped with personal GPS receivers such as smartphones using tracking applications, or those supplied by a researcher. GPS receivers are easy to use with comparatively little effort required from participants apart from carrying and returning the equipment. More effort is involved in PPGIS mapping where participants need to accurately recall, locate, and mark specific places on a map to assign spatial attributes. In this study, we will evaluate the benefits and disadvantages of GPS tracking and PPGIS mapping to address different park management questions.

National parks and other public green spaces are frequented for a range of activities including mountain biking (Heer, Rusterholz, & Baur, 2003; Newsome & Davies, 2009). In recent decades the popularity of mountain biking has increased significantly in Australia, New Zealand (Mason & Leberman, 2000; Newsome & Davies, 2009; Ryan, 2005), North America (Attarian, 2001; Cordell, 2008) and Europe (Christie et al., 2006; Heer et al., 2003). A study by Christie et al. (2006) for instance revealed that technical single-track mountain biking and cross-country mountain biking, enjoyed by 20.0% and 10.5% of all visitors, respectively, were some of the most common visitor activities in seven forest areas in Great Britain. The Australian Cycling Participation survey 2013 (Australian Bicycle Council, 2013) showed that 37.4% of people in Australia participated in cycling over the last year with an increasing trend compared to previous years. The survey, however, did not segment by type of cycling.

Our study focused on mountain biking in the semi-rural, Northern Sydney area where demand for this activity is rapidly growing in national parks and surrounding land tenures. Increasing demand has resulted in the development of formal strategies to promote and sustain high-quality mountain biking experiences in national parks in Sydney and other parts of New South Wales (NSW). In 2011, the Office of Environment and Heritage NSW (2011) published a strategy that outlines the provision of high quality, sustainable mountain biking experiences that (1) improve and maintain existing tracks, (2) identify suitable links between tracks, and (3) where appropriate, develop new mountain biking experiences consistent with standards for design, construction, and maintenance proposed by the International Mountain Bicycling Association. The strategy targets all skill levels, as well as families and other travel groups to provide diverse riding experiences. In the strategy, high importance is placed on communication and consultation to build a strong partnership between management agencies and public stakeholders of mountain biking activities. Mountain biking currently co-exists with other tourism and recreation activities on certain multi-use trails in the region where potential conflicts need to be monitored closely, especially if demand for this activity continues to grow.