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Research article

Recreational use in dispersed public lands measured using social media data and on-site counts

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ABSTRACT

Outdoor recreation is one of many important benefits provided by public lands. Data on recreational use are critical for informing management of recreation resources, however, managers often lack actionable information on visitor use for large protected areas that lack controlled access points. The purpose of this study is to explore the potential for social media data (e.g., geotagged images shared on Flickr and trip reports shared on a hiking forum) to provide land managers with useful measures of recreational use to dispersed areas, and to provide lessons learned from comparing several more traditional counting methods. First, we measure daily and monthly visitation rates to individual trails within the Mount Baker-Snoqualmie National Forest (MBSNF) in western Washington. At 15 trailheads, we compare counts of hikers from infrared sensors, timelapse cameras, and manual on-site counts, to counts based on the number of shared geotagged images and trip reports from those locations. Second, we measure visitation rates to each National Forest System (NFS) unit across the US and compare annual measurements derived from the number of geotagged images to estimates from the US Forest Service National Visitor Use Monitoring Program. At both the NFS unit and the individual-trail scales, we found strong correlations between traditional measures of recreational use and measures based on user-generated content shared on the internet. For national forests in every region of the country, correlations between official Forest Service statistics and geotagged images ranged between 55% and 95%. For individual trails within the MBSNF, monthly visitor counts from on-site measurements were strongly correlated with counts from geotagged images (79%) and trip reports (91%). The convenient, cost-efficient and timely nature of collecting and analyzing user-generated data could allow land managers to monitor use over different seasons of the year and at sites and scales never previously monitored, contributing to a more comprehensive understanding of recreational use patterns and values.

1. Introduction

Outdoor recreation is one of many important benefits provided by public lands. Nearly 900 million visits to federally-managed lands in the United States support over 800,000 jobs and contribute $49 billion in economic activity annually (FICOR, 2012; White et al., 2016). The outdoor recreation economy as a whole accounts for $887 billion in annual consumer spending and 7.6 million jobs in the United States (OIA, 2017). As the population grows and makes increasing demands on conservation areas, managers and policy-makers find themselves facing challenging decisions about where and how to manage recreation opportunities and associated infrastructure (Cerveny and Ryan, 2008). Data on recreational use are critical for informing such decisions and evaluating their outcomes, especially when there are competing demands for limited budget and staff resources. Managers of large dispersed areas without controlled access points, which characterizes many public lands and protected areas worldwide, often lack actionable information on the amount and character of recreation use.

Recreation managers from the U.S. Forest Service (USFS) and other management agencies need visitor use data in order to evaluate the benefits and costs to the public of proposed policies and management alternatives such as transportation and facility planning, staffing and budget levels, prioritizing maintenance, outfitter and guide use allocations, and many others (Cerveny et al., 2011; Manning, 2010).

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Recreation use numbers are also frequently used in applications for grant opportunities. Since 2000, the USFS has relied on the National Visitor Use Monitoring (NVUM) Program to count and characterize recreation use through a systematic random sample of recreation sites within each unit of the National Forest System (NFS). For each NFS unit, traffic counts and visitor interviews are done at multiple locations over the course of a year, every five years. Typically less than 1% of the population of site-days (recreation locations and days with expected recreation use) are sampled using a combination of temporary and permanent traffic counters, recreation reservations or permits, and counts provided by concessionaires (e.g., ski areas and campgrounds). NVUM data also describe certain characteristics of recreational use, including activity participation, visitor demographics, visit duration, measures of satisfaction, and trip spending generated from the visit (USFS, 2016). The NVUM Program sampling protocol was designed to produce statistically reliable estimates of recreational use across the entire NFS, for each Forest Service region, and for individual national forests and grasslands; it was not designed to generate estimates of recreation use at the recreation site or landscape level or for specific seasons of the year.

A range of well-studied techniques for counting visits at the site level do exist, but the cost and time required to collect such data restricts their application to a limited number of sites and short timeframes. Thus managers are often challenged to monitor recreation use at remote, dispersed, and openly accessible areas that characterize the vast majority of public lands (Leggett, 2015). Two broad methods for measuring use at a recreation site involve either devoting staff to conduct on-site counts or deploying automated devices to count people or vehicles. Existing methods have advantages and disadvantages. Staff-based methods for counting visits may be the most accurate but they are also the most labor intensive and expensive. Infrared beam counters are a common automated tool for counting pedestrians, and have been shown to be 94% correlated with on-site observations (Cessford and Muhar, 2003), yet they still require regular maintenance and are not suitable for all locations. Video monitoring is another option for passive data collection, with the advantage of distinguishing general activities as well as counting users, but the volumes of data may require technical expertise to manage and counts require staff-time to review the recorded images (Arnberger et al., 2005).

Recent technological developments and the widespread use of mobile phones and the internet have opened opportunities to address the challenges of counting visitors in dispersed areas and inferring their preferences for different types of recreation sites and experiences. In this application, we discuss social media data as user-generated geographic content that is shared in online public platforms for purposes other than facilitating research (Elwood et al., 2012). Some have referred to this as “ambient” geographic information (Stefanidis et al., 2013). User-generated geographic content has been used to answer questions about visitor preferences and behaviors in many research domains including conservation biology, ecosystem services, and landscape planning (Becken et al., 2017; Hausmann et al., 2017a, 2017b; Levin et al., 2015; Sonter et al., 2016; van Riper et al., 2012; van Zanten et al., 2016). Many applications of these data for measuring use across public parks or protected areas have dealt with aggregated use across an entire park unit (Heikinheimo et al., 2017; Levin et al., 2017; Sessions et al., 2016; Tenkanen et al., 2017). Some studies have measured use across a network of individual recreation sites such as trails, but have largely done so in urban areas or high-use areas in national parks where social media data are plentiful (Donahue et al., 2018; Hamstead et al., 2018; Korpilo et al., 2017; Walden-Schreiner et al., 2018; Wu et al., 2017). Using social media data, or any other means, to accurately measure use in dispersed areas and across a large set of recreation sites remains challenging.

We address this challenge by building on prior research that shows the density of geolocated images shared by Flickr users is correlated with on-site counts of visitors at recreation sites. Previous studies have evaluated this correlation at recreation destinations globally (Wood et al., 2013), lakes in the U.S. (Keeler et al., 2015), protected areas in Victoria, Australia (Levin et al., 2017), urban parks in the Twin Cities, Minnesota (Donahue et al., 2018) and New York City, New York (Hamstead et al., 2018), natural water treatment areas worldwide (Ghermandi, 2016), and at sites within a national park in Finland (Heikinheimo et al., 2017). In addition to correlations, a recent study showed that a statistical model using geotagged photographs from Flickr as a predictor can approximate seasonal trends in recreational use to national parks in the Western U.S. (Sessions et al., 2016). In the U.S., access to most national parks is controlled through a limited number of entry points (often staffed or with a permanent traffic counter), which makes on-site counts of recreation obtainable and provides the basis for reliably estimating seasonal visitation rates. Furthermore, U.S. national parks such as Yellowstone, Yosemite, and Glacier are premier tourism destinations where visitors may be having a once-in-a-lifetime experience, and are likely to share their experiences on social media for others to see. It is unclear whether information gathered from social media platforms can effectively measure recreation use in more dispersed, lower-profile destinations, such as those typical in U.S. national forests.

The purpose of this study is to explore the potential for user-generated social media data to provide land managers with useful measures of recreational use to dispersed and remote areas that have been costly and difficult to monitor, and to provide lessons learned from comparing several more traditional methods for counting visitors. We explore the utility of user-generated social media content at two scales. First, we measure visitation rates at individual trails – much finer scales than are typically tested for such remote areas – in the Mount Baker-Snoqualmie National Forest (MBSNF) in western Washington. For this fine-scale test, we compare traditional visitor-counting techniques to those based on the locations of geotagged photographs and user-contributed trip reports, both shared publicly via online platforms. Second, in order to understand how applicable and generalizable the results from MBSNF might be on a national scale, we directly compare measurements derived from geotagged photographs with official estimates from NVUM, the program charged with tracking use at every NFS unit.

2. Methods

2.1. Study area

The NFS covers 7,73,000 km^2 and includes 154 national forests and 20 national grasslands in 43 states and Puerto Rico. The individual NFS units are administered in nine Forest Service regions spanning the country. NFS lands are managed for multiple uses including recreation, commodity resource extraction, grazing, production of clean water and air, and protection of habitat and ecosystems. In general, national forest lands represent rural areas with limited development that are open to public use. Hiking is the most common recreation activity: about 46% of visits involve hiking/walking and it is the primary recreation activity in one in four visits (USFS, 2016). Most visits to national forests are fairly short: the median visit duration is 3.9 hours. About half of national forest visits come from individuals who make between one and five trips to that same national forest each year. However, those who live relatively close to national forests report visiting with greater frequency and, in some cases, report up to near daily visitation (USFS, 2016).

The MBSNF in Washington extends over 225 km along the western slopes of the Cascade Mountains from the Canadian border to the northern boundary of Mt. Rainier National Park (Fig. 1). The forest is divided into four ranger districts with nine wilderness areas, four ski areas, and over 6880 km^2 of temperate forest, riverine, and alpine landscapes. The MBSNF contains over 1642 km of hiking trails (over half in designated Wilderness areas, and over half open to equestrian use). The Forest also includes 209 km of crosscountry ski trails, 335 km