Research Paper

# Using social media to understand drivers of urban park visitation in the Twin Cities, MN

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## ARTICLE INFO

## ABSTRACT

Green space and parks in urban environments provide a range of ecosystem services and public benefits. However, planners and park managers can lack tools and resources to gather local information on how parks are used and what makes them desirable places for recreation and a wide variety of uses. Traditional survey methods to monitor park use and user preferences can be costly, time consuming, and challenging to apply at scale. Here, we overcome this limitation by using geotagged social media data to assess patterns of visitation to urban and peri-urban green space across park systems in the metropolitan area of the Twin Cities, Minnesota, USA. We find that parks with nearby water features, more amenities, greater accessibility from the presence of trails, and that are located within neighborhoods with higher population density, are associated with higher rates of visitation. As cities grow and shifts in demographics occur, more responsive management of public green space will become increasingly important to ensure urban parks provide ecosystem services and meet users' needs. Using social media data to rapidly assess park use at a lower cost than traditional surveys has the potential to inform public green space management with targeted information on user behavior and values of urban residents.

## 1. Introduction

Opportunities for outdoor recreation are often classified as cultural ecosystem services, as they relate to the non-material health, well-being, and experiential benefits that humans derive from directly interacting with nature (Chan et al., 2012; Millennium Ecosystem Assessment, 2003). Cultural services is a broad category of physical and psychological relational benefits from nature that generally includes not only recreation but also spirituality, aesthetics, and mental health, among others (Haines-Young & Potschin, 2010). Historically, these services have been notably difficult to quantify and represent spatially (Paracchini et al., 2014) without robust, participatory mapping or engagement processes (Brown & Fagerholm, 2015; Plieninger, Dijks, Oteros-Rozas, & Bieling, 2013). Furthermore, cultural services depend on the specific context in which they occur, surrounding infrastructure that mediates how nature is experienced, and the preferences or perceptions of the individuals who value these services (Andersson et al., 2015). As a result, they have traditionally been the least studied service in ecosystem services assessments, which typically focus on the classes of provisioning, regulating, and supporting services that land-scapes provide (Daniel et al., 2012). This is a notable gap, especially in studies of urban ecosystem services where cultural services may have a large importance in connecting urban populations with nature (Andersson, Tengö, McPhearson, & Kremer, 2015; Gómez-Baggethun & Barton, 2013; Haase et al., 2014; Luederitz et al., 2015).

In urban areas, recent examples of cultural ecosystem services assessments have demonstrated the site-specific and temporally sensitive nature of cultural values, challenges in quantifying or mapping these preferences and behaviors, and the need for additional research and methods on this topic (see, for example, Bauer, Tynon, Ries, & Rosenberger, 2014; Bertram & Rehdanz, 2015; Langemeyer, Baró, Roebeling, & Gómez-Baggethun, 2015; Thiagarajah, Wong, Richards, &

Friess 2015; Tratalos, Haines-Young, Potschin, Fish, & Church, 2016). Our study is motivated by the growing demand for readily available, spatially-explicit information on cultural ecosystem services in cities, particularly for assessments of the drivers of recreation patterns in urban parks.

More specifically, public green space and parks in urban and peri-urban areas provide users—including urban residents and visitors—-with a connection to nature not always possible elsewhere in cities and with a broad range of social, psychological, and recreational services (Bolund & Hunhammar, 1999; Chiesura, 2004; Gómez-Baggethun et al., 2013). Previous research has illustrated a range of park characteristics that affect the benefits users receive from visiting parks, though these factors may vary depending on specific context and type of green spaces analyzed (Andersson et al., 2015). For example, park size, recreational amenities like water features or trails, organized recreational activities, and accessibility have had demonstrated, positive effects on park use and suitability of nature-based recreation (Cohen et al., 2010; Dallimer et al., 2014; Kienast, Degenhardt, Weilenmann, Wäger, & Buchecker, 2012; Paracchini et al., 2014). While population density and forested land cover were associated with greater demand for green space in some contexts (Kienast et al., 2012; Paracchini et al., 2014), these factors did not always have positive effects in others (Cohen et al., 2010; Dallimer et al., 2014). Although metrics of accessibility and park amenities appear important across contexts, this literature also suggests that the full suite of factors influencing nature-based recreation in urban areas likely varies by location, type of green space, or user groups studied.

Reviewing this literature, measures of visitation to parks are also clearly important to understanding patterns of green space use in urban settings. Most studies about urban parks to-date rely, at least in part, on traditional survey measures (e.g., visitor counts at park entrances or questionnaires from random or representative samples of park users) to measure demand for recreation and elicit preferences of park users for different amenities (Cohen et al., 2010; Dallimer et al., 2014; Eagles, 2014). These methods, however, are generally limited by staff capacity (i.e., time, expertise, or number of employees to conduct rigorous surveys), costly to conduct regularly or across large or multi-jurisdictional geographic areas, and not always spatially explicit (Cessford & Muhar, 2003; Freeman, 2014). Furthermore, there is potential for implicit bias in these surveys techniques from the reference group or data collection process (*Ibid.*). With this in mind, urban park managers and researchers are both demanding and developing new methods derived from geospatial information and sensors to strengthen and expand the available toolkit for measuring and mapping park visitation (Shoval & Ahas, 2016).

Inspired by the need for readily available, low cost park use data and by these new approaches to assessing park visitation, we seek to overcome logistical challenges facing previous urban park research and management by supplementing traditional survey methods with a wealth of novel, spatially explicit data from two online social media platforms—Flickr and Twitter—used to estimate park visitation. In so doing, we estimate recreational demand in 1581 diverse public urban parks and urban and peri-urban green spaces, including, but not limited to city parks and recreation centers, regional linear parks, golf courses, and nature preserves, in the Twin Cities Metropolitan Area (TCMA) in Minnesota, USA. Hereafter, we refer to this wide range of features in the area's park systems, which make up the spatial unit of our analysis, by the simple shorthand of "parks" or "urban parks."

Our research follows from recent studies demonstrating that social media can provide a rich source of geographic information for a broad range of applications (Goodchild, 2007; Zook & Graham, 2007), including in the ecosystem services and outdoor recreation communities. Notably, there have been broader calls to incorporate crowd-sourced and geotagged social media data and a growing number of examples using these data both in conservation science and practice (Di Minin, Tenkanen, & Toivonen, 2015; Levin, Kark, & Crandall, 2015; Levin,

Lechner, & Brown, 2017), as well as in urban planning (Dunkel, 2015; Guerrero, Møller, Olafsson, & Snizek, 2016; Tao, 2013). Other studies have shown that visitation rates to recreation sites, for example, can be reliably estimated using users' online image-sharing activity (Wood, Guerry, Silver, & Lacayo, 2013). This finding has inspired a number of recent studies of nature-based tourism that use these data across various subjects and both spatial and temporal scales (e.g., Arkema et al., 2015; Casalegno, Inger, DeSilvey, & Gaston, 2013; Keeler et al., 2015; Sessions, Wood, Rabotyagov, & Fisher, 2016; Sonter, Watson, Wood, & Ricketts, 2016; van Zanten et al., 2016). Nature-based recreation is a common focus across these examples, but researchers have tended to focus their assessments in predominantly rural wilderness areas at large scales, including at state and national levels.

However, more people now live in cities than in rural areas (United Nations & Social Affairs, 2014), making it likely that the average individual's outdoor recreation experiences occur more often in smaller-scale, more heavily managed urban parks and green spaces than in remote wilderness areas (Standish, Hobbs, & Miller, 2013). As a result, while some have started to use social media data within cities to assess, for example, transportation patterns (Toole et al., 2015; Wu, Wood, Fisher, & Lindsey, 2017) or public perceptions and values in landscape and urban planning (Dunkel, 2015), these methods are still nascent and other potential applications of these data are vast (Guerrero et al., 2016). Few studies have yet to test or use these data explicitly as indicators of recreation services or proxies for surveyed visitation to urban parks at the scale of a single metropolitan area.

Filling this gap, our study adapts and builds on existing methods that aggregate social media data within nature-based recreation sites (Wood et al., 2013) to test how well data from multiple social media platforms perform in approximating urban park visitation and how these data, combined with other geospatial information about urban parks, can be used to assess observed user preferences within the TCMA context. Specifically, we ask how social media data from two platforms compare to survey methods for estimating visitation to these parks. Then, building on previous studies of urban park characteristics and visitation, we use these data to ask what attributes within and around urban parks predict observed patterns of park use across the region. We conclude by presenting a discussion of our key findings, limitations of these results, proposed next steps for building on this approach and improving our understanding of TCMA park use, and the usefulness of social media as data to inform urban planning and park research and management more broadly.

## 2. Methods

### 2.1. Study area and park system

Our study analyzed the visitation patterns, amenities, and neighborhood characteristics of 1581 unique parks in Minnesota's TCMA (Fig. 1). Parks within the study area range in type, size, and management—from small, municipal pocket parks to large, multi-jurisdictional regional parks—representing a diverse sample of urban and peri-urban parks across a single metropolitan area. More than 50 different municipalities and agencies manage the park systems in our study.

For spatial information on these parks, we compiled available vector data with the locations of these features within our study area from the regional metropolitan planning agency Metropolitan Council (Met Council), Hennepin County, Three Rivers Park District, Ramsey County, Minneapolis Park and Recreation Board, and City of Saint Paul Parks and Recreation Department. From these datasets, we then selected those parks located within a three-mile radius of Hennepin and Ramsey counties, allowing us to include parks whose boundaries overlapped with or extended just beyond county lines (see Table S1, in supplementary material, for summary statistics of these parks). Hennepin and Ramsey Counties, which cover approximately 2000 square kilometers (800 square miles), were chosen because they contain the Twin Cities of