



SCORP Data Methods Guide

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I. Introduction

First, the basics. What is data? Simply put, data is the raw, unprocessed collection of facts, figures, images, or observations that represent information about people, plants, animals, objects, events, or phenomena. Data collection is the approach we take to obtaining this information, and data analysis is the method by which data is organized and interpreted into meaningful insights for decision-making. SCORP supply and demand data collection and analysis methods fall into one of two categories: quantitative or qualitative data.

- **Quantitative data (The "What", "How many?", "How much?", and "How often?"):** This is numerical data and spatial analysis that can be objectively measured and counted. For example, what are the existing outdoor recreation assets such as parks, playgrounds and trails in a given area?
- **Qualitative data (The "Why?" and the "How?"):** This is non-numerical, descriptive information that captures opinions, preferences, emotions, or experiences. For example, insights from focus groups and interviews tell us about visitor values, motivations, and the quality of the experience on the ground.

The gold standard for planning is a mixed-methods approach where we collect both quantitative and qualitative data. For instance, pairing spatial analysis with a survey to understand what kind of recreation people want and where there are gaps in these opportunities. Oh yeah, and the Land and Water Conservation Fund (LWCF) Act requires you to understand Demand (typically qualitative) and Supply (typically quantitative) to develop SCORPs.

Table 1: Overview of Qualitative and Quantitative Methods

	Qualitative	Quantitative / Spatial Analysis
What it measures	Resident and provider values, preferences, and perceived needs	Physical supply of resources and population access gaps
Key methods	Surveys, focus groups, workshops, interviews	GIS mapping, service area analysis, demographic overlays
Strengths	Captures local knowledge; builds community trust	Identifies specific gaps; supports equity analysis; scalable
Best used for	Understanding demand and setting investment priorities	Understanding supply and identifying where investments are most needed

This guide primarily focuses on quantitative data methodologies that inform the supply analysis. It also includes methods for site-specific data collection which may be needed to ground truth big data (e.g., cell phone, social media) or to support site-specific investments. See the companion SCORP Public Engagement guide for qualitative data related to demand analysis.

Data 101*

Now, let's explore considerations for data collection and analysis. Hint: one size does not fit all!

*Data 101 information applies to qualitative methods as well. For conciseness, this information is not repeated in the SCORP Public Engagement Guide.

Rigor & Representativeness

When evaluating the quality of data for applicability to planning, we are often looking at two dimensions:

- **Rigor** - Rigorous data collection meets a high standard for research design, methodology, analysis, and reporting. The methods are standardized, transparent, and follow established protocols that are well-documented. This results in data that is trustworthy. For instance, instead of relying on a one-time visual estimate of a crowd, a rigorous approach utilizes a stratified random sampling design which employs standardized survey windows and peer-reviewed formulas to ensure results are statistically valid.
- **Representativeness** - Representativeness describes how well your data captures the "true" picture of your visitor population, including demographics and background characteristics. For instance, if you are conducting a recreation provider survey but only include providers who offer parks and playgrounds, your data will be missing the full range of recreation uses.

Bias

In our data collection and analysis, we always strive to minimize bias. "Bias" in this instance is not about personal prejudice but rather refers to the systematic errors where a dataset fails to accurately represent the entire visitor population due to the procedures, timing, or locations of data collection. When our data is biased, we may inadvertently prioritize the needs of a small group of visitors while ignoring others. While biases cannot always be eliminated, understanding and documenting them is an important step toward a defensible planning process.

Common sources of bias include:

- **Demographic bias:** Many "big data" sources, like social media and mobile app data, are prone to self-selection bias because they only capture information from people who use or contribute to those technologies. For instance, platforms such as Strava may overrepresent middle-aged, high-income, and fitness-focused users while significantly underrepresenting elderly and low-income users.

- **Activity bias:** Different tools are better at detecting certain activities than others. For instance, trail counters may undercount groups because they often record a cluster of people as a single "ping," leading to a systematic underestimation of family or social group use.
- **Non-compliance bias:** Tools like self-registration slips, trail logs, and even mandatory parking permits are often biased by low visitor compliance. If you are trying to estimate total use but only 40% of visitors register, your data will undercount total use and may only reflect the behavior of rule-abiding visitors.
- **Temporal and spatial bias:** This occurs when data collection is only conducted at specific times or places, such as peak summer weekends or popular visitor sites.

Sampling

One of the ways we improve both rigor and representativeness is to utilize random sampling approaches in data collection, when possible. *Random sampling* (probability-based sampling) means that every visitor has an equal chance of being included in your count or survey, which helps eliminate bias. Other types of probability-based sampling are *cluster sampling*, where data is collected at specific spatial intervals, such as setting up wildlife cameras on a grid, and *systematic sampling*, where every nth person is sampled. Probability-based sampling allows for generalizability. However, this type of sampling can be difficult, impractical, or expensive to implement.

There are also many types of non-probability sampling. *Convenience sampling* is an approach where samples are based on proximity (nearby recreation site) or easy availability (such as a public market or seminar participants). An example of convenience sampling is gathering data from trailheads near major interstates because they are more accessible than backcountry sites. *Purposive sampling* involves choosing participants based on special expertise or knowledge. *Chain referral (snowball) sampling* is an approach that asks respondents to identify other potential subjects in their network. *Quota sampling* involves having a specific portion of participants from different study groups.

The choice of which strategy to use depends on the purpose of the study. Random samples are more expensive and extensive, and are best for generating results that are generalizable. Non-probability samples are efficient and quick, and best for reaching targeted populations, learning about specific sites, or gathering background information (preliminary research). However, the results are not generalizable, and the potential for bias is high because the respondents do not represent the population. A mixed-methods approach can help to reduce bias while increasing efficiencies, offering an opportunity for ground-truthing. In addition, a convenience method such as social media data analysis could be calibrated using a high-rigor method like a trail camera or counter.

Selecting Methods

Data collection requires varying levels of time, money, and expertise, so it's important to scale your level of effort to the complexity and risk of the management decision at hand. We've broken down

some operational and data-quality factors for you to consider when sorting through options.

1. Accuracy and Statistical Validity

This category assesses how much you can trust the data to represent the actual population of visitors.

- **High Rigor (Representative):** Statistically valid surveys using stratified random sampling and calibrated trail counters provide the most defensible data for major policy changes.
- **Moderate Rigor:** Systematic observations and condition assessments provide reliable ground-truth data for specific resource impacts but may not capture all visitor trends.
- **Low Rigor:** Convenience sampling and crowdsourced fitness tracks (like Strava) provide useful information but can contain greater bias, overrepresenting specific groups of people, such as tech-savvy or fitness-focused users.

2. Spatial Resolution

Planners should consider the spatial extent of data needed to satisfy planning objectives.

- **Landscape-Scale:** Large data sets from ORAPS or big data sources from mobile devices and social media can illustrate visitor use levels across an entire state or region.
- **Site-Specific:** Cameras and systematic observations provide high-granularity data (like group size and activity type) for a specific location at a specific time.

3. Temporal Resolution

Planners should choose a method based on whether they need a "snapshot" of conditions or long-term trends.

- **Long-term/Longitudinal:** Critical for understanding trends and seasonal fluctuations, long-term monitoring efforts provide insights across multiple years.
- **Periodic/Seasonal:** These methods capture data over a season or specific period of time. For instance, trail counters might be deployed during summer months and provide highly accurate visitor counts, but would fail to capture visitation in the winter, when trails are under snow, and visitors are not always following the trail corridor.
- **Single Snapshot:** These methods, such as aerial surveys and community workshops, provide a high level of detail but only represent conditions on the specific day they were conducted.

4. Operational Investment (Cost and Field Staff)

Planners must distinguish between the "sticker price" of data and the total labor required to collect it.

- **High Cost/High Field Staff:** Intercept surveys, aerial surveys, and community workshops require significant personnel time and travel.
- **Moderate Cost/Low Field Staff:** Automated trail and traffic counters have an upfront equipment cost but require minimal staff for occasional data downloads and maintenance.

- Low Cost/No Field Staff: Secondary data analysis of existing administrative records (like permits) or free governmental satellite imagery leverages work already being done.

5. Technical Difficulty and Analysis Capacity

This measures the specialized skills, such as GIS or programming, required to make the data usable.

- High Difficulty: Analyzing mobile device location data, implementing machine learning for image classification, and complex spatial modeling require data science or advanced GIS expertise.
- Moderate Difficulty: Standard survey design, counter calibration, and structured public comment analysis can typically be handled by trained planners using common statistical software.
- Low Difficulty: Ad-hoc observations, parking lot tallies, and informal interviews can be processed using basic spreadsheets like Excel.

6. Burden on the Visitor

Managing the "visitor burden" is critical for maintaining public trust and ensuring high response rates.

- High Burden: Long-form surveys, focus groups, and design charrettes require visitors to give up significant time and personal information.
- Moderate Burden: Intercept surveys and digital chatbots require a brief interaction but may still interrupt the recreation experience.
- Low/No Burden (Passive): Automated counters, remote sensing, and passive mobile location data collect information without the visitor ever knowing or needing to stop.

Data Limitations & Interpretation

While data is powerful, no study is flawless. Essentially, data can tell us what might be happening within an observed or analyzed context, but it does not capture the total complexity of people and places.

Data provides probabilistic conclusions rather than absolute truths. It is always subject to the precision of technology and accuracy of data collection, transcription, and database management. Data collection is inherently limited by a variety of methodological constraints, such as small sample sizes, potential researcher bias, measurement errors, and specific social or environmental contexts, which restrict the generalizability and absolute certainty of findings. A study conducted in one setting may have limited relevance in another location, due to differences in infrastructure, physical conditions, or socio-economic factors.

When evaluating existing studies or reports, it is important to consider the authors' statements about study limitations and the applicability or relevance of findings to other populations or settings. Careful interpretation is necessary to distinguish correlation from causation, understand the scope of the data, and recognize that conclusions are evolving and subject to revision. Awareness of limitations helps to provide context for the results and prevents premature or inaccurate application of findings. When in

doubt about the relevance or applicability of research, it is advisable to contact the study authors or specialists familiar with the discipline.

Ethics & Policy

An understanding of ethical considerations and relevant agency policy around data collection is critical to make sure our methods and approaches are legally defensible, maintain public trust, are thoughtful, respectful, appropriate, and protect the privacy of visitors, partners, and the public. Before initiating any new methodology or query that involves the public, planners should verify agency-specific authorities to ensure the proposed approach is permitted and meets standards and requirements for engaging human subjects. When working with university partners, it will be important to meet the university's Institutional Review Board requirements for working with human subjects. On projects involving American Indian or Alaska Native Tribes and entities, it is important to consult with agency Tribal liaisons and review the ethics policies of respective Tribal governments.

II. Types of Data

Existing Data

While collecting new data can be incredibly exciting, some of the most useful information available to a planner may already be at your fingertips.

Administrative Data

Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
Moderate rigor	Site-specific or landscape-level	Varies	Low	Low	None

Tapping into administrative data, or “mining the paper trail”, can be a great way to generate insights about the needs and opportunities on your landscape of interest.

Internal administrative data sources can include:

- Recreation Asset Databases - These data provide critical information about recreation facilities, trails, buildings, roads, administrative sites, special uses, and others. You may need to collect data from multiple agencies, municipalities, park districts, etc.
- Fee receipts and permit logs - While not a substitute for more robust methods, this data can supplement understanding of peak days and trends without extra field work.
- Law enforcement and incident reports - This information can highlight hotspots for public safety issues, break-ins, or other management concerns.

Advantages

This information is free and readily available to planners. Depending on the source, records may go back years.

Limitations

Planners have no control over the original data quality or collection methods. Records are not always available digitally and may require extensive manual data entry (for instance, those stacks of self-issued wilderness permit receipts stashed in a district office closet).

Spatial Analysis

The following methods have been used and tested by the Trust for Public Lands to support SCORP

Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
Varies	Landscape & Site-level	Varies	Low to Moderate	Moderate to High	None

While a map is the visible output most people recognize, the true power of spatial analysis lies in its ability to function as a specialized analytical partner for recreation planners. It serves as a "superpower" that allows you to detect patterns and conflicts across millions of acres that would be invisible from the window of a truck. A skilled analyst can take a complex planning question and suggest tools to show data for specific places or heat maps to illustrate use density. The value of spatial analysis for recreation planning cannot be overstated.

The Trust for Public Land (TPL) has partnered with several states to include spatial analysis in SCORP development and priority identification. See the [Spatial Analysis Case Studies](#) resource to learn more about these projects.

Advantages

The greatest strengths of spatial analysis tools is the ability to visualize and layer data. Spatial analysis turns abstract data into a story that the public can actually react to during a public meeting or comment period.

Limitations

Spatial analysis uses models, not a perfect mirror of reality. Because maps look professional and official, people (including decision-makers) can trust them blindly, as it can be easy to ignore map labels that indicate data limitations. Using GIS requires specialized skills and agency investments in GIS analysts

or contracting these skills with a consultant or trusted partner. Technology is rapidly evolving, emphasizing the need for training and continued learning.

Regional & National Data

Regional and national datasets provide the wide-angle lens necessary to see the social and economic trends shifting across the entire landscape. These resources allow you to benchmark your forest against its neighbors and translate local recreation into the high-level language that regional leadership and external partners value most.

Socioeconomic Data

It's always good to get to know your neighbors. Socioeconomic data can help us understand the background of people living in the surrounding area who are served by current recreation programs, sites, and facilities or who may benefit from proposed recreation planning actions or investments. Socioeconomic data can also be studied to evaluate or project consumer demand for outdoor recreation. Data exist at the national, state, county (parish, borough), and community level. Some forms of data include:

- Population data - Provides total population for a particular area, including trends over time
- Demographic data - Age, sex, race, ethnicity, languages spoken at home, marital status, household size, and composition
- Socioeconomic data - Individual and household income (level and sources), earnings, education level, occupation, employment status, employment type

Socioeconomic data are collected at the national level by the U.S. Census, [Bureau of Economic Analysis](#), and [Bureau of Labor Statistics](#). Many of these agencies report data down to the community level (e.g., [American Community Survey](#)). Socioeconomic data also may be collected or corralled by states, counties, and other jurisdictions. In addition, local agencies collect important data that can be used to understand trends. This includes school district enrollment data as well as data from public utilities and infrastructure projects.

Advantages

Socioeconomic data have been collected using proven strategies by authoritative governmental entities with a high degree of replicability and validity. Data can be analyzed comparatively by location or longitudinally to examine changes over time.

Limitations

Socioeconomic data is gathered at different levels, such as census tract, city, county, metropolitan area, or state. These data may not match the geographic footprint of the management unit. For example, one national forest may encompass parts of several counties or states. In addition, data may be gathered in different years, depending on the level of analysis, making comparison difficult. It takes skill and insight to know how to find the most appropriate data for your management unit.

Health Data

Scientists continue to generate new insights about how the type of recreation activity, physical setting, activity duration, and frequency relate to improved physical health, mental health, and cognition. Governmental agencies and non-governmental organizations dedicated to human health are increasingly partnering with public land agencies to provide outdoor settings and experiences for specific populations, such as veterans, persons with disabilities, and at-risk populations.

Innovative partnerships and shared stewardship programs are emerging with public land management agencies working in cooperation with health and human service organizations to expand the supply, improve the quality, or enhance the accessibility of recreation facilities, such as parks and open space, trail networks, and campgrounds.

State or county-level health data may be valuable for describing statewide priorities and project impact. The [Centers for Disease Control \(CDC\)](#) provides health statistics and data at the county, city, and census tract level. Other [online clearinghouses](#) link users to data from individual counties across the United States. State-level health data can be accessed through individual state sites or at this [CDC site](#).

Oregon State University worked with the Oregon Parks and Recreation Department (OPRD) to develop the [Oregon Outdoor Recreation Health Impacts Estimator Tool](#). This tool was used to estimate the health benefits of Oregonians' outdoor recreation activities as part of the 2019-2023 and 2025-2029 SCORPs. In Oregon, the plan functions not only to guide the LWCF program but also provides guidance for other OPRD-administered grant programs, including the Local Grant, County Opportunity Grant, Recreational Trails, and All-Terrain Vehicle Programs. It also provides recommendations for operating the Oregon State Park System and guidance to federal, state, and local units of government, as well as the private sector, in delivering quality outdoor recreational opportunities to Oregonians and out-of-state visitors.

The Health Impacts Estimator Tool estimated that adult Oregonians participated in 31 outdoor recreation activities across 794 million user occasions, expending 503 billion kcals of energy. That is equivalent to oxidizing 144 million pounds of body fat, enough to fill 29.5 Olympic-sized swimming pools. Oregonians also realized \$1.416 billion in COI savings associated with eight chronic illnesses affected by physical activity. These cost savings accrue to health insurers, providers, and participants. This data was used to recommend investments in local parks and recreation infrastructure, state parks, and connections to other public lands.

Key Takeaways: Estimating the health benefits obtained through outdoor recreation demonstrates that parks and recreation providers have a role in improving public health and well-being. Collaboration between health, transportation, and parks and recreation providers, among others, has the potential to significantly influence community health and may be a cost-effective health prevention strategy.

Advantages

Access to health data at the state or county level can be combined with visitation data to measure the health benefits of a particular land unit. For example, when you know the type of recreation activity, duration of a visit, and frequency of visit, calculations associated with national health goals and guidelines can be made.

Limitations

Health data that is aggregated at the county, city, or census tract level may not match the geographic footprint of the SCORP or subregions in the SCORP. Applying local county health statistics to a county or region without validating that the majority of visitors actually originate from that specific county can result in misleading conclusions about localized impact. Accurately integrating public health databases with visitation data requires specialized expertise.

National Surveys

Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
High rigor	Landscape	Long-term	Low	Low	None

Existing studies can supply a big picture view of recreation demand over time, providing important context for local planning efforts. Sources of this information include:

- Outdoor Industry Association Research Reports - This organization provides [reports by state and nationwide](#) on the economic benefits and impact of outdoor recreation.
- Outdoor Recreation Satellite Account statistics - Published by the U.S. Bureau of Economic Analysis, this [data measures the economic activity](#) as well as the sales or receipts generated by outdoor recreational activities across the U.S.
- National Survey of Fishing, Hunting, and Wildlife-Associated Recreation - Since 1955, these [surveys have provided information on participation](#) in fishing, hunting, and other wildlife-related recreation.
- Resources Planning Act Assessments - Updated every 10 years, these [reports summarize current conditions and trends](#) of renewable resources, including outdoor recreation, across all forests and rangelands and project their availability and condition 50 years into the future.
- Outdoor Recreation Access and Participation Survey (ORAPS) - Currently under development, ORAPS builds on the former National Survey for Recreation and Environment (phased out in 2014). ORAPS has been tested and used by several states (OR, VT, AL) to inform SCORPs. Once implemented, ORAPS modules will be usable at the state and national level.

Advantages

Many of these sources provide years of data applicable to a state or sub-region which is ideal for long-term trend analysis and landscape-level planning.

Limitations

Planners may lack information about how the original data was collected or defined. While this information is generally freely available, you may need training in GIS or advanced statistics to interpret it correctly.

Field Methods

Even though planners get more desk time than we might like, we know that all good planning starts in the field. The following methods are tried-and-true approaches to gathering site-specific data about what is happening on-the-ground.

Trail Counters

Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
High rigor	Site-Scale	Periodic or Long-term	Moderate	Moderate	Low

Trail counters are automated devices that primarily utilize infrared technology to detect the presence of a visitor. These durable battery-operated devices can log data continuously for months before being collected via download for analysis.

Counters utilize a range of technology:

- **Passive infrared (heat):** The most commonly used counters, these devices detect the heat signature of a person, cyclist, or animal passing within their field of view (within 10' of passing traffic is generally optimal).
- **Active infrared (beam):** These counters send a beam of infrared light to a receiver or reflector on the opposite side of a trail or narrow passage. When an object breaks the beam, the counter registers a visit.
- **Magnetic/inductive loops:** Used specifically for counting bicycles, these sensors are placed beneath the trail surface and detect the presence of metal in bikes or off-road vehicles.

Advantages

Trail counters provide rich site-specific spatiotemporal data over long periods and have a very low burden on visitors, who typically are unaware of the devices. When functioning correctly, they provide high-rigor, defensible data for routine management decisions. While they have an upfront equipment cost, they require relatively low field staffing, primarily for occasional data downloads and battery maintenance. Counters are also useful for calibrating other sources of user data, such as social media estimates.

Limitations

Counters require an initial up-front cost and require staff capacity to install, maintain, and collect the data. While modern units are fairly durable, counters can be subject to damage from weather, wildlife, or vandalism. If data is not collected regularly, it can be lost if the unit is stolen or damaged. Trail counters cannot distinguish visitors by activity type (e.g., hikers vs. mountain bikers). Traditional infrared counters can undercount groups because multiple people may trigger only one count. Sensors can also be triggered by non-target movements, such as animals or swaying vegetation, which can lead to overestimation if the device is not positioned carefully. Raw counter data often include spikes or errors that require careful review and cleaning by planners before analysis.

Tips

To minimize undercounting, counters should be installed on narrow trail segments where visitors are most likely to travel in single-file. For the highest data quality, planners can pair counters with trail cameras for short periods to "ground-truth" the sensor data and adjust for group-size biases. For system-wide monitoring, ensure that all counters are configured to record data at the same temporal resolution (e.g. daily, hourly, or individual time-stamped counts) so that data can be compared across locations.

Traffic Counters

Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
High rigor	Site-Scale	Periodic or Long-term	Moderate	Moderate	Low

Vehicle counters typically use pneumatic tubes (which sense air pressure changes when driven over) or inductive loops (which detect metal disrupting a magnetic field) to tally traffic at entrance points or along forest roads. Vehicle counters are most useful for informing visitation estimates when planners have an accurate “multiplier” to estimate the average number of people per vehicle. For example, the U.S. Forest Service National Visitor Use monitoring (NVUM) data establishes an average group size per vehicle for each national forest. If NVUM determines there is an average of 2.5 people per vehicle on a given national forest and the car counter captures 20 cars on a given day, you can confidently estimate that 50 visitors traveled the road that day ($20 \times 2.5 = 50$).

Advantages

When functioning and installed correctly, vehicle counters provide highly accurate, continuous monitoring with a low amount of staffing required.

Limitations

Standard traffic counters cannot distinguish between different types of users, such as local residents, agency staff, contractors, or recreational visitors. If a visitor enters and exits through the same point, or visits multiple sites within a single unit on the same day, they may be counted multiple times.

Trail Cameras

Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
High rigor	Site-Scale	Periodic	High	Moderate	Low

A picture says a thousand words... Commonly used for wildlife research and monitoring, trail cameras (also called “camera traps”) can also be used for visitor use monitoring. These small devices utilize a passive infrared sensor to detect the heat signatures of people or animals within the field of view. The heat signature acts as a “trigger” to initiate the camera to capture an image or short video. Low-glow or no-glow infrared LEDs are used in lieu of a flash to capture images at night. Most cameras store images on SD cards within the unit, while some higher-end models transmit photos by cellular or satellite data. By mounting cameras higher up (10-12 feet), images can capture the activity without capturing high-resolution images of visitors’ faces.

Advantages

Cameras generate a rich data that distinguishes user types, which can be particularly helpful for multi-use trails. Cameras are also useful for calibration purposes to establish whether trail counters are under or overestimating use.

Limitations

While cameras provide the most detailed data, they require a higher investment of staff time and resources than other methods. They require regular field visits to replace batteries and memory cards, and the high volume of resulting images necessitates either extensive manual processing or specialized machine-learning software for classification. Cameras can be prone to false triggers on warm windy days, resulting in additional data that must be filtered out during analysis. Because cameras capture identifiable images, managers must adhere to strict ethical and privacy protocols regarding their placement and the handling of the data. It is considered best practice to post signage notifying visitors that cameras are in use.

Systematic Field Observation

Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
Moderate rigor	Site-specific	Snapshot	Moderate to High	Low to Moderate	Low

While surveys tell you what people say they do or what they say conditions are like, systematic field observations tell you what the actual behaviors and conditions look like on the ground. Systematic observation is a formal way for field staff or volunteers to record specific behaviors or conditions, typically using standardized forms and recording observations at set intervals.

Examples of this method include:

- Trail condition assessments: Physical monitoring of trail segments for indicators like erosion depth, trail width, and drainage issues. These assessments identify precise areas where trails are failing to handle use levels.

- On-site visitor counts and/or parking lot counts: This approach includes periodic tallies of people or cars at specific "point-of-interest" locations. Such data provides a simple, reliable indicator of crowding that requires very little technical training but only provides a snapshot of conditions.
- Rule compliance monitoring: For instance, tracking the prevalence of off-leash dogs on a trail or monitoring a parking lot for compliance with parking fees or permits.

Systematic observation is in stark contrast to informal or ad-hoc observation, where staff or volunteers collect information during their routine duties. While ad-hoc monitoring leverages existing "eyes on the ground" at zero additional cost, this approach lacks consistent protocols, is prone to memory errors, and lacks the rigor needed for long-term trend analysis.

Advantages

Field observations provide direct evidence of what is actually happening on the ground. For many types of data, such as trail or facility conditions, there is no substitute.

Limitations

Many field observation techniques require extensive training for staff or volunteers to collect consistent and comparable data. These field assessments can be resource-intensive and require regular observations to capture trends over time.

Tips

When observing visitor behavior, be aware that people act differently when they realize they are being watched. Put away the giant clipboard and consider less obtrusive approaches to recording data. Observers should be dressed in plain clothes and positioned at a distance, when possible.

Advanced Remote Sensing and Aerial Methodologies

Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
High rigor	Landscape and Site-Specific	Periodic	Moderate	High	Low

Sometimes in order to understand what is happening on the ground, we need to get off the ground. Aerial and remote sensing can provide landscape scale insights at incredible resolutions. As technology advances, a variety of approaches can be utilized for data collection, such as:

- **LiDAR** –LiDAR uses laser pulses to create a highly accurate 3D map of the earth's surface. LiDAR digital terrain modeling can be incredibly helpful for trail and facility siting including avoiding floodplains and unstable slopes.
- **Aerial surveys (manned):** Monitoring flights can quantify recreation intensity where ground sensors are impractical, such as snowmobile tracks in remote backcountry areas or for counting boats on rivers and lakes.
- **Unmanned Aerial Systems (Drones/UAVs):** In addition to some of the applications for aerial surveys, these nimble devices are known for their ability to capture high-resolution imagery. Drones can be helpful for monitoring trail conditions or visitor impacts in remote or difficult to reach areas.
- **Acoustic Monitoring:** Autonomous recording units are small, rugged devices with high-fidelity microphones that can record ambient noise at set intervals. They can be used to monitor noise impacts associated with both motorized and non-motorized recreation.

Advantages

These methods are highly accurate and capture use in areas with low recreation intensity that apps or surveys often miss. Remote sensing allows for monitoring at inaccessible sites without a field presence and offers a repeatable way to monitor changes over time. Drones offer more flexible operation than piloted aircraft and can fly closer to the surface to get better resolution. Satellite imagery costs are decreasing as more governmental images become free. LiDAR [data is readily available](#) for much of the U.S. via the U.S. Geological Survey. Acoustic monitoring provides a high degree of accuracy with a very low degree of bias.

Limitations

Methods have high costs, extensive labor requirements, and require specialized training. Aerial and drone surveys may only provide a "snapshot" in time, which can be difficult to compare with continuous data. Federal use of drones requires certification and for an operator to maintain a line-of-sight on the ground, which may limit applications in environments with high vegetation cover. Analyzing and extracting usable numbers from imagery requires advanced technical training and significant time.

Big Data Methods

Ready to level up? Partner with researchers or other technical experts to tap into the power of big data sources for landscape-scale insights over multiple months or even years. Novel methods like social media analysis or mobile device location data should not be used as primary evidence without being "ground-truthed" or calibrated against high-rigor onsite counts.

Social Media Content

Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
High rigor	Landscape and Site-Specific	Longitudinal	Moderate	High	Low

Many of today's visitors are taking and sharing photos, posting trip reports, and tracking and sharing routes and fitness stats from outdoor adventures, resulting in millions of geospatial data points. Social media data provides a novel way for planners to understand visitor behavior at a scale that was previously cost-prohibitive to monitor. Geotagged photos and posts have been found to be highly correlated with actual visitor numbers, allowing researchers to estimate usage levels even at unmonitored sites. Harvesting these digital traces of visitation is sometimes called "passive crowdsourcing" since visitors are generally unaware that their publicly shared data is being used for research. Social media analysis methods include:

- Georeferenced metadata analysis - This method involves utilizing the coordinates included in photo or post metadata on platforms such as Instagram, Flickr, or X to map and estimate actual visitation.
- Crowdsourced fitness tracking - Platforms like Strava provide aggregated GPS tracks that illustrate where, when, and even how fast visitors are traveling. This data can highlight movement patterns, hotspots of activities, and even flag unsanctioned routes for planners.
- Content and sentiment analysis - With the advent of artificial intelligence, researchers can now scan thousands of geotagged photos to identify activity types and characterize visitor use. By analyzing the text of photo captions or trip reports on platforms such as AllTrails, researchers can also gauge public sentiment about their recreation experiences.

Advantages

Social media data provides a massive scale of data with incredible resolution, without consuming time and resources from field staff. This can be particularly helpful for monitoring visitation in dispersed or remote areas where on-site monitoring with counters can be logistically challenging, if not impossible. GPS tracks and georeferenced photos can be particularly helpful for indicating popular cross-country

routes or flagging unsanctioned uses. Social media data is often available over many years, essentially allowing researchers to “look back in time”.

Limitations

Social media data does not represent all visitors. They can over-represent middle-aged, fitness-focused, or tech-savvy users while under-representing the elderly, children, and lower-income individuals. Data is sourced from private companies that may not be transparent about how they clean and aggregate data, and they can limit access to or increase the costs of data without notice. Social media data should be ground-truthed with on-site data, such as that from trail counters, to calibrate findings. Lastly, there is a range of privacy and ethical concerns around the use of social media data, as many visitors do not reasonably expect their personal information to be used for government research.

Mobile Device Location Data

Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
High rigor	Landscape and Site-Specific	Longitudinal	Moderate	High	Low

Today’s planners can access aggregated, anonymized GPS and cellular signals from mobile phones to track visitor use patterns at a landscape scale. While this data is expensive to purchase, it can provide even more information than social media data, including home location at the census block level, stops made along the way to the forest, duration of visit, “dwell time” at specific locations, and routes. This information allows planners to get a picture of visitation across an entire landscape simultaneously without installing a single sensor.

Beyond mobile GPS data, other technological signals can be monitored:

- Bluetooth and Wi-Fi detectors: These devices can detect the unique "handshake" of mobile devices to measure crowd flows through a facility like a visitor center or dwell times at specific points of interest.
- Connected vehicle data: Modern vehicles transmit geolocation data back to manufacturers, which can then be used to analyze traffic volumes and speeds around public lands.

Advantages

Mobile device data provides a massive scale of data over many years. Data is collected without impact on field staff and zero burden on the visitor.

Limitations

This data can be very expensive to purchase, and there is often a lack of vendor transparency on how data is processed. Mobile data may underrepresent visitors in areas without cellular connectivity. Data may also overrepresent visitors with higher incomes.

III. Data Summary Table

Data Type	Accuracy and Statistical Validity	Spatial Resolution	Temporal Resolution	Operational Investment	Technical Difficulty	Burden on the Visitor
Administrative Data	Moderate rigor	Site-specific or landscape-level	Varies	Low	Low	None
Spatial Analysis	Varies	Landscape & Site-level	Varies	Low to Moderate	Moderate to High	None
National Surveys	High rigor	Landscape	Long-term	Low	Low	None
Trail counters	High rigor	Site-Scale	Periodic or Long-term	Moderate	Moderate	Low
Traffic counters	High rigor	Site-Scale	Periodic or Long-term	Moderate	Moderate	Low
Trail cameras	High rigor	Site-Scale	Periodic	High	Moderate	Low
Systematic Field Observation	Moderate rigor	Site-specific	Snapshot	Moderate to High	Low to Moderate	Low
Advanced Remote Sensing and Aerial Methodologies	High rigor	Landscape and Site-Specific	Periodic	Moderate	High	Low
Social Media Content	High rigor	Landscape and Site-Specific	Longitudinal	Moderate	High	Low
Mobile Device Location Data	High rigor	Landscape and Site-Specific	Longitudinal	Moderate	High	Low