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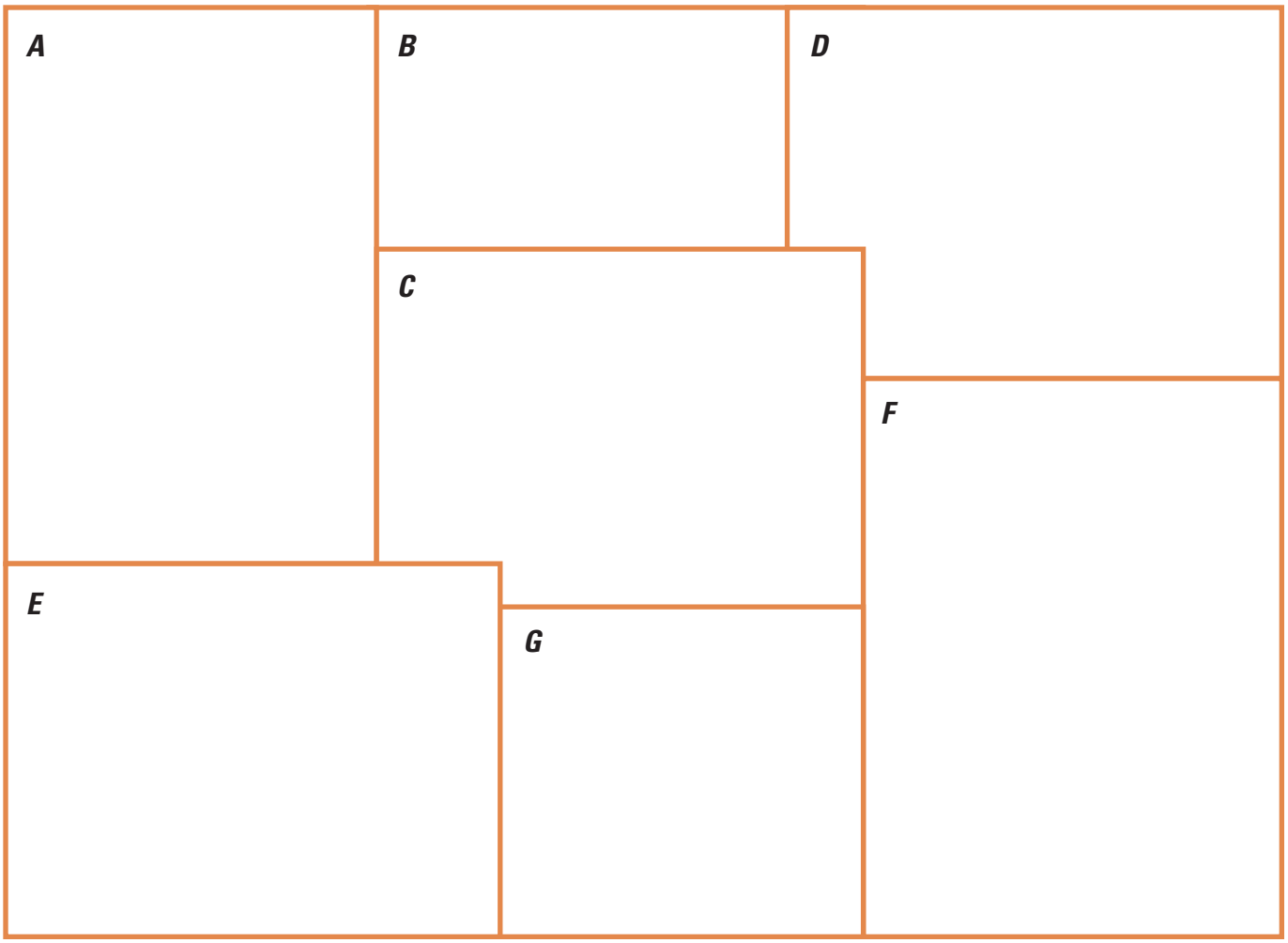
Monitoring Recreation on Federally Managed Lands and Waters—Visitation Estimation

Scientific Investigations Report 2025–5022

U.S. Department of the Interior
U.S. Geological Survey



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Monitoring Recreation on Federally Managed Lands and Waters—Visitation Estimation

By Dieta Hanson, Emily J. Wilkins, Spencer A. Wood, Christian Crowley, Whitney Boone, and Rudy Schuster

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm^2)
acre	0.004047	square kilometer (km^2)

Contributors

Dieta Hanson	Writing (original draft, review, and editing) and investigation.
Emily J. Wilkins	Conceptualization, writing (original draft, review, and editing), and investigation.
Spencer A. Wood	Conceptualization, writing (original draft, review, and editing), and investigation.
Christian Crowley	Conceptualization, writing (original draft, review, and editing), and investigation.
Whitney Boone	Conceptualization, writing (original draft, review, and editing), and investigation.
Rudy Schuster	Conceptualization, writing (review and editing), and funding acquisition.

Abbreviations

API	Application Programming Interface
BLM	Bureau of Land Management
CDR	call detail records
Corps	U.S. Army Corps of Engineers
EXPLORE	Expanding Public Lands Outdoor Recreation Experiences Act
FS	U.S. Department of Agriculture Forest Service
FWS	U.S. Fish and Wildlife Service
GPS	Global Positioning System
IRMA	Integrated Resource Management Applications (used by the National Park Service)
LBS	location-based services
NMS	national marine sanctuary
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NVUM	National Visitor Use Monitoring (used by the U.S. Department of Agriculture Forest Service)
OMB	Office of Management and Budget
ONMS	Office of National Marine Sanctuaries (within the National Oceanic Atmospheric Administration)
Reclamation	Bureau of Reclamation
RMIS	Recreation Management Information System (used by the Bureau of Land Management)
SDK	Software Development Kit
SEM	Socioeconomic Monitoring (used by the National Park Service)
VERS	Visitation Estimation and Reporting System (used by the U.S. Army Corps of Engineers)

Monitoring Recreation on Federally Managed Lands and Waters—Visitation Estimation

By Dieta Hanson,[1] Emily J. Wilkins,[2] Spencer A. Wood,[1] Christian Crowley,[3] Whitney Boone,[3] and Rudy Schuster[2]

Abstract

Federally managed public lands and waters attract millions of visitors each year, generating significant economic benefits for surrounding communities. Accurate visitation data are crucial for guiding policy decisions and managing resources effectively. This report explores the methods employed by agencies to collect and use data on recreational visitation to Federal lands and waters. Visitation estimation practices across seven agencies are reviewed, revealing similarities such as the use of automated counters for on-site data collection, alongside differences in reporting frequencies, visit definitions, and public access to data. Emerging technologies, including social media, mobile device activity, and community science, are also evaluated for their potential to improve visitation estimation. Although these technologies offer promising opportunities, they come with challenges such as data biases, the need for calibration, costs, and privacy concerns. The report concludes with opportunities to enhance data collection, coordination, and accessibility, ensuring more efficient resource management and informed decision making.

Introduction

Federal agencies—U.S. Army Corps of Engineers (Corps), Bureau of Land Management (BLM), Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (FWS), U.S. Department of Agriculture Forest Service (FS), National Oceanic and Atmospheric Administration (NOAA), and the National Park Service (NPS)—manage hundreds of millions of acres of public lands and waters that provide abundant recreation opportunities and receive about 1 billion visits each year (table 1). Visitation data support informed agency management of recreational resources to meet the needs of visitors, provide positive and safe visitor experiences, and maintain the quality of natural resources. Visitation data can inform agencies' visitor services (for example, facilities, emergency services, and interpretive programs), recreation site planning and staffing, and investments to improve recreation experiences. In addition, visitation data can assist external (nonfederal) visitor service providers (for example, outfitters and guides) in planning and providing services to visitors of public lands and waters (Leggett and others, 2017). Visitation estimates are also important inputs for measuring the economic benefits of recreation, including economic value to the recreator and economic impacts on the nearby communities from recreation spending (Horsch and others, 2017), and visitation estimates have been used in natural resource damage studies, such as those related to the Deepwater Horizon oil spill (Tourangeau and others, 2017).

In 1965, the U.S. Recreation Advisory Council stated that "the best use of the Nation's lands and waters for outdoor recreation purposes depends upon a full knowledge of the kind and amount of recreation activities taking place on them" (U.S. Recreation Advisory Council, 1965, p. 1). The policy requires that all member agencies of the Recreation Advisory Council report annual numerical totals for visitor-days on the sites and areas they administer. Since then, many agencies have been consistently estimating and reporting annual visitation numbers (with some agencies already consistently estimating visitation prior to 1965). The U.S. Recreation Advisory Council's 1965 Policy also recommends that agencies collect and report data in a comparable way and in a single uniform system (U.S. Recreation Advisory Council, 1965). Although the value of comparable data in a single uniform system is recognized (for example, Morse and others, 2022), the data collection methods and quality of visitation data vary from agency to agency, reflecting the diversity in Federal lands and waters available to visitors.

Data quality is an important consideration for agencies using visitation estimates to inform management decisions, legislators using visitation estimates to inform appropriations, and other people using visitation data. Poor-quality data may lead to ineffective or inefficient resource use that degrades visitor experiences, safety, or the quality of natural resources. The Information Quality Act of 2000 (Public Law 106-554, Sec. 515) and the Foundations for Evidence-Based

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Table 1. Acreage managed and annual recreational visitation estimated by Federal land and water managing agencies.

[Data for the acreage of public lands and waters managed come from the following sources: Comay and others (2023) for the Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (FWS), U.S. Department of Agriculture Forest Service (FS), and National Park Service (NPS); Leggett and others (2017) for the U.S. Army Corps of Engineers (Corps); Bureau of Reclamation (Reclamation; 2024) for Reclamation; and National Oceanic and Atmospheric Administration (NOAA; undated) for the NOAA Office of National Marine Sanctuaries (ONMS). Data for the recreation visits come from the following sources: Corps (2023a) for the Corps; BLM (2024) for the BLM; U.S. Department of the Interior and U.S. Department of Agriculture (2024) for Reclamation, the FWS, and the FS; and NPS (2024a) for the NPS]

Agency or office	Public lands and waters managed (in millions of acres)	Recreation visits (in millions)[1] and the year of visits (in parentheses)
U.S. Army Corps of Engineers	12	269.3 (2023)
Bureau of Land Management	244	82.3 (2023)
Bureau of Reclamation	[2]6.1	46.6 (2022)
U.S. Fish and Wildlife Service	89	68.5 (2023)
U.S. Department of Agriculture Forest Service	193	158.7 (2022)
National Oceanic and Atmospheric Administration Office of National Marine Sanctuaries	403	Unknown
National Park Service	80	325.5 (2023)

[1]Definitions of "visit" are not comparable across agencies (refer to the "Existing Visitation Estimation Methods" section for additional information).

[2]This number does not include easements; with easements, Reclamation manages 7.8 million acres (Reclamation, 2024).

Policymaking Act of 2018 (Public Law 115-435) generally underscore the value of high-quality data, especially for information that could affect important public policies or private sector decisions. The Federal Committee on Statistical Methodology's Framework for Data Quality (Federal Committee on Statistical Methodology, 2020) includes descriptions of the dimensions of data quality, which include relevance, accessibility, timeliness, punctuality, granularity, accuracy and reliability, coherence, scientific integrity, credibility, computer and physical security, and confidentiality. Agency scientific integrity policies (for example, NOAA, 2024; U.S. Department of Agriculture, 2024; and U.S. Department of the Interior, 2024) define expectations for the collection of scientific or technological data, prevent the suppression or distortion of data, and ensure the quality, accuracy, and transparency of scientific information used to support policy and decision making.

"Visitor use" is a general term that refers to human presence in an area for recreational purposes, including education, interpretation, inspiration, and physical and mental health (Interagency Visitor Use Management Council, 2016). Visitor use data can include many metrics, such as visitation, activity participation, visitor experiences and behavior, visitor satisfaction, visitor demographics, and visitor spending. This report focuses on visitation and the related metric of activity participation; a companion report focusing on other aspects of visitor data, such as visitor experiences and behavior, satisfaction, demographics, and spending, is planned. Visitation data refer to the total number of visits or visitors at a particular place over a specified time. Different Federal agencies use slightly different definitions of a "visit," as described in the "Comparison of Definitions and Methods Used Across Agencies" section of this report. Throughout this report, we often refer to visitation data as "visitation estimates" and the process as "visitation estimation" because counting the total number of visits to public lands and waters is an inherently challenging task, and almost all visitation data are estimates with some degree of uncertainty. It may be straightforward to count visitors to places like museums where every visitor pays an entrance fee, but many public lands and waters are free to visit and have numerous entrance and exit points, creating a challenging landscape for visitation estimation. The sheer scale of public lands and waters poses additional challenges, with more than 1 billion acres (table 1) for which to estimate recreation visits.

This report describes the methods used by Federal land and water management agencies to estimate recreational visitation, reviews alternative and emerging approaches that may help estimate visitation, and identifies opportunities for improving interagency visitation estimation approaches. This report is an update to, and an expansion on, information in a 2017 report describing visitor estimation on federally managed lands (Leggett and others, 2017). Federal agency staff and academic researchers have used the 2017 report in their work (for example, Wilkins, Howe, and Smith, 2021; Liang and others, 2022; Sinclair and others, 2022; Dagan and Wilkins, 2023), and we hope this update will bring continued attention to opportunities to improve visitation estimation approaches so that agencies can make more informed recreational resource management decisions to meet the needs of visitors, provide positive and safe experiences, and maintain the quality of natural resources. In the "Existing Visitation Estimation Methods" section of this report, we review the existing methods that Federal land and water managing agencies use to estimate visitation on Federal lands and waters. The methods for estimating visitation often involve onsite data

collection and rely on automated counters, visitor surveys, and administrative data such as permits and visitor logs. In the "Novel Methods" section of this report, we review newer and largely unused methods and data sources for estimating visitation, including geolocated social media, mobile device activity data, remote sensing, and community science. The "Implementing a Visitation Estimation Method" section of this report provides considerations for selecting an estimation method, and the "Case Studies" section of this report presents case studies to illustrate how some of those methods have been implemented by Federal agencies. In the "Opportunities" section of this report, we discuss potential improvements to the ways in which recreational visitation is monitored and provide areas for further study aimed at filling in gaps in the research on visitation monitoring. Finally, the "Legislative Activity" section of this report discusses legislation related to Federal visitation monitoring programs.

Existing Visitation Estimation Methods

This section details the methods used by Corps, BLM, Reclamation, FWS, FS, NOAA's Office of National Marine Sanctuaries (ONMS), and NPS to estimate recreational visitation to Federal lands and waters and to store visitation data. We begin with a broad overview and comparison of the definitions and methods used to estimate recreational visitation, then provide more in-depth summaries by agency, and end with case studies of visitation estimation. All information in this section was developed by reviewing the Leggett and others (2017) report on visitation estimation, consulting with agency staff for changes or additions, and reviewing publicly available documents related to visitation estimation. All references to Leggett and others (2017) were confirmed to be accurate as of October 2024.

Comparison of Definitions and Methods Used Across Agencies

All seven Federal land and water managing agencies estimate recreation visits to their lands and waters. The definition of a recreation visit differs across agencies. The U.S. Recreation Advisory Council's 1965 Policy defines several terms that are still in use (as of 2024), to varying degrees, by agencies for use in visitation estimation (U.S. Recreation Advisory Council, 1965, p. 2):

- Recreation visit—"A visit by a person for the purpose of engaging in any activities except those which are part of or incidental to the pursuit of gainful occupation."
- Visitor-hour—"The presence of one or more persons on lands or waters, generally recognized as providing outdoor recreation, for continuous, intermittent, or simultaneous periods of time aggregating 60 minutes."
- (Recreation) Visitor-day—"[12] visitor-hours, which may be aggregated continuously, intermittently, or simultaneously by one or more persons," which have been spent "in any activities except those which are part of or incidental to the pursuit of a gainful occupation." (Recreation visitor-day and visitor-day definitions were combined for simplicity.)

Although the 1965 definitions for visitor-hour and visitor-day are specific enough to operationalize, the definition of a recreation visit leaves room for interpretation and does not specify whether to count people once per day or once per trip, for example. Consequently, agencies use slightly different definitions for what constitutes a "recreation visit" for estimation purposes (table 2). Importantly, some agencies count a visit as each day of a multiday trip (for example, 3 consecutive days visiting the same location would count as 3 visits), whereas others count one whole trip as 1 visit (for example, 3 consecutive days visiting the same location would count as 1 visit). In addition to recreation visits, some agencies track visitor-hours, visitor-days, or overnight stays.

Federal agencies also have differing approaches to how visitation data are collected, stored, and disseminated. Table 3 shows a comparison of existing methods to estimate recreational visitation across the agencies. Although the specific techniques vary, and agencies may use different terminology to refer to their methods, there are five general visitation estimation approaches in use by Federal land and water management agencies:

1. Direct observation, in which visitation is estimated using counts of visual observations;
2. Traffic or trail counters, in which visitation is estimated using vehicle counters, door counters, or trail counters;
3. Administrative data, in which visitation is estimated using sources such as entrance fees, permits, guest book entries or trail registers, and transaction or revenue data;
4. Interviews or surveys, in which visitation is estimated using mail surveys, telephone surveys, traffic-stop surveys, and interviews with visitors; and
5. Indirect estimation, in which visitation is estimated using sources such as professional judgment, historical information, and similar site data.

All seven agencies use a combination of these five approaches to create official estimates of recreational visitation at a unit level (table 3). There is variation in whether and how agencies attempt to eliminate double counting of visits (for example, if one person visits multiple locations within the same unit on the same day) and how they estimate conversion factors. Conversion factors are used with traffic and trail counters for various reasons, such as using a persons-per-vehicle multiplier to convert the number of vehicles to visits or calibrate the counters. Finally, some agencies have begun using emerging methods and data sources

Table 2. Definitions Federal land and water managing agencies use to define a recreation visit and other metrics agencies track related to recreational visitation as of 2024.

[Corps, U.S. Army Corps of Engineers; BLM, Bureau of Land Management; FS, U.S. Department of Agriculture Forest Service; ONMS, Office of National Marine Sanctuaries; NOAA, National Oceanic and Atmospheric Administration; NPS, National Park Service]

Agency	Definition of a recreation visit	How this agency would count one person camping for three days, who is also fishing	Other tracked metrics related to recreational visitation[1]
U.S. Army Corps of Engineers	"The entry of one person into a recreation area or site to carryon one or more recreational activities" (Corps, 2025).[2]	3 visits (one per day for camping)	• Number of overnight stays • Visitor-hours
Bureau of Land Management	A visit is "the entry of a person onto lands or waters, administered by the BLM for the pursuit of recreational experiences regardless of duration. A visit begins when an individual enters public lands and ends when they leave for the last time. A single visit may last one hour or one week. A same day reentry, negligible transit, or entry to another recreation site, or detached portion of the same management area on the same day is considered the same visit and [is] counted as a single visit" (Greg Wolfgang, BLM, written commun., 2024).	1 visit (the entire trip is counted once)	• Number of visitor-days (one day defined as 12 hours) • Number of visitor-days by activity
Bureau of Reclamation	A visit occurs "when a person enters Reclamation lands to engage in recreation on a given day" (Leggett and others, 2017, p. A-2). However, the definition could vary at partner-managed sites, where different partners may use slightly different definitions.	3 visits (one per day), although this definition could vary by unit	• May vary and is dependent on the managing partner
U.S. Fish and Wildlife Service	"A 'visit' occurs when a visitor engages in a particular recreational activity ([for example], hunting). A visitor engaging in multiple activities is counted as multiple visits" (Leggett and others, 2017, p. A-2).	2 visits (one per activity)	• Number of visitor-days • Number of visits by activity
U.S. Department of Agriculture Forest Service	"One person participating in one or more recreation activities on a national forest or grassland for an unspecified period of time" (FS, 2023, p. 9). Visits by employees and contractors are excluded from this definition, as are visits to simply use a restroom or obtain information. During a single recreation visit, an individual may visit multiple "sites" within the national forest or national grassland (for example, trailheads or campgrounds).	3 visits (one per day) if the camper is staying outside the park and enters each day; 1 visit if the camper is staying within the park and does not exit and re-enter	• Average length of stay • Hours engaged in the main activity • Visits per year (to the national forest or grassland)

Table 2. Definitions Federal land and water managing agencies use to define a recreation visit and other metrics agencies track related to recreational visitation as of 2024.—Continued

[Corps, U.S. Army Corps of Engineers; BLM, Bureau of Land Management; FS, U.S. Department of Agriculture Forest Service; ONMS, Office of National Marine Sanctuaries; NOAA, National Oceanic and Atmospheric Administration; NPS, National Park Service]

Agency	Definition of a recreation visit	How this agency would count one person camping for three days, who is also fishing	Other tracked metrics related to recreational visitation[1]
National Oceanic and Atmospheric Administration	The Office of National Marine Sanctuaries (ONMS) does not use the term recreation visit. Instead, NOAA ONMS uses two different terms: (1) A person-trip is equal to one person who makes a trip, and (2) A person-day is defined as one person doing any recreational activity for a whole day or any part of a day, so people could do several person-days of activities in a single day (Danielle Schwarzmann, NOAA, written commun., 2024).	3 person-days (ONMS does not use the term "visit")	• Visitor-days • Number of visits by activity (varies by location)
National Park Service	"The entry of a person onto lands or waters administered by the NPS except…for non-reportable and non-recreation visits. Funeral parties at National Cemeteries, school groups, [and so on] are reportable as 'recreation' use since their use is for the purpose for which the park was established. Visits originating on surface vehicles (trains, boats, other) and aircraft may be counted if they stop and disembark passengers on NPS administrated territory. The applicable rule is that one entrance per individual per day is countable" (NPS, 2024b).	3 visits (one per day) if the camper is staying outside the park and enters each day; 1 visit if the camper is staying within the park and does not exit and re-enter	• Hours of recreation use • Number of overnight stays

[1]This only includes metrics related to visitation estimation and is not an exhaustive list of all recreation-related data, such as activity participation, visitor demographics, or spending. Activity participation is mentioned only if agencies are tracking the number of hours or days related to specific activities. Additionally, these lists do not include the tracking of recreation permits.

[2]To better align with other agencies and to provide a consistent reporting approach, camping is reported as 1 visit per person per night (rather than counting multiple consecutive nights as 1 visit).

Table 3. Comparison of existing methods Federal agencies use to officially report total estimated recreational visitation.

[Corps, U.S. Army Corps of Engineers; BLM, Bureau of Land Management; Reclamation, Bureau of Reclamation; FWS, U.S. Fish and Wildlife Service; FS, U.S. Department of Agriculture Forest Service; NOAA ONMS, National Oceanic and Atmospheric Administration Office of National Marine Sanctuaries; NPS, National Park Service]

Method of estimating recreational visitation	Corps	BLM	Reclamation	FWS	FS	NOAA ONMS	NPS
Use of direct observation	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Use of traffic or trail counters	Yes	Yes	Yes	Yes	No[1]	No[2]	Yes
Use of administrative data	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Use of surveys or interviews	Yes	No	No	Yes	Yes	Yes	Yes
Use of indirect estimation	Yes	Yes	Yes	Yes	No[3]	No	Yes
Elimination of double counting of visits	Yes	Determined by each site	Determined by each site	Determined by each site	Yes	Yes	Yes—updates underway
How are conversion factors for counters developed?	Visitor surveys	Determined by each site	Determined by each site	Determined by each site[4]	Visitor surveys	Not used often[5]	Visitor surveys; observational studies
Use of emerging methods and data (for example, mobile device locations) in visitation estimates	No	No	No	No, but used in research	No, but used in research	In select locations	In select locations

[1]The FS no longer uses temporary traffic or trail counters as part of the National Visitor Use Monitoring Program but does collect proxy data through some permanent counters (English and others, 2020).

[2]The NOAA ONMS uses bridge cameras and buoy cameras rather than traffic and trail counters, although NOAA ONMS may use traffic and trail counter data from adjacent parks or public use areas to inform use.

[3]The FS generally does not use indirect estimation but occasionally may use this method to fill in missing values.

[4]Research is underway to better understand conversion factors at a subset of wildlife refuges; results have been built into visitation estimation training tools and resources.

[5]The NOAA ONMS does not regularly use conversion factors for counters (because they do not use traffic and trail counters) but has used visitor surveys at some locations to convert the number of boats to number of people.

(for example, mobile device data) in visitation estimates, but others are not yet using emerging data sources or are using these data in a research capacity but not official estimates.

The agencies estimate visitation at different spatial and temporal scales and take different approaches to data reporting (table 4). The spatial scale represents the measurement unit at which estimates are made and reported. For example, the NPS reports visitation at the park-unit level (for example, one estimate for an entire park), and the BLM reports visitation at individual sites within each field office (for example, individual campgrounds, trailheads, access points). The time scale of reporting by the different agencies also varies. Most agencies report data on an annual scale, although the NPS reports monthly visitation, and the FS reports visitation for a given forest or grassland every fifth year. The Corps, FS, and NPS all centrally coordinate visitation estimation; for the Corps and NPS, this means headquarters or national-level staff work with field staff and contractors to review and approve the visitation estimation methods at each unit, but FS visitation estimates are completed by national-level staff for all units. These three agencies also share visitation estimates on a publicly accessible website for each unit for which estimates are made. Although the BLM does not make estimates publicly available for individual sites, they do publish data on nationwide annual visits and visits by State in their annual Public Lands Statistics reports (such as BLM, 2024).

Related to recreational visitation estimates, Federal agencies monitor participation in a variety of recreational activities. This is often accomplished through visitor surveys, for example, the NPS Socioeconomic Monitoring (SEM) survey, the FS National Visitor Use Monitoring (NVUM) survey, and the FWS National Visitor Survey (FS, 2023; Otak, Inc. and others, 2023), but can also be estimated through visual observation or staff knowledge of an area. Table 5 shows a list of recreational activities that are monitored across multiple Federal agencies.

Table 4. Comparison of scales and approaches Federal agencies use to record and report recreational visitation.

[Corps, U.S. Army Corps of Engineers; BLM, Bureau of Land Management; Reclamation, Bureau of Reclamation; FWS, U.S. Fish and Wildlife Service; FS, U.S. Department of Agriculture Forest Service; NOAA ONMS, National Oceanic and Atmospheric Administration Office of National Marine Sanctuaries; NPS, National Park Service; N/A, not applicable]

Scales and approaches	Corps	BLM	Reclamation	FWS	FS	NOAA ONMS	NPS
Spatial scale of estimates for official reporting (the unit at which estimates are made)	Project site areas	Individual sites	Management Areas	Refuges	Forests or grasslands	Varies	Park units
Approximate number of units (or sites) that report visitation	4,750	Over 3,400 plus over 1,400 dispersed sites	289	571	120	N/A, spatial scales vary	404
Frequency of estimates for official reporting	Monthly or annual[1]	Annual	Annual	Annual	Every 5th year	N/A, no official reporting	Monthly
National office coordinates or provides a review of data collection methods and reporting documentation	Yes	No	No	No	Yes	N/A, no official reporting	Yes
Visitation estimates posted online for each unit or site (publicly available)	Yes	No	No	No	Yes	Individual site reports as available	Yes
Estimation methods posted online (publicly available)	No	No	No	No	Yes	Individual site reports as available	Yes

[1]Some locations have monthly estimates, whereas other locations (for example, dispersed use areas) only have annual estimates.

Table 5. Activities that are monitored across multiple Federal agencies.

[Only categories monitored by at least two Federal agencies are listed in this table. How these activities are monitored varies by agency. Data for activity monitoring comes from the following sources: Dena Williams (U.S. Army Corps of Engineers [Corps], written commun., 2024) for the Corps; Greg Wolfgang (Bureau of Land Management [BLM], written commun., 2024) for the BLM; Ronnie Baca (Bureau of Reclamation [Reclamation], oral commun., 2024) for Reclamation; U.S. Fish and Wildlife Service (FWS; 2021) and Andrew Don Carlos (FWS, written commun., 2024) for the FWS; U.S. Department of Agriculture Forest Service (FS; 2023) for FS; Danielle Schwarzmann (National Oceanic and Atmospheric Administration [NOAA], written commun., 2024) for the NOAA Office of National Marine Sanctuaries (ONMS); Otak, Inc. and others (2023) for the National Park Service (NPS). No, activity is not monitored by this agency; Yes, activity is monitored by this agency]

Activity type	Corps	BLM[1]	Reclamation	FWS	FS	NOAA ONMS[2]	NPS
Backpacking	No	Yes	No	No	Yes	Yes	No
Biking (general)	Yes	No	Yes	Yes	Yes	Yes	No
Biking (mountain)	No	Yes	No	No	No	No	Yes
Biking (road)	No	Yes	No	No	No	No	Yes
Boating (motorized)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Boating (nonmotorized)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Camping (general)	No	Yes	Yes	No	No	No	No
Camping (developed)	Yes	No	No	No	Yes	Yes	No
Camping (primitive)	No	No	No	No	Yes	Yes	No
Climbing	No	Yes	No	No	No	No	Yes
Creative arts (photography, drawing, painting, and others)	No	Yes	Yes	Yes	No	Yes	Yes
Driving for pleasure	No	Yes	No	Yes	Yes	Yes	Yes
Environmental education	No	Yes	Yes	Yes	No	Yes	No
Field sports (for example, frisbee or throwing a ball)	Yes	No	Yes	No	No	Yes	No
Fishing	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hiking or walking	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Horseback riding	No	Yes	Yes	No	Yes	Yes	Yes
Hunting[3]	No	Yes	Yes	Yes	Yes	No	No
Motorized trail activity	No	Yes	Yes	No	Yes	No	No
Nature study	No	Yes	No	No	Yes	No	No
Off-highway vehicle (OHV) use	No	Yes	Yes	No	Yes	No	No
Picnicking	Yes	Yes	No	Yes	Yes	Yes	Yes
Relaxing	No	No	No	No	Yes	Yes	No
Resort or spa use	No	No	No	No	Yes	Yes	No
Running or jogging[4]	No	Yes	No	Yes	No	Yes	Yes
Skiing (cross-country)	Yes	Yes	No	No	Yes	No	No
Skiing (downhill)	No	Yes	No	No	Yes	No	No
Snowmobiling	No	Yes	No	No	Yes	No	No
Special events	Yes	Yes	Yes	Yes	No	Yes	Yes
Viewing night skies or astronomy[5]	No	Yes	No	No	No	No	Yes
Viewing scenery or natural features (sightseeing)	Yes	Yes	No	No	Yes	Yes	Yes
Viewing wildlife	No	Yes	Yes	Yes	Yes	Yes	Yes
Visiting cultural or historic sites	No	Yes	Yes	No	Yes	Yes	Yes
Water play or sports (for example, swimming, snorkeling)	Yes	Yes	Yes	No	No	Yes	Yes

[1]The BLM monitors many activities that other agencies do not, including but not limited to the following: archery, boat launching, caving, dog mushing, dog trials, geocaching, hang gliding or parasailing, heli-skiing, high-speed time trials, hot springs or soaking, ice climbing, ice skating, interpretive programs, land or sand sailing, model airplane or rocket, orienteering, pack trips, racing, re-enactment events or tours, recreation inquiry, rockhounding or mineral collection, skating (roller or inline), skijoring, snow play (general), snowboarding, snowshoeing, spectator sports, staging or comfort stop, target shooting, therapeutic programs, trapping, motorcycle trials, vending or services, and windsurfing. The BLM also has subcategories for many of the categories listed in this table (for example, different types of OHV use).

[2]The NOAA ONMS includes many other categories on their visitor survey and many subcategories for water activities. For example, subcategories under the "water activities" category include swimming at beaches, swimming in outdoor pools, swimming with dolphins, surfing, and windsurfing. The NOAA ONMS also has many subcategories under visiting cultural or historic sites, for example, visiting culturally significant landscapes, visiting burial sites, visiting ancestors, visiting archeological sites, and attending heritage events.

[3]The BLM splits hunting into six groups: big game, other, predator, small game, upland bird, and waterfowl. The FWS splits hunting into four groups: waterfowl hunting, other migratory bird hunting, upland game hunting, and big game hunting.

[4]Some agencies (BLM, Reclamation) combine running with hiking or walking, whereas other agencies (NPS, FWS) separate them.

[5]The NOAA ONMS does not have "viewing night skies or astronomy" as an activity option on visitor surveys as of 2024 but is planning to add this option in the future.

Agency Summaries

The subsections in the "Agency Summaries" section detail the methods used by Corps, BLM, Reclamation, FWS, FS, NOAA ONMS, and NPS to estimate recreational visitation to Federal lands and waters and to store visitation data.

U.S. Army Corps of Engineers

The Corps defines a recreation visit as "The entry of one person into a recreation area or site to carryon [sic] one or more recreational activities" (Corps, 2025). In addition to recreation visits, Corps estimates overnight-use data, which are the number of nights that sites are occupied, the number of occupants per site, and visitor-hours. To better align with other Federal agencies and provide a consistent reporting approach, camping is reported as 1 visit per person per night (rather than counting multiple consecutive nights as 1 visit). Corps adopts the definition of a visitor-hour from the 1965 Federal Executive Policy Governing the Reporting of Recreation Use of Federal Recreation Areas: "the presence of one or more persons on lands or waters, generally recognized as providing outdoor recreation, for continuous, intermittent, or simultaneous periods of time aggregating 60 minutes" (U.S. Recreation Advisory Council, 1965, p. 2).

The Corps visitation estimates are measured by recreation area or project site area levels. Estimates are produced for each of the 4,750 project site areas. Visitation is calculated on a monthly basis at some sites and on an annual basis at other sites, following the fiscal year calendar. Visitation estimation is centrally controlled through procedures, policies, and guidance that are implemented by individual locations. Visitation is primarily estimated through five data sources and methods (Leggett and others, 2017):

- Automated counters—These include traffic and trail counters, which are combined with onsite surveys to estimate visitation. A guidance manual contains the best practices for selecting and deploying traffic counters (Corps, 2015).
- Transaction data—Examples include camping and shelter transaction data from https://www.recreation.gov/, which are used to estimate overnight visitation.
- Revenue data—Overnight use data are from the Corps Financial Management System and are used to estimate overnight visitation.
- Ratio estimates—These are based on the number of parking spaces or campsites, combined with an assumed occupancy rate. This method is primarily used at places with no automated counters and no fees.
- Third-party estimates—These are independent estimates from leased areas managed by other agencies or private entities.

Visitation is occasionally estimated using tally counts through visual observation, for example during special events or for school groups on buses. Visitation is estimated in dispersed-use areas by using additional methods, such as shoreline management permit data and household census data. It is extremely difficult to estimate visitation in dispersed-use areas. For example, adjacent homeowners may use lakes daily without ever crossing a site boundary or automated counter.

The Corps calibrates automated counters to ensure accuracy and develops conversion factors for automated counters. Calibration and conversion factors are developed using onsite surveys that take into consideration the types of traffic counters, vehicles, and lanes that are monitored. Persons-per-vehicle multipliers are updated based on visitor surveys that collect information about the number of people per vehicle and the percentage of vehicles associated with recreation. The agency also tries to avoid double counting visits by using onsite visitor surveys with questions about the percentage of vehicles departing for the last time and the length of stay.

Visitation data are stored in the internal Visitation Estimation and Reporting System (VERS). Annual visitation estimates from 2016 to the prior fiscal year (from the current fiscal year) are publicly available from a Corps website called "Value to the Nation" (https://www.iwr.usace.army.mil/Missions/Value-to-the-Nation/Recreation/), which can produce reports with visitation estimates at various levels (national, lake or river, State, Corps division, Corps district, and watershed levels; Corps, 2023b). This website also allows users to download a spreadsheet that contains more detailed visitation estimates and estimates by activity type. Annual visitation by Corps division is also available online from 2014

to the prior fiscal year (Corps, 2023a). The methods used to estimate visitation at each site are documented internally but are not publicly available.

For many years, Corps and other agencies have used estimates of recreational visitation for planning, management, and reporting purposes. Visitation is one of many data metrics used to ensure Federal appropriation investments are prioritized appropriately based on efficiency and performance. However, visitation is not the only consideration for establishing recreation budgets.

Bureau of Land Management

The BLM defines a recreational visit as:

> "[T]he entry of a person onto lands or waters, administered by the BLM for the pursuit of recreational experiences regardless of duration. A visit begins when an individual enters public lands and ends when they leave for the last time. A single visit may last 1 hour or 1 week. A same day reentry, negligible transit, or entry to another recreation site, or detached portion of the same management area on the same day is considered the same visit and are counted as a single visit" (Greg Wolfgang, BLM, written commun., 2024).

The BLM also estimates the number of visitor-days and the number of visitor-days by activity, where 1 visitor-day standardizes recreation visits of different lengths into 12-hour visitor-days (Leggett and others, 2017), which is consistent with the definition of a visitor-day from the Federal Executive Policy Governing the Reporting of Recreation Use of Federal Recreation Areas (U.S. Recreation Advisory Council, 1965). For example, 1 visitor-day could be one person visiting for 12 hours or 12 people visiting for 1 hour each. The BLM also tracks the number of recreation permits issued (Leggett and others, 2017).

The BLM collects these visitation data at all open and active BLM sites as well as dispersed areas. There are more than 3,500 developed sites and more than 1,000 dispersed areas where visitation is estimated. The BLM has more than 150 field offices and offices at other designation types, such as national monuments and national conservation areas, and each one is responsible for developing its own site-specific methods to estimate visitation. Although this approach grants individual field offices and units flexibility to develop methods that work best for their unique context, the accuracy of the methods used to estimate visitation varies substantially across sites and field offices (Leggett and others, 2017).

Because each field office is responsible for developing their own methods for estimating visitation, there are a variety of methods used across the BLM. The three most common methods for estimating visitation are as follows (Leggett and others, 2017):

- Automated traffic and trail counters—These counts are converted into visitation estimates using information from onsite observations and professional judgment.
- Counts based on fee data—Visitation can be estimated using fee data at sites that charge fees. Fee data include permits, registrations, and fee envelopes. In some cases, onsite observations are used to estimate the percentage of visitors who comply with fee envelopes or registration forms.
- Other counts based on observation and professional judgment—Some sites, particularly dispersed-use areas, are challenging to estimate visitation and not amenable to automated counters. In these cases, visitation is estimated through visual observation (for example, BLM staff in the field might keep a log of the number of observed visitors on certain days) or professional judgment of staff.

Because each office is responsible for developing site-specific methods to estimate visitation, the methods used to develop and implement conversion factors (for example, to convert the number of vehicles to the number of recreation visits) vary by office. Additionally, the methods used to reduce or eliminate double counting of visits vary by office and there is no single protocol used across the agency.

Visitation is reported annually at the end of each fiscal year, although some sites have data on smaller time scales, such as monthly. Processed data (including any adjustments and conversions) are stored in a database called the Recreation Management Information System (RMIS). These data are only available to certain BLM staff who have access to RMIS and are not publicly available. However, aggregated visitation data are reported at the national and State levels in the BLM's Public Land Statistics reports (such as BLM, 2024). In spring 2024, BLM field staff who were involved in visitation estimation completed an internal spreadsheet to indicate methods used to collect data and estimate visitation at each site. This is the first step in the process of internally documenting the methods used to estimate visitation at each site.

The agency uses visitation data for the annual Public Land Statistics reports. In addition, the data are used to conduct impact analyses for the National Environmental Policy Act, support budget requests and grant applications, and help prioritize monitoring and allocation of resources.

Bureau of Reclamation

Reclamation considers a visit to occur "when a person enters Reclamation lands to engage in recreation on a given day" (Leggett and others, 2017, p. A-2). However, Reclamation often shares jurisdiction with other Federal agencies or nonfederal partners (for example, State, county, and city governments). In cases of shared jurisdiction, Reclamation usually cedes recreation management, including

the definition and estimation of visitation, to the partner agency. Therefore, the definition of a visit could vary at partner-managed sites where different partners may use slightly different definitions (Ronnie Baca, Reclamation, oral commun., 2024).

Reclamation estimates visitation at each management area (for example, reservoir). Visitation estimates are reported annually by either Reclamation or partner agencies with shared jurisdiction. Given the site-level variation across partner-managed sites, staff at each management area are responsible for developing their own site-specific methods for estimating visitation. Although methods vary by management area, there are three main methods to estimate visitation (Leggett and others, 2017):

- Automated or manual traffic counters—These counts are typically combined with an assumed number of people per vehicle to estimate visitation.
- On-site camp hosts—In places with campgrounds and onsite hosts, the host often records occupancy and helps to estimate visitation.
- Fee collection—This is a common method used at management areas that have entrance fees or fees for specific activities, such as camping.

Because each management area develops site-specific methods to estimate visitation, the methods used to develop and implement conversion factors (for example, to convert the number of vehicles to the number of recreation visits) vary by management area. Additionally, Reclamation does not have a standard method to avoid double counting visitors who enter multiple times in 1 day; this is also up to each management area. Some management areas have methods to avoid double counting, but other management areas do not. There is no agency-wide documentation for how visitation is estimated at different areas; some management areas may have documented methods, but other management areas may not.

Visitation numbers for each area are reported annually in an ArcGIS program. The data are stored in a database on an ArcGIS server, and reports are accessed through an ArcGIS dashboard. This visitation dashboard is only available internally and is not publicly accessible. Combined annual visitation estimates for all Reclamation sites can be found in the Federal Lands Recreation Enhancement Act Report to Congress (U.S. Department of the Interior and U.S. Department of Agriculture, 2024). The agency considers visitation data for a broad range of decision-making and planning purposes and for reporting. For example, visitation data can help inform Reclamation on how to allocate resources at a regional level.

U.S. Fish and Wildlife Service

The FWS defines a recreation visit as "when a visitor engages in a particular recreational activity ([for example], hunting). A visitor engaging in multiple activities is counted as multiple visits" (Leggett and others, 2017, p. A-2). Although this definition is still in use, FWS continues to have discussions around the definition as it pertains to reducing the propensity to double count. For example, counting an individual only once on the same day for inclusion in annual visitation estimates while also maintaining the ability to estimate the number of different activity-type visits for the same individual. This metric also does not consider the length of stay; for example, a person on a 3-day camping trip or a 1-day camping trip would both be counted as 1 visit. In addition to total visits, FWS tracks the total number of visitor-days and the number of visits by activity. The definition of a visitor does include a time component; a person on a 3-day camping trip in a refuge would count as 3 visitor-days. The FWS primarily uses this visitor-days metric to estimate visitation.

The FWS estimates visitation at the unit level; this is most often at the national wildlife refuge level but also includes marine national monuments and wetland management districts. Visitation estimates are reported annually. Similar to the BLM, each unit is responsible for developing unit-specific protocols for visitation estimation. In the past few years, the staff at the headquarters for the refuge system have developed a collaborative program of visitation estimation research with university partners. The goal of this project is to understand how to improve visitation estimation accuracy through the adoption of more efficient methods and the development of greater staffing capacity and training across the system.

Because each national wildlife refuge, marine national monument, and wetland management district is responsible for developing site-specific protocols, the mix of methods used at each unit varies. Common techniques include (Leggett and others, 2017):

- Direct observation—This includes visual observation from staff as well as video cameras in some locations.
- Traffic and trail counters—These include automated vehicle counters that are often placed on entrance roads or near visitor centers or infrared counters that count the number of people that pass by on a trail or walkway.
- Patrols—Certain public use areas are regularly patrolled, and the number of recreational visits is counted each time a patrol takes place.
- Self-registration—This includes guest books or trail registers in places where fees are not collected.
- Entrance fee stations and permits—About 35 refuges charge entrance fees and slightly more than 100 refuges require fees or permits for certain activities such as camping or hunting.
- Visitor surveys—This can include mail, telephone, and traffic-stop surveys.

- Indirect estimation based on professional judgment—This may involve combining limited site observations with staff assumptions about visitor patterns and behavior.

Because each unit develops site-specific methods to estimate visitation, the methods used to develop and implement conversion factors (for example, to convert the number of vehicles to the number of recreation visits) vary by unit. Additionally, the methods used to reduce or eliminate double counting of visits vary by unit, and there is no set protocol used across the agency. Recently, FWS has partnered with researchers from the University of Washington and Clemson University to improve, standardize, and simplify visitation estimation across the system. This effort includes identifying conversion factors used for counters across a subset of units. This will help inform visitation estimation training tools and resources, with an overall goal of working toward standardization across the agency. The project has five interrelated components: (1) interviews with FWS staff involved in visitor estimation; (2) a systematic literature review and synthesized decision tool; (3) engagement and capacity building with refuges; (4) developing a statistical modeling approach for reliably estimating visitation at refuges, including using geolocated social media and mobile data in the models; and (5) an interactive framework for a new visitation estimation toolkit (Dagan and others, 2024).

Visitation data reported by FWS staff are stored in an internal database called "Refuge Results" that is not available to the public. However, visitation numbers for individual units can be found in reports produced by the National Wildlife Refuge Visitor Survey. Each report contains visitation estimates for the same year that visitor surveys took place at each refuge (Dietsch and FWS Human Dimensions Branch, 2024). The agency uses visitation data for a broad range of decision-making and planning purposes. Some of these purposes include staffing and resource allocation, infrastructure development, and community outreach and engagement.

U.S. Department of Agriculture Forest Service

The FS defines a recreation visit as "one person participating in one or more recreation activities on a national forest or grassland for an unspecified amount of time" (FS, 2023, p. 9). People who do not recreate are not included in the visit count; for example, employees, contractors, and people who enter FS lands simply to use a restroom or obtain information are not counted. During a single recreation visit to an FS area, an individual may visit multiple sites within the national forest or national grassland. The FS produces separate estimates for national forest visits and individual site visits. Visitation is estimated across the FS as part of the larger NVUM program.

The NVUM program was piloted in the late 1990s and launched in 2000 to collect annual data on visitors to FS lands. "The NVUM program serves two concurrent goals: (1) to estimate the volume of recreation visits to units of the [National Forest System], and (2) to describe salient characteristics of those visits, including activity participation, visit duration, visitor demographics, and visitor satisfaction" (English and others, 2020, p. 65). The NVUM program is a large-scale effort, typically surveying 24 or 25 National Forest System units each year, with an average of around 23,000 surveys completed annually across the system (English and others, 2020). The forests are surveyed on a 5-year rotation, meaning that each forest will have data collected once every 5 years, and data will be representative regionally or nationally over any 5-year period (English and others, 2020). The method and effort have been fairly consistent for more than 20 years, which allows for a long-term consistent dataset of visitation estimates and other visitor use data.

The NVUM program chooses sampling sites and days within a forest using a stratified random sampling approach to get a representative sample across the forest. Sites are stratified based on site type and use levels. Site types consist of day-use sites, overnight sites, wilderness access sites, and general forest area access sites. Use levels are categorized by field staff for each site and each day of the year as not used or closed, low, medium, high, or very high, which considers both the time of year and time of the week, recognizing many locations have higher use on weekends or holidays. This sampling framework for selecting sites for data collection that are representative across the forest and throughout the year allows for accurate visitation estimates across the forest. Each forest has an average of 230–240 sample days during an NVUM year. For more information about specific methods used for NVUM, including site stratification and field sampling methods, refer to the article by English and others (2020).

Visitation is estimated as part of the NVUM program. Visitation estimates are produced for each forest once every 5 years. This process is centrally controlled (meaning national-level employees administer and oversee the program) and consistent across FS lands. Estimates are made using three types of information (English and others, 2020):

- Manual counts—This involves counting all people or vehicles leaving the site during a randomly selected 6-hour period. A study was conducted to convert 6-hour counts to 24-hour estimates, and this procedure is now in use (English and others, 2018).

- Interviews with visitors—Interviews are used to acquire information on the number of people per vehicle and the number of sites visited, and the data are used to convert raw counts to visitation estimates.

- Proxy data—This includes administrative data that are collected through the FS's normal course of business (for example, fee envelopes or receipts, wilderness

permits, ski tickets, toll booths, and permanent traffic counters). Proxy data are incorporated into the annual estimates. Available proxy data are used if they capture 80 percent or more of the site's use.

During interviews, visitors are asked if they are exiting for the last time, and only those who are finishing their visit are asked to complete a survey. The manual count from the sample day is adjusted based on the share of those interviewed who are exiting for the last time. Additionally, the FS eliminates double counting of visitors by asking how many FS sites visitors went to during their trip. Finally, visitors are asked how many people are in their vehicle and these data are used to convert traffic counts to visit estimates. These conversion factors are updated for each forest every 5 years with the NVUM cycle; the conversion factors use both the current year and prior sample year data, so a single sample year does not dominate the conversion factors (Sarah Cline, FS, written commun., 2024).

The NVUM data are stored in the "Results Application," and data stored in this database are cleaned from the raw data to produce estimates. Estimates are then transmitted to the FS Natural Resource Manager Program (an internal FS information technologies program), which maintains the database. The "Results Application" can be used to produce reports and tables. Summarized data are publicly available through a web-based user interface, the NVUM website (https://apps.fs.usda.gov/nvum/results). The website allows users to select any forest and obtain summary statistics of data that were collected for any year NVUM data collection took place for that forest. Users can also retrieve results at a regional or national scale over any 5-year period, and the FS produces a national-level annual report that is available on the NVUM website. Because visitation estimates are produced using the same methods at each location, there is no need for site-specific documentation of methods; however, there is publicly available documentation describing methods used in the NVUM program, including how visitation is estimated (English and others, 2020). Visitation estimates have been used for various purposes within the agency, including congressional and departmental reporting, agency accomplishments and communication, executive dashboards, National Environmental Policy Act analyses, forest and strategic planning, natural disturbance effects analysis (for example, effects of major fires), forest and recreation management, and partnerships (English and others, 2020).

National Oceanic and Atmospheric Administration Office of National Marine Sanctuaries

This report includes information from the ONMS only and does not include information from other parts of the Department of Commerce, such as the National Marine Fisheries Service, International Trade Administration, or National Travel and Tourism Office. ONMS does not use the term "recreational visit" but instead defines a "person-trip" as equal to one person who makes a trip and a "person-day" as one person doing any recreation activity for any part of a day (Danielle Schwarzmann, NOAA, written commun., 2024). A visitor could engage in several person-days of different activities in 1 day. ONMS tracks different metrics at locations across the system including visitor-days (person-days) and visits by activity. The metrics that are tracked vary based on the specific management priorities of a given marine protected area.

Currently (as of 2024) and historically, ONMS has not collected consistent visitation data for the entire system. The ONMS network includes 17 national marine sanctuaries (NMS) and 2 marine national monuments. However, ONMS has collected consistent data at specific sites and locations for several years as part of socioeconomic research projects. The ONMS is in the process of developing a visitation monitoring program that will allow for consistent data collection. The ONMS is working with the Office of Management and Budget (OMB) on a NOAA "Compendium of Questions" that would allow for consistent collection of visitation data. The ONMS estimates visitation using two methods (Danielle Schwarzmann, NOAA, written commun., 2024):

- Visitor surveys—These are used at different locations to estimate visitation and recreational activities, as well as understand other aspects of visitors and visitor experiences.

- Partner-collected data—These may include hotel occupancy data, traffic counts, and surveys that partners or other organizations conduct. ONMS also uses data from State agencies that collect fishing-effort data for recreational and commercial fisheries.

For ONMS, the reporting scales are dependent on the management action or site-specific research need. Common scales are per facility (for example, visitor centers), sanctuary, specific habitat, or cultural resource or management area within a larger protected area. Data are most commonly reported at the monthly time scale, though the specific timescale is defined by the management scope and application of the data (Danielle Schwarzmann, NOAA, written commun., 2024). The ONMS uses survey questions to estimate the number of people on each vessel and, when other data on the number of boats, such as satellite imagery or photographs, are available, will continue this across sites to estimate the number of recreational boaters. In one previous project, NOAA partners used mobile device location data in the process of estimating visitation in the Florida Keys NMS in Florida (Schwarzmann and others, 2022).

The ONMS conducts recreational studies to support specific regulatory or policy needs. Examples include reports on Washington State resident use of the Olympic Coast NMS off the coast of Washington State (Leeworthy and others, 2016), whale watching in the Stellwagen Bank NMS off the coast of Massachusetts (Schwarzmann and Shea, 2020), and recreational fishing in the Florida Keys NMS in Florida

(Schwarzmann and others, 2022). For these reports, ONMS produced technical appendixes detailing the methods applied. The ONMS stores the datasets for these studies internally and can provide them upon request. The National Centers for Environmental Information (part of NOAA) supports ONMS's developing visitation monitoring program and may offer centralized data storage, including raw (unadjusted) visitor count data in the future. The National Centers for Environmental Information applies specific protocols to ensure that data are publicly available in a timely manner and to protect personally identifiable information and business identifiable information.

The ONMS visitation data are used to support rulemaking (including sanctuary expansions and updates to regulations). The data are also used for designating new sanctuaries, producing condition reports, and reporting official statistics, like the Outdoor Recreation Satellite Account (https://www.bea.gov/data/special-topics/outdoor-recreation), Marine Economy Satellite Account (https://coast.noaa.gov/digitalcoast/data/marine-economy.html), and Economics: National Ocean Watch (https://coast.noaa.gov/digitalcoast/data/enow.html).

National Park Service

The NPS defines a recreation visit as "the entry of a person onto lands or waters administered by the NPS except… for non-reportable and non-recreation visits" (NPS, 2024b). Funeral parties at national cemeteries, school groups, and other visitors, are reportable as "recreation" use because such uses are for the purpose for which the park was established. Visits originating on surface vehicles (trains, boats, other) and aircraft may be counted if they stop and disembark passengers on NPS-administrated territory. "The applicable rule is that one entrance per individual per day is countable" (NPS, 2024b). In addition to recreation visits, the NPS monitors the number of nonrecreation visits, hours of recreation and nonrecreation use, number of recreation and nonrecreation overnight stays, and other information, such as visitation associated with special events or a particular attraction (NPS, 2024c). Definitions for each term can be found online at https://www.nps.gov/subjects/socialscience/nps-visitor-use-statistics-definitions.htm.

Visitation is estimated only for areas administered by the NPS. An area is administered by the NPS when one or more of the following conditions are met: (1) the park superintendent has the authority to develop and enforce regulations on the property, (2) NPS funds directly support the management of the property, or (3) legislation or interagency agreements direct the NPS to administer the property. Official NPS reporting of visitation is not allowed for areas primarily operated by other Federal agencies or in areas specifically excepted by NPS management, legislation, cooperative agreements, and memoranda of understanding or other official documentation (for example, affiliated areas). Data collected in miscellaneous areas where the NPS has partial administrative responsibility or limited presence may be maintained as sources for comparisons but are not reported in the combined total statistics of those areas directly administered by the NPS. Visitation of areas for which the NPS provides services (for example, patrol or other emergency services) without any legislative, contractual, or other official and externally imposed requirement is not counted as NPS visitation.

The NPS uses a wide variety of technologies and methods for estimating visitation. Some parks find that manually counting visitors at a visitor center, on the grounds, or at other attractions provides a reasonable estimate for their park. Many parks, particularly those with entrances on travel corridors such as roads and trails, find it optimal to use automated counters. Where necessary, mathematical relationships may be used instead of manual or automated counts to estimate the number of visits to an area based on a count of visits to a more easily measured area of the park. The NPS estimates recreational visitation using four techniques (Leggett and others, 2017):

- Direct counts—This includes counting the number of people at visitor centers, tickets sold, permits issued, or similar. In many cases, these are a census (meaning every person is counted), but in some cases, such as at the Washington, D.C., memorials, sampling is used (meaning counts are obtained for a sample of times or days and extrapolated).

- Proxy counts—These are counts that are correlated with the number of visits but require a multiplier or conversion factor. For example, this would include occupied campsites or traffic counts, which would require a multiplier for the number of people per campsite or vehicle. Proxy counts are most often obtained using automated counters such as traffic, trail, or door counters.

- Statistical correlation estimates—This is used to estimate visitation at some locations based on visitation data from other locations. For example, a regression model could be used to estimate visitation at some areas within a park based on estimates from other locations within a park.

- Flat estimates—These are used for locations that cannot be monitored in a cost-effective way and are based on historical information and professional judgment.

Data collection techniques are selected specifically for each park considering what is operationally feasible, data that are available monthly, and data that can be collected over many years. If these data do not directly represent visits or overnight stays, various adjustments must be applied to convert the "raw" measurements to visits or overnight stays. For example, when automated counters are used, parks need various conversion factors to change readings from counters to monthly visitor use estimates. These conversion

factors are established by studies of visitor use. A study may consist of systematically observing the number of people in vehicles coming into the park, the number of visitors entering a visitor facility, or asking visitors questions about their visit. The NPS Social Science Program assists parks in the technicalities of such studies and reports conversion and correction factors needed for the valid and accurate reporting of visitor use statistics. Additionally, for most parks where multiple entrances per day are common, the NPS applies adjustment factors to correct for duplicate visits. There are updates underway using SEM survey data to build adjustments for same-day reentry counts and duplicate measurements. The NPS has also started using mobile device location data at some locations to develop multipliers and adjustment factors. These data (described in the "Mobile Device Location Data" section of this report) are only used to develop adjustment factors and are not used for continuous data collection or reporting. Mobile device locations are used to develop adjustments in certain locations when they are considered a better source than traditional sources, such as visitor surveys (refer to the first case study in the "Case Studies" section of this report).

The NPS visitation data are stored in a Microsoft Structured Query Language Server database managed by a contractor and owned by the NPS Visitor Use Statistics Team Lead. Data can be accessed internally and externally through the visitor-use statistics website at https://irma.nps.gov/Stats/. The NPS Visitor Use Statistics Program is centrally coordinated, and visitor-use statistics staff in the NPS Social Science Program are responsible for collaborating with parks to develop site-specific data collection methods. This ensures consistency and reliability of data collection across NPS units. Monthly and annual visitation estimates are available on the Integrated Resource Management Applications (IRMA) website (https://irma.nps.gov/Stats/) for both the national level and individual park units. The spatial scale for official reporting is the park unit, but most park units have measurements or estimates on a smaller spatial scale (for example, an entrance station, a visitor center, or a road) that are used as building-block elements of the broader park-level reporting.

Methods for estimating visitation at each park unit are also available online through the IRMA website (https://irma.nps.gov/Stats/). These count procedures are reviewed periodically, ideally every decade or when there are new considerations (for example, new construction or legislation) that alter visitor use (Pamela Ziesler, NPS, written commun., 2024). The counting and reporting instructions for each park describe the protocol for estimating visitation. However, the instructions do not provide further documentation on the estimation approach, such as how conversion factors were developed, for example, how to convert total vehicles to the number of recreation visits (Leggett and others, 2017).

Within the NPS, information about visitation allows park managers to handle the challenges of increasing or decreasing visitation and mitigate negative effects on cultural and natural resources related to visitor use (Pamela Ziesler, NPS, written commun., 2024). Visitation data are a measure of workload requirements for the cost-effective dispersal of park staff. The data support planning visitor services and related functions, scheduling maintenance and cleanup, tracking crime and accident rates, estimating resource deterioration and use concentration indices, monitoring public hazard zones, verifying fee revenue, informing reports to Congress and other stakeholders, and developing construction-contract specifications for visitor facilities. In addition, modern park management practices, such as decisions on the need for and monitoring of reservation or permitting systems, require information on visitor use. Outside of the NPS, accurate visitor-use information allows local communities and businesses to determine the types and quantities of amenities, goods, and services needed by visitors to nearby parks. Provision of community services such as public water supplies, water treatment, solid-waste handling, emergency services, food, lodging, and transportation services may all require accurate NPS visitor use statistics. Consequently, a detailed understanding of visitation levels in nearby parks is beneficial for the appropriate management of community resources. Visitation data also provide information to local communities about the potential economic effects of nearby parks (Pamela Ziesler, NPS, written commun., 2024).

Novel Methods

This section describes emerging data sources and technologies for measuring visitation, changes in sources and availability of those technologies since Leggett and others (2017), and current (as of 2024) practices for using the data sources to estimate visitation. The section is organized into subsections according to the three data categories identified in the 2017 report (social media, cellular activity [referred to as mobile device location in this report], and remote sensing) and introduces community science as an additional fourth category. Geolocated social media data (discussed in the "Social Media Data" section) are one type of volunteered geographic information, as are data submitted by community scientists, which are discussed in the "Community Science Data" section (Goodchild, 2007; See and others, 2017). Together with mobile device location data (as discussed in the "Mobile Device Location Data" section), these data sources are collectively known as digital mobility data (Luca and others, 2021; Winder and others, 2025). Remote sensing data (discussed in the "Remote Sensing Data" section) cover a wide variety of sources that involve remotely gathered data, including those from satellite imagery, aerial imagery, and other sensors. Each of these four subsections consists of an "Overview," which provides background information on each source and the state of the literature, and an "Assessment," which provides information on considerations and limitations associated with using each data type for estimating recreational visitation. Finally, the "Best Practices for Novel

Methods" section discusses best practices for effectively incorporating novel data sources into visitation estimation and monitoring programs.

Social Media Data

This section consists of an overview of social media data and an assessment of the data for estimating recreational visitation.

Social Media Data Overview

During the past decade, social media use has continued to increase among the U.S. population. Both the number of social media platforms and the percentage of Americans using social media platforms have increased (Pew Research Center, 2024a). There have concurrently been large changes in the makeup of social media applications that people most widely use, as well as the ways that people interact with these platforms (Pew Research Center, 2024a). As some platforms have increased in use, gaining more users and postings over time, the use of other platforms has declined. Instagram, for example, has continued growing as an image-sharing platform since 2017 (Pew Research Center, 2024a), whereas Flickr use has decreased (Stuart, 2019; Goebel and others, 2023). Over the last 10 years (2014–24), the age of social media users has expanded to include older demographics, and users have shifted from interacting with social media primarily through their computer and web browser to using mobile phone applications (Cotten and others, 2022; Pew Research Center, 2024a, 2024b).

During the same period that social media use has been increasing and evolving, researchers have been testing the potential for information provided by social media platforms to function as a source of recreational visitation data (Wilkins, Wood, and Smith, 2021). Generally, studies have concluded that data derived from various social media platforms are informative for estimating visitation, if care is taken to assess and model the data properly (Wilkins, Wood, and Smith, 2021; Ghermandi, 2022). This has remained true even as the specific sources, types, and availability of social media have shifted over time.

In 2017, Leggett and others (2017) described three types of social media platforms that could be used to infer recreational visitation data for public lands: (1) photograph sharing, where the geographical location (geotag) of a photograph shared on social media (for example, on Flickr) is used to infer the presence of a person; (2) location sharing, where the user can choose to geotag the location that corresponds to the place where the social media were generated (such as a post on Twitter, renamed "X" in July 2023); and (3) path sharing, where users can share the entire path they took on a trip, usually running/hiking or cycling (for example, on Strava). Additionally, beyond the photograph-sharing, location-sharing, and path-sharing platforms that were discussed by Leggett and others (2017), there is now a multitude of platforms that visitors use to share reports about their trips to specific recreational sites. These review-sharing platforms are often designed to serve a specific community or user group that wants to share information about a particular recreational activity, such as off-highway vehicle use, mountain biking, or hiking. The level of access that researchers have to social media has shifted over time for individual platforms and, as of 2024, most social media companies do not allow free data access to researchers.

Among the review-sharing platforms, Trailforks (https://www.trailforks.com) has emerged as a popular platform for people to share information about mountain biking trails and to report on their experiences. Similarly, the AllTrails platform (https://www.alltrails.com/) is commonly used to share trip reports and review trails for activities such as hiking and running. On a more local scale, a trip-reporting platform run by the Washington Trails Association (https://www.wta.org/) is widely used by hikers in Washington (Armstrong and others, 2022); similarly, the Colorado Trail Explorer is used to share trip reports for trails in Colorado (https://trails.colorado.gov/). Because trip reports posted on these platforms are geolocated and time-stamped, they provide a source of information on visitation. A study by Fisher and others (2018) found that the monthly counts of trip reports on the Washington Trails Association's platform are highly correlated with on-the-ground counts of trail users at 16 trails across Washington. White and others (2023) determined that geolocated reviews on AllTrails were useful (in addition to data from other social media platforms) to model changes in visitation to public lands in the Columbia Gorge for a study on the effects of wildfires and associated closures in Oregon and Washington State.

The conclusion from research during the past decade is that geolocated social media are informative for visitation estimation, but no one data source is accurate enough to serve as a substitute for on-the-ground counts across a wide range of site types. Although the number of social media users and posts is generally positively correlated with the actual number of people in a place and time, there is high site-to-site variability in the relationship between the number of geotagged social media posts and actual visitation (Wood and others, 2013; Sessions and others, 2016; Heikinheimo and others, 2017; Tenkanen and others, 2017; Fisher and others, 2018). Furthermore, this relationship varies by data source and over time (Donahue and others, 2018; Winder and others, 2025). So, although a data source might be strongly related to actual visitation in one location, it may be weakly related to visitation in another location where an alternative social media data source may work better.

To make sense of variability in space and time, researchers have developed visitation modeling approaches that use equations to combine multiple social media sources into predictions that leverage their combined explanatory power while at the same time attempting to statistically correct for known issues. Importantly, these methods use onsite

"ground-truth" data to calibrate the relationship between social media data and actual visitation. These calibrated relationships form the basis of statistical models that convert the data to estimates of actual visitation, potentially even at new sites or times where onsite data are not available, with varying success. Wood and others (2020) developed and tested this calibrated-relationship approach using social media posts from Flickr, Instagram, and Twitter (now X) with onsite visitation counts from 42 recreation sites on Federal lands in the Western United States. They found that including predictors derived from the three social media data sources substantially improved model performance, measured as the accuracy of visitation estimates at new locations, even when models were developed with data from one location (Washington) and applied in another location (New Mexico). The best performing models also included other variables known to affect visitation, such as seasonality, local weather conditions, and holiday timings.

Social Media Data Assessment

During the past decade, researchers have concluded that the location and timing of geolocated social media posts can be used to improve visitation estimation. For example, a study that evaluated the use of social media data for visitor estimation on public lands and waters in the United States showed that between 45–91 percent (approximately) of the variability in weekly visitation to a site can be determined by statistical approaches that rely on learned relationships between numbers of social media posts from multiple data sources and onsite counts (Wood and others, 2020). This variability likely reflects underlying biases in who is actively using different social media platforms and, therefore, how social media under- or over-represent visitation to different locations.

Although the overall conclusion is that geolocated social media are inherently useful for visitation estimation, there can be challenges to using these data in practice. One known limitation is that data quality and data access vary not just spatially but also over time (Wood and others, 2020; Ghermandi, 2022). During the last decade, the popularity of social media platforms has varied, and others are no longer available for use in visitation estimation because the companies that own them have made the data unavailable, often to monetize data access. Previously, Twitter (now X) allowed researchers to query and download an unlimited number of geolocated tweets and metadata for free (Tromble, 2021; Pfeffer and others, 2023). In February 2023, X started charging a fee for access to the same data (Developers, 2023). Similarly, in 2018, Meta (the parent company of Instagram) shut down its public Instagram Application Programming Interface (API), which had previously allowed access to geotagged posts, and replaced it with an API restricted to business use with less data availability (Gummadi, 2018). This general loss of social media data access was raised by Leggett and others (2017) as one of the risks of relying on data owned by private companies, and this continues to be a concern. The monetization of previously free data access will likely continue to make it more difficult for researchers to access social media data. This issue, and many other issues with digital mobility data, are not unique to social media. Additional issues and limitations on implementation with other types of digital mobility data are discussed in their respective subsections below and in the "Implementing a Visitation Estimation Method" section of this report.

Mobile Device Location Data

This section consists of an overview of mobile device location data and an assessment of the data for estimating recreational visitation.

Mobile Device Location Data Overview

Since the 2017 report by Leggett and others was published, there has been a shift in the type of mobile device location data that is available. The main source of data available in 2017 was derived from call detail records (CDR). These data were generated by cellular service providers based on the location of the hardware (the "tower") that connected with the cellular phone at the time of a phone call or text message. In 2024, the most commonly available location information from mobile devices (including mobile phones, tablets, and smartwatches) is provided by applications (apps) that use location-based services (LBS). The recorded location is often determined by the device using a Global Positioning System (GPS).

Very few studies have researched the use of CDR to estimate recreational visitation, and none of the known studies have been conducted in the United States. Fisher and others (2019) were the first to test the relationship between CDR data and onsite visitation estimates at parks and other nature-based tourism destinations. Using sites on Jeju Island, South Korea, the authors found that CDR data provided by Sun Kyung Telecom (SK Telecom Co., Ltd.)—one of three major mobile communications providers in South Korea—were positively correlated with field-based counts (Fisher and others, 2019). Other studies using CDR data to study tourism patterns outside the United States are discussed in Zaragozí and others (2021). In 2019, major telecommunications companies in the United States voluntarily stopped selling CDR data (Krebs, 2018) and shortly after, in 2020, the Federal Communications Commission issued a notice of liability for forfeiture and admonishment and then fined four U.S. companies for selling customers' location data without their consent (Federal Communications Commission, 2024). Accordingly, CDR data are unlikely to be a source of visitation data in the United States going forward.

During the last 5 years (2020–25), as the number of smartphone users and smartphone applications has risen, there has been an increase in the availability of mobile

device location data from LBS running on those applications. Simultaneously, an industry has arisen that is devoted to the buying and selling of those data. The applications generating these data provide a variety of services to the device user such as weather information, social networking, games, and a multitude of others. These applications are location-aware because the developers integrate software, often by using a Software Development Kit (SDK), which then interfaces with GPS hardware or uses other information, such as surrounding wireless access points, to determine the location of the device. This data collection requires users to grant permission for the app to access the location of devices running the Android and iOS operating systems.

Each recorded location contains, at a minimum, a latitude and longitude, timestamp, and user identifier, but can also contain information on the speed of the device, information about the device itself (such as make and model), and a measure of the GPS precision, as well as other information. These data are then transmitted back to the application developer or, if there is no cellular connectivity available, optionally cached on the mobile device and uploaded once connectivity is reestablished. To reach the market, the location data received by the application developer is then de-identified (personal information, such as names, is removed) and sold, typically through third-party data vendors.

There has been a rapid proliferation of third-party companies buying and selling mobility data derived from SDKs since 2017. These vendors package data into a wide range of products. Some companies sell unaggregated and minimally processed location data, which contains latitude and longitude coordinates of each individual device (according to the anonymized device identifier described in the previous paragraph). Other data companies sell data that have been aggregated to certain geographical areas or points-of-interest. Still others apply considerable processing to the data. Many vendors will, for example, use the number of devices detected in a given area to extrapolate the total number of people in that area.

A 2025 study comparing five sources of geolocated social media data and three sources of mobile device location data created by visitors to United States Federal public lands indicated that, relative to social media, LBS-derived data products often capture a larger proportion of total visitors (Winder and others, 2025). Nonetheless, mobile device location data are similar to social media in that the raw data represents a fraction of visitors to a location. The same study observed between 9–288 percent of visitors counted onsite in a sample of United States national wildlife refuges are recorded in one vendor's location dataset, showing that mobile device location data can show much smaller or much larger visitation numbers than those observed on the ground (Winder and others, 2025). The percentage of total visitors captured by a given dataset—and potentially also the representativeness of the dataset—at a site depends on several factors. First, individuals must carry a mobile device for their location to be recorded. The device also needs to be running an application that determines and stores its location using GPS data (through a mobile application), and the user needs to opt in to location sharing. When applications are not able to cache data, a connection to cellular service is needed to reliably capture location data, and such connections can vary across sites. Some data vendors also adjust the dataset to attempt to correct for changing device sample volume across space, but whether and how adjustments are made is not usually shared with the data purchaser. Finally, because each location-data vendor buys data from a subset of applications and SDKs, and because it is not feasible for a vendor to buy all data on the market, there will be a bias in the app data purchased by a given vendor, which can differentially affect data reliability at different sites.

Despite the increasing availability of LBS-derived data, few studies have evaluated the use of the data to estimate recreational visitation. Most research has involved comparisons with estimates based on observational data (for example, ticket sales and traffic counters). Merrill and others (2020) compared total visitation estimates from a third-party location-data vendor for 18 water recreation areas in the Eastern United States (such as beaches and boat ramps) to visitation measured using various observational methods. The extrapolated estimates from the vendor were about four times greater than the observational estimates. Tsai and others (2023) and Winder and others (2025) estimated visitation in 38 U.S. national parks and 13 U.S. national wildlife refuges, respectively, and both observed that visitation according to location data derived from LBS that was sold by two different vendors showed a wide range of correlation with actual visitation across the entire United States, from less than zero to 0.996 (Pearson's correlation values). Filazzola and others (2022) measured the relationship between empirical visitation estimates and an "activity index" based on data derived from apps providing LBS and observed generally strong correlations between the two in urban green spaces in the Greater Toronto Area.

Research into methods for using LBS-derived data to estimate recreational visitation has reached similar conclusions as studies evaluating social media—that LBS-derived data is most useful for producing estimates of visitation when included as inputs into statistical models, along with covariates such as weather and seasonality, and parameterized using on-the-ground counts (Merrill and others, 2020). Multiple studies have found that, similar to social media, LBS-derived location data on their own may not be a suitable proxy for recreational visitation (Tsai and others, 2023; Winder and others, 2025), but when used as a model input along with other variables and calibrated using onsite data, LBS-derived data can provide valuable information for land managers.

In general, studies evaluating the use of third-party location data from LBS for measuring recreational visitation conclude that, although mobile device location data are a promising data source to complement more traditional onsite counting methods, they should be calibrated with onsite data and ideally used to develop predictive models for similar

locations where onsite data are not available. Furthermore, out-of-sample model testing, where model performance is evaluated on a portion of the initial dataset that was held out from model training, should be used to avoid overfitting and ensure models can be used successfully for new sites or time periods without onsite data (Merrill and others, 2020; Wood and others, 2020).

Mobile Device Location Data Assessment

Mobile device location data derived from LBS have been shown to be most valuable when used as one of multiple sources of information in models predicting visitation. For example, variables that are known to affect visitation, such as weather, as well as other proxies for visitation, such as geolocated social media posts, can improve models that use LBS data to predict visitation (Merrill and others, 2020; Winder and others, 2025). These data may be particularly useful for situations where visitors are dispersed across large and remote areas because LBS data have the potential to fill gaps in visitation estimates where onsite counting is unfeasible, as long as best practices, such as calibration with onsite data from other sites and out-of-sample testing, are followed.

There are several additional considerations and challenges to using mobile device location data for visitation estimation. First, there are logistical and operational considerations, including the monetary cost of acquiring data from third-party vendors, which can be from tens to hundreds of thousands of U.S. dollars depending on the company, the geographic extent, the purchaser, and the amount and type of data. Companies generally sell data either as a single, one-time purchase of data for a defined geography (for example, a single park) or as part of an ongoing data subscription for any geography as long as the subscription is active. Terms of service may put limits on data sharing, which can also factor into the cost (for example, if data cannot be shared with multiple field offices).

After data are acquired, data storage and processing pose potentially significant costs. When data are aggregated for a limited number of geographies or points of interest, files are generally small enough to store on personal computer hard drives, but raw mobility data, especially for a large area such as the entire United States, can require hundreds of terabytes of disk storage and cloud storage systems. These services can incur costs for storage as well as access to the data. Processing such large datasets may also require cloud computing resources that have associated costs. Additionally, purchasing, transferring, storing, processing, and analysis of mobile device location data need to be done by personnel with the technical expertise required to perform these tasks. Finally, privacy issues associated with mobile device location data must be considered, including removing sensitive information, securing storage, and creating publicly available policies for working with private data. This issue applies to other forms of mobility data and is discussed in further detail in the "Best Practices for Novel Methods" section of this report.

Beyond the operational considerations, it is important to consider issues associated with representation and sampling bias that are inherent in mobile device location data. These issues will vary from one data vendor to another, and it cannot be assumed that data for a site purchased from one provider will perform similarly to data purchased from a different provider. Moreover, as discussed in the "Mobile Device Location Data Overview" section, data derived from LBS are limited to the subset of visitors who have a mobile device, use an application that collects location data, and consent to share their data. If a particular user group is less likely to use a device (for example, older visitors or foreign visitors), their visits will be underrepresented in the dataset. This bias could affect the accuracy of absolute measures of visitation and comparisons among locations that differ in the makeup of visitors. Additionally, technical aspects of the mobile applications and SDKs that provide LBS can affect data representativeness, as can proprietary decisions made by the third-party vendors that resell location data.

Application developers and third-party data vendors do not provide much information about how location data are generated and their proprietary data processing steps. For example, third-party location data vendors generally do not share specific information on which specific mobile applications—or even the number and type of applications—are used in their commercial data products. If, for example, a third-party vendor resells data collected through an application that is popular with recreational fishers, then the dataset may have high correspondence to visitation at sites where fishing occurs but will be less representative at sites where there is no fishing. Data companies typically buy data from many mobile applications and SDK developers as one way to increase representativeness. However, with the lack of transparency from developers and vendors, it is difficult to gauge whether these decisions are responsible for the observed bias and changing volumes of mobile device location data over time (Winder and others, 2025). Further, because these decisions are made by each data vendor individually, datasets from one vendor cannot be assumed to be interchangeable with those from another.

Without knowledge of which mobile applications are used to create a dataset, it is unclear how data representativeness is affected by differences in the technical design of each mobile application from which third-party data vendors source data. Each developer of a mobile application or SDK that provides LBS makes different decisions, such as whether applications must be running and open on the device to determine a location or whether locations are collected in the background on a regular schedule, which are factors that depend on permissions the user has given to the app. Either way, the frequency with which an application determines a location affects the utility of the data. Applications that determine a location once per day, for example, are

underestimating actual visitation to an area compared with an application that collects a location once per hour or more frequently.

One design decision made by developers of mobile applications and SDKs is whether to cache location data when a device is out of range of cellular service. This decision is likely affecting the amount and potentially the representativeness of location data from Federal public lands where there is often limited cellular connectivity (Lawson and others, 2023). The extent to which applications have the capability to cache data is unknown, because this information is not shared by application developers nor the third-party companies selling LBS-derived data.

An additional unknown factor with third-party location data is the amount and nature of data processing that vendors apply before reselling the data. Data can generally be bought either in a raw form or in an aggregated form. During aggregation, data may undergo significant processing, and sometimes a population-level estimate is extrapolated from the sample. However, those processing methods are usually considered proprietary and not shared with customers. Even data sold as unaggregated locations of individual, anonymized devices can still be altered and processed by the company, for example, by adding small amounts of noise to the data to prevent unauthorized sharing or reselling of data (also known as salting or watermarking) or by processing to remove data artifacts and to preserve privacy. The technologies, application developers, and third-party data resellers that bring location data to the market will all vary over time. As applications are launched and discontinued, there is turnover in the data that underlie commercial data products, and the representativeness or biases associated with those data will change. Similarly, the ways that companies process data will change. For example, the algorithms used to extrapolate from a sample to a population may change, and this information may or may not be divulged to customers. Costs to buy, store, and process the data are also not fixed, which is difficult to factor into long-term study plans and budgets. Furthermore, there may be changes in the legalities and social acceptance of using LBS data that may create risks that decisionmakers will need to weigh.

Research on the use of mobile device location data for estimating visitation has identified many potential issues with data sold by third-party vendors, including biased representation of visitors, instability over time, and lack of transparency on data sources and methods applied by vendors. There are many unanswered questions about when and where mobile device data can be used to accurately estimate visitation. As such, recent studies have cautioned against using mobile device location data that are available from third-party vendors without calibration using onsite count data (Winder and others, 2025).

Remote Sensing Data

This section consists of an overview of remote sensing data and an assessment of the data for estimating recreational visitation.

Remote Sensing Data Overview

Leggett and others (2017) presented several data sources under the category of remote sensing, which is the gathering of data at some distance away from the site of interest. These sources include satellite or aircraft imaging, time-lapse photography, and Bluetooth or Wi-Fi device detectors. None of these sources have been used extensively in the intervening years as a source of visitation data.

Aerial surveys were used to estimate changes in recreational visitation to the coastlines of Louisiana, Mississippi, Alabama, and Florida after a major oil spill (Tourangeau and others, 2017), but high costs have so far prevented this method from being widely adopted (Andrew and others, 2021). As an alternative to aerial surveys, drones provide a new option for monitoring visitation from the air in locations where on-the-ground methods are difficult to implement, such as marine settings. Commercial drone technology requires an operator within line-of-sight on the ground but can fly in an array of weather conditions and, compared to aerial survey equipment, can fly for longer periods of time and closer to the surface for the purpose of collecting high-resolution images (Tang and Shao, 2015; Andrew and others, 2021). Data from drones are used to monitor animal populations in remote settings with good results (for example, Johnston and others, 2017; Hodgson and others, 2018).

Satellite data have been used in a limited number of studies of recreational visitation since 2017. The temporal resolution of satellite data is constrained by the rate at which the satellite orbits over the site and collects an image (Andrew and others, 2021). Kendall and others (2021) used counts of boats identified in satellite images collected once every 4–5 days to develop a model predicting visitation at a marine protected area, although they did not calibrate their satellite counts with onsite data.

In other settings that are not recreation sites, studies have investigated the use of Bluetooth detectors to measure crowd flows (Kitazato and others, 2018; Al Anbouri and others, 2019) and building occupancy (Park and others, 2018). In principle, the approach is similar to established methods that use technologies such as passive infrared beams or magnetometers to detect people and traffic. However, this approach has only been researched as a method for measuring visitation to Federal public lands and waters at one site (Otak Team and others, 2022).

“Connected vehicles” are emerging as one new source of potentially useful information on traffic in and around Federal public lands. The data originate from modern vehicles that are increasingly equipped with GPS-enabled technologies

and software used to detect the vehicle's geolocation. The data collected by these vehicles are transmitted back to the car manufacturer who then sells the data to third-party data aggregators and vendors, who in turn resell the de-identified data as a commercial product, provided the vehicle owner has given consent. The only known study of recreational visitation using connected vehicle data was conducted in Grand Teton National Park in Wyoming by the NPS (Otak Team and others, 2022), but more studies are expected (Lawson and others, 2023). It is possible that these data (and other types of remotely sensed data) are included in mobile location datasets sold by many third-party vendors, but this is difficult to verify because the vendors generally do not disclose the sources of their composite dataset.

Remote Sensing Data Assessment

Because there are so few examples of remote sensing data used for visitation monitoring at recreational sites, especially ones that research the validity of the method (for example, by comparing remotely sensed data to direct observations), it is difficult to assess the utility of such data. As shown in table 6, satellites and aircraft have high labor and training requirements, so data from these remote sensors can be expensive to purchase, but the high accuracy and ability to obtain data at inaccessible sites may offset those costs. Additionally, as more governmental satellites make images available for free, the costs associated with satellite-based methods will likely decrease (Levin and others, 2015). The greater flexibility of operating drones compared to piloted aircraft also makes drones a promising future data source, recognizing tradeoffs in the spatial extent and resolution that can be covered using drones versus aerial platforms. Other remote sensing data sources, such as connected vehicles and Bluetooth detectors, have yet to be extensively tested as reliable sources of visitation data. These data may face many of the same issues as discussed for mobile device location data, including temporal instability, sampling bias, cost, and privacy concerns.

Community Science Data

This section consists of an overview of community science data and an assessment of the data for estimating recreational visitation.

Community Science Data Overview

Although not discussed by Leggett and others (2017), community science approaches may be valuable for generating useful data on the recreational use of Federal lands and waters (Cheung and others, 2022; Lia and others, 2023). Broadly, community science (also known as citizen science and participatory science) involves people—who are not professional or academic researchers in scientific research—collecting data and performing other research activities. Commonly used in fields such as ecology and public health, community science programs are often geographically focused and rely on local volunteers as participants (Cheung and others, 2022). Community science is often used to enhance a research program by augmenting the amount of data collected and increasing public interest (Conrad and Hilchey, 2011; Bonney and others, 2016). Modern digital technologies like smartphone apps and other online platforms have provided more accessible opportunities for community science, which have the added benefit of easy data collection and increased reliability (Lia and others, 2023).

Community science is not yet used extensively in outdoor recreation research, though it holds promise as a tool for measuring recreational visitation and filling data gaps (Cheung and others, 2022). One motivator for implementing a community science program is to free professional staff from data collection obligations. This is potentially most valuable for land managers with large and remote management units where recreationists may visit sites even more regularly than field staff. Additionally, because recreation data is often easily observable—such as parking lot or campground occupancy—volunteers may not need special training and expertise (Cheung and others, 2022). Because people who are recreating outdoors are often enthusiastic about the outdoors and outdoor activities, they might be motivated to participate in community science and provide regular data contributions, especially when there is a clear connection between their participation and some benefit for the places where they are recreating (Lia and others, 2023).

There have been several efforts to develop technologies that facilitate participation by reducing barriers to entry and encouraging continued participation and, therefore, provide for sustained data contributions. Most recently, Lia and others (2023) developed and tested a novel method for engaging visitors in recreation monitoring using a chatbot to converse with visitors through text messages sent to the visitors' mobile phones. A chatbot is a computer program that interacts with people by exchanging messages (Adamopoulou and Moussiades, 2020). The chatbot that Lia and others (2023) developed facilitated a community science effort specifically aimed at visitation estimation. The program encouraged visitors to recreation sites in national forests in the United States to submit counts of vehicles at trailheads. The counts reported by participants were highly correlated with ground-truth data gathered using cameras, and as much as 12 percent of visiting parties participated, regardless of whether there was cellular service at the site or not. Overall, the study concluded that chatbot technology, and community science more generally, are potentially valuable approaches for gaining high-quality data for visitation estimation.

Community science efforts commonly use custom smartphone applications. One such application is eBird, which allows community scientists to document the location and timing of bird sightings, both for their own record and to share with other bird watchers, as well as scientists. Although

Table 6. Attributes of different visitation estimation methods.

[Modified from Dagan and others (2024, table 3). OMB, Office of Management and Budget; GPS, Global Positioning System]

Attribute of visitor estimation	Method used to estimate visitors in parks and protected areas								
	Administrative counts	Automatic counts—People	Automatic counts—Vehicles	Collaborator counts—Adjacent lands	Collaborator counts—Service operators	Direct observations—Remote observer	Direct observations—On-site human observation	Mobile device information—Actively collected	Mobile device information—Passively collected
Overall accuracy and reliability[1]	Moderate	High	High	Depends	Depends	High	High	Inconclusive	Inconclusive
Requires conversion factors	Depends	Yes	Yes	Depends	Depends	Yes	Sometimes	Yes	Yes
Degree of bias	Depends	Low	Low	Depends	High	Low	Low	High	High
Probability of double counting	Low	High	High	Depends	Depends	Moderate	Low	High	High
Can distinguish between visitors and local residents	Depends	No	No	Depends	Depends	No	No	No	No
Overall cost (for example, data, labor hours, equipment)	Depends	Moderate	Moderate	Low	Low	Moderate	Moderate	High	High
Amount of labor hours for collection	Depends	Low	Moderate	Low	Low	Low	High	Low	Low
Amount of labor hours for data processing and analysis	Low	Low	Low	Low	Low	High	Low	High	High
Amount of field staff required	Depends	Low	Low	None	None	Low	Moderate	None	None
Cost of field equipment installation	Depends	Moderate	Moderate	None	None	Low	None	High	None
Cost of field equipment maintenance	Depends	Moderate	Moderate	None	None	Low	None	Moderate	None
Requires data purchase	No	No	No	No	No	No	No	No	Yes
Agency can generate the data internally[4]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No
Level of training required to collect data	Depends	Low	Low	Low	Low	Low	Low	High	High
Level of training required to analyze data	Depends	Low	Moderate	Low	Low	Low	Moderate	High	High
Overall visitor burden	Depends	None	None	Low	Low	Low	Low	Moderate	Low
Requires interacting with or contacting visitors	Yes	No	No	No	No	No	No	Yes	No
Time burden on visitors	Depends	None	None	None	None	None	None	None	None
Cost burden on visitors	Depends	None	None	None	None	None	None	None	None
Potential for identifying information	Depends	None	None	Depends	Depends	Yes	Yes	Yes	Yes
Overall generalizability	Depends	High	Low	Low	Low	Moderate	High	Moderate	Moderate
Method can be used at most types of sites	Yes	No	No	No	No	Yes	Yes	No	No
Can capture additional information about visitors	Yes	No	No	Depends	Depends	Yes	Yes	No	No
Overall technological and administrative complexity	High	Moderate	Moderate	Low	Moderate	Low	Low	Moderate	Moderate
Currently [as of 2024] or previously used by agencies to estimate visitor use	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Administrative burden (for example, requires OMB approval, compliance)	High	Low	Moderate	Low	High	Low	Low	Low	Low
Requires cooperation from external partners	Depends	No	No	Yes	Yes	No	No	No	No
Is the data availability predictable long term?	Yes	Yes	Yes	No	No	Yes	Yes	No	No
Requires cellular connectivity	Depends	No	No	No	No	No	No	No	No
Requires visitor-owned GPS-enabled devices	No	No	No	No	No	No	No	Yes	Yes

[1]Any time a method requires use of technology or automatic equipment, such as infrared counters, we evaluated accuracy and reliability based on functioning equipment and appropriate research design. Accuracy and reliability are lower when equipment fails.

[2]While some platforms' data are available without purchase and some volunteered geographic information methods do not require data purchase, they may benefit from it in cases where the best available data source is not freely available.

Table 6. Attributes of different visitation estimation methods.—Continued

[Modified from Dagan and others (2024, table 3). OMB, Office of Management and Budget; GPS, Global Positioning System]

Attribute of visitor estimation	Method used to estimate visitors in parks and protected areas								
	Mobile device information—Volunteered geographic information	Remote sensing—Acoustic monitoring	Remote sensing—Manned aircraft	Remote sensing—Unmanned aerial system	Remote sensing—On-site equipment	Remote sensing—Satellite	Surveys—On-site	Surveys—On- and off-site hybrid	Surveys—Off site
Overall accuracy and reliability[1]	Inconclusive	High	High	High	High	High	High	High	High
Requires conversion factors	Yes	Yes	Depends	Depends	No	Depends	Yes	Yes	Yes
Degree of bias	High	Low	Low	Low	Low	Low	Potential for high	Potential for high	Potential for high
Probability of double counting	Low	High	Low	Moderate	Low	High	Moderate	Low	Low
Can distinguish between visitors and local residents	No	No	No	No	No	No	Yes	Yes	Yes
Overall cost (for example, data, labor hours, equipment)	High	High	High	High	Moderate	High	High	High	High
Amount of labor hours for collection	Low	Low	High	High	Low	Low	High	High	High
Amount of labor hours for data processing and analysis	High	Moderate	High	High	High	High	High	High	High
Amount of field staff required	None	Low	Low	Low	Low	Low	Moderate	Moderate	Low
Cost of field equipment installation	None	Moderate	None	Moderate	High	None	Low	None	None
Cost of field equipment maintenance	None	Low	None	Low	Low	None	None	None	None
Requires data purchase	No[2]	No	No	No	No	Yes	No	No	No
Agency can generate the data internally[4]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Level of training required to collect data	High	Low	High	High	High	Low	Moderate	Low	Low
Level of training required to analyze data	High	Low	Moderate	High	High	High	High	Moderate	Moderate
Overall visitor burden	Low	None	Low	Moderate	Low	None	High	High	High
Requires interacting with or contacting visitors	No	No	No	No	No	No[3]	Yes	Yes	Yes
Time burden on visitors	None	None	None	None	None	None	High	High	High
Cost burden on visitors	None	None	None	None	Low	None	None	None	None
Potential for identifying information	Yes	None	Low	High	Low	Yes	Yes	Yes	Yes
Overall generalizability	Inconclusive	Low	High	High	High	High	Moderate	Moderate	Moderate
Method can be used at most types of sites	Yes	No	Yes	Yes	Yes	Yes	No	No	No
Can capture additional information about visitors	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes
Overall technological and administrative complexity	Moderate	Moderate	High	High	High	High	Moderate	Moderate	Moderate
Currently [as of 2024] or previously used by agencies to estimate visitor use	No	Yes	No	No	No	No	Yes	Yes	Yes
Administrative burden (for example, requires OMB approval, compliance)	Low	Moderate	High	High	Low	Low	High	High	High
Requires cooperation from external partners	No	Yes	No	No	No	Yes	Yes	Yes	No
Is the data availability predictable long term?	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Requires cellular connectivity	No	No	No	No	No	No	No	No	No
Requires visitor-owned GPS-enabled devices	Yes	No	No	No	No	No	No	No	No

[3]In some cases, it may be appropriate to post signage informing visitors that data is being collected. For example, visitors may be informed that they are "opting in" by turning on their device's Bluetooth.

[4]This attribute refers to distinctions between methods that can only be generated externally and those that agencies could produce with ideal resources. Contextual considerations, such as administrative and technical capacity, influence whether the data can be generated internally in a specific scenario.

visitor estimation is not an explicit goal of eBird, the data are also potentially useful for studying recreation because the reporter is recording their presence in a particular place at a specific time (Echeverri and others, 2022). iNaturalist is another application for sharing sightings and identifications of organisms with the goal of documenting species' distributions and biodiversity but can also be used to infer the presence of people.

One study has evaluated whether bird observations (as a proxy for the presence of a person) recorded using eBird are related to actual visitation. Winder and others (2025) compared estimated visitation at 13 FWS refuges with the number of eBird checklists from the same refuges and found that, although the two metrics were generally correlated, the relationship varied across refuges. Chen and others (2022) used eBird data to estimate visitation in the absence of ground-truth data and observed a decrease in birdwatching trips to municipalities in Mexico as a response to deforestation. Although not estimating recreational visits directly, several other studies have used eBird (Roberts and others, 2017; Jayalath and others, 2023) and iNaturalist (Costadone and Balzan, 2023; Cao and Hochmair, 2024) to answer research questions focused on outdoor recreation patterns and preferences. These studies demonstrate that community science may be a valuable but underused source of recreational visitation data.

Community Science Data Assessment

Many of the drawbacks of community science data for visitation estimation are like those drawbacks outlined previously for social media and mobile device location data; that is, there is a clear potential for sampling bias. Community science platforms are best at capturing patterns of recreation when performed by visitors who are interested in the purpose and objectives of the program, such as birding in the case of eBird and natural history in the case of iNaturalist. Furthermore, there will be a selection bias toward individuals who have the ability and time to volunteer, the knowledge and training necessary to perform the requested tasks, and the skill to use the technologies, such as smartphone applications, that support the science.

Beyond the selection biases, there can be concerns about the quality of data collected through community science programs (Burgess and others, 2017; Cheung and others, 2022). Programs that ask volunteers to follow specific protocols—like counting people in a specific area or at a specified time—may be difficult to follow, resulting in miscounts or other inaccuracies in the data or metadata. Yet, studies repeatedly observe that, with proper training, community science programs generate useful data, including one aimed specifically at visitation estimation (Lia and others, 2023).

Another consideration with using community science is the expertise and resources that are needed to coordinate a program, recruit participants, and develop technologies that facilitate data collection. To ease the burden, there are existing communities and technologies, such as the eBird mobile application, that can be leveraged. Still, considerable technical skills and resources are necessary to develop technologies for collecting and storing data. However, compared to the cost of onsite data collection by field staff or purchasing mobile phone location data or devices such as vehicle and trail counters, community science data may be a relatively lower cost option.

Best Practices for Novel Methods

Several best practices have emerged from studies researching the use of novel data. This research has focused on practices for improving the accuracy of visitation estimation methods and reducing the potential for biases in underlying data sources. This includes methods for leveraging multiple novel data sources and calibrating the relationships among those data sources using ground-truth data. A smaller number of studies have addressed other issues, such as preserving visitor's privacy, particularly when using location data derived from LBS.

Many sources of novel data contain multiple observations of one person or device as they move through space. Data from social media platforms, for example, typically include multiple posts by the same user at a site of interest (refer to the "Social Media Data" section). Therefore, one practice for working with these data is to aggregate data by individuals (for example, by the user, mobile device, or vehicle) to avoid repeat counts of the same visitors at a given site during a given time period. Common practice is to compute the total number of visitor-days or user-days based on the number of unique individual mobile devices or social media users per site per day (Wood and others, 2013). If, for example, a visitor shares 10 geotagged posts on a social media platform for the same recreation site on the same day, this is counted as 1 visitor-day instead of 10 separate visits. Any duplicates of site and date data by user identifier values are removed by the researcher, then the remaining posts are summed by site and date to produce the total number of user-days (Wood and others, 2013).

Given the research that found that digital mobility data are not consistently related to visitation in space and time (refer to the "Social Media Data" and "Mobile Device Location Data" sections), the best practice is to calibrate the relationship between each novel data source and actual visitation, and to recalibrate the relationship at regular intervals over time (Wilkins and others, 2024). This requires having onsite visitor counts or other independent and reliable visitation estimates from at least some sites and some time periods for the purpose of adjusting the visitation estimates directly (for example, using a simple multiplier). If such data are not available, it is not possible to quantify what proportion of total visitation is captured by a digital mobility data source. The accuracy of this calibration relies on the onsite counts being estimated accurately and repeated temporally to account

for changes in the correlations between the two data sources over time, which can result from changes in the popularity of social media platforms or mobility data algorithms and sources or other causes. Few studies provide direct practical guidance on the number of onsite observations that should be used, or how frequently to recalibrate. Where sites are similar to one another (for example, geographically adjacent sites with similar activity participation), it is possible that only a subset of sites would be needed for calibration, as the relationship between digital mobility data and onsite counts may be similar across all sites (Winder and others, 2025). For sites where it is impossible to estimate visitation independently for at least some time periods or at similar sites (for example, because of remoteness or lack of funds for field staff), digital mobility data could be used directly as an estimate of actual visitation, though it must be recognized that it may be an inaccurate and misleading proxy. Finally, onsite calibration done for data bought from one data vendor cannot be assumed to apply to data from a different vendor or even from the same vendor for a different time period. Data for the same recreation site bought from different vendors or at different times from the same vendor can show very different relationships with onsite data (Winder and others, 2025), and calibration will be most effective if done for each source independently.

When using digital mobility data to estimate visitation, the best estimates will be produced by using multiple sources of data. Individual mobility data sources represent a nonrandom sample of visitors, and research indicates that different mobility data sources are biased toward different groups of visitors (Wood and others, 2020; Wilkins, Wood, and Smith, 2021; Ghermandi, 2022; Lawson and others, 2023; Whitney and others, 2023). Therefore, combining multiple data sources can increase representativeness and capture a larger proportion of the total user population. This is supported by studies observing that visitation estimates produced using multiple mobility data sources are more accurate than estimates based on any single source (Winder and others, 2025).

The technique for calibrating multiple mobility data sources involves developing an equation (for example, a simple linear regression) that quantifies the relationship between observed visitation and multiple mobility data sources as predictor variables (Merrill and others, 2020; Wood and others, 2020). These models commonly control for other factors, such as access and seasonality, that are known to have predictable relationships with visitation (refer to the "Mobile Device Location Data" section for further details). Importantly, these models are best suited for sites or time periods where onsite counting is not feasible; if onsite counts are available, they should be used because they are likely to be more accurate estimates. Ideally, model development involves cross-validation to test model predictions against out-of-sample data. Training the model on only a portion of the onsite data and then testing its performance on the held-out portion of data is an essential step for avoiding model overfitting and evaluating the transferability of the model to sites or time periods without onsite data (Merrill and others, 2020; Wood and others, 2020).

Most of the geolocated data types discussed in the "Novel Methods" section (including social media, LBS, and community science data that rely on GPS locations) are associated with recreation sites by defining and delineating the site boundaries using geographic information system software. The data that are geographically tagged within the shape defined by those boundaries (known as a polygon) are assigned to the site. This process can introduce errors if there is imprecision in the polygons. For example, if a highway runs alongside a recreation site, it is possible that part of the road might be included within an imprecisely drawn polygon, which could result in people driving on the road but not visiting the site being misidentified as visiting the site. There is also inherent imprecision in GPS-based locations that could have the effect of erroneously adding or subtracting visitors from a dataset if they are detected close to a polygon border. Errors caused by these issues can be mitigated by the careful drawing of polygon borders, inspection of the extracted data for obvious outliers, and calibration with onsite data.

Any novel data source that uses geolocated data from individuals, for example, social media and mobile device location data, potentially contains personally identifiable information (Li and Goodchild, 2013) and there are best practices for storing and processing the data to preserve the privacy of individuals (Zook and others, 2017). Consent, anonymization, and aggregation are three primary best practices to protect privacy (Di Minin and others, 2021). Consent to share data should always be obtained from individuals, a process that will be different for different data sources. For example, LBS data should be sourced from apps that have asked for and received permission from the user to collect and share location data. Similarly, a community science program should inform participants of what data they are sharing and receive consent. Social media platforms will generally include data-sharing clauses in their terms and conditions that a user must accept before using the platform. Anonymizing data means never collecting any personally identifiable information or removing that data from the dataset. For example, in a mobile device location dataset, each device location should be associated only with an anonymized user identification that cannot be tied to their identity. Finally, data aggregation is another step to ensure privacy for individuals contributing data. Even anonymized data should not be shared or published in an unaggregated form; computing the number of user-days, as discussed earlier in this section, is a common aggregation method (Wood and others, 2013). The development of a publicly available code of conduct or other set of guidelines for dealing with personally identifiable information would help researchers and managers avoid unethical practices and alleviate concerns that the public has regarding the use of personal data (Zook and others, 2017).

Implementing a Visitation Estimation Method

Visitation data can inform agencies' decisions about how to manage recreational resources to meet the needs of visitors, provide positive and safe visitor experiences, and maintain the quality of natural resources. Different types of management decisions (for example, implementing a permit system, staffing a recreation area, or developing infrastructure) may require different data; ideally, the decision(s) will then inform the selection of a visitation estimation method. When implementing or redesigning a visitation monitoring program, factors to consider when choosing a monitoring method and data source include the budgets and staff resources, level of training required, feasibility of collecting the data, and accuracy of the data in that particular setting. This section provides considerations of the various visitation estimation methods described in this report and then outlines cost considerations. In general, the factors discussed in this section apply to situations where the monitoring program is used to create estimates for entire units, which can be aggregated to total visitation for an agency. Estimating visitation at a smaller scale, for example, at an individual trailhead, may generally follow the guidance presented here, but the highly heterogeneous nature of these smaller-scale estimation projects means that the considerations presented might not apply or may apply differently.

Every visitation estimation method has advantages and disadvantages to consider when determining the most appropriate method for different situations (Muhar and others, 2002; Ziesler and Pettebone, 2018; Andrew and others, 2021; Dagan and others, 2024; refer to table 6). Among the key considerations is the accuracy of the method and the ability to apply it consistently at different locations and over time. For each method, it is important to understand how much error is associated with a visitation estimate, both to gauge the level of confidence in estimates that are used in decision-making, and to judge ground-truth measures for calibrating other data sources. Additionally, there are operational considerations, such as the level of training, staff time, and cost required, all of which can present major barriers to implementing visitor monitoring programs (Dagan and others, 2024).

The potential benefits and costs of different estimation methods are affected by the characteristics of the recreational site. In many situations, established methods and devices, such as traffic counters or visitor surveys, may be the most reliable and cost effective. Specifically, in locations with controlled access points and trained staff, automated and inferred counts are often a cost-effective method for producing accurate visitor counts (refer to the FWS case study in the "Case Studies" section of this report). Conversely, digital mobility data and remotely sensed data (described in the "Novel Methods" section) may be more advantageous for situations where recreation is dispersed over large areas or sites with porous access (that is, multiple entrances and exits that would be difficult to monitor using direct observation or other onsite counting methods such as passive sensors or surveys). This is because, in part, monitoring porous areas with passive sensors requires complex adjustments to avoid double counting and to account for people entering and exiting through different access points, which in turn requires intensive onsite data collection. Nonetheless, digital mobility data do not fully alleviate the need for onsite counts, because the data require calibration using onsite data from other sites or time periods (as detailed in the "Novel Methods" section).

Another factor that can affect the choice of methods is the level of total visitation to a site. Digital mobility data sources represent a fraction of total visitors (refer to the "Social Media Data" and "Mobile Device Location Data" sections), and sites with low visitation often lack enough digital mobility data to provide estimates using these data alone (Wood and others, 2020; Winder and others, 2025). At low-use sites, community science approaches may be especially useful, particularly in remote or hard-to-reach locations where visitors can volunteer to collect onsite counts that would otherwise require a large investment in field staff for data collection. Indeed, this is the conclusion reached by Lia and others (2023), who found that up to 12 percent of visitors to sites in one national forest would voluntarily contribute visitor count data at low-use sites, demonstrating how community science is a valuable option for monitoring recreation.

Cellular connectivity is an important consideration when choosing among data collection methods. Many of the automated and inferred methods described in table 6 do not rely on connectivity, such as self-registration boxes and some automated counters, but other automated counters can take advantage of cellular connections to transmit data to centralized cloud data storage. Some self-registration methods for recreation, such as those found on the Federal outdoor recreation registration website (https://www.recreation.gov/; including web pages for camping, day-use permits, tours, and boating), also require visitors to access the internet at the site or before they begin their trip. As discussed in the "Social Media Data" and "Mobile Device Location Data" sections, connectivity is an important consideration for using mobile device location data, because sites with greater connectivity are likely to have larger volumes of data from visitors. This increase in data is because the amount and accuracy of LBS-derived data is related to which mobile applications visitors are using and whether those applications can cache location data when there is no cellular coverage. Conversely, in very urban settings, especially those with tall buildings, GPS connectivity can be poor because antennas in mobile devices can fail to connect to satellites consistently, meaning that visitors to urban parks may not be detected. GPS data also have spatial errors that can introduce noise in calculations based on the detection of visitors who travel along site boundaries. Refer to the data assessments in the "Novel Methods" section for more details on how connectivity may affect how well digital mobility datasets represent visitation.

Visitation estimation methods differ in their technical requirements and the types of technical capacity that are required to collect, store, and process data. Methods that rely on data from social media and mobile device LBS can require data science skills to implement effectively. The specific skills that are necessary depend on the data source and the size of the dataset, which is related to the number of locations and the geographic extent of the area being monitored. As the "Social Media Data" and "Remote Sensing Data" sections describe, acquiring digital mobility data often requires the use of custom computer programs for requesting information from an API. In other cases, data may be acquired as a bulk download or through a web-based user interface. Depending on the size of the mobility dataset, which can range from several gigabytes to hundreds of terabytes, data engineering and computer programming skills may be required to perform the data calibration and statistical modeling described in the "Novel Methods" section.

To reduce heterogeneity in the accuracy and precision of visitation estimates spatially and temporally (as discussed in the "Social Media Data" and "Mobile Device Location Data" sections), it is important to consider if a visitation estimation method can be implemented consistently over time and across the locations of interest. It may be particularly difficult to ensure that data collection and estimation methods are implemented with consistency by different individuals or within multiple offices or management units. Changes in staffing levels and staff turnover could also lead to different levels of consistency, particularly with methods that require higher levels of training, such as those that rely on digital mobility data sources (table 6). Clear protocols, guidance, and regular training can mitigate this issue, or a method that is more temporally consistent, such as onsite counting using sensors, could be used instead.

All these considerations have implications for the cost of visitation estimation. Every visitation estimation program involves up-front costs for staff to identify sites, select methods, decide which data sources should be used, and create data collection protocols and sampling designs. This may require significant time for market research if the method is reliant on automated sensors, remote sensing, or digital mobility data purchased from a vendor. Other methods, such as using data from community science or direct observation by human observers, would not have significant (if any) market research costs. Often, the process of scoping methods and determining which data sources to use is best informed by designing and implementing small pilot projects, which have associated costs.

Programs using direct observations and automated counting methods will have costs associated with purchasing and maintaining hardware such as vehicle or trail counters, and the cost of staff to collect data in the field. These operational costs are also inherent to any effort using digital mobility data because some onsite counts are needed to calibrate estimates based on the mobility data, although this approach can reduce the overall burden on field staff. As table 6 shows, the potential reduction in costs associated with onsite data collection comes with trade-offs and costs associated with the acquisition and analysis of the digital mobility data.

Programs that incorporate digital mobility data will have a direct cost to purchase data from a third-party vendor and costs associated with paying staff or contractors with the technical expertise to collect, store, process, and analyze the data. Exact costs to purchase data vary by vendor, product, geographic extent, temporal extent, and the terms of use. Contracts and prices are negotiated on a case-by-case basis and are likely to differ by requesting organization (for example, a Federal agency, local government, university, or nonprofit organization), so market research and a request for proposals is often required to determine exact costs and solicit a vendor. Beyond the cost of buying data, staff or contractors are required to receive, clean, and process the data to transform it into a usable form such as user-days. Beyond the personnel time, cloud computing resources may be required if the volume of data is too large to be stored and processed on computer workstations. The cost to store and back up data, whether on a cloud-based system or on local hardware, is also a consideration when evaluating program options.

Case Studies

In this section, we present three case studies of visitation estimation from the NPS, FS, and FWS. Each example showcases an advancement in monitoring approaches that goes beyond the use of traditional methods. The goal is to illustrate how new approaches, whether by using novel data sources or other sampling strategies, can improve numerical estimates or answer specific management questions.

Case Study 1—Estimating visits to national parks with onsite counts and mobile device data

Case study 1 was written in collaboration with Pamela Ziesler (NPS)

Gateway Arch National Park in Saint Louis, Missouri, is a 91-acre park on the banks of the Mississippi River. Attractions within the park include the iconic Gateway Arch, the visitor center under the arch, Saint Louis' Old Courthouse, and a large greenspace with walkways, plantings, ponds, and other amenities that contribute to the park's popularity with local and nonlocal visitors. More than 2.4 million people visited the park in 2023. Gateway Arch National Park and its philanthropic partner, the Gateway Arch Park Foundation, engaged a contractor in 2023 to improve their method of estimating the number of monthly visits to the park. Previous estimation methods combined onsite counts at the park's visitor center and the Old Courthouse with a small expansion

multiplier to estimate grounds-only visits not captured at either of those two locations. The original multiplier does not appear to have been developed empirically and was likely an informed estimate. Significant renovations to the park layout also required a renewal of the grounds-only estimate.

The study combined two datasets: (1) mobile device track data and (2) a reliable and regular onsite visit count at the security checkpoint in the visitor center. The mobile device dataset preserved the device tracks but scrubbed the data of all personally identifying information. For each unique and anonymous device identifier, the dataset provided a latitude and longitude collection for each device trip and the time and date stamps for each observation in a trip. Although the mobile device data offered insights into individual movement patterns in the park, these data provided only a sample of visits to the park. In addition, although the visitor center onsite count was a complete census of visits at a specific point in the park, it did not capture all visits to the park. Although neither dataset could be used on its own to estimate total use in the park, taken together they were used to build an estimate of total use.

To build this total use estimate, the study team overlaid a map of the park grounds with cleaned mobile device track data. Device tracks that were not considered park visits (for example, passing traffic) were removed. The remaining tracks were then split between those that included a visit to the visitor center security point and those that did not. From this information, the study team developed a new expansion multiplier from the visitor center count to estimate grounds-only visits. Following the study, recreation visits are estimated using the security count at the visitor center, an estimate of grounds-only visitors who are entering the park grounds but not the visitor center (1.1 times the visitor center count), and additional visitor counts for special events to the park that are not captured in the visitor center or grounds-only counts (NPS, 2023).

Case Study 2—Using subunits to address manager needs under the U.S. Department of Agriculture Forest Service National Visitor Use Monitoring Program

Case study 2 was written in collaboration with Eric M. White (FS) and Sarah Cline (FS)

In the typical implementation of the FS NVUM program, estimates of recreation use and visitor characteristics are developed for an entire administrative unit, usually a national forest. However, the NVUM sampling approach provides a monitoring framework that is adaptable to geographies other than the entirety of a national forest. Beginning in the 2005 monitoring cycle and continuing through the 2009 monitoring cycle, the NVUM program allowed national forests to opt-in to additional sampling at one or more subunits within the national forest to meet custom information needs. Subunits typically represent areas of a national forest that (1) are subject to different governance (for example, national monuments), (2) have a unique management focus (for example, national recreation areas), (3) are ecologically different from the rest of the forest (for example, grassland areas), (4) were previously independent national forests but became administratively combined into a larger unit, or (5) are the focus of a planning effort. In fiscal year 2024, one of the 24 national forests undergoing NVUM sampling used a subunit; in fiscal year 2023, eight of the sampled national forests used subunits.

Those national forests opting into subunit monitoring receive additional onsite NVUM sampling to produce sufficient data to estimate recreation use and visitor characteristics for both the subunit(s) and the entire national forest. Subunits must be places where the NVUM sampling approach can be applied; each subunit must be a contiguous polygon area with potential interview locations that capture departing recreation traffic. These interview locations can be distinct recreation sites, such as campgrounds, trails, or roads used by visitors recreating in undeveloped areas. For a simple subunit with only undeveloped recreation, where visitation does not change much during the year, a subunit may require just 10–20 days of additional sampling. More typically, however, subunits are complex landscapes with diverse recreation site types and levels of use and can require 100 or more additional sample days.

For managers, subunits provide the opportunity to better understand how recreation differs (or not) across the forest, implement management actions that respond to localized needs, and report on recreation use patterns for areas that are of political or administrative interest. In some cases, subunits are created and only monitored in a forest once, such as those subunits established for short-term planning purposes or because two national forests merged just before NVUM sampling (and each previous forest is temporarily considered a subunit). But more commonly, subunits are long-term investments in recreation monitoring. For example, the subunit of Spring Mountains National Recreation Area in the Humboldt-Toiyabe National Forest in Nevada is monitored repeatedly because of the unique recreational use this subunit provides compared to the rest of the national forest (table 7). Information about recreation within that subunit is used by the national forest manager to fulfill reporting requirements, including the biennial FS monitoring program. Funding the additional sampling effort remains a challenge for managers interested in using a subunit as part of their NVUM monitoring. However, the use of subunits may become ever more pertinent in coming years as managers and policymakers try to understand recreation patterns in specific areas of the landscape, such as areas with wildfires, focused investment in restoration, or unique forest characteristic reporting requirements, including the biennial FS monitoring program.

Case Study 3—Onsite counting and collaborative data collection in Okefenokee National Wildlife Refuge in Georgia and Florida

Case study 3 was written in collaboration with Matthew Brownlee (Clemson University)

Okefenokee National Wildlife Refuge covers more than 400,000 acres in southeast Georgia and northeast Florida. The refuge's wet prairies and forested cypress swamps contain a variety of plants and wildlife, and visitors to the refuge can participate in activities such as wildlife watching, hiking, camping, boating, hunting, and fishing. The refuge receives more than 600,000 visits annually, approximately 10 percent of which are international visitors. The refuge's visitation estimation program involves direct observation and use of data from collaborative stakeholders.

The success of the refuge's visitor monitoring program is attributable to several factors. First, visitors' access to the refuge is through a limited number of controlled entrances, most of which can be monitored by field staff from the managing agency, the FWS. Field staff can count many visits using vehicle counters placed strategically at various entrances to the refuge. These automated counters provide a baseline figure of visits by vehicle, offering consistent and reliable data over time.

Vehicle counters in the refuge do not capture all visitation (because some visitors use entrances not controlled by the FWS), and during peak periods the counts may not accurately reflect the high volume of visits. Therefore, in addition to direct traffic counts taken by FWS staff, the system benefits from collaboration with key stakeholders, including the Georgia Department of Natural Resources staff that manages Stephen C. Foster State Park, which is contained entirely within the boundaries of the refuge. Additional stakeholders include Okefenokee Swamp Park and Adventures, a private nonprofit organization that borders the park and provides meaningful access to the refuge. These two entities contribute their own counts of visits entering through their facilities, ensuring that all access points to the refuge are monitored for visitation measurements. Concessionaires operating within the refuge also provide vital count data, particularly those engaging in boat tours, rentals, and other guided activities. Some data from FWS, concessionaires, the Stephen C. Foster State Park, and private organizations provide more granular estimates about the use of specific facilities and locations within the refuge. Redundant counting of visits (for example, overestimation) is unlikely because of the great distances between controlled entrance points, which decreases the likelihood of a daily visitor accessing the refuge through multiple entry points on a single day.

These visitor counts, whether from vehicle counters, partner organizations, or concessionaires, are combined by FWS personnel and carefully adjusted to create the most accurate visitation estimation possible. The adjustments consist of multipliers, such as the average number of visitors per vehicle, or census counts for large events, such as school groups from local educational institutions. This multipronged system of data collection ensures that Okefenokee National Wildlife Refuge obtains a precise understanding of visits, allowing for better management and preservation of the refuge's unique ecosystem.

Opportunities

This section describes key opportunities to improve the comparability of visitation and activity data across agencies, increase access to visitation data, and better understand applications of novel methods for visitation estimation. Implementing these opportunities may enable improved visitation estimation that will better inform the managers of Federal public lands and waters. In addition, several of these opportunities address recent legislative activity (for example, the Expanding Public Lands Outdoor Recreation Experiences [EXPLORE] Act Sec. 132 and 133 (16 U.S.C. 8442 and 8443)) in advancing comprehensive, real-time recreation data; consistent visitation data management and modeling; interagency standards for recreational data collection and dissemination; and developing standard interagency categories of recreation activities.

Table 7. Example National Visitor Use Monitoring (NVUM) results from sampling on the Humboldt-Toiyabe National Forest, Nevada and California, and the associated Spring Mountains National Recreation Area subunit, Nevada, 2016.

[Data from Eric M. White and Sarah Cline (U.S. Department of Agriculture Forest Service, written commun., 2024). %, percent]

Monitoring item	Within the Spring Mountains National Recreation Area	Elsewhere in the Humboldt-Toiyabe National Forest
Visits annually	516,000	1,228,000
Activities (percentage of visits)	• Hiking (45%) • Downhill skiing (11%) • Picnicking (9%) • Other activities (35%)	• Hiking (48%) • Downhill skiing (21%) • Viewing nature (6%) • Other activities (25%)

Visitation Estimation Metrics

Although visitation data collection methods are necessarily variable because of the diversity of recreation sites on Federal lands and waters, agencies could establish a core set of consistently defined management concepts to enable more meaningful comparisons or aggregations of visitation estimates across agencies. This follows recommendations by Leggett and others (2017), who suggested forming an interagency working group to develop consistent definitions for terms such as "visit," "visitor-hours," and "visitor-days." Although all agencies report "visits," the term "visit" is not consistently defined by different agencies (table 2), and therefore, the visit numbers reported by one agency are not necessarily comparable to visit numbers reported by another. As was the case in 2017, there are still differences across agencies regarding the counting of multiday trips, persons entering and exiting a site multiple times, persons who only stop at the site for a few minutes (for example, to use a restroom or ask for directions), persons who pursue multiple recreational activities on a single day, and persons who enter multiple Federal sites in a single day. Consistently applied definitions for "accuracy" and "error" for visitation estimates would also facilitate comparisons and aggregations across agencies. There has not been a comprehensive study of the root cause of this variation or the barriers to reducing heterogeneity. Because agencies have used their own definitions to estimate visitation for many years, there may be concerns that modifying the definitions would affect comparability within agency-specific time series. In addition, there may be costs associated with changing to more uniform definitions. In the absence of consistently defined visitation estimation metrics, agencies could collaborate to establish methods to convert definitions.

Common Activities

As shown in table 5, the set of activities defined and counted in recreation monitoring differs from agency to agency. Because of the diversity of Federal lands and waters and the experiences offered, each agency has some activities that are more prevalent in the agency's areas. For example, NOAA ONMS has more categories for water-related recreation activities, and BLM has more categories for motorized recreation activities. However, there are many common recreational activities provided across all seven Federal agencies that could be monitored in a more consistent manner. The EXPLORE Act directs agencies to establish categories of recreation activities to be reported consistently (16 U.S.C. 8442(a)). Developing a standard set of activities monitored across all Federal agencies could offer a range of benefits, including:

- Supporting comparison and aggregation of data across agencies at the regional or national level;
- Minimizing confusion and discrepancies in recording and interpreting data;
- Supporting collective identification of recreation trends at the local, regional, or national level for specific activities and timing, and facilitating adaptive management in response to trends;
- Managing local and regional environmental effects of specific activities;
- Alleviating supply and demand imbalances across areas that are over- or under-used by visitors, and supporting informed decisions on staffing and budgeting;
- Understanding regional visitor preferences, and supporting planning for future recreation areas and amenities;
- Supporting cooperative interagency projects and initiatives such as developing trail systems, managing crowding, establishing targeted visitor education and outreach promoting sustainable recreation, and addressing effects on infrastructure, resources, and ecosystems;
- Coordinating diverse agency missions and management goals, for example, for areas with both recreational and nonrecreational uses;
- Streamlining public outreach, reporting (for example, reports to Congress), and analysis of recreation activities and management outcomes (for example, analysis to comply with regulatory requirements such as the National Environmental Policy Act [43 U.S.C. 1638]), complemented by consistent metrics and terminology; and
- Sharing tools, such as shared technology platforms for data collection, analysis, and reporting.

If Federal agencies were to adopt a core set of recreational activities monitored across all agencies, each agency could still choose to monitor additional activities that are important for the lands and waters they manage.

Open Visitation Data

Agencies could take several steps to disseminate and improve accessibility to visitation data. The Open Government Data Act, which is Title II of the Foundations for Evidence-Based Policymaking Act of 2018 (Public Law 115-435), and the OMB's principles of open data (OMB, undated) provide agencies with broad guidance for storing and disseminating data about visitation on Federal public lands and waters. The policy and principles state that visitation data should not only be public, but also accessible, described, reusable, complete, timely, and managed after release.

As a first step, agencies could consider making unit-level visitation estimates available to the public. As of 2024, four of the seven agencies that we reviewed disseminate visitation estimates for individual units publicly; the NPS, FS, and Corps disseminate their information through custom web-based user interfaces, and the NOAA ONMS disseminates visitation estimates through reports about individual sites (when estimates are produced). The other agencies do not currently (as of 2024) make unit-level estimates that are consistently available to the public. Next, agencies could put concerted effort into improving the accessibility of visitation data. Specifically, according to the Federal Open Data Policy guidance, visitation data should be disseminated in common and machine-readable file formats, such as comma-separated values (OMB, 2013). Furthermore, it would be beneficial to make data files searchable and accessible using programmatic methods, for example, through an API, instead of user interfaces that require users to perform a series of manual steps to query and download information.

Inconsistencies in how agencies define and measure visitation and the lack of documentation of methods, as described in the "Comparison of Definitions and Methods Used Across Agencies" and "Agency Summaries" sections of this report, underscore the need for data to be better described with metadata that details collection methods, temporal scale, and definitions of recreational visits. There is also value in agencies producing metadata that are consistent across agencies and complete. Additionally, policy and guidance state that metadata should be machine-readable and available to download independently of datasets containing visitation estimates (OMB, 2013).

These objectives might be best achieved by developing a single visitation data reporting system to report accurate annual visitation data for each unit of Federal recreational lands and waters, which is a requirement of the Expanding Public Lands Outdoor Recreation Experiences (EXPLORE) Act (16 U.S.C. 8442 (a(1))). This data repository would ideally contain annual visitation estimates for all Federal recreational lands and waters, be publicly accessible, and be updated in a timely manner.

Areas for Further Study

There is a growing amount of research on visitation estimation methods, especially using novel data sources. Yet, there are gaps in our understanding and methods that have not been addressed (Wilkins and others, 2024). Studies investigating the following topics would be particularly beneficial to inform the field of practice:

- Monitoring dispersed recreation, including in marine and urban environments,
- Using satellite or other remote-sensing technologies to estimate visitation,
- Combining multiple novel data sources into single visitation estimates,
- Evaluating the return on investment in novel data sources (for example, understanding cases when novel data sources might be more cost effective than traditional data collection),
- Estimating visitor reentry rates and multidestination itineraries,
- Measuring and comparing the accuracy (for example, error estimates for visitation numbers) and applicability of proven technology and new methods,
- Estimating visitation in areas with multiple entry points,
- Improving sampling techniques for visitor surveys (for example, frame and stratification),
- Measuring the effects of weather and environmental hazards on visitation,
- Measuring the effects of management actions on visitation,
- Monitoring visitation in low-use areas; and
- Estimating and publishing visitation data in real time.

In addition, an improved understanding of how visitation data are used in decision-making could help ensure visitation estimates are useable and relevant. This could be achieved through collecting case studies or surveying staff at various levels (for example, site manager, regional director, or director) within Federal agencies. Reviewing methods used by other Federal agencies for similar types of questions could also be insightful, for example, reviewing how other agencies monitor transit numbers, urban mobility, or disease transmission could provide new perspectives that could be useful for visitation estimation.

Legislative Activity

Since the publication of the report on visitor estimation by Leggett and others (2017), this topic has received congressional attention (app. 1). In January 2025, the EXPLORE Act (Public Law 118-234) was signed into law with bipartisan support to "improve recreation opportunities on, and facilitate greater access to, Federal public land" (U.S. Congress, 2025, p. 2) The EXPLORE Act includes several provisions related to visitation data and estimation. These provisions call for a single reporting system for visitation data across units of Federal lands and waters as well as land held in trust for Tribes (on request of the Tribe), a pilot program that publicly reports real-time or predictive visitation data for selected units and information about nearby lesser-known

recreation sites, more comprehensive recreation use data, and pilot protocols to model recreation use patterns not effectively measured by existing data collection methods (for example, in low use or dispersed use areas). The EXPLORE Act also contains a provision directing agencies to establish categories of recreation activities reported consistently across agencies. In addition, the Modernizing Access to Our Public Land Act (Public Law 117-114), which was signed into law in April 2022, calls for the Secretaries of Agriculture, Interior, and Army to collectively "develop and adopt interagency standards" (U.S. Congress, 2022, p. 1) for the collection and dissemination of data related to recreational use on Federal lands. Themes of more comprehensive recreation data, real-time data, consistent visitation data management and modeling, interagency standards for recreation data collection and dissemination, and tracking standard interagency categories of recreation activities are echoed in multiple pieces of legislation introduced by the 117th and 118th Congresses. It should be noted that agencies already possess the authorities to manage the actions described in these bills; therefore, should agencies collectively agree to collect more comprehensive recreation data or real-time data, establish more consistent approaches to visitation estimation and data management, or track recreation use for standard categories of recreation activities, they would not require congressional action to do so.

Conclusion

This report reviews established methods and emerging technologies for estimating recreational visitation on federally managed lands and waters. Accurate visitation data support effective resource management, policy-making, estimating economic benefits, and planning for visitor services. Traditional data sources such as onsite visitor counts, visitor surveys, and administrative data remain the foundation for visitation estimation, and emerging sources and technologies may improve accuracy, efficiency, and the scope of estimates.

Emerging data and methods discussed in this report, such as mobile device location data, social media analysis, and community science data, offer managers options for addressing the challenges posed by the diversity and scale of land types and visitor behaviors on public lands and waters. However, emerging techniques require attention to address issues like data privacy, ground-truthing, and the variability in data quality over time and across geographies. In addition to refining approaches to visitation estimation, greater interagency coordination and standardization of methods could allow for more comprehensive, comparable, and available data.

Finally, we discussed how Federal agencies and other stakeholders could develop studies and research initiatives to incorporate emerging technologies and refine existing methodologies. These projects could provide a test of proposed approaches and lead to additional standard methods to improve how managers monitor and understand visitation patterns, make resource-management decisions, and contribute to the well-being of the communities surrounding these treasured public spaces. This would support consistent and efficient management of Federal natural and cultural resources and programs throughout the United States, and the long-term sustainability of public lands for future generations.

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Appendix 1. Relevant Legislation

Table 1.1 contains legislative text that addresses visitation data for Federal lands and waters, as excerpted from legislation introduced during the 117th and 118th United States Congresses.

Table 1.1. Legislative activity relating to visitation data during the 117th U.S. Congress (January 2021–January 2023) and the 118th U.S. Congress (January 2023–January 2025).

Timing	Title	Relevant text
118th Congress (Legislation became law on January 4, 2025)	Expanding Public Lands Outdoor Recreation Experiences (EXPLORE) Act (Public Law 118-234)	Section 132 of the EXPLORE Act is the same as the "Improved recreation visitation data" section of the 118th Congress' version of the Gateway Community and Recreation Enhancement Act. Section 133 of the EXPLORE Act is the same as Section 3 of the Recreation for All Act.
118th Congress (Legislation introduced on November 18, 2024)	Review and Evaluation of Strategies for Equitable Reservations for Visitor Experiences (RESERVE) Federal Land Act (H.R. 10162; U.S. House of Representatives, 2024, p. 3)	Section 3. National academy of sciences study of Federal reservation systems for recreational activities on Federal land. "(a) Study.— (1) IN GENERAL.—The Secretaries, acting jointly, shall, not later than 60 days after the date of enactment of this Act, enter into an agreement with the National Academy of Sciences to carry out a study of Federal reservation systems for recreational activities on Federal land. (2) REQUIREMENTS.—In carrying out the study under paragraph (1), the National Academy of Sciences shall consult with the Secretaries to carry out the following: (A) A review of the history of Federal reservation systems, such as recreation.gov, including a review of— (i) the considerations, including data, that led to the establishment of the applicable Federal reservation system… (B) Based on available data and existing research, answer the following questions…(ii) What data are available, and what additional data are needed, to understand demand for recreation on Federal land? How can the data be used to balance visitor management and conservation goals?…"
118th Congress (S. 3123 introduced on October 25, 2023; H.R. 6127 introduced on November 1, 2023)	Modernizing Access to Our Public Waters Act (H.R. 6127; U.S. House of Representatives, 2023b, p. 3; S. 3123; U.S. Senate, 2023c, p. 3)	Section 3. Interagency Data Standardization "Not later than 30 months after the date of enactment of this Act, the Secretaries shall jointly develop and adopt interagency standards to ensure compatibility and interoperability among applicable Federal databases with respect to the collection and dissemination of geospatial data relating to public outdoor recreational use of Federal waterways and Federal fishing restrictions."
118th Congress (Legislation introduced on April 27, 2023)	Recreation for All Act (S. 1385; U.S. Senate, 2023d, p. 3)	Section 3. Monitoring for improved recreation decisionmaking. "(a) IN GENERAL.—The Secretaries shall seek to capture comprehensive recreation use data to better understand and inform decisionmaking by the Secretaries. (b) Pilot protocols.—Not later than 1 year after the date of enactment of this Act, and after public notice and comment, the Secretaries shall establish pilot protocols at not fewer than 10 land management units under the jurisdiction of each of the Secretaries to model recreation use patterns (including low-use recreation activities and dispersed recreation activities) that may not be effectively measured by existing general and opportunistic survey and monitoring protocols."
118th Congress (Legislation introduced on March 16, 2023)	America's Outdoor Recreation Act of 2023 (S. 873; U.S. Senate, 2023a, p. 63)	Section 144 of America's Outdoor Recreation Act of 2023, "Improved recreation visitation data" is the same as the "Improved recreation visitation data" section in the 118th Congress' version of the Gateway Community and Recreation Enhancement Act. Section 145. Monitoring for improved recreation decision making. "(a) In general.—The Secretaries shall seek to capture comprehensive recreation use data to better understand and inform decision making by the Secretaries. (b) Pilot protocols.—Not later than 1 year after the date of enactment of this Act, and after public notice and comment, the Secretaries shall establish pilot protocols at not fewer than 10 land management units under the jurisdiction of each of the Secretaries to model recreation use patterns (including low-use recreation activities and dispersed recreation activities) that may not be effectively measured by existing general and opportunistic survey and monitoring protocols."

Table 1.1. Legislative activity relating to visitation data during the 117th U.S. Congress (January 2021–January 2023) and the 118th U.S. Congress (January 2023–January 2025).—Continued

Timing	Title	Relevant text
118th Congress (S. 390 introduced on February 13, 2023; H.R. 3200 introduced on May 10, 2023)	Gateway Community and Recreation Enhancement Act (S. 390; U.S. Senate, 2023b, p. 5; H.R. 3200; U.S. House of Representatives, 2023a, p. 6)	Section 4.[1] Improved recreation visitation data. "(a) Consistent visitation data.— (1) ANNUAL VISITATION DATA.—The Secretaries shall establish a single visitation data reporting system to report accurate annual visitation data, in a consistent manner, for— (A) each unit of Federal recreational lands and waters; and (B) land held in trust for an Indian Tribe, on request of the Indian Tribe. (2) CATEGORIES OF USE.—Within the visitation data reporting system established under paragraph (1), the Secretaries shall— (A) establish multiple categories of different recreation activities that are reported consistently across agencies; and (B) provide an estimate of the number of visitors for each applicable category established under subparagraph (A) for each unit of Federal recreational lands and waters. (b) Real-Time Data Pilot program.— (1) IN GENERAL.—Not later than 2 years after the date of enactment of this Act, using existing funds available to the Secretaries, the Secretaries shall carry out a pilot program, to be known as the "Real-time Data Pilot Program" (referred to in this section as the "Pilot Program"), to make available to the public, for each unit of Federal recreational lands and waters selected for participation in the Pilot Program under paragraph (2)— (A) real-time or predictive data on visitation (including data and resources publicly available from existing nongovernmental platform) at— (i) the unit of Federal recreational lands and waters; (ii) to the extent practicable, areas within the unit of Federal recreational lands and waters; and (iii) to the extent practicable, recreation sites managed by any other Federal agency, a State agency, or a local agency that are located near the unit of Federal recreational lands and waters; and (B) through multiple media platforms, information about lesser-known recreation sites located near the unit of Federal recreational lands and waters (including recreation sites managed by any other Federal agency, a State agency, or a local agency), in an effort to encourage visitation among recreational sites. 2) LOCATIONS.— (A) INITIAL NUMBER OF UNITS.—On establishment of the Pilot Program, the Secretaries shall select for participation in the Pilot Program—(i) 10 units of Federal recreational lands and waters managed by the Secretary; (ii) 5 units of Federal recreational lands and waters managed by the Secretary of Agriculture (acting through the Chief of the Forest Service); (iii) 1 unit of Federal recreational lands and waters managed by the Secretary of Commerce (acting through the Administrator of the National Oceanic and Atmospheric Administration); and (iv) 1 unit of Federal recreational lands and waters managed by the Assistant Secretary of Army for Civil Works. (B) REPORT.—Not later than 6 years after the date of the enactment of this title, the Secretaries shall submit a report to Congress regarding the implementation of the pilot program, including policy recommendations to expand the pilot program to additional units managed by the Secretaries. (C) FEEDBACK; SUPPORT OF GATEWAY COMMUNITIES.—The Secretaries shall— (i) solicit feedback regarding participation in the Pilot Program from communities adjacent to units of Federal recreational lands and waters and the public; and (ii) in carrying out subparagraphs (A) and (B), select a unit of Federal recreation lands and waters to participate in the Pilot Program only if the community adjacent to the unit of Federal recreational lands and waters is supportive of the participation of the unit of Federal recreational lands and waters in the Pilot Program. (3) DISSEMINATION OF INFORMATION.—The Secretaries may disseminate the information described in paragraph (1) directly or through an entity or organization referred to in subsection (c). (4) INCLUSION OF CURRENT ASSESSMENTS.—In carrying out the Pilot Program, the Secretaries may, to the extent practicable, rely on assessments completed or data gathered prior to the date of enactment of this title. (c) Community partners and third-Party providers.—For purposes of carrying out this section, the Secretary concerned may— (1) coordinate and partner with— (A) communities adjacent to units of Federal recreational lands and waters; (B) State and local outdoor recreation and tourism offices; (C) local governments; (D) Indian Tribes; (E) trade associations; (F) local outdoor recreation marketing organizations; (G) permitted facilitated recreation providers; or (H) other relevant stakeholders; and

Table 1.1. Legislative activity relating to visitation data during the 117th U.S. Congress (January 2021–January 2023) and the 118th U.S. Congress (January 2023–January 2025).—Continued

Timing	Title	Relevant text
118th Congress (S. 390 introduced on February 13, 2023; H.R. 3200 introduced on May 10, 2023)—Continued	Gateway Community and Recreation Enhancement Act (S. 390; U.S. Senate, 2023b, p. 5; H.R. 3200; U.S. House of Representatives, 2023a, p. 6)—Continued	(2) coordinate or enter into agreements, as appropriate, with private sector and nonprofit partners, including— (A) technology companies; (B) geospatial data companies; (C) experts in data science, analytics, and operations research; or (D) data companies. (d) Existing programs.—The Secretaries may use existing programs or products of the Secretaries to carry out this section. (e) Privacy clauses.—Nothing in this section provides authority to the Secretaries— (1) to monitor or record the movements of a visitor to a unit of Federal recreational lands and waters; (2) to restrict, interfere with, or monitor a private communication of a visitor to a unit of Federal recreational lands and waters; or (3) to collect— (A) information from owners of land adjacent to a unit of Federal recreational lands and waters; or (B) information on non-Federal land. (f) Reports.—Not later than 1 year after the date of the enactment of this title, and annually thereafter, the Secretaries shall publish on a website of the Secretaries a report that describes the annual visitation of each unit of Federal recreational lands and waters, including, to the maximum extent practicable, visitation categorized by recreational activity. (g) DEFINITIONS.—In this section (1) FEDERAL RECREATIONAL LANDS AND WATERS.—The term "Federal recreational lands and waters"—(A) has the meaning given the term in section 802 of the Federal Lands Recreation Enhancement Act (16 U.S.C. 6801); and (B) includes Federal lands and waters managed by the National Oceanic and Atmospheric Administration and the U.S. Army Corps of Engineers. (2) SECRETARIES.—The term "Secretaries" means—(A) the Secretary, with respect to lands under the jurisdiction of the Secretary; (B) the Secretary of Agriculture, acting through the Chief of the Forest Service, with respect to lands under the jurisdiction of the Forest Service; (C) the Secretary of Commerce, acting through the Administrator of the National Oceanic and Atmospheric Administration, with respect to Federal waters under the jurisdiction of the National Oceanic and Atmospheric Administration; and (D) the Assistant Secretary of Army for Civil Works, with respect to lakes and reservoirs under the jurisdiction of the U.S. Army Corps of Engineers."
117th Congress (Legislation became law on April 29, 2022)	Modernizing Access to Our Public Land Act (Public Law 117-114; U.S. Congress, 2022, p. 1)	Section 3. Interagency Data Standardization "Not later than 30 months after the date of enactment of this Act, the Secretaries shall jointly develop and adopt interagency standards to ensure compatibility and interoperability among applicable Federal databases with respect to the collection and dissemination of data— (1) relating to public outdoor recreational use on Federal land; and (2) used to depict locations at which recreation uses are available to the public."

Table 1.1. Legislative activity relating to visitation data during the 117th U.S. Congress (January 2021–January 2023) and the 118th U.S. Congress (January 2023–January 2025).—Continued

Timing	Title	Relevant text
117th Congress (Legislation introduced on February 1, 2022)	Gateway Community and Recreation Enhancement Act (S. 3551; U.S. Senate, 2022, p. 2)	Section 3. Visitation pilot program. "(a) In general.—Not later than 2 years after the date of enactment of this Act, using existing funds available to the Secretaries, the Secretaries, in partnership with gateway communities, State and local outdoor recreation and tourism agencies, local governments, Tribal governments, data and technology companies, and other relevant stakeholders, shall carry out a pilot program for the purposes described in subsection (b). (b) Purposes.—Under the pilot program carried out under subsection (a), the Secretaries shall, with respect to each Federal land management unit selected for participation in the pilot program under subsection (c), make available to the public, either directly or through partner organizations—(1) data on visitation, including data and resources publicly available from existing nongovernmental platforms, at—(A) the Federal land management unit; and (B) to the extent available, recreation sites managed by any other Federal agency, a State agency, or a local agency located near the Federal land management unit; and (2) through different media platforms, information about lesser-known recreation sites (including recreation sites managed by any other Federal agency, a State agency, or a local agency) located near the Federal land management unit, in an effort to disperse visitation among recreational sites. (c) Locations.— (1) IN GENERAL.—The Secretaries shall select Federal land management units to participate in the pilot program carried out under subsection (a) in accordance with this subsection. (2) FEEDBACK; SUPPORT OF GATEWAY COMMUNITIES.—In selecting a Federal land management unit to participate in the pilot program carried out under subsection (a), the Secretaries shall—(A) solicit feedback from gateway communities; and (B) select a Federal land management unit that is supported by the applicable gateway community. (3) INITIAL NUMBERS OF FEDERAL LAND MANAGEMENT UNITS.— (A) IN GENERAL.—The Secretaries shall select for participation in the pilot program carried out under subsection (a)—(i) 15 Federal land management units managed by the Department of the Interior; and (ii) 5 Federal land management units managed by the Forest Service. (B) EXPANSION.—Not later than 5 years after the date of enactment of this Act, in addition to the Federal land management units selected for the pilot program under subparagraph (A), the Secretaries shall select for participation in the pilot program carried out under subsection (a) 80 additional Federal land management units managed by the Secretaries, not fewer than 50 of which shall be Federal land management units managed by the Department of the Interior. (d) Existing programs.—The Secretaries may use existing programs or products of the Secretaries to carry out this section. (e) Effect.—Nothing in this section authorizes the Secretaries— (1) to monitor or record the movements of a visitor to Federal land; (2) to restrict, interfere with, or monitor a private communication of a visitor to Federal land; (3) to take possession of any documents, data, or other personal effects of a visitor to Federal land; or (4) to collect—(A) information from owners of land adjacent to Federal land; or (B) information on non-Federal land."

Table 1.1. Legislative activity relating to visitation data during the 117th U.S. Congress (January 2021–January 2023) and the 118th U.S. Congress (January 2023–January 2025).—Continued

Timing	Title	Relevant text
117th Congress (Legislation introduced on November 18, 2021)	America's Outdoor Recreation Act of 2022 (S.3266; U.S. Senate, 2021, p. 21)	Section 203. Improved Recreation Visitation Data "(a) .—The Secretaries shall establish a single visitation data management and modeling system for public recreation to provide accurate, real-time visitation data, at a site-specific level and in a consistent manner, with respect to Federal land managed by each of—(1) the Chief of the Forest Service; (2) the Director of the Bureau of Land Management; (3) the Director of the Bureau of Indian Affairs, in coordination with Indian Tribes; (4) the Director of the National Park Service; (5) the Director of the United States Fish and Wildlife Service; and (6) the Commissioner of Reclamation. (b) .—For purposes of carrying out this section, the Secretary concerned shall coordinate or contract with private sector partners, including—(1) technology companies; (2) mapping companies; (3) experts in data science, analytics, and operations research; or (4) data companies. (c) .—The Secretaries shall coordinate with trade associations, State outdoor recreation offices, offices of tourism, and local outdoor recreation marketing organizations to design and deploy, for purposes of making data available under subsection (a), the optimum user interface that balances ease of use by the public with the available resources of the Secretaries. (d) .—The Secretaries and any partner described in subsection (b) may make use of smart phone technology for purposes of making data available under subsection (a). (e) .—Nothing in this section provides authority to the Secretaries—(1) to monitor or record the movements of a visitor to Federal land; (2) to restrict, interfere with, or monitor a private communication of a visitor to Federal land; (3) to take possession of any documents, data, or other personal effects of a visitor to Federal land; or (4) to collect—(A) information from owners of land adjacent to Federal land; or (B) information on non-Federal land. (f) .—To the maximum extent practicable, the Secretaries shall categorize the data collected under subsection (a) by recreational activity. (g) .—Information or data collected under this section shall be limited only to actual recreation visitation information for recreation sites managed by the Secretary concerned. (h) .—Not later than January 1, 2024, and annually thereafter, the Secretaries shall publish on a website of the Secretaries a report that describes the annual visitation of each unit of Federal land, including, to the maximum extent practicable, visitation categorized by recreational activity."

[1]Note this section is Section 5 in H.R. 3200 (text is the same).

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