



Estimating Recreational Visitation to Federally-Managed Lands

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prepared by:

Christopher Leggett, Eric Horsch, Christopher
Smith, and Robert Unsworth

Industrial Economics, Incorporated

2067 Massachusetts Avenue

Cambridge, MA 02140

617/354-0074

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1. INTRODUCTION

Federal lands and waters provide recreational opportunities to millions of visitors every year (Exhibit 1.1). These include areas managed by the National Park Service (NPS), the Bureau of Land Management (BLM), the Fish and Wildlife Service (USFWS), the Bureau of Reclamation (Reclamation), the Forest Service (USFS), as well as the Army Corps of Engineers (USACE) (hereafter referred to as “federal land management agencies”). In addition, local communities and businesses derive significant benefits from the economic activity and spending associated with trips to these locations.

EXHIBIT 1.1. ANNUAL RECREATION VISITATION BY AGENCY

AGENCY	ACREAGE MANAGED (IN MILLIONS)	RECREATION VISITATION ESTIMATE (IN MILLIONS) ^A
National Park Service	84	331
Bureau of Land Management	250	62
Fish and Wildlife Service	150	50
Bureau of Reclamation	6.5	28
Forest Service	193	149
Army Corps of Engineers	12	250 ^B
Total	695.5	870

Sources:
Acreage: NPS (2016a); BLM (2016a); USFWS (2016); Reclamation (2015); CRS (2014); Kathleen Perales (USACE), personal communication, February 2017.
Recreation Visitation Estimate (for most recent year available): NPS (2016b); BLM (2016b); Phil LePelch (USFWS), personal communication, December 2016; Jerome Jackson (Reclamation), personal communication, January 2017; USFS (2016a); and Kathleen Perales, personal communication, February 2017.

Notes:
A. All visitation estimates are for the 2016 calendar year with the exception of BLM (which is for 2015) and USFS (which is an annual estimate for the 2011-2015 period).
B. The USACE’s 2016 visitation estimate is lower than publicly-available estimates for recent years due to changes in data collection methods, as described in Chapter 2.

Federal land management agencies require accurate data on recreation occurring on lands under their jurisdiction, including the number of visits, the spatial and temporal distribution of those visits, and the characteristics of the visitors themselves. These data are used to evaluate economic values and impacts, develop plans for transportation and infrastructure projects, assess visitor impacts on natural resources, make informed decisions regarding policies that potentially impact visitors, conduct natural resource

damage assessments, meet agency reporting requirements, and efficiently allocate scarce resources across sites. Businesses, local governments, and other planning agencies located near federal lands also have an interest in these data for operations planning and scaling. Finally, researchers and academics use these data to conduct research on a wide-array of topics related to visitation.

While the importance of recreation data is well-established, characterizing visitation on federally-managed lands is a significant challenge because many sites have multiple unmonitored access points and are rural in nature. With limited operating budgets, federal agencies must be efficient in designing and implementing data collection efforts. Furthermore, although consistency in data collection methods is desirable, there is enormous diversity in the types of federal lands and recreational opportunities available to visitors, so the most accurate and cost-effective data collection methodology often differs across sites.

In general, visitation data can be collected using either an on-site or an off-site method, and each method poses unique challenges. With off-site methods, a survey is typically implemented, and respondents are asked to report the number of trips taken to specific destinations within a fixed time period in the past, such as the most recent month or quarter. These surveys lean heavily on memory (Chu et al., 1992; Connelly and Brown, 2011) and have recently suffered from declining response rates common to general population surveys (Groves, 2007). Furthermore, for many sites, the incidence of visitors in the general population will be extremely low, making it difficult to find visitors in a random sample of households, even when reasonably large sample sizes are used. With on-site methods, visits are counted where they occur, at the recreation areas, thus avoiding issues with response or recall bias. The challenges associated with on-site counts on federal lands are primarily (1) obtaining sufficient resources to implement high-quality counts at sites where recreation is widely dispersed, and (2) ensuring that field personnel or counting technologies used at different types of sites in all areas of the country implement data collection protocols in a consistent manner.

This report describes the methodologies currently used by federal land management agencies to characterize visitation on the lands under their jurisdiction. It then discusses a number of alternative approaches that capitalize on technology that may be useful to these agencies in the future. Finally, it provides a series of recommendations for improving data collection, documentation, and accessibility of the data.

Chapter 2 focuses on current methods. For each of the six agencies, we describe the methods currently used to characterize visitation, including the absolute number of visits and the characteristics of visitors. We also describe how those agencies use the visitation statistics that are generated, and we compare and contrast data collection methods across agencies. With regard to similarities, we find that all six agencies apply on-site methods to estimate visitation (as opposed to implementing off-site surveys), use automated vehicle and pedestrian counters where practical, and take advantage of a variety of types of administrative data (e.g., campsite registrations). We find a number of differences across agencies, including the degree to which data collection efforts are coordinated by a

central office, the availability of methods documentation, the spatial and temporal resolution of the estimates, the method and frequency with which conversion factors for automated counters are updated, the degree to which double counting of visits is addressed, the definitions used for various visitation metrics, and the provision of public access to the statistics.

After describing current methods in Chapter 2, we describe several alternative approaches in Chapter 3 that may be useful in future assessments of visitation, including using social media data, cellphone activity data, and remote sensing data. For each approach, we provide technical details regarding implementation, discuss research linking the approach to recreation data, and provide an overall assessment of its potential usefulness to federal land management agencies. We find that while social media data provide opportunities for visitor use data collection at a scale never before imagined, their usefulness may be limited by participation bias and evolving popularities of various platforms. Cellular activity data are somewhat more promising in that visitors typically carry cellphones when visiting recreation areas and cellphone ownership rates are approaching 100 percent. However, there are challenges related to the availability and spatial resolution of cellular data, and potential issues related to privacy. Pilot studies using social media data and cellular activity data would likely be useful in further evaluating their potential. Finally, remote sensing data are likely useful for specialized applications, but we do not believe they would be practical for the generation of long-term visitation statistics across numerous sites.

Chapter 4 provides a series of recommendations for improving the collection, documentation, and accessibility of visitation data by federal agencies. Specifically, the recommendations focus on: (1) documentation of current data collection methods, (2) inter-agency coordination of current data collection methods, (3) inter-agency coordination of reporting methods, (4) improvements in current data collection methods, (5) the development of guidance documents and training materials for site-level personnel, and (6) exploration of alternatives to current data collection methods.

2. EXISTING METHODS

This chapter summarizes the methods used by federal land management agencies to gather information about visitation and visitor characteristics. A separate summary is provided for each agency (NPS, BLM, USFWS, Reclamation, USFS, and USACE). Each summary was developed using a combination of available documentation and conversations with agency staff. The final section of the chapter compares methods across agencies. Appendix A provides definitions of key terms that federal land management agencies use to track and report their visitation data.

2.1 AGENCY SUMMARIES

NATIONAL PARK SERVICE

The National Park System is comprised of 413 units that cover more than 84 million acres across all 50 states, the District of Columbia, and several territories (NPS, 2016a). 331 million visits occurred at NPS sites for cultural, historical, interpretative, and recreational purposes in 2016 (NPS, 2016b). These sites include national parks, monuments, battlefields, recreation areas, lakeshores, seashores, scenic rivers and trails, parkways, and preserves.

Information about visitation is currently collected to inform a range of stakeholders, including NPS leadership, researchers, businesses, and members of the public. The information assists with operational planning, facilities design and management, economic impact analysis, natural resource damage assessments, and other purposes (NPS, 2016c). Visitation is not measured or reported for a small number of sites for a variety of reasons; some sites are administered by other agencies, while others are not staffed, are closed to the public, or do not have approval from NPS management on data collection methods.

Visits to NPS units are estimated using a range of methods, which are listed below.

- **Direct counts:** These include counts of people at visitor centers or on the grounds, tickets sold for specific attractions, backcountry permits issued, and other similar counts. In many cases, these are census counts, though for some sites, such as the Washington D.C. memorials, visitation estimates are based on sampling (i.e., counts are obtained for a sample of times during a day).
- **Proxy counts:** These are counts that are correlated with the total number of visits, such as counts of occupied campsites or traffic counts. They are often obtained using automated counters, such as vehicle, trail, and door counters. The proxy

counts are combined with a multiplier (e.g., campers per occupied campsite or persons per vehicle) to estimate total use. The multipliers are developed from on-site surveys conducted periodically.¹ Appendix B contains an example protocol and schedule for collecting person-per-vehicle data, along with an example data collection form.

- **Statistical correlation estimates:** Some visitation estimates are based on estimates for other areas. For example, at Fort Scott National Historic Site, visitors entering the visitor center are counted by hand, and a regression-based estimate is produced for the additional visitors that enter the park but are not counted at the visitor center. This method is based on historical information and/or professional judgment.
- **Flat estimates:** A flat, or constant, estimate of visitation is used for some resources that cannot be monitored in a cost-effective way. These estimates are based on historical information and/or professional judgment.

Visitor use statistics staff in the NPS Social Science Program are responsible for collaborating with parks to develop site-specific data collection methods, ensuring consistency and reliability of data collection across units, and publishing visitation estimates on the publicly-accessible Integrated Resource Management Applications (IRMA) website (<https://irma.nps.gov/Stats/>). Personnel at each NPS unit collect visitation data using methods approved by the Social Science Program and submit the data on a monthly basis via IRMA. Units are required to report the following information:

- number of recreation and non-recreation visits;
- hours of recreation and non-recreation use (i.e., visits scaled by average hours per visit);
- number of recreation and non-recreation overnight stays; and
- other requested information, such as visitation associated with special events or a particular attraction within the park (NPS, 2016c).

Appendix C provides an example calculation for estimating visits to Walnut Canyon National Monument, located near Flagstaff, AZ. There is no overnight use at this unit, so the example covers the estimation of recreation and non-recreation visits and hours only.

The NPS is currently working to operationalize the rule that one entrance per day per individual is a countable visit. However, this rule is not always implemented consistently. At some sites, visitors who enter multiple times in a single day are only counted once. At other sites, these visitors are counted every time they enter. For most parks where multiple entrances per day are common, the NPS applies adjustment factors to correct for

¹ The NPS does not conduct systematic and cyclical data collection to acquire information needed to update the multipliers. Efforts are underway to establish rationale and support for socioeconomic monitoring and to pilot studies that will more regularly represent visitor and group characteristics vital to use calculations.

duplicate reporting. At Great Smoky Mountains National Park, for example, total estimated visits are reduced by fixed percentage based on results from a site-specific visitor survey.

The visitor use statistics are published on IRMA as they are developed. The portal allows the user to search for a park using a map or search bar, and the following information is provided:

- annual recreation visitation;
- monthly public use report;
- counting and reporting instructions; and
- other site-specific information (e.g., traffic counts by location).

While parks are required to report visitation at the monthly level, some parks also collect data by hour or by day. These data are available by special request. The counting and reporting instructions for each park describe the “recipe” for estimating visitation. However, they do not provide documentation supporting the estimation approach, such as how a persons-per-vehicle estimate was developed or when it was last updated.

In addition to the visitor use statistics described above, site-specific surveys are conducted periodically to collect additional information about visitors, such as expenditure data for economic impact analyses (WSU, 2016). In many cases, these site-specific surveys are used to support planning applications. Examples include visitor use management plans, wilderness and backcountry management plans, long range transportation plans, and long-range interpretive plans.

BUREAU OF LAND MANAGEMENT

The BLM manages over 3,600 recreation sites on approximately 250 million acres located primarily in the western United States (BLM, 2016a). In 2015, BLM recreation sites hosted approximately 62.4 million visits (BLM, 2016b). These sites feature diverse landscapes and recreation experiences, with both diffuse and concentrated visitor access. For example, the Yaquina Head Lighthouse in Oregon is a 100-acre site accessible by a single road that passes through an entrance booth, whereas the Red Rock Canyon National Conservation Area in Nevada is a 197,000-acre site accessible via roadside parking and numerous designated parking areas.

Information about visitation is currently collected at all open and active BLM recreation sites.² This information is used to support site and land-use planning, facilities management, economic impact analysis, and other purposes (David Baker, personal communication, December 2016). The BLM has over 150 field offices, each of which is responsible for developing site-specific methods to estimate visitation. While this grants

² A small number of BLM sites are closed or inactive.

individual field offices flexibility and autonomy, the accuracy of the methods used to track visitation varies substantially (Moisey, 2008). Further, the documentation of site-specific methods is often limited or nonexistent.

The methods listed below are used to track visitation at BLM sites.

- **Automated traffic and trail counters:** At some sites, automated counters are used to measure traffic volume or foot traffic on trails. These counts are converted into visitation estimates using information about the percentage of vehicles associated with recreation, number of visitors per vehicle, length of time on site, and other visit characteristics. This information is based on a mixture of on-site observations and professional judgment.³
- **Counts based on fee data:** Visitation is tracked at some sites using fee data, including permits (e.g., overnight camping), registrations, and fee envelopes. About 440 BLM recreation sites charge fees (DOI and USDA, 2015). For these data, the BLM requests that visitors self-report group size, length of stay, recreational activities, and other visit characteristics. On-site observations are used in some cases to estimate the percentage of visitors who do not comply with fee envelopes or other similar registration forms, or to evaluate the accuracy of the self-reported information about visit characteristics.
- **Other counts based on observation and professional judgment:** BLM staff also use a combination of observation and professional judgment to estimate visitation at some sites. For example, BLM staff might record the number of observed visitors for a period of time at a site in their patrol logs. In other cases, estimated visitation is based solely on professional judgement (Moisey, 2008; David Baker and Larry Ridenhour, personal communication, December 2016).

Site-level counts and supporting information from on-site observations or professional judgment are entered into BLM's Recreation Management Information System (RMIS) database on an annual basis. The database uses this information in site-specific formulas to estimate total visitation (personal communication, David Baker, December 2016). The RMIS database offers the following information about annual recreation visitation at each BLM site:

- number of visits;
- number of visitor days by activity; and
- number of recreation permits issued.

A "visit" begins when a visitor enters BLM lands for recreational purposes and ends when the visitor leaves. For example, a visit might include a short dog-walk or a multi-

³ The BLM does not conduct any formal surveys or rely on information from other agencies to generate information needed to convert automated counts into visitation estimates.

day camping trip. The estimate of “visitor days” standardizes recreation visits of different lengths into an estimate of 12-hour visitor days. One person visiting for 12 hours or 12 people visiting for one hour each would both yield one visitor day. The number of visitor days is also reported by activity using BLM formulas that describe the activities of an “average” visitor (David Baker, personal communication, March 2017). “Visits” may differ significantly from “visitor days” for a site or a state, though the figures are fairly similar when aggregated to the national level. “Recreation permits” reflect the number of permits issued by BLM in exchange for recreation fees paid by visitors.⁴ These permits allow visitors to use BLM services and facilities such as visitor centers, campgrounds, boat launches, national conservation areas, and special recreation areas (BLM, 2016b).

RMIS is an internal system accessible only to BLM personnel (Coray et al., 2007). However, BLM staff can prepare custom reports upon request. Aggregated visitation data are reported at the national and state levels in the BLM’s annual “Public Land Statistics” reports (BLM, 2016b).

In addition to collecting information about recreation visits and visitor days, the BLM collects information about visitor characteristics. To this end, the BLM partners with Washington State University to administer and analyze 150 to 400 visitor surveys each year at about 20 BLM sites. These surveys primarily focus on visitor satisfaction, but they also provide information about visitor demographics and activities (David Baker, personal communication, December 2016).

FISH AND WILDLIFE SERVICE

The USFWS manages the National Wildlife Refuge System, which includes 560 national wildlife refuges and 38 wetland management districts. Together, these cover more than 150 million acres of land and water (USFWS, 2016). The refuge system received approximately 50 million visits in 2016 for hunting, fishing, wildlife observation, and environmental education and interpretation (Phil LePelch, personal communication, December 2016). Information about visitation is currently collected at about 460 national wildlife refuges and 35 wetland management districts. The remaining refuges and wetland management districts are closed to the public. Visitation information is used by the USFWS to support operational planning, facilities management, recreational programming, budget requests, natural resource damage assessments, economic impact analysis, and visitor satisfaction (Phil LePelch, personal communication, December 2016).

⁴ The types of recreation permits issued by the BLM include Standard Amenity Permits (e.g., for use of visitor centers or national conservation areas); Expanded Amenity Permits (e.g., for recreational facilities or services such as campgrounds or boat launches); Special Area Permits (e.g., for noncommercial uses of select “special” areas such as off-highway vehicle areas or backcountry areas); and Commercial Competitive, Group, and Event Permits (e.g., for organized group events or commercial entities providing recreational services).

To guide visitation estimation and reporting, the USFWS developed the Visitation Estimation Workbook in 2005. The workbook describes seven different methods for estimating visitation, which are listed below. Broadly speaking, the workbook outlines strategies for: (1) refuges “where visitor activities are reached by road and occur primarily in designated areas” (focused on the use of traffic counters); and (2) more remote or roadless refuges where “visitor activities occur primarily in an unconfined setting,” requiring a broader mix of visitation estimation methods (USFWS, 2005, p. 2). The formation of a specific plan for estimating visitation is left to the discretion of the individual refuge or wetland management district.

- **Direct observation:** Visits are counted either directly or indirectly (e.g., using video cameras).
- **Traffic counters:** Automated traffic counters are placed on entrance roads or near visitor centers to record vehicles entering sites. The traffic counts are combined with information from direct observation or surveys to estimate total visitation (e.g., number of visitors per vehicle, percentage of vehicles engaging in recreation, etc.) (see “Surveys” below).
- **Patrols:** Public use areas (e.g., boat ramps or parking lots) are patrolled and the number of recreational visits is counted over a set period of time. This sample is used to estimate the total number of visits in that area. For wetland management districts and refuges with diffuse access or dispersed recreation sites, the patrols method offers a useful alternative to traffic counters.
- **Self-registration:** Self-reported information is collected from visitors via guest books, trail registers, and voluntary hunting or fishing permits in cases where fees are not collected. Visitors are asked to provide information about their visit, such as group size, length of visit, and recreation activities pursued.
- **Entrance fee stations and permits:** About 35 refuges charge an entrance fee, and about 106 refuges charge fees for activities such as overnight camping, hunting, and boating (DOI and USDA, 2015). Fees are collected either by staff members (e.g., at entrance stations or visitor centers) or at self-pay stations, then converted to visits.
- **Surveys:** Visitation information is collected via surveys (e.g., mail, telephone, and traffic-stop surveys), which provide information about visitation and visit characteristics like group size, length of stay, recreational activities, visitor satisfaction, and more.
- **Indirect estimation based on professional judgment:** In some cases, professional judgment is used to estimate visitation. This may involve combining limited site observations with assumptions about visitor patterns and behavior (USFWS, 2005).

Each year, between August and September, refuges and wetland management districts upload their visitation information to the USFWS’s Refuge Annual Performance Plan

(RAPP) database. This database is an internal system accessible only to USFWS personnel. The RAPP database tracks the total number of visitors and number of visits by activity (e.g., hunting, fishing, wildlife observation) for each USFWS site. A “visitor” is defined as someone who enters a refuge or wetland management district to engage in a recreational activity. A “visit” occurs when a visitor engages in a particular recreational activity (e.g., hunting). A visitor engaging in multiple activities is counted as multiple visits. For example, if a visitor takes a hike and goes hunting in a refuge, that visitor would be counted as a hiking visit and also as a hunting visit.

In addition to gathering data on site, the USFWS periodically conducts off-site surveys to collect information about visitor characteristics. Most recently, the USFWS collaborated with the U.S. Geological Survey (USGS) from 2010 to 2012 to survey visitors at 78 refuges (Sexton et al., 2012; Dietsch et al., 2013). These surveys provided information about visitor demographics (e.g., age, income), trip characteristics (e.g., recreational activities, number of persons per party, spending in local communities), and visitor satisfaction (e.g., satisfaction with services, facilities, and recreational opportunities).

The USFWS also partners with the U.S. Census Bureau, state-level fish and wildlife agencies, and national conservation organizations to produce the “National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.” The survey focuses on recreation participation in fishing, hunting, and wildlife viewing throughout the United States, including but not limited to USFWS lands. The reports generated using the survey data provide estimates of participants by recreational activity, the number of trips and recreation days by activity, trip and equipment expenditures of visitors engaged in each activity, and demographic characteristics of participants (USFWS, 2015). The survey is conducted every five years and relies on a stratified random sample of US households. Although the survey has been conducted since 1955, results from recent reports are not comparable with results from surveys conducted earlier than 1991 due to changes in the methodology (DOI and DOC, 2011).

BUREAU OF RECLAMATION

Reclamation manages approximately 6.5 million acres of land and water in 17 western states, with 289 separate sites (or “project areas”) providing recreation access for camping, hiking, fishing, wildlife viewing, boating, and other activities (Reclamation, 2015). These project areas attract more than 28 million recreation visits per year (Jerome Jackson, personal communication, January 2017). Given the agency’s role in managing water supplies and producing hydroelectric energy, most recreation occurs on or near water.

Due to resource constraints and shared jurisdiction of lands, Reclamation usually cedes recreation management to a partner agency. Of the 289 project areas, 102 are managed by Federal partners (e.g., NPS), over 156 are managed by a non-Federal partner (e.g., state, county, and city governments), and the remaining areas are managed by Reclamation. Information about visitation is currently collected at all Reclamation project areas and is

used to support resource management planning, economic impact analysis, and inquiries about public use (Jerome Jackson, personal communication, December 2016).

Reclamation uses a decentralized approach to track visitation at its project areas, allowing its regional offices, area offices, and managing partners to develop site-specific methods. This decentralized approach results in the application of a wide range of methods. Visitation to project areas managed by Federal partners is tracked using the methods described in other sections of this chapter. The methods used to track visits to project areas managed by Reclamation or non-Federal partners are listed below.

- **Automated or manual traffic counts:** These counts are usually combined with an assumed number of persons per vehicle to estimate visitation.
- **On-site camp hosts:** Some project areas rely on on-site camp hosts to generate and log visitation counts.
- **Fee collection:** At some project areas, overnight camping fees, parking fees, and managing partner entrance fees are used to estimate visitation (Jerome Jackson, personal communication, December 2016).

Each regional office, area office, or managing partner generates an annual visitation estimate for a project area and uploads it into Reclamation’s Recreation Use Data Report (RUDR) database sometime between Labor Day and mid-October. RUDR is an internal database accessible only to Reclamation staff. The RUDR database stores current visitation data for each project area and for each Reclamation region.⁵ The database tracks the number of “visits,” which occur when a person enters Reclamation lands to engage in recreation on a given day. Reclamation does not currently have a method in place to account for situations where a visitor enters a site multiple times in the same day (Jerome Jackson, personal communication, December 2016). As a result, visitors are counted each time they enter a Reclamation site, even if those entrances occur during the same day.

Reclamation does not collect data on visitor characteristics. Where these data are collected by Reclamation’s managing partners, Reclamation may use them to inform its recreation and operational planning.

FOREST SERVICE

The USFS manages 193 million acres of land in 42 states and Puerto Rico, including 403 wilderness areas; 155 national forests; 22 national grasslands; 20 national recreation areas; 9 national scenic areas; and 7 national monuments, volcanic monuments, and national preserves (CRS, 2014; USFS, 2016b). Any of these units may contain a number of “sites” as defined by the USFS, including campgrounds, alpine ski areas, picnic areas,

⁵ The RUDR database also stores information on revenues, expenditures, and recreational facilities (e.g., information about number of campsites, miles of trails, concessionaires, exclusive use permits, etc.).

boating sites, and swimming areas. Nearly 149 million recreation visits occur annually on national forests, and an additional 300 million viewing occasions occur annually on scenic byways located on or near national forests (USFS, 2016a).⁶

Visitor use estimates for lands under the jurisdiction of the USFS are generated through the National Visitor Use Monitoring program (NVUM), which was initiated in 2000 (English et al., 2002; Zarnoch et al., 2011). This monitoring program has two goals: (1) to produce estimates of the volume of recreation at national forests and grasslands, and (2) to produce descriptive information about that visitation, including visitor activities, demographics, visit durations, satisfaction, and spending (USFS, 2016c). The NVUM assesses visitation at one-fifth of all National Forest System units every year, covering all units in the country every five years.⁷ Uses of NVUM estimates include economic impact analysis, economic valuation, budgeting, and forest planning.

The NVUM program defines a *recreation visit* as “one person entering and exiting a national forest, national grassland or designated wilderness area for the purpose of recreation” (English et al., 2002). Visits by employees and contractors are excluded from this definition, as are visits to simply use a restroom or obtain information (Zarnoch et al., 2005). The length of a recreation visit can range from a few minutes to many days. The program focuses on “last-exiting” visitors so that visitors who briefly leave a site during a visit (e.g., to obtain supplies) are not counted multiple times. During a single *recreation visit*, an individual may visit multiple “sites” within the national forest or national grassland. Visits to individual sites are defined as *recreation site visits*.

A two-stage sampling approach is used to estimate visitation. In the first stage, a sample of *site days* is drawn. A *site day* is defined as a continuous 24-hour period at a single site. The population of site days for an individual National Forest System unit can be conceptualized as a matrix where each column represents a single site exit and each row represents a single day within the calendar year (Zarnoch et al. 2011, pg. 2).

Three characteristics are used for stratification prior to sampling site days: (1) site type, (2) existence of proxy data, and (3) expected use level.

- **Site type:** All sites are classified as either day-use developed sites (e.g., picnic areas), overnight use developed sites (e.g., campgrounds), wilderness sites (e.g., trailhead providing hiking access to a wilderness area), general sites not in the previous three categories (e.g., trailhead providing hiking or hunting access to a national forest), and viewing corridor sites (e.g., public road providing views of a National Forest).

⁶ A “viewing occasion” occurs when an individual enjoys the scenery while simply passing by or through USFS-managed land. Viewing occasions occur on lands outside of USFS jurisdiction, such as on state or federal highways that pass through national forests. Additional details are provided below in this section.

⁷ For NVUM purposes, some of the 155 national forests are combined, resulting in 120 National Forest System units, 24 of which are selected for data collection every year.

- **Proxy data:** All sites are classified as either having “proxy” information or not having proxy information. Sites with proxy information have information available that is expected to be closely related to the volume of recreation visits. Examples include data from fee envelopes at campgrounds, permanent traffic counters, and lift ticket sales at ski areas. When this type of proxy data covers all recreation visits at the site and is available year round, it can be used to improve the accuracy of estimates of recreation site visits.
- **Expected use level:** All site days in the calendar year are assigned to one of five use levels (very high, high, medium, low, or none) based on site managers’ expectations regarding the flow of last-exiting recreation visitors. Site days with higher expected exiting visitor flows are sampled at higher rates.

In the second stage, field personnel—including USFS employees, contractors, and university personnel—are deployed on selected site days to gather data that allows one to estimate the number of last-exiting visitors leaving the site on that day. Specifically, with the exception of viewing corridor sites and sites with proxy data, field personnel gather three types of data for every sampled site day:

- **Automated counts:** Automated counts of all people or vehicles entering and departing the site throughout the entire 24-hour period. These counts are obtained by installing a temporary vehicle counter, such as a pneumatic tube, at a point near the entrance to the site that all (or nearly all) vehicles must pass by in order to enter.⁸
- **Manual counts:** Manual counts of all people or vehicles leaving the site during a randomly-selected six-hour shift (either 8 AM to 2 PM or 2 PM to 8 PM). Two-thirds of the sampled site days are assigned to the shift that is expected to have the heaviest flow of last-exiting recreational visitors; the remaining one-third are assigned to the other shift.⁹ These manual counts are used, together with readings from the automated counter at the beginning and end of the six-hour shift, to convert the 24-hour automated count to an estimate of exiting vehicles.
- **Interviews:** Interviews with vehicle occupants during the randomly-selected six-hour shift. Field personnel attempt to intercept all exiting vehicles for interviews (i.e., there is no sampling of vehicles), provided that they are not busy conducting an interview with another visitor when the vehicle passes by. The interview begins with screening questions to identify vehicles with last-exiting recreation visitors. For these vehicles, a randomly-selected occupant (age 16 or over) is asked additional questions to obtain general data on trip characteristics,

⁸ At pedestrian access points, infra-red pedestrian counters are used.

⁹ For example, most visitors exit day use sites for the last time during the afternoon, while most visitors exit overnight sites for the last time in the morning.

including persons per vehicle and number of sites visited. Data on persons per vehicle are used to convert the 24-hour vehicle count into a visitation estimate for the sampled site day. Data on the number of sites visited within each national forest are used to convert estimates of site visits to estimates of national forest visits.

At proxy sites, data collection on sampled site days focuses on information necessary to calibrate the proxy data source. Field personnel visit the site during the six-hour period expected to have the most last-exiting recreational visitors. They conduct interviews to gather information on factors such as noncompliance (i.e., percentage of visitors not submitting fee envelopes), non-recreation visits, group size, number of nights per registration, and duplicate registrations. These data are used to convert an annual total for the proxy variable to an estimate of unique recreation visits.

Viewing corridor sites are unique in that “visits” to these sites (or “viewing occasions”) occur on lands outside of USFS jurisdiction, such as on state or federal highways that pass through national forests. Viewing corridor sites are only included within the NVUM program if travelers are expected to spend at least 15 minutes within a national forest while on the corridor. Trips on viewing corridors are incorporated in the NVUM estimates if either (1) the primary purpose of the trip is recreation, or (2) recreation is not the primary purpose of the trip, but viewing forest scenery was the main reason for choosing that particular travel route.

Interview and count procedures are modified somewhat for viewing corridor sites in order to ensure the safety of field personnel. First, an automated traffic counter is only installed where it is considered safe to do so. Second, the counter only monitors vehicles traveling in one direction (the direction associated with the interview location for the site). Third, interviews are conducted at a safe stopping point within the corridor, such as a rest area, provided one can be identified.¹⁰ Finally, rather than simultaneously conducting manual vehicle counts and interviews, field personnel alternate between two tasks during the six-hour shift: (1) manual traffic counts focused on determining the number of non-commercial vehicles passing through in one direction and (2) interviews at the safe stopping point.

Additional viewing occasions occur outside of these viewing corridor sites during scenic overflights, train rides, or tram tours. These viewing occasions are documented by USFS reporting units and included in the viewing occasion estimates, but surveys are not conducted with these individuals (English et al. 2002).

Visitor use data are published online at <http://apps.fs.fed.us/nfs/nrm/nvum/results/>. Visitation estimates are generated at the national forest, multi-forest, and Forest Service regional levels, with separate estimates of site visits and national forest visits provided. The estimates of site visits are classified as: “day use developed,” “overnight use

¹⁰ If a safe stopping point cannot be identified, then interview information is transferred from another viewing corridor site.

developed,” “undeveloped areas (general forest area),” or “wilderness.” Because visitors can go to multiple sites within a national forest, the site visit estimate for a national forest is always at least as large as the corresponding national forest visit estimate. The quantity of special event and organized camp use visits is also available. These figures are developed separately from the sampling process described above by simply tallying all participants. Annual estimates are available for one of two five-year periods, either 2005-2009 or 2010-2014. The estimates can be tailored by the user to focus on any subset of National Forest System units desired. In addition to use estimates, the USFS online portal provides customizable summaries of interview data, including demographics, visit duration, group size, satisfaction with visit, number of sites visited, number of axles per vehicle, number of annual visits, and activities (including primary activity). Finally, the portal provides customizable maps depicting the number of survey respondents by ZIP code, county, and state.

Example Calculation for a Sampled Site Day without Proxy Data

- Field personnel arrive at 8:00 AM, set up a pneumatic tube counter at the site exit (crossing both lanes), then remain on site until 2:00 PM.
- During the six-hour shift, the vehicle counter records a total of 95 vehicles (traveling in both directions), while the field personnel manually counts 50 vehicles leaving the site, providing an estimate of 0.526 exiting vehicles for every vehicle counted by the pneumatic tube ($0.526 = 50/95$).
- Interviews conducted with 30 exiting vehicles indicate that 15 (or 50 percent) of the exiting vehicles are completing a recreation visit and that there are 2.6 people, on average, in these 15 vehicles.
- Field personnel return to the site at 8:00 AM on the next day to retrieve the automated vehicle counter. A total of 190 vehicles have been recorded during the 24-hour period.
- With 0.526 exiting vehicles per vehicle counted by the pneumatic tube, an estimated 100 vehicles have exited the site ($100 = 0.526 \times 190$), 50 percent of which are assumed to be completing a recreation visit. Assuming 2.6 people per vehicle, there are an estimated 130 recreation visits to the site during the 24-hour period ($130 = 100 \times 0.5 \times 2.6$).

ARMY CORPS OF ENGINEERS

The USACE recreation program is comprised of 4,989 recreation sites (also called Project Site Areas, or PSAs) across more than 400 water resource projects on 12 million acres in 44 states (USACE, 2016; Kathleen Perales, personal communication, February 2017).¹¹ These sites received about 250 million visits in 2016 for hiking, camping,

¹¹ Personal communication reflects information stored in the USACE Operations and Management Business Information Link (OMBIL) database, which is not publicly accessible.

boating, fishing, swimming, picnicking, and other recreation uses (Kathleen Perales, personal communication, February 2017).¹² Most USACE projects are oriented around a body of water, typically a lake or river, and include the adjacent land up to maximum pool or potential flood height. Most projects contain numerous PSAs. For example, Canyon Park is one of 26 PSAs at Canyon Lake in Texas. Visitation data are collected at the PSA level and estimates are produced for all PSAs to support USACE managers with facilities management, recreation program evaluation, and economic impact analysis (USACE, 2015a; USACE, 2013).

Visits to USACE sites are estimated using several methods and data sources, which are listed below and described in the following paragraphs.

- **Automated counters:** These include traffic and trail counters, which are combined with on-site surveys to estimate visitation.
- **Transaction data:** Camping and shelter transaction data from the National Recreation Reservation Service (NRRS) (www.recreation.gov).
- **Revenue data:** Overnight use revenue data from the Corps of Engineers Financial Management System (CEFMS).
- **Ratio estimates:** Estimates based on the number of parking spaces or campsites combined with an assumed occupancy rate. These are used primarily at small/remote PSAs with no automated counters for day use or no charge for camping.
- **Third-party estimates:** Independent estimates from leased areas managed by state/local parks, nonprofit parks, and private entities (USACE, 2015b, Kathleen Perales, personal communication, February 2017).

Automated counters are particularly effective for enumerating day use at USACE sites because many PSAs have a single or limited road entry system.¹³ All counters are calibrated to ensure an accurate count is obtained, and “load factors” are applied to the counts to estimate total visitation. The load factors are developed using on-site surveys, which collect information about the number of people per vehicle, the percentage of vehicles associated with recreation, the percentage of vehicles departing for the last time, length of stay, and other visit characteristics. If a vehicle exits a site multiple times, the data collection protocol is to interview and count the vehicle at its last departure (using an initial screening question), resulting in a unique estimate of visits. The USACE recently conducted a round of on-site surveys at a subset of PSAs to develop load factors

¹² The 2016 estimate is lower than publicly-available estimates for recent years due to changes in data collection methods, as described below in this section.

¹³ Several types of counters are used, including pneumatic tubes, inductive loops, magnetometers, breakbeams, and infrared focused beams.

(USACE, 2015a; USACE, 2013).¹⁴ Additional surveys are planned for the near future, pending information collection approval from the Office of Management and Budget.

NRRS transaction and CEFMS financial data provide information about overnight use. The NRRS system provides the number of nights that sites are occupied and the number of occupants per site. In CEFMS, revenues collected from overnight use are reported separately from other revenues, and can be extracted on a monthly basis. The revenue estimate is converted into an estimate of overnight visits using a load factor developed from the NRRS data.

Some USACE PSAs are remote and offer little capacity for recreation use (i.e., the number of parking spaces and campsites available is small). These areas are referred to as “dispersed lands.” These sites do not charge for parking or camping, so fee data cannot be used to estimate visitation. Instead, assumed occupancy rates per parking space and per campsite are combined with the number of parking spaces and campsites in these areas to estimate visitation.

Approximately 44 percent of PSAs are operated by third-party entities (e.g. a state park, marina, or local YMCA chapter) (Kathleen Perales, personal communication, February 2017). At some of these PSAs, the USACE maintains responsibility for collecting visitation data, and coordinates with the operator to implement the methods described above. At the other PSAs, the third-party entities collect visitation data independently. The USACE accepts these estimates as-is and includes them in their visitation statistics.

All data sources described above are entered into the USACE’s Visitation Estimation and Reporting System (VERS) on a monthly basis. USACE personnel enter the “raw” automated counter readings (i.e., without application of a load factor) and the VERS software converts the raw counts into visitation estimates using information about the traffic counters (e.g., whether they provide one-way or two-way counts) and characteristics from on-site surveys.

The visitor use statistics are published online in a section of the USACE website called “Value to the Nation” (<http://www.corpsresults.us/recreation/recfastfacts.cfm>). The website provides state and national reports, as well as reports for individual water resource projects. It does not provide statistics at the PSA level, but this information is available from the USACE upon request. Each report provides an overall visitation estimate as well as separate estimates for various use categories (e.g., water contact).

The USACE has been working since 2011 to update its visitor use data collection system, with assistance from the U.S. Department of Transportation’s Volpe Center in Cambridge, Massachusetts. This effort includes a review of how recreation sites are classified for the purpose of management and data collection (USACE, 2011). It also includes a review of best practices for automated counters (USACE, 2015a). The

¹⁴ Historically, a unique load factor was developed for every individual counter. In contrast, the USACE is currently developing general load factors that can be applied to counters with similar characteristics.

visitation information posted on the USACE's Value to the Nation website at the time of this writing reflects 2012 data and estimation methods that are no longer in use.¹⁵

Future information will be based on the methods described above and will be reported in terms of "visits," "recreation days of use," and "12-hour visitor days." A "visit" constitutes a single person entering a USACE site for recreation on one or more occasions, regardless of the length of stay. A "recreation day of use" is a visit by a single person during any reasonable portion within a day on the same trip. If a day visitor enters a site four times in a day, he or she is counted as one visit and one recreation day of use. If a camper stays on site for three days, he or she is counted as one visit and three recreation days of use. The estimate of "12-hour visitor days" is the number of recreation visitor hours (i.e., time spent on site) divided by 12.

To complement estimates of visitation, the USACE collects information about visitor characteristics using three different types of surveys. First, the on-site surveys used to produce load factors capture targeted information about the party (e.g., number of individuals under 18 years old; whether or not any members have mobility or sensing limitations; origin ZIP code). Second, at some sites, respondents are invited to participate in follow-up surveys online, which gather additional demographic and expenditure data for economic impact analyses. Third, the USACE has a comment card program, which is employed at the discretion of Project or District/Division leadership and does not utilize statistical sampling techniques. The primary purpose of these cards is to provide feedback to management on basic visitor satisfaction with recreation areas and visitor centers. Demographic information collected on these cards includes ZIP code, age, gender, race, and ethnicity.

2.2 COMPARISON OF METHODS

Federal land management agencies use a wide variety of methods to characterize recreation on lands within their jurisdiction. Methods vary both across agencies and across individual sites within agencies (Exhibit 2.1). This is not surprising, given the differences in the types of federally-managed recreation sites across the United States, including reservoirs, grasslands, ski areas, historic buildings and monuments, iconic national parks, large tracts of forest land, and urban parks.

The way in which visitors interact with these disparate sites impacts the suite of methods available to managers for developing accurate and cost-effective measures of visitation. Important considerations include whether entrances to the site are concentrated or diffuse, the typical mode of entry (e.g., vehicle, pedestrian, bike, OHV, or boat), whether registration is required, whether visitors pay an entry fee, and whether or not entrances are staffed by agency personnel. The preferred method may also vary with the importance of recreation at the site. Sites where very little recreation is expected to occur may not

¹⁵ A discussion of these outdated estimation methods is beyond the scope of this document.

warrant expensive data collection methods. Further, providing recreation opportunities to the public is not central to the mission of some land management agencies, and these agencies may devote fewer resources to characterizing recreation.

Our review identified several common threads across federal land management agencies with regard to the methods used to characterize visitation:

- **On-site data collection:** All agencies implement some form of on-site data collection, rather than relying on off-site general-population surveys (e.g., phone, mail, or web) to characterize visitation.
- **Automated counters:** All agencies rely at least to some extent on automated counters to track visitation, particularly at sites where visitors enter in a few concentrated locations. The counters are typically vehicle counters installed on entrance roads; automated pedestrian counters may be deployed to cover pedestrian entrances. Conversion factors are developed through on-site studies to provide an estimate of the number of recreational visits per count. This involves identifying the purpose of the visit (recreation versus non-recreation) and, in the case of vehicle counters, the number of persons per vehicle.
- **Administrative data:** All agencies make use of administrative data at sites where such data are available and reliable. Examples of administrative data include camping registrations (e.g., from www.recreation.gov provided by the NRRS), ski tickets, backcountry permits, hunting permits, and boat launch registrations. These data provide a near census of visits to certain sites, assuming non-compliance is minimal. They are also relatively inexpensive, as the data are routinely collected for management purposes.

Our review identified substantial differences across agencies in the following areas:

- **Centralization of data collection:** Agencies differ in the degree to which responsibility for data collection and analysis methodologies is centrally controlled or delegated to individual sites and outside partners. At the USFS and NPS, data collection and analysis is centrally controlled. With these two agencies, statistical personnel develop, review, and revise estimation methods that are applied at all sites. In contrast, the BLM, USFWS, and Reclamation delegate data collection methods entirely to individual sites or to the partners (federal and non-federal) who manage those sites (USFWS does provide a reference document on data collection methods for site managers). The USACE uses a hybrid approach: it develops methodologies centrally for the subset of sites that it manages, providing recommendations related to the placement/calibration of vehicle counters, as well as recommendations related to the development of conversion factors for translating automated counts into recreation visits. For sites managed by public or private third parties, the USACE delegates data collection to the individual sites.

- **Documentation of methods:** Agencies differ in the degree to which their data collection methodologies are documented. Of all the agencies, the USFS appears to have the most complete documentation.¹⁶ It has publicly-available documents that clearly describe its data collection and estimation methodology for all sites. The NPS also provides reasonable documentation of methods for each site, but the publicly-available documentation focuses only on the detailed steps required to develop an estimate; there are few details regarding the rationale for those steps. As far as we are aware, the remaining agencies (USFWS, USACE, BLM, and Reclamation) do not have publicly-available documentation of the methods used to estimate visitation at individual sites. The USFWS has developed a guidance document for data collection (USFWS, 2005), and the USACE has developed a document providing best practices for automated counters (USACE, 2015a), but neither agency has documentation of the specific methods applied at individual sites.
- **Spatial and temporal resolution of estimates:** Agencies differ in the spatial and temporal resolution of visitation estimates available. The NPS appears to provide the most detailed estimates, with monthly visitation estimates available for every site. With the exception of the USFS, other agencies provide annual estimates by unit. The USFS develops an annual estimate for each unit every fifth year. When agencies use permanent automated counters or administrative data to generate visitation estimates, more detailed spatial (e.g., at the level of individual vehicle counters or campgrounds) and temporal (e.g., daily) data are often available by special request.
- **Conversion factors for automated counters:** Agencies differ in the frequency with which they implement studies to develop conversion factors for automated counters (i.e., for converting automated counts to recreation visits), the method used to develop conversion factors (i.e., use of on-site surveys vs. on-site observations), and the extent to which those studies are documented. The USFS rotates data collection across sites every year, and it develops conversion factors for counters every time it collects new counts at a unit. All other agencies apply fixed “multipliers” to their automated counts, and the NPS and USACE appear to be the only other agencies that have detailed internal documentation related to the on-site methodology used to develop these multipliers.
- **Elimination of double counting:** Agencies differ in the extent to which they attempt to eliminate double counting of visits. The NPS incorporates adjustment factors from on-site surveys for most parks where multiple entrances per day are common. The USACE and USFS are the only agencies that focus only on “last-exiting” visitors when calibrating automated counters, thereby avoiding double

¹⁶ Documentation is somewhat easier for the USFS to develop than for other federal agencies, as the USFS applies a consistent methodology across all sites.

counting individuals who leave a site temporarily during their visit. The USFS also uses survey data to avoid double counting visitors who visit multiple sites within a single national forest during a single trip. None of the agencies adjusts for double counting of individuals who visit separate federal sites within the same day. For example, a visitor to Washington D.C. might visit the National Mall and the C&O Canal within the same day (NPS sites), and each visit would be counted in the site-specific totals.

- **Definitions for visitation metrics:** Agencies differ in the way in which they define various visitation metrics (Appendix A). While definitions of a “visit” are broadly consistent across agencies, the USFWS differs somewhat from other agencies in that a single person entering a site to pursue two different recreational activities (e.g., fishing and hunting) on a single day is counted as two separate visits. In addition, while the USFS explicitly excludes some types of very brief visits from its estimates (e.g., to use a restroom or obtain information from a ranger station), it appears that the remaining agencies do not.
- **Public access to visitation statistics:** Agencies differ in the extent to which detailed visitation estimates are posted online. The NPS and USFS both post visitation statistics online, with estimates broken down by unit and by year.¹⁷ The USACE provides estimates by site for a single year online, with estimates broken down by activity. The remaining agencies do not post site-specific visitation data online, though the BLM includes a total visitation estimate for the country and by state in their annual “Public Land Statistics” reports.

EXHIBIT 2.1. COMPARISON OF EXISTING METHODS

	NPS	BLM	USFWS	RECLAMATION	USFS	USACE
On-site Data Collection	✓	✓	✓	✓	✓	✓
Use of Automated Counters	✓	✓	✓	✓	✓	✓
Use of Administrative Data	✓	✓	✓	✓	✓	✓
Data Collection and Documentation Centrally Controlled	✓				✓	✓
Estimation Methods Posted Online	✓				✓	
Frequency of Unit-Level Estimates	Monthly	Annual	Annual	Annual	Every 5 th Year	Annual
Regular Development of Conversion Factors for Individual Automated Counters					✓	
Eliminate Double Counting of Visits	✓ (at some sites)	Unknown	Unknown	Unknown	✓	✓

¹⁷ The NPS website also provides monthly-level estimates.

	NPS	BLM	USFWS	RECLAMATION	USFS	USACE
Primary Recreation Visitation Metric(s) (see Appendix A for Definitions)	Visits and Hours	Visits and Days	Visits	Visits	Visits	Visits and Days
Visitation Estimates Posted on Website	✓				✓	✓

3. NEW TECHNOLOGIES FOR VISITOR COUNTS

Over the past decade, rapid technological changes have led to a variety of new approaches for monitoring and quantifying visitor use and behavior. This section of the report discusses potential opportunities for using these new approaches to estimate recreational visits to federally-managed lands, focusing on social media data, cellular activity data, and remote sensing data.

3.1 SOCIAL MEDIA DATA

OVERVIEW

Social media users who visit recreation sites often leave digital footprints, allowing researchers to acquire information about locations that they visited on specific dates. Examples include location metadata associated with photographs posted online (e.g., Flickr), geotagged tweets, and recreation trip routes shared through specialized applications (e.g., Strava). The visitor's geographic location is primarily established using GPS-enabled devices such as smartphones, but some social media platforms also allow users to input a location manually. Location data are stored by the platform provider, and some providers allow public access to the data via an application program interface (API). Researchers can mine these data to obtain information about visits to federally-managed lands.

There are several mechanisms by which social media users share their location data, either voluntarily or involuntarily:

- **Photo sharing:** When an individual takes a photograph with a GPS-enabled device such as a smartphone, the time, date, and geographic location associated with the photo are stored as metadata (EXIF data) linked to the image file, assuming the individual has not purposefully chosen to disable geotagging. When the image file is uploaded to a photo sharing site, this metadata accompanies the photo. Companies can then choose whether or not to strip out the metadata (e.g., Facebook and Instagram), store it for internal purposes, or make it publicly available (e.g., Flickr). Standard practice for the retention of photo metadata is continually evolving.
- **Location sharing:** Some social media platforms allow users to voluntarily share the location from which they take a particular action, such as visiting a geocache

or posting a tweet.¹⁸ With Twitter, for example, users with GPS-enabled devices have the option to automatically geotag their tweets with a precise geographic location. If the user is public (the default setting when creating a Twitter account), then this location information is available to researchers.

- **Path sharing:** A variety of smartphone apps allow users to trace out the precise path that they took during a trip and share that path with others. These apps are popular with runners and bikers and are referred to as “volunteered geographic information” (VGI) services. Examples include Strava, Endomondo, MapMyRide, GPSies, and Wikiloc. The availability of these recorded paths to researchers varies by company, and users typically have the option to opt out of sharing personal data.

An important advantage of social media data is related to its scale. For example, Flickr users upload approximately 40 to 50 million geotagged photos every year (Wood et al., 2013); Twitter users post nearly 400 million geotagged tweets every year (Mapbox, 2017); and Strava has released maps showing the paths of nearly 100 million completed bike rides and runs (Strava, 2017). In the last few years, researchers have taken advantage of this wealth of social media data, using it to analyze outdoor recreation and tourism in a variety of settings. Many applications to date have relied on data from photo sharing services, primarily Flickr (Wood et al., 2013; Levin et al., 2015; Torrisi et al., 2015; Ghermandi et al., 2016; Sonter et al., 2016, and Sessions et al., 2016) and Instagram (De Minin et al., 2016; Stienmetz and Fesenmaier, 2016). To a lesser extent, researchers have also taken advantage of data from geotagged tweets (Forst and Foster, 2015; Nguyen et al., 2016), geocaching (Cord et al., 2015), and VGI services (Campelo and Mendes, 2016; Korpilo et al., 2017).

Only a handful of studies have attempted to relate social media data to external estimates of recreation on public lands, and all have focused on geotagged photographs. The first significant exploration along these lines appears to have been conducted by Wood et al. (2013), who evaluated visitation data at 836 sites throughout the world, relating external estimates of annual visitation to annual Flickr “photo user days.” A photo user day (PUD) is defined as a Flickr user posting at least one photo from one site on one day. While the authors find that PUDs are positively correlated with visitation, a substantial amount of variation in use remains unexplained.¹⁹ At individual sites, the within-year temporal variation in PUDs does appear to closely follow expected visitation patterns. For example, there is a distinct annual spike in PUDs during the week-long Burning Man Festival at the Black Rock Desert in Nevada, and there was another spike in PUDs during the 2011 Occupy protests at Zucotti Park in lower Manhattan.

¹⁸ A geocache is a small container concealed in an outdoor location. The coordinates of the geocache are posted on the internet for “geocaching” game participants who try to find it with the assistance of a GPS-enabled device.

¹⁹ Similar findings are reported in Keeler et al. (2015), who compare PUDs from a similar Flickr dataset to survey-based estimates of annual trips to Iowa lakes.

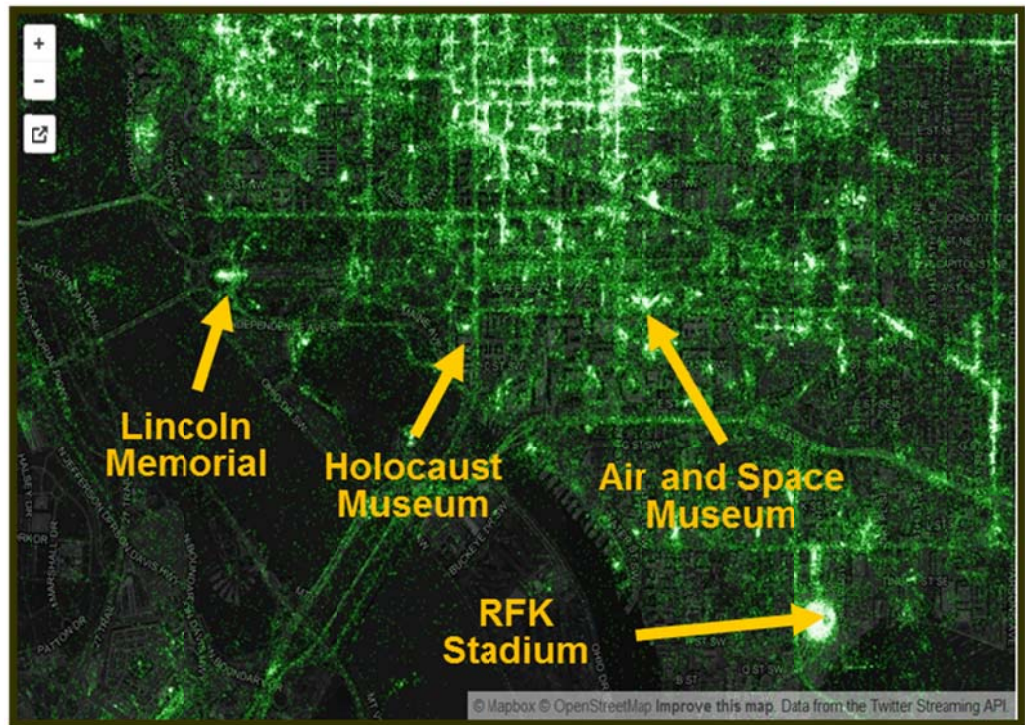
Recently, two unpublished studies have reported mixed results related to the ability of social media data to accurately reflect temporal trends in visitation. Di Minin et al. (2016), in a poster presentation, compare the number of monthly geotagged Flickr and Instagram photos posted between 2014 and 2015 with monthly visitation statistics at 54 national parks in Finland and South Africa. They find a strong correlation between what they describe as the “number of social media users” and official visitation estimates at the parks, although few details regarding the analysis are provided. They also find that monthly visitation patterns are similar across the two data sources at Kruger National Park in South Africa. Stienmetz and Fesenmaier (2016) evaluate geotagged Instagram photos posted online between 2012 and 2015, comparing the number of monthly photos posted by unique users at Castillo de San Marcos National Monument (in St. Augustine, Florida) to monthly visitation estimates for the same site from the NPS. The relationship between the two measures is poor, which the authors attribute to the exponential growth in Instagram use during the study period.

Finally, in an analysis focused on 38 national parks in the western United States, Sessions et al. (2016) compare geotagged Flickr PUDs to monthly visitation estimates from the NPS, focusing on 2007 to 2012. The NPS monthly visitation estimates are regressed on monthly PUDs, with dummy variables incorporated to control for year, month, and park. They find that the coefficient associated with the PUDs variable is statistically significant and that the model’s predictions are reasonably accurate. However, the ability of the model to accurately predict visitation is likely dependent on the use of park-specific dummy variables, as these variables implicitly calibrate the model to match average NPS visitation for each park.²⁰ As the authors acknowledge, “Without data to calibrate, PUD data can still show temporal trends in park visitation, but may produce less certain estimates of total visitor counts” (p. 708).

The spatial resolution of social media data allows for analyses of visitor movements *within* a site, which can be useful for infrastructure planning. One could, for example, examine the specific locations of geotagged photos or tweets, rather than simply determining whether or not they were taken within the overall boundaries of a park (Exhibit 3.1). These location data allow for a low-cost evaluation of the relative popularity of specific attractions within a park. For example, Levin et al. (2015, Fig. 5) show the density of geotagged photographs taken from various areas within Yellowstone and Grand Canyon national parks.

²⁰ Using statistical terminology consistent with the analysis of panel data, these park-specific dummy variables are described as “fixed effects” in the paper.

EXHIBIT 3.1. MAP OF TWEET LOCATIONS NEAR THE NATIONAL MALL

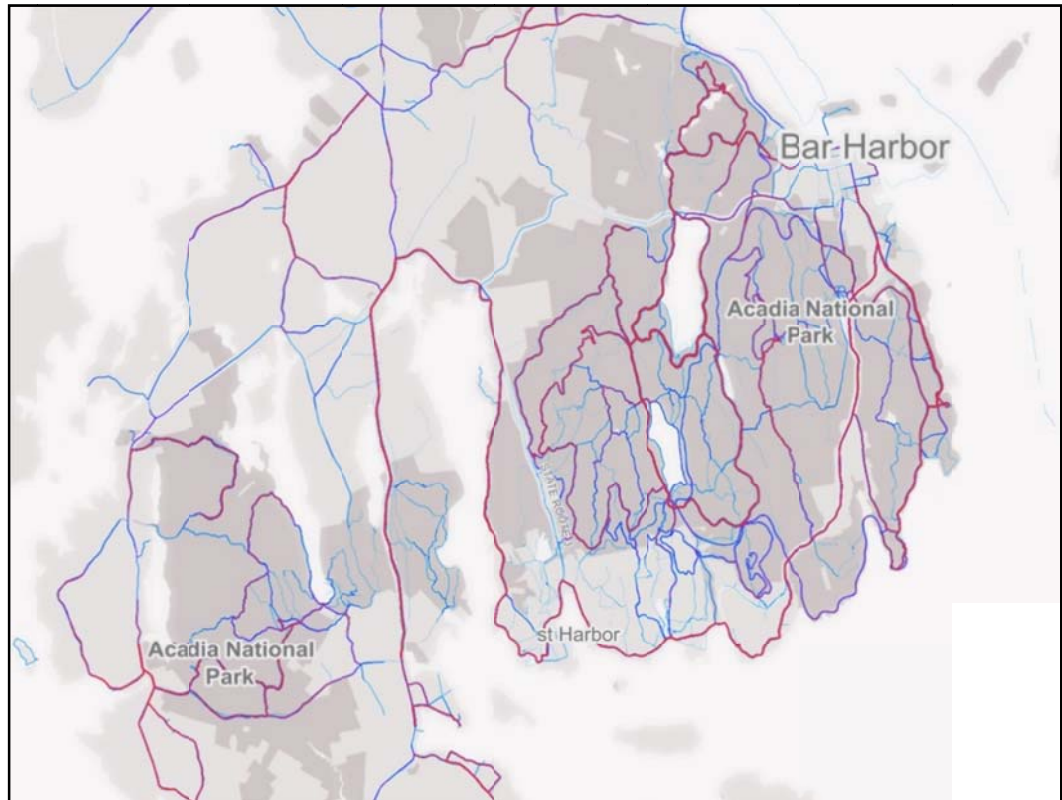


Source: Developed using mapping tool available at <https://www.mapbox.com/blog/twitter-map-every-tweet/>.

The growing popularity of VGI services allows for even more detailed evaluations of intra-park movements for bikers and runners/walkers (Exhibit 3.2). For example, Korpilo et al. (2017) recruited volunteers using a variety of sports tracking applications to share the routes that they travel when visiting an urban forest park in Finland.²¹ Campelo and Mendes (2016) also rely on VGI, but they take a slightly different approach to data collection. Rather than recruiting volunteers, they obtain pre-existing, publicly-available VGI data from GPSies and use the data to examine mountain biking routes within parks in Portugal. The use of VGI for this type of analysis is not likely to be useful in developing visitation estimates, but it could improve the efficiency of sampling strategies when counting pedestrian/biker visits at parks with numerous entrances. For example, the relative use levels suggested by VGI data could be used to assign higher selection probabilities to entrances with greater use.

²¹ This is similar to the approach used in studies that provide physical GPS devices to volunteers, allowing researchers to analyze their movements within sites (e.g., D'Antonio et al. 2010).

EXHIBIT 3.2. ILLUSTRATIVE HEAT MAP OF STRAVA RUNNING/WALKING/BIKING TRIPS WITHIN AND NEAR ACADIA NATIONAL PARK



Source: Created using StravaLabs tool at www.labs.strava.com/heatmap). The colors depict relative use levels, ranging from dark red (heavy use) to light blue (light use).

ASSESSMENT

With regard to estimating visitation to federally-managed lands, we envision four potential uses for social media data, focused primarily on its potential to provide low-cost measures of *relative* use. First, the data could be used to estimate relative use across days or months at individual sites. Second, the data could provide an independent assessment of the relative magnitude of recreation use estimates developed by federal land management agencies. The agencies' on-site estimates are not perfect and methodologies differ greatly across agencies, so low-cost, independent estimates of relative use may be informative, despite their weaknesses. Third, measures of relative use could be used to improve the efficiency of sampling for agencies such as the USFS that use sampling-based approaches to estimating visitation (e.g., English et al., 2002). Fourth, social media data could potentially provide useful information about visitor destinations *within* recreation sites – information that typically requires resource-intensive surveys to collect.

The primary disadvantage of social media data is that they only reflect the behaviors of a self-selected subset of visitors. Social media users tend to have more years of formal

education, are younger, and are wealthier than the general population (Li et al., 2013; Cord et al., 2015) (Exhibit 3.3). Further, only a subset of social media users will choose to post georeferenced data related to their visits online. Some will choose not to post any information at all, while others will choose to post information that is not georeferenced. Sessions et al. (2016) report, for example, that only three percent of Flickr photographs are geotagged.

EXHIBIT 3.3. PERCENTAGE OF U.S. ADULTS WHO USE SELECTED SOCIAL MEDIA PLATFORMS

CATEGORY	FACEBOOK	INSTAGRAM	TWITTER
All U.S. Adults	68%	28%	21%
By Age			
Ages 18-29	88%	59%	36%
Ages 30-49	79%	31%	22%
Ages 50-64	61%	13%	18%
Ages 65+	36%	5%	6%
Education			
High school or less	56%	19%	14%
Some college	77%	35%	24%
College graduate	77%	32%	28%
By Household Income			
Less than \$30,000	65%	29%	18%
\$30,000 - \$49,999	68%	27%	16%
\$50,000 - \$74,999	70%	30%	26%
\$75,000+	76%	30%	30%
Source: Pew Research Center. 2017. Social Media Fact Sheet. Based on survey conducted March 7 - April 4, 2016. Retrieved from: http://www.pewinternet.org/fact-sheet/social-media/ .			

Compounding the problem is that the subset of users who post georeferenced data will likely vary with the timing and location of the trip. Visitors to Glacier National Park, for example, may be more likely to take photographs during the summer than during the winter (when they would need to remove their gloves to take a picture). And visitors to scenic parks such as Yosemite may be more likely to take photographs than visitors to historical parks such as Gettysburg National Battlefield. In fact, Levin et al. (2015) find that Yosemite is the most photographed national park in the United States, despite the fact that Smoky Mountain National Park is the most visited. Along similar lines, users of apps such as Strava or GPSies are more likely to post information from trips to parks with natural running, hiking, or biking routes. Finally, cell coverage at the park may impact the likelihood that visitors will post visit-related information online: visitors to parks without cell coverage may be less likely to post after they have left the park and their memories of the visit begin to fade.

The rapid changes in technologies and the popularity of particular social media platforms makes the evaluation of time trends particularly difficult. The recent explosion of Instagram use, for example, stymied attempts by Stienmetz and Fesenmaier (2016) to

relate geotagged Instagram photos to trends in park visits. Further, it is impossible to predict whether a given social media platform will continue to provide access to georeferenced data in future years.

Finally, an additional risk associated with relying on social media data to derive visitation estimates involves future uncertainty about the availability of the data. The data are owned by the platform providers, and they could choose at any time to either (1) withhold access or (2) substantially increase the price of access.

3.2 CELLULAR ACTIVITY DATA

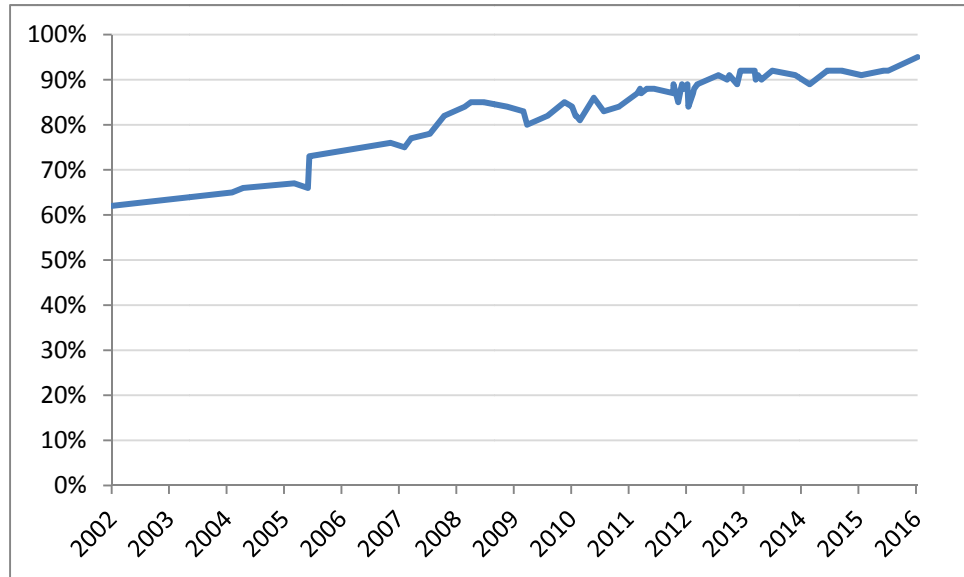
OVERVIEW

The Pew Research Center estimates that approximately 92 percent of adults (and 98 percent of adults 18-29 years old) own cellphones in the U.S. (Pew Research Center, 2015) (Exhibit 3.4). When these cellphones are used for communication or data transfers during visits to recreation sites with cell coverage, they leave digital traces, providing an enormous amount of metadata that researchers have recently begun to use to evaluate travel and recreation behavior (see reviews by Williams, 2016 or Shoval and Ahas, 2016).

The primary form of this metadata is the “call detail record,” or CDR. Every time a mobile device connects to the cellular network for a phone call, text message, or data transfer, a CDR is created. CDRs are routinely collected and stored by cellular providers for billing purposes. They contain the time, date, base station ID, and mobile device ID associated with the cellular activity, among other details. CDR metadata are referred to as “passive” mobile data, as the user does not actively choose to allow cellular activity to be recorded; it is simply recorded as a matter of course for all users.

The base station ID in the CDR is what allows the user’s cellphone activity to be geolocated. Physically, a “base station” is a piece of electronic equipment that connects a mobile device to the provider’s cellular network. In rural areas, it is typically located at the base of a cell tower, and it connects to the mobile device through antennae that are attached to the tower. Every base station is associated with a specific geographic area, so knowledge of the base station ID allows the analyst to link the CDR to that area. Using a triangulation algorithm, it is also feasible to more precisely specify (within approximately 200-300 meters) the user’s location within the geographic area served by the base station (Alexander et al. 2015).

EXHIBIT 3.4. PERCENTAGE OF U.S. ADULTS WHO OWN A CELLPHONE



Source: Pew Research Center. 2017. Mobile Fact Sheet. Based on surveys conducted 2002-2016.
Retrieved from: <http://www.pewinternet.org/fact-sheet/mobile/>.

Although CDRs are confidential, cellular providers have shared them with researchers after removing personally identifiable information (e.g., see Alexander et al. 2015). In these cases, the provider replaces the unique ID associated with the mobile device with an anonymized ID. Providers have also shared aggregated CDR data with some researchers (e.g., see Girardin et al., 2009). As an illustration of the scale of cell phone activity data, consider Alexander et al. (2015), who studied transportation patterns in the Boston area using CDRs from cellular providers covering a two-month period. Despite focusing on a single city and a relatively short period of time, more than eight billion CDRs were used in the analysis, covering the cellular activities associated with two million unique mobile devices.

CDR data can potentially be used to calculate the number of unique cellular devices used within a recreation site on a specific day. Suppose, for example, that a recreation site is served by a single base station linked to a cell tower in the center of the site. An analyst could calculate the number of unique devices by simply (1) identifying all CDRs associated with that base station and (2) deleting duplicate device IDs. By evaluating nationwide data over time, one could also assign every device ID to a specific “home” location (e.g., base stations associated with cellular activity that typically takes place between 5:00 PM and 9:00 AM), thus allowing for an analysis of visitor origins.

Despite the promise of cellular activity data, applications related to outdoor recreation have been relatively scarce.²² In a series of studies over the last decade, researchers in Estonia have used CDRs to analyze spatial and temporal patterns of tourism behavior in their country, linking CDR-based estimates to external data on hotel nights (Ahas et al., 2008) and the number of ferry passengers traveling between Finland and Estonia (Eurostat, 2014). However, these studies do not focus on visits to outdoor recreation sites. Rasanen and Kolehmainen (2008) use CDR data to evaluate cellular activity in the vicinity of a Finnish ski resort, but no external visitation estimates were available for validation. Similarly, Girardin et al. (2009) used aggregated hourly CDR data to analyze the temporal and spatial patterns of cellular activity near a temporary outdoor art exhibit along the New York City waterfront, but external visitation estimates were unavailable.

ASSESSMENT

The potential use of cellular activity data to assess visitation at recreation sites is in many ways parallel to the potential use of social media data for the same purpose. In particular, the attractiveness of cellular activity data lies in its tremendous scale, its low cost (relative to on-site data collection), and in the spatial and temporal resolution of the data.

One potential application would be in characterizing *relative* activity levels across time at a given park. Thus, even if the activity data reflect the behavior of a subset of visitors, it can be useful in describing variation in use across days, months, or years for that particular subset of visitors.²³ This may be helpful in identifying temporal trends that are difficult to detect using standard visitation data, or in reducing the frequency of on-site data collection.

Another potential application would be in examining overlap in use estimates associated with multiple recreation sites. If two recreation sites are located in the same region, for example, individuals who go to both sites in the same day are typically counted separately at each site. With CDR data, it would be relatively simple to estimate the percentage of visitors who visit both sites within the same day, provided that the sites are far enough apart that they are associated with different base stations.

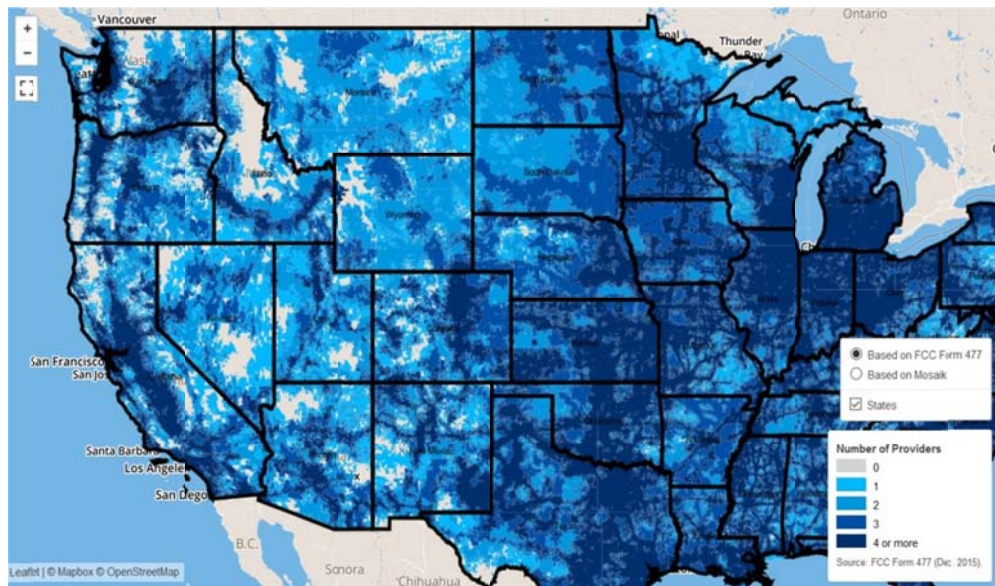
However, with regard to generating comprehensive, long-term estimates of recreation on federally-managed lands, the use of cellular activity data is currently limited by the fact that many remote recreation areas lack cellular coverage (Exhibit 3.5). Furthermore, at sites that do have cellular coverage, the spatial resolution of the data can be somewhat limited. Rather than GPS-based location data, information on geographic locations is derived from communications with a nearby base station. Although cellular providers

²² Airsage, a company that collects and analyzes wireless signaling data from several cellular providers, recently completed a study that relates CDRs in the United States to national park and national forest visitation data, but a final report is not yet available (Airsage, 2016).

²³ The data would be less useful for describing within-day usage patterns, as cellular use would not be evenly distributed across the visit (e.g., phone calls to family or friends in the evening).

can use triangulation algorithms to locate the user to within approximately 200 to 300 meters (Alexander et al. 2015), standard CDR data only links records to the nearest base station. As a result, the spatial resolution of the data depends critically on the density of the provider's cellular network. In rural areas where many recreation sites are located, networks typically have low densities, providing poor spatial resolution. This can make it difficult to separate cellular activities taking place outside the boundaries of a recreation site (e.g., in an adjacent town, on a nearby highway, or from ferries in coastal areas) from cellular activities of visitors. It can also make it difficult to separate the cellular activities associated with two adjacent recreation sites.

EXHIBIT 3.5. CELLPHONE COVERAGE IN THE WESTERN UNITED STATES



Source: Federal Communications Commission (FCC). Retrieved from: <https://www.fcc.gov/reports-research/maps/3gorbetter-number-providers-ye-2015/>

In addition, cellular activity data reflect the behavior of a biased sample of visitors – those who (1) own cellular devices and (2) choose to use those devices during a visit to a recreation site. The degree of bias will unfortunately differ across sites, as cell phone penetration rates vary regionally, and cell phone usage rates vary across parks and even across activities within parks. However, as cellphone penetration rates continue to approach 100 percent, and as more and more visitors bring their cellphones on recreation trips, this bias will decrease.

As with social media data, a significant risk associated with relying on cellular activity data to derive visitation estimates involves future uncertainty about the availability of the data. The data are owned by cellular providers, and they could choose to withhold access or substantially increase the price of access at any time. Providers are sensitive to customer perceptions related to privacy; even the appearance of an erosion of privacy

may cause customers to switch providers. Furthermore, future regulations may restrict what data providers are *allowed* to provide to analysts.

Finally, while cell use is becoming rather ubiquitous in the United States (Exhibit 3.4), future technological change may lead to alternative communication mechanisms that disrupt the ability of the data to accurately reflect visitation trends. For example, low-cost satellite phones or increased availability of wifi networks could reduce future traffic on cellular networks.

Apart from these purely technical concerns regarding the use of cellular activity data to quantify visitation, cellular users may have substantial privacy concerns. CDRs provide detailed information about the time and location of all cellular activities, and many visitors would not want this information to be viewed by government employees or contractors. Although the CDRs would be anonymized, do not include content (e.g., photos or texts), and only provide locations accurate to the nearest base station, privacy may still be a significant concern for many individuals.

3.3 REMOTE SENSING DATA

OVERVIEW

Remote sensing can be defined as gathering data about an object from a distance. Typically, remote sensing applications involve gathering data from a satellite or aircraft, but a more inclusive definition of the term could cover the use of on-site equipment to gather data about visits.²⁴

Federal agencies have used on-site “remote” sensing techniques to gather data about visits for decades. The standard inductive loop vehicle counter, for example, counts vehicles from a distance (albeit, a very short distance) as they pass over a wire loop, thereby inducing changes in the electric current within the loop. At many sites, agencies rely on infrared counters to quantify visitation at pedestrian entrances, remotely monitoring the infra-red radiation emitted by visitors as they pass by the device. For reviews of recent developments in these types of on-site counter technologies, see Turner et al. (2013), Kittelson & Associates et al. (2013), Benz et al. (2013) and Leggett (2015).

ASSESSMENT

The use of satellite- or aircraft-based remote sensing for long-term monitoring of visitation on federal lands would be extremely challenging. Satellite-based remote sensing is limited by periodic cloud cover, vegetation, and resolution levels (~0.5 meters) that make it difficult to count individuals and distinguish them from animals and other objects (Stapleton et al., 2014). We are not aware of any visitor count studies that rely on satellite-based remote sensing. Aircraft-based imagery shows more promise, as it can

²⁴ Note that the use of social media and measures of cellular traffic can also be interpreted as remote sensing applications, but these technologies were discussed in sections 3.1 and 3.2.

provide higher resolutions and is less affected by clouds. It has been used in several NRDA-based assessments of beach visitation (e.g., Byrd et al., 2001; Horsch et al., 2017a) and in creel studies to evaluate use at large sites with diffuse access (Pollock et al., 1994; Normandeau, 2003). However, aerial overflights can be expensive and may therefore be impractical for long-term visitor counts across numerous sites by federal agencies.²⁵ An added complication with both satellite- and aircraft-based counts is that they only provide “instantaneous” counts of use levels; on-site interviews would still be required to obtain visit durations so that the visitor-hour estimates generated by instantaneous counts can be converted to estimates of visits (Leggett, 2017).²⁶

With regard to on-site remote sensing, time-lapse digital photography offers tremendous potential for specialized visitor count studies, given dramatic recent reductions in memory costs. Relatively inexpensive game cameras are available that can be deployed for several months at a time, recording photographs at pre-specified time intervals and stitching them together to provide time-lapse video footage. For low-use sites, this can be extremely useful, as the video footage can be reviewed quickly by an analyst by fast-forwarding through time periods with little or no visitation (e.g., Arnberger et al., 2005). Unfortunately, cost-effective, reliable software for automating these counts has not yet been developed, so video-based counts are still too expensive for widespread use (Turner et al., 2013). Furthermore, there can be significant privacy concerns that may lead site managers to reject the use of cameras.

Two additional sensing technologies that show tremendous promise involve the detection of either Bluetooth or Wi-Fi enabled devices. Every Bluetooth and Wi-Fi enabled device has a unique media access control (MAC) address that it broadcasts continually (unless Bluetooth and/or Wi-Fi have been disabled). This unique MAC address can be detected and anonymously recorded, together with the date and time, using a specialized device mounted to a roadside sign or post. Bluetooth detectors have been used in many recent transportation studies (e.g., RSG, 2016), as many newer vehicles are Bluetooth enabled and continually broadcast a unique MAC address. The detection range for these studies is approximately 50 to 100 meters. In pedestrian studies, Wi-Fi detection is potentially more useful, as many pedestrians carry cellphones and have Wi-Fi (but not Bluetooth) enabled. Krzeminski and Hiles (2016) used Wi-Fi detection in a study of shuttle bus usage within Zion National Park. If Bluetooth installations and cellphone ownership rates continue to climb, the detection of MAC IDs at site entrances could feasibly develop into attractive alternatives to standard automated vehicle or pedestrian counters.

²⁵ The use of newer technologies such as drones or aerostats may reduce the cost of aerial imagery, but the cost would still be substantial if applied across numerous sites for long periods of time.

²⁶ Instantaneous counts are sometimes also referred to as “persons at one time,” or PAOT estimates.

4. RECOMMENDATIONS

This chapter provides a series of recommended tasks that, if implemented, could potentially improve the collection, documentation, and distribution of visitation data by federal agencies. The recommendations arose out of information gathered for this report and an inter-agency workshop on recreation visitation that was jointly facilitated by DOI and IEc on March 20, 2017.²⁷ The recommendations provided below were developed by IEc and do not necessarily reflect the views of DOI personnel or of the participants at the inter-agency workshop.

The specific recommendations are as follows:

1. **Documentation of current data collection methods:** An understanding of the methods currently used to develop visitation estimates is critical to evaluating those methods and ensuring that they are applied consistently through time. It is also necessary for informed use of the estimates in policy analysis. Having a well-documented data collection methodology will increase external acceptance of agency-generated estimates and allow DOI to evaluate whether the methods are consistent with its Information Quality Guidelines (DOI, 2017).

Documentation of data collection methods should be developed at both the individual site and the agency levels. The documentation should be dated and archived, allowing analysts and managers to understand methodological changes over time that could affect the estimates. The documentation should describe any specialized studies, such as efforts to develop ratios of visits to automated counts.

For agencies where data collection efforts are decentralized, there appear to be barriers to documenting site-level methodologies. We recommend that these agencies consider a phased approach to documentation in order to minimize these barriers. For example, in the first year, the goal could be to simply survey site managers to determine which sites use automated counters, administrative data, or professional judgement. In the second year, sites could provide a thumbnail sketch of their data collection method, even if it is just a few sentences. Additional details could be obtained in future years.

2. **Inter-agency coordination of current data collection methods:** The methods used to estimate visitation differ widely across agencies. This is understandable and even expected, given variation across sites with respect to visitor activities

²⁷ For details, see 4/25/17 memorandum from Eric Horsch, Robert Unsworth, Chris Smith, and Chris Leggett, "March 20, 2017 Interagency Workshop on Recreation Visitation Data: Summary and Next Steps."

and the configuration of site entrances. However, in order for inter-agency comparisons or aggregations to be meaningful, consistent definitions of key measurement concepts are necessary. We recommend that a working group be established to develop these definitions.

The primary focus should be on developing a standard definition of a “visit.” Specifically, agencies should have a consistent approach to addressing visitors who enter and exit a site multiple times, visitors who only stop at the site for a few minutes (e.g., to use a restroom or ask for directions), and visitors who enter multiple federal sites in a single day. Our recommendation is that the USFS definition of a “last-exiting recreationist” be used as a starting point, although the use of this particular definition does necessitate intercept surveys to identify which visitors are leaving for the last time. The working group could also discuss definitions for alternative visitation metrics, such as visitor hours or visitor days, and consider defining and measuring a common set of activities.

An ancillary benefit to periodic inter-agency coordination would be the exchange of information about automated counters. Many agencies use automated vehicle and pedestrian counters, and it would be useful to regularly share ideas on cost, reliability, ease of use, and recent technological advances.

3. **Inter-agency coordination of reporting methods:** In addition to developing consistent visitation metrics, agencies should have consistent approaches to reporting visitation estimates. For example, it would be desirable to have consistency in the spatial and temporal resolution of the reported estimates, as well as in the approach to presenting supporting information such as data collection methodologies. If site-level estimates are aggregated to broader geographic areas (e.g., states), it would be desirable to have aggregation units that are consistent across agencies. Establishing consistent reporting methods could eventually facilitate the creation of a single website providing public access to visitation estimates across all federal land management agencies (e.g., hosted by Recreation.gov).
4. **Improvements in current data collection methods:** Existing data quality varies by agency. Some agencies that have decentralized data collection efforts have expressed a desire to improve their data collection methods and in turn the quality of their data. Given the wide variety of methodologies used to estimate visitation, it is difficult to identify cross-cutting improvements that would apply to all agencies and sites. However, there are several improvements to current methods that are potentially broadly relevant.

In our opinion, the most significant improvement to current methods would involve the elimination of double counting of visitors who enter and leave a site within the same day. The extent to which this is an issue will differ across sites, but it is likely to be a significant concern at locations with restaurants, stores, or other attractions located near site entrances. One approach to addressing this issue would be to ensure that only “last-exiting recreationists” are counted.

An additional area for potential improvement involves the use of more sophisticated automated counters. For example, agencies should consider the use of automated counters that incorporate data loggers, thus allowing for more detailed analyses of temporal use patterns. Many newer data loggers use Wi-Fi or the cellular network to upload data to the internet, thus eliminating the need for site visits and allowing for real-time identification of equipment failures. At remote sites with low visitation, periodic counts based on time-lapse video (e.g., “plot watcher” game cameras) could replace estimates that are based largely on professional judgement.

Finally, agencies should carefully consider data needs and the potential to substitute simple, sampling-based strategies for methodologies that require that every visit be counted on every day at every site (e.g., a census-based approach). The sampling methodology used by the USFS may be too complex for some agencies to implement, but alternative, simpler approaches may be feasible, such as simply counting visits every third year or on a sample of days each month. By counting visits less frequently, agencies may be able to shift resources towards counting more carefully. Of course, less frequent visitor counts would potentially reduce agencies’ ability to evaluate detailed time trends for individual sites.

- 5. Development of guidance documents and training materials for site-level personnel:** With the exception of the USFWS, NPS, and USFS, agencies do not appear to have developed comprehensive guidance documents or training materials related to estimating visitation for use by site-level managers. These materials are critical to ensuring that personnel implement consistent and accurate approaches to quantifying and characterizing visitation. We recommend that agencies consider developing such materials, including both written documents and more applied training tools such as instructional videos.

Guidance documents and training materials for site-level professionals should be practical, user-friendly, and include concrete examples (e.g., USFS, 2007; Horsch et al., 2017b). They should cover topics such as: the motivation for collecting visitation data; the selection of an appropriate estimation method for a given site; the evaluation and selection of various types of automated counters; setting up, calibrating, and maintaining automated counters; implementing surveys to convert automated counts to visits; selecting and using proxy data; field forms and documentation; and safety protocols.

In order to accommodate alternative learning styles, we recommend that agencies develop simple, practical video-based training tools that demonstrate topics covered by the guidance documents. These training tools could be shared across agencies.

6. **Exploration of alternatives to current data collection methods:** As discussed in earlier sections of this report, if robust, long-term visitation statistics are desired, we do not believe there are currently any viable alternatives to careful, on-site data collection. That is, estimating visitation by leveraging big data available via social media, cellular activity, or remote sensing does not show significant promise at present.²⁸ Of the big data options, CDRs from cellular providers show the most potential, but we do not recommend that agencies use these data given the potentially large error rates, low spatial resolution, and uncertainty regarding future data access.

That said, with the widespread adoption and use of cell phones, site-level estimation methods that rely on unique Bluetooth/Wi-Fi IDs from cell phones may be feasible in the near future. In order to better understand the potential advantages and disadvantages of these methods, we recommend that agencies implement pilot projects at one or more sites to better understand visitor use of cell phones during recreation visits. For example, an exit survey could be implemented to determine whether or not visitors' leave Bluetooth/ Wi-Fi enabled during their visits, and whether visitors with cell phones have characteristics that differ from visitors without cell phones. In combination with these exit interviews, field personnel could use temporary sensors to gather unique MAC IDs, allowing for comparisons of manual visitor counts versus Bluetooth/Wi-Fi-based counts.

²⁸ We recommend that DOI monitor the evolution of vehicle transponder technologies currently used for automated toll systems. If universal radio-frequency identification (RFID) transponders are eventually pre-installed in new vehicles, they may provide opportunities for cost-effective monitoring of unique vehicles entering parks.

REFERENCES

- Ahas, Rein, Anto Aasa, Antti Roose, Ular Mark, Siiri Silm. 2008. Evaluating passive mobile positioning data for tourism surveys: An Estonian case study. *Tourism Management*, 29(3), 469-486.
- AirSage. 2016. TechBriefing: Estimating Recreational Visitors to National Park Service and US Forest Service Units from Cell Phone Sample Data - DRAFT. Coordinated Technology Implementation Program, Office of Federal Land Highway, Federal Highway Administration, U.S. Department of Transportation.
- Alexander, Lauren, Shan Jiang, Mikel Murga, and M.C. Gonzalez. 2015. "Origin-Destination Trips by Purpose and Time of Day Inferred from Mobile Phone Data," *Transportation Research Part C*, 58: 240-250.
- Arnberger, A., W. Haider, and C. Brandenburg. 2005. Evaluating visitor-monitoring techniques: A comparison of counting and video observation data. *Environmental Management*, 36(2): 317-327.
- Benz, R.J., S. Turner, and T. Qu. 2013. *Pedestrian and bicyclist counts and demand estimation study*. Prepared for the Houston-Galveston Area Council by the Texas A&M Transportation Institute. January.
- BLM. 2016a. Recreation and Visitor Services. Available online at: <https://www.blm.gov/wo/st/en/prog/Recreation.html>. Accessed 3/1/2017.
- BLM. 2016b. 2015 Public Land Statistics. Available online at: https://www.blm.gov/public_land_statistics/index.htm. Accessed 3/1/2017.
- Byrd, H., E. English, D. Lipton, N. Meade, and T. Tomasi. 2001. Chalk Point oil spill: lost use valuation report. National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, Maryland Department of the Environment, Maryland Department of Natural Resources. Prepared for the Chalk Point Trustee Council. March.
- Campelo, Maria B., and Ricardo M. Nogueira Mendes. 2016. "Comparing webshare services to assess mountain bike use in protected areas." *Journal of Outdoor Recreation and Tourism*, 15: 82-88.
- Chu, A., D. Eisenhower, M. Hay, D. Morganstein, J. Neter, and J. Waksberg 1992. Measuring Recall Error in Self-Reported Fishing and Hunting Activities. *Journal of Official Statistics*, 5, 13-39.
- Connelly, N. A. and T. L. Brown. 2011. "Effect of Recall Period on Annual Freshwater Fishing Effort Estimates in New York," *Fisheries Management and Ecology*, 18, 83-87.

- Congressional Research Service (CRS). 2014. "Federal Land Ownership: Overview and Data." December 29, 2014. Available online at: <https://fas.org/sgp/crs/misc/R42346.pdf>. Accessed 3/1/2017.
- Coray KE, L. Klyne, and V. Josupait. 2007. Deliverable 3: Final Report to Bureau of Land Management. National Visitor Use Monitoring Pilot Evaluation. Coray Gurnitz Consulting. Prepared for the Bureau of Land Management.
- Cord, Anna F., Franz Roeßiger, and Nina Schwarz. 2015. "Geocaching Data as an Indicator for Recreational Ecosystem Services in Urban Areas: Exploring Spatial Gradients, Preferences and Motivations." *Landscape and Urban Planning*, 144: 151-162.
- D'Antonio, A., Monz, C., Lawson, S., Newman, P., Pettebone, D. and Courtemanch, A., 2010. GPS-based Measurements of Backcountry Visitors in Parks and Protected Areas: Examples of Methods and Applications from Three Case Studies. *Journal of Park and Recreation Administration*, 28(3).
- Di Minin, E., Tenkanen, H., Hausmann, A., Heikinheimo, V., Järvi, O. and Toivonen, T., 2016. Social Media Data for Analysing Spatio-Temporal Patterns and Nature-Based Preferences of People in National Parks. Conference presentation.
- Dietsch, A.M., Sexton, N.R., Koontz, L.M., and Conk, S.J. 2013. National wildlife refuge visitor survey 2012—Individual refuge results: U.S. Geological Survey Data Series 754. Available online at: <https://pubs.usgs.gov/ds/754/>. Accessed 3/1/2017.
- English, D. B. K., S. M. Kocis, S. J. Zarnoch, J. Stanley, and J. Ross. 2002. Forest Service National Visitor Use Monitoring Process: Research Method Documentation. United States Department of Agriculture, Forest Service, Southern Research Station, General Technical Report SRS-57.
- Eurostat. 2014. Feasibility Study on the Use of Mobile Positioning Data for Tourism Statistics. Available online at: <http://ec.europa.eu/eurostat/documents/747990/6225717/MP-Consolidated-report.pdf>. Accessed 3/1/2017.
- Forst, Jeremy and Malena Foster. 2015. "Using Open Data to Model Recreation in Seattle's Urban Parks." Capstone Project, Master's Program in Geographic Information Systems for Sustainability Management, University of Washington, Seattle, Washington. August 21.
- Ghermandi, A., 2016. Analysis of intensity and spatial patterns of public use in natural treatment systems using geotagged photos from social media. *Water Research*, 105, pp.297-304.
- Girardin, Fabien, Andrea Vaccari, Alexandre Gerber, Assaf Biderman, and Carlo Ratti. 2009. Towards estimating the presence of visitors from the aggregate mobile phone network activity they generate. 11th International Conference on Computers in Urban Planning and Urban Management.

- Groves, R. M. 2007. Nonresponse Rates and Nonresponse Bias in Household Surveys. *Public Opinion Quarterly*, 70, 646–675.
- Horsch, E., English, E., and Stein, J. 2017a. Using Aerial Photography to Measure the Decline in Beach Trips after the Deepwater Horizon Oil Spill. *Journal of Survey Statistics and Methodology*. Forthcoming.
- Horsch, E., M. Welsh, and J. Price. 2017b. Best Practices for Collecting Onsite Data to Assess Recreational Use Impacts from an Oil Spill. U.S. Dept. of Commerce, NOAA Technical Memorandum NOS OR&R 54. Silver Spring, MD: Assessment and Restoration Division, NOAA. 121 pp.
- Keeler, B.L., S.A. Wood, S. Polasky, C. Kling, C. Filstrup, and J.A. Downing. 2015. “Recreational Demand for Clean Water: Evidence from Geotagged Photographs by Visitors to Lakes.” *Frontiers in Ecology and the Environment* 13(2): 76-81.
- Kittelsohn & Associates, Ryan Snyder Associates, and Los Angeles County Bicycle Coalition. 2013. *Conducting pedestrian and bicycle counts: A manual for jurisdictions in Los Angeles County and beyond*. Prepared for the Southern California Association of Governments (SCAG) and Los Angeles County Metropolitan Transportation Authority. June.
- Korpilo, S., Virtanen, T. and Lehvavirta, S., 2017. Smartphone GPS tracking—Inexpensive and efficient data collection on recreational movement. *Landscape and Urban Planning*, 157, pp.608-617.
- Krzeminski, J. and T. Hiles. 2016. “Visitor Origin / Destination Methodology and Summary.” Zion National Park Transportation Data Collection for Visitor Use Management (GSA Contract No. GS-10F-0133N. Task Order No. P15PD03646). Technical Memorandum to Lilly Hardin and Jack Burns, National Park Service, July 26.
- Leggett, C. G. 2015. “Estimating Visitation in National Parks and Other Public Lands,” Report prepared for the National Park Service under contract to Bioeconomics, Incorporated, under award number P13PD02250, April 13.
- Leggett, C.G. 2017. Sampling Strategies for On-Site Recreation Counts. *Journal of Survey Statistics and Methodology*. Forthcoming.
- Levin, N., Kark, S. and Crandall, D., 2015. Where have all the people gone? Enhancing global conservation using night lights and social media. *Ecological Applications*, 25(8), pp.2153-2167.
- Li, L. N., M. F. Goodchild, and B. Xu. 2013. Spatial, temporal, and socioeconomic patterns in the use of Twitter and Flickr. *Cartography and Geographic Information Science* 40:61–77.
- Mapbox 2017. Available online at: <https://www.mapbox.com/blog/twitter-map-every-tweet/>. Mapbox, Incorporated. Accessed 2/6/17.

- Moisey RN. 2008. Concept Paper Describing Three Visitor Use Estimation Options for BLM National Visitor Use Estimation. The University of Montana, College of Forestry and Conservation. Prepared for the Bureau of Land Management.
- NPS. 2016a. National Park Service Overview. Available online at: <https://www.nps.gov/aboutus/news/upload/NPS-Overview-09-01-2016.pdf>. Accessed 3/1/2017.
- NPS. 2016b. National Reports. Annual Visitation Summary. Available online at: <https://irma.nps.gov/Stats/>. Accessed 3/1/2017.
- NPS. 2016c. Visitor Use Statistics. Available online at: <http://www.nature.nps.gov/socialscience/stats.cfm>. Accessed 3/1/2017.
- Nguyen, Q.C., Kath, S., Meng, H.W., Li, D., Smith, K.R., VanDerslice, J.A., Wen, M. and Li, F., 2016. Leveraging geotagged Twitter data to examine neighborhood happiness, diet, and physical activity. *Applied Geography*, 73, pp.77-88.
- Normandeau Associates, Inc. 2003. Assessment of Hudson River Recreational Fisheries, December.
- Pew Research Center. 2015. "Technology Device Ownership: 2015." October 29. Available online at <http://www.pewinternet.org/2015/10/29/technology-device-ownership-2015/>. Accessed 3/1/2017.
- Pollock, K.H., C.M. Jones, and T.L. Brown. 1994. *Angler survey methods and their applications in fisheries management*. American Fisheries Society Special Publication 25. Bethesda, MD.
- Rasanen, T. and M. Kolehmainen. 2008. Neural Network based method for predicting regional visitor attendance levels in recreational areas. International Congress on Environmental Modelling and Reclamation. 2015. Recreation Overview. Available online at: <http://www.usbr.gov/recreation/overview.html>. Accessed 3/1/2017.
- Reclamation. 2015. Recreation Overview. Available online at: <http://www.usbr.gov/recreation/overview.html>. Accessed 3/1/2017.
- Resource Systems Group (RSG). 2016. "Beachline Origin-Destination Study." Prepared for Florida's Turnpike Enterprise, in cooperation with AECOM. White River Junction, Vermont. November 1.
- Sessions, C., Wood, S.A., Rabotyagov, S. and Fisher, D.M., 2016. Measuring recreational visitation at US National Parks with crowd-sourced photographs. *Journal of environmental management*, 183, pp.703-711.
- Sexton, N.R., Dietsch, A.M., Don Carlos, A.W., Miller, H.M., Koontz, L.M., and Solomon, A.N. 2012. National wildlife refuge visitor survey results—2010/2011: U.S. Geological Survey Data Series 685. Available online at: <https://pubs.usgs.gov/ds/685/>. Accessed 3/1/2017.

- Sonter, L.J., Watson, K.B., Wood, S.A. and Ricketts, T.H., 2016. "Spatial and temporal dynamics and value of nature-based recreation, estimated via social media." PLoS one, 11(9), p.e0162372.
- Stapleton, S., LaRue, M., Lecomte, N., Atkinson, S., Garshelis, D., Porter, C. and Atwood, T., 2014. Polar bears from space: assessing satellite imagery as a tool to track Arctic wildlife. PloS one, 9(7), p.e101513.
- Stienmetz, J.L. and D. Fesenmaier. 2016. "Validating Volunteered Geographic Information: Can We Reliably Trace Visitors' Digital Footprints?" Paper presented at 2016 Tourism Travel Research Association International Conference.
- Strava 2017. Available online at: <http://labs.strava.com/blog/global-heatmap/>. Strava, Incorporated. Accessed 2/6/2017.
- Turner, S. M., P. H. Lasley, and J. C. Pourteau. 2013. "Monitoring Trail Use: Case Study Applications at San Antonio Missions National Historical Park and Guadalupe Mountains National Park," Prepared for National Park Service Social Science Branch by the Texas A & M Transportation Institute, April.
- USFS. 2007. National Visitor Use Monitoring Handbook: July 2007. USDA Forest Service, Washington D.C. Available online at: https://www.fs.fed.us/recreation/programs/nvum/reference/july07_handbook.pdf. Accessed 3/1/2017.
- USFS. 2016a. National Visitor Use Monitoring Survey Results. Available online at: http://www.fs.fed.us/recreation/programs/nvum/pdf/508pdf2015_National_Summary_Report.pdf. Accessed 3/1/2017.
- USFS. 2016b. Recreation Quick Facts. Available online at: http://www.fs.fed.us/recreation/programs/facts/facts_sheet.shtml. Accessed 3/1/2017.
- USFS. 2016c. National Visitor Use Monitoring Program. Available online at: <http://www.fs.fed.us/recreation/programs/nvum/>. Accessed 3/1/2017.
- USACE. 2011. National Recreation Strategy. May.
- USACE. 2013. U.S. Army Corps of Engineer Visitor Use Surveys. Available online at: <https://corpslakes.erdc.dren.mil/visitors/VisitorSurvey/index.cfm>. Accessed 3/1/2017.
- USACE. 2015a. Best Practices Guide for Selecting and Deploying Equipment to Meter Vehicular Traffic at USACE Project Site Areas. August. Available online at: <https://corpslakes.erdc.dren.mil/employees/usurveys/pdfs/2015-BPG.pdf>. Accessed 3/1/2017.
- USACE. 2015b. Visitation Estimation and Reporting System (VERS) Modernization. Contact: Kathleen Perales. October 20.

- USACE. 2016. USACE Recreation. Available online at: <http://www.usace.army.mil/Missions/Civil-Works/Recreation/>. Accessed 3/1/2017.
- USFWS. 2005. Visitation Estimation Workbook and its Technical Supplements.
- USFWS. 2015. National Survey - Overview. Available online at: https://wsfrprograms.fws.gov/subpages/nationalsurvey/national_survey.htm. Accessed 3/1/17.
- USFWS. 2016. About the U.S. Fish and Wildlife Service. Available online at: https://www.fws.gov/help/about_us.html. Accessed 4/11/17.
- United States Department of the Interior (DOI) and the United States Department of Agriculture (USDA). 2015. Implementation of the Federal Lands Recreation Enhancement Act. Available online at: <https://www.doi.gov/sites/doi.gov/files/uploads/2015%20FLREA%20Triennial%20Report%20-%20Web%20Version.pdf>. Accessed 3/1/2017.
- U.S. Department of the Interior (DOI), U.S. Fish and Wildlife Service, and U.S. Department of Commerce (DOC), U.S. Census Bureau. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.
- U.S. Department of the Interior (DOI). 2017. Information Quality Guidelines Pursuant to Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001. Available online at: <https://www.doi.gov/sites/doi.opengov.ibmcloud.com/files/uploads/515Guides.pdf>. Accessed 3/1/2017.
- Washington State University (WSU). 2016. National Parks Service Projects. Available online at: <https://sesrc.wsu.edu/national-park-service-projects/>. Accessed 3/1/2017.
- Williams, Susan. 2016. Statistical uses for mobile phone data: literature review. Office for National Statistics. ONS methodology working paper series no. 8.
- Wood, S.A., Guerry, A.D., Silver, J.M. and Lacayo, M., 2013. Using social media to quantify nature-based tourism and recreation. *Scientific reports*, 3.
- Zarnoch, S.J., English, D.B.K., and Susan Kocis. 2005. “An Outdoor Recreation Use Model with Applications to Evaluating Survey Estimators.” United States Department of Agriculture, Forest Service, Southern Research Station, Research Paper SRS-37, Asheville, North Carolina.
- Zarnoch, S.J., White, E.M., English, D.B.K., Kocis, Susan M. and Arnold, Ross. 2011. “The National Visitor Use Monitoring Methodology and Final Results for Round 1,” United States Department of Agriculture, Forest Service, Southern Research Station, Gen. Tech. Rep. SRS-144, Asheville, North Carolina.

APPENDIX A | GLOSSARY OF VISITATION TERMS

This glossary provides definitions of key terms that federal land management agencies use to track and report their visitation data. Generally speaking, agencies monitor visitation for a variety of recreation activities, including hiking, wildlife viewing, hunting, fishing, and boating. Some agencies break out their visitation data by activity, while others only report aggregate visitation data.

NATIONAL PARK SERVICE

Recreation Visits - A “recreation visit” occurs when a visitor enters park-administered lands or waters for recreational purposes.

Non-Recreation Visits - A “non-recreation visit” occurs when a visitor enters park-administered lands or waters for non-recreation purposes. Examples include people crossing park lands to visit private inholdings, commuters using park roads, or citizens attending public hearings at NPS buildings.

Visitor Hour - A “visitor hour” represents one hour of visitation on park-administered lands or waters (e.g., one person for one hour or four people for 15 minutes each). Visitor hours are classified as recreation and non-recreation.

Visitor Day - The term “visitor day” standardizes visits of different lengths into an estimate of 12-hour visits (e.g., one person for 12 hours or 12 people for one hour each). Visitor days are classified as recreation and non-recreation.

Overnight Stays - An “overnight stay” is defined as a visitor spending one night within a park. For example, a group of three visitors spending two nights camping on park lands would yield six overnight stays. Overnight stays are classified as recreation and non-recreation.

BUREAU OF LAND MANAGEMENT

Visit - A “visit” begins when a visitor enters BLM lands for recreational purposes and ends when the visitor leaves. For example, a visit might include a short dog walk or a multi-day camping trip.

Visitor Day - The term “visitor day” standardizes recreational visits of different lengths into an estimate of 12-hour visitor days. The number of visitor days is also reported by activity using BLM formulas that describe the activities of an “average” visitor.

Recreation Permit – The BLM issues “recreation permits” in exchange for recreation fees paid by visitors. These permits allow visitors to use BLM services and facilities. The types of recreation permits issued by the BLM include: Standard Amenity Permits (e.g., for use of visitor centers or national conservation areas); Expanded Amenity Permits (e.g., for recreational facilities such as campgrounds or boat launches); Special Area Permits (e.g., for use of select “special” areas such as off-highway vehicle areas or backcountry areas); and Commercial Competitive, Group, and Event Permits (e.g., for organized group events or commercial entities providing recreational services).

FISH AND WILDLIFE SERVICE

Visitor - A “visitor” is defined as someone who enters a refuge or wetland management district to engage in a recreational activity.

Visit - A “visit” occurs when a visitor engages in a particular recreational activity (e.g., hunting). A visitor engaging in multiple activities accounts for multiple visits. For example, if a visitor takes a hike and goes hunting in a refuge, that visitor would account for a hiking visit and a hunting visit.

BUREAU OF RECLAMATION

Visit - A “visit” occurs when a person enters Reclamation lands to engage in recreation on a given day.

FOREST SERVICE

Recreation Visit - The NVUM program defines a “recreation visit” as “one person entering and exiting a national forest, national grassland or designated wilderness area for the purpose of recreation.” Visits by employees and contractors are excluded from this definition, as are visits to simply use a restroom or to obtain information. The length of a visit can range from a few minutes to many days.

Recreation Site Visits - During a single recreation visit, an individual may visit multiple sites within a national forest, national grassland, or wilderness area. Visits to individual sites are defined as “recreation site visits.”

Last-Exiting Recreation Visitor - If the purpose of the intercepted individual’s visit is recreation and if the individual is exiting the site for the last time on the current visit, then the individual is considered a last-exiting recreation visitor. The program focuses on “last-exiting” visitors so that visitors who briefly leave a site during a visit (e.g., to obtain supplies) are not counted multiple times.

ARMY CORPS OF ENGINEERS

Visit - A “visit” constitutes a single person entering a USACE site for recreation on one or more occasions, regardless of the length of stay.

Recreation Days of Use - A “recreation day of use” is a visit by a single person during any reasonable portion within a day on the same trip. If a day visitor enters a site four

times in a day, he or she is counted as one visit and one recreation day of use. If a camper stays on site for three days, he or she is counted as one visit and three recreation days of use.

12-Hour Visitor Days - The estimate of “12-hour visitor days” reflects the number of recreation visitor hours (i.e., time spent on site) divided by 12.

APPENDIX B | PERSONS-PER-VEHICLE DATA COLLECTION MATERIALS (NPS)

INSTRUCTIONS FOR ENTERING DATA ON THE PERSONS-PER-VEHICLE SURVEY FORM

1. This survey will help your park establish a person-per-vehicle multiplier to be used with traffic counts for estimating the number of people entering the park by vehicle.
2. The surveyor conducts the survey for only one (1) hour during the sample period at each of the sample locations that is open on the day of the survey.
 - a. If a survey time period is marked AM on the accompanying survey calendar please conduct a one hour survey between the hours of 8:00 AM and 12:00 PM.
 - b. If the survey time period is marked PM please conduct a one hour survey between the hours of 12:00 PM and 5:00 PM.
 - c. The surveyor selects the AM or PM time period when he/she can safely and completely conduct one hour survey at the required location on the day listed on the accompanying survey calendar.
 - d. Please vary your start times during each AM or PM sample period. Start times do not need to be on the hour but do need to be conducted for a one hour period.
3. The surveyor fills out the bottom of the form by entering their name, the date of the survey and the time the survey begins.
4. To fill out the body of the form, count the number of people in each vehicle as they enter the park. Place a tally mark in the appropriate box representing the number of persons in that vehicle. (If there are 2 persons in a vehicle, put a tally mark in column two (2). If there are more than 6 passengers in a vehicle, put the exact number in column 7+.
5. The survey is conducted every other month for 12 months. At the end of each month being surveyed send the completed forms to:

Pam Ziesler
National Park Service
NRSS/EQD/SSB
1201 Oakridge Drive
Fort Collins, CO 80525

If you have any questions, please contact Pam at the above address or phone 970-225-3564.

Thank you for your cooperation.

November 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
2	3	4 Survey PM	5	6	7	8 Survey AM
9	10 Survey AM	11	12 Survey PM	13	14	15
16	17	18	19	20 Survey AM	21	22
23 Survey PM	24	25	26	27	28 Survey PM	29
30						

January 2015

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3
4	5	6 Survey AM	7	8	9	10
11 Survey PM	12	13	14	15	16 Survey AM	17
18	19 Survey AM	20	21 Survey PM	22	23	24
25	26	27	28	29 Survey AM	30	31 Survey PM

March 2015

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4 Survey PM	5	6	7
8	9 Survey AM	10	11	12	13 Survey PM	14
15	16	17 Survey AM	18	19	20	21
22 Survey PM	23	24	25	26 Survey PM	27	28 Survey AM
29	30	31				

May 2015

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2 Survey AM
3	4	5	6 Survey AM	7	8	9
10	11 Survey AM	12	13	14 Survey PM	15	16
17	18	19	20	21	22 Survey AM	23
24 Survey PM	25	26 Survey PM	27	28	29	30
31						

July 2015

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2 Survey PM	3	4
5	6	7	8	9	10	11 Survey AM
12	13 Survey AM	14	15	16	17 Survey PM	18
19	20	21	22 Survey AM	23	24	25
26 Survey PM	27	28 Survey PM	29	30	31	

September 2015

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2	3	4	5
6	7 Survey PM	8	9 Survey AM	10	11	12 Survey AM
13	14	15	16	17	18 Survey AM	19
20 Survey AM	21	22 Survey PM	23	24 Survey PM	25	26
27	28	29	30			

FORM 10-157A

<PARK NAME>

PERSONS-PER-VEHICLE - SURVEY FORM

BLOCK 1	NUMBER OF PERSONS-PER-VEHICLE								
	1	2	3	4	5	6	7+		
RECREATION VEHICLES								8	
TOTAL VEHICLES	1	2	1					1	A. 5
PERSON MULTIPLIER	x 1	x 2	x 3	X 4	x 5	x 6		sum of entries	
TOTAL PEOPLE	1	4	3					8	B. 16
								AVG. PPV (^{B.} / _{A.}) =	C. 3.2

SAMPLE DATE: 3 / 4 / 2015

STARTING SURVEY TIME PERIOD 14 : 12

SURVEYOR Pam Ziesler

Put ONE Tick Mark for each Vehicle in the appropriate column above which corresponds to the number of people within the vehicle. For example, if there are 5 people in a car, one tick mark would be noted in column five. This survey should be carried out the entire survey time period. At the end of the day, please tally the subtotals at the bottom and complete the appropriate math.

If you have any questions, please call Pam Ziesler at 970-225-3564.

At 1417 a van arrives with 8 people



Put the number 8 in the column labeled '7+'

At 1432 a minivan arrives with 3 people



Put a tick mark in the column labeled '3'

At 1436 another minivan arrives with 2 people



Put a tick mark in the column labeled '2'

At 1506 a car arrives with 2 people



Put a tick mark in the column labeled '2'

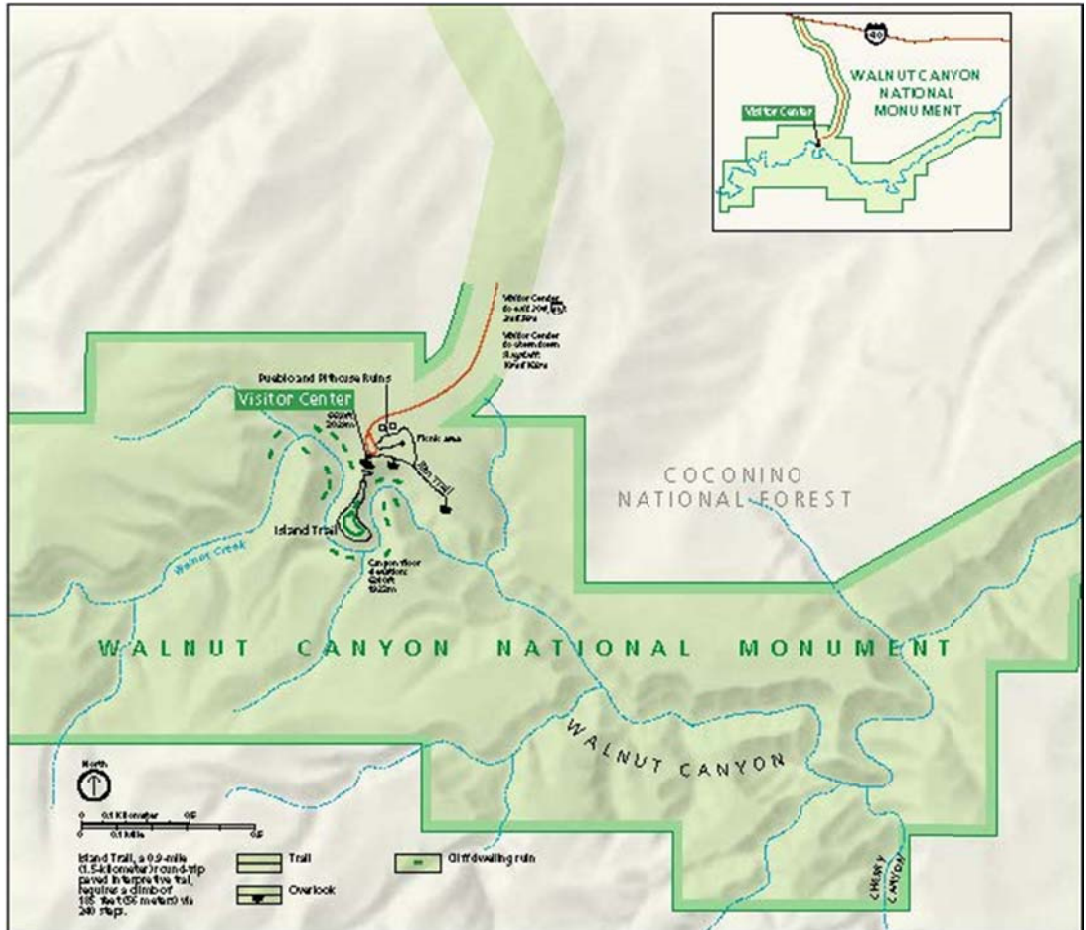
At 1510 a car arrives with 1 person



Put a tick mark in the column labeled '1'

APPENDIX C | ESTIMATING VISITATION AT WALNUT CANYON NATIONAL MONUMENT (NPS)

EXHIBIT C.1. MAP OF WALNUT CANYON NATIONAL MONUMENT



Source: <https://www.nps.gov/waca/planyourvisit/upload/WACAmap1.pdf>.

NPS unit collects:

- Raw traffic count at main entrance
 - Battery operated traffic counter; read monthly and reset.
- Manual count of buses and bus passengers
 - Buses are removed from the traffic counts and bus passengers are included in total visitation.

There are flat, or constant, estimates of non-reportable vehicles (NPS, concession, and non-recreation vehicles) that do not represent 'visitation' and are removed from the raw traffic count. These estimates are developed using local park staff knowledge about how often these vehicles cross the traffic counter each month.

- Approximately 1,150 NPS vehicles cross the traffic counter each month between May and September
- Approximately 670 NPS vehicles cross the traffic counter each month between October and April

There is a flat estimate of the number of non-recreation visits per month, which is based on local staff knowledge (e.g., researchers, tour operators, deliveries, etc. entering the park each month).

- 40 non-recreation visits per month

The persons-per-vehicle multiplier used for private passenger vehicles is based on a site-specific study.

- 2.9 persons per vehicle (PPV)

The hours-per-visit multipliers are based on a site-specific visitor use survey and local staff knowledge.

- 1.3 hours per recreation visit
- 0.5 hours per non-recreation visit

EXAMPLE CALCULATIONS (JULY 2016)

Raw traffic count at main entrance: 6,795

Buses: 10

Bus passengers: 170

Flat estimate of non-reportable/non-recreation vehicles: 1,150

Non-recreation visits per month: 40

PPV multiplier: 2.9

Hours per recreation visit: 1.3

Hours per non-recreation visit: 0.5

Adjusted traffic count (number of private passenger vehicles):

Adjusted Traffic Count = Raw Traffic Count – Non-Reportable Vehicles – Buses =
6,795-1,150-10 = 5,635

Expand adjusted traffic count to recreation visits from private passenger vehicles:

Rec Visits by Car = Adjusted Traffic Count * PPV = 5,635 * 2.9 = 16,342

Recreation Visits are sum of recreation visits from passenger vehicles and buses:

$$\text{Recreation Visits} = \text{Rec Visits by Car} + \text{Rec Visits by Bus (bus passengers)} = 16,342 + 170 = \mathbf{16,512}$$

Recreation Visitors Hours are total recreation visits times hours per visit:

$$\text{Recreation Visitor Hours} = 16512 * 1.3 = \mathbf{21,465}$$

$$\text{Non-Recreation Visits} = \mathbf{40}$$

Non-Recreation Visitors Hours are total non-recreation visits times hours per visit:

$$\text{Non-Recreation Visitor Hours} = 40 * 0.5 = \mathbf{20}$$