An Introduction to Visitor Use Monitoring Methods in Wilderness

U.S. Forest Service, Chief's Wilderness Advisory Group: Del Orme, Sarah Erickson, Miguel Macias, Tangy Wiseman
U.S. Forest Service, Wilderness Information Management Steering Team: Troy Hall

Introduction

This document was initially developed in 2019 by the USFS Wilderness Advisory Group as a resource for managers to monitor recreational use in wilderness. It was revised in 2021 in response to marked increases in use of wilderness and other areas observed during the COVID-19 pandemic of 2020. The focus is on techniques and tools for monitoring trends in use levels; other characteristics of wilderness or impacts of recreation are not addressed. The companion document, "Considerations in Monitoring Visitor Use" may also be of interest.

Trailhead Car Counts

Car counts at trailheads can provide an overall sense of recreational use levels, facility capacity, and safety issues. Although they do not generate data on length of stay or visitor characteristics (other than stock user vs. pedestrian), in some cases they can be very easy to collect. This is a useful technique for urban-proximate or small wildernesses where travel time to reach trailheads is minimal. It can also be effective in wildernesses with enough volunteers to generate multiple data points for individual trailheads over the course of a season.

Implementation

1. Develop a data collection form (paper or electronic). This should include, at minimum, the date and time of day; it may be useful to distinguish types of vehicles.
2. Although a single observer may maintain a running log throughout the season, it is advisable to have data copied (or photographed) and stored in a common location on a regular schedule.

Advantages

- Data can be collected by anyone with virtually no training required.
- Depending on the nature of the wilderness and the schedules of agency staff or volunteers, it can be very inexpensive to collect data.
- If data are collected systematically over time, analysis may reveal trends that enable proactive management attention where use is increasing.

Limitations

- Data on car counts do not provide a strong indication of the nature of the wilderness experience visitors are having or resource impacts in wilderness.

Trail Counters

Trail traffic counters can be incorporated into data collection efforts to provide continuous (24/7), often highly accurate data about use of specific trails. Because of their accuracy, they can provide data to triangulate or validate data collected using other methods that have lower compliance rates (such as trailhead registers) or lower sampling intensities (such as intermittent car counts).

Figure 1. Beebe, Sam. Discreet trail counter. *Public Lands Tour Wordpress Blog*.

American Trails, a national nonprofit that provides comprehensive trail resources, offers insight on trail monitoring and highlights the advantages of trail counters for their ability to collect continuous data that can be aggregated in various ways (by day of week or time of day, for example). A 2019 article[1] on their website, by Matt Ainsley of Eco-Counter, reported on the outcomes trail managers in Pennsylvania saw when they installed trail counters. For example, they were able to document that "trail use was 50% higher during the weekend compared to mid-week," and one of their trails was receiving nearly 10,000 visitors a month. This kind of data demonstrates how a data collection effort with trail counters can generate data to support implementation of a permit system in the future if necessary.

Several trail traffic counter models are available on the market. The Missoula Technology and Development Center (MTDC) studied several models and provided an overview of their benefits and challenges[2]. However, that report is quite dated, and a recent summary by Bergman and Cohen provides more up-to-date information[3]. Technology continues to improve, and one of the leaders in development is TRAFx[4]. This brand is used extensively by land management agencies in the United States and abroad and is praised for its simplicity in design and web-based functions. This review is not an endorsement; rather it illustrates how these tools have been used to successfully collect trail use data by many land management agencies.

Figure 2. TRAFx Infared Trail Counter.

Implementation

The installation location of the trail counter can vary. Because it is rare to be able to afford enough trail counters to monitor all trails, the trail counter data should ideally supplement a trailhead register or mandatory self-issue permit system. It is suggested to place the sensor approximately .25-mile from the trailhead entry at a point where the trail is narrow enough to prevent side-by-side hiking. If using a passive or active infrared counter, the specific mounting location should be far enough away from the trail (or camouflaged by vegetation) to avoid drawing attention to the device.

Some counter types require downloading of data from the recorder unit. Data download frequencies can vary. Depending on the amount of trail use and data analysis needs, the frequency of visits to the

counter can be adjusted, but it is suggested that the counter should be visited at least once a week initially to review the downloaded data, confirm proper functioning, and ensure the sensor is securely in place. If the counter is working well, the visitation interval can be as long as a month between visits.

Advantages

- Once the system has been purchased (software, counters), it is easily 'scalable' if more counters are desired or needed.
- Data are collected 24-hours/7-days a week, giving greater detail to the timing of use.
- 10-year battery life.
- Easy data download from the trail counter in the field without a laptop.
- Data are stored in a web-based program. This software included with TRAFx counters maintains data and has a user-friendly interface for analyzing data.
- The TRAFx counter has a simple set-up that doesn't require a receiver on the other end of the infrared scope.

Limitations

- Placement and calibration can take some time but are critical to ensuring accurate counts. Care must be taken to hide the unit, ensure the angle and height relative to the trail are appropriate, and set the time delay between counts.
- Counters tally the total number of people passing the sensor but cannot distinguish other useful details like duration of hike, entry/exit time, or destination. Counters do not distinguish direction of travel; for an in-and-back trail, counts can be divided by two to estimate total visitation, but for complex trail networks, it can be challenging to obtain an accurate estimate of visitation. (However, this limitation would be less of a problem if the counter is used the same way year after year to document trends.)
- Trail counters tally all objects that break the sensor's beam, such as wildlife or motion from a falling tree, which can create errors in total visitor counts.
- Cold temperatures reduce battery life, requiring more frequent monitoring, and ill-placed counters may be buried by snowfall.
- Although the costs are much less than would be required to collect similar data through other approaches, it can quickly become expensive to purchase enough units to monitor multiple trails.

Resources

[1]Ainsley, M. 2019. The role of trail counters in visitor use data
[2]Missoula Technology Development Center analysis of trail counter technology
[3]Bergman, B. & Cohen, L. 2016. Trails count! Creating a regional program to measure trail use in the Bay Area. A report of the Bay Area Trails Collaborative.
[4]TRAFx technologies

Trailhead Registration

Figure 3. Cloud Peak Wilderness, Bighorn National Forest.

Self-registration systems, whether voluntary or mandatory, can be used to collect an array of visitor use data, including the number of people and groups visiting, dates of use, group size, travel methods, length of stay, itineraries, and visitor characteristics such as demographics, visitation frequency, and visitor comments and perceptions. Mandatory registration systems like self-issue permits generate higher quality data, because compliance is much higher and, typically, more types of data can be collected than on a voluntary register. Mandatory systems also provide more opportunities for education. However, they are more costly and place a greater burden on the visitor. Watson et al. (2000) provide a detailed description of how to implement trailhead registration and permit systems.

Implementation

1. Determine the intent and purpose of implementing a self-registration system and determine whether it should be mandatory or voluntary.
2. Estimate costs to develop and maintain, including kiosk construction, educational materials, registration materials, and staff time for regular maintenance/stocking.
2. Design the register or permit form to capture desired data and/or include education components (note: FS-2300-32 is the OMB approved voluntary registration form; however many wildernesses with registration systems have developed their own forms suited to meet local needs)
3. Install registration stations (kiosk, trailhead sign, box) at desired locations (all trailheads, high use areas, etc.)
4. Consider augmenting registration data with traffic counter data or trail counter data.
5. Collect registration compliance data through unobtrusive observation of visitors at trailheads.
5. Monitor and maintain registration system (stock and collect registration forms, data entry, data analysis).

Advantages

- Registration forms may be used as education tools listing rules and regulations along with Leave No Trace information on the registration form or at the registration box.
- Voluntary registrations, though often providing poorer data than mandatory registration, can provide data for establishing baseline visitation levels and help determine if a mandatory type of registration is needed (i.e., a mandatory non-limiting permit system or a mandatory limited use permit system).
- For complex trail networks, registration data can be used in conjunction with strategically placed trail counters to understand use patterns within the wilderness.
- Voluntary systems allow unrestricted visitor use and are minimally intrusive.

- Data may be used to help locate visitors in emergency situations.
- There are multiple ways to collect and analyze the data. Use of desktop scanners removes the need to enter data manually and provides capability to collect data written in pen or pencil; scanners can capture "bubble" sheet data and image clip handwritten data such as "comments." Despite initial start-up costs, this can save money in the long run (see "Costs" below)

Limitations

- Compliance checks via field monitoring are *critical* to determine compliance rates for different visitor types, as research has shown that rates vary substantially between day and overnight users and between pedestrians and stock users. This is especially important for voluntary self-registration systems, because non-compliance is high, leading to underestimation of use.
- The amount of data collected is constrained by the form.
- These systems may be less accurate for gathering travel route information than trail counters because people don't always record their routes, may use incorrect names for locations, and may change plans during their trip. (However, they may be less expensive than deploying enough trail counters to accurately understand visitor flow patterns.)
- Neglected register stations destroy the credibility of the system and can actually discourage visitors from filling out the form. Gaps in data due to a lack of forms of pens can be considerable and difficult to account for in analysis.
- Costs:
    - Start-up costs can be high to install permit boxes and education materials at trailheads, purchase registration forms (printing costs) and stock boxes.
    - Ongoing cost to manage (printing costs, maintaining signs/boxes, conducting compliance checks, stocking and retrieving registration forms, data entry, analysis, salary) are also high.
    - Costs may increase if other tools are used to improve the accuracy of data collection (e.g., augmenting a registration system with trail counters; using field staff to conduct compliance checks).

Resources

Wilderness Connect – Visitor Use Management Toolbox

Wilderness Stewardship Desk Guide (2010)

Aldo Leopold Wilderness Research Institute (Publications Search: Permits, and Wilderness Rec Use Estimation Handbook of Methods and Systems)

Interagency Visitor Use Management Council

FSH & FSM

Voluntary Registration Card (Form FS-2300-32, OMB 0596-0106)

Watson, A., Cole, D., Turner, D., & Reynolds, P. 2000. Wilderness recreation use estimation: A handbook of methods and systems. GTR-56. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.

Citizen Science

Figure 4. Participants from a case study in *Investing in Citizen Science*, a Forest Service Publication.

Citizen science has potential to be leveraged for visitor use data collection and wilderness character monitoring with the added benefit of providing an opportunity for visitors to become wilderness stewards. Citizen science projects involve designing research questions and protocols that are suitable for volunteers to conduct. In the case of visitor use monitoring, volunteers could be asked about details from their trip to the wilderness and who or what they encountered along the way.

Potential volunteers include local stakeholders and groups that regularly visit the forest. Partnering with local groups that are already conducting citizen science or guiding other activities in wilderness could provide a good foundation for this work. They can provide the infrastructure for data storage and analysis, as many citizen science groups use applications on mobile phones like ESRI products including *Collector, Survey123, and GeoForm.* Another group to consider partnering with is the local conservation education staff to find out how they are engaging the community. If they hold regular programs in certain parts of the forest, they could use that framework to incorporate wilderness education and data collection. No matter the group, providing resources for volunteers to stay up to date on wilderness activities and future stewardship projects can allow them to become wilderness stewards in the long run.

Figure 6. ESRI's Collector Application.

Figure 5. ESRI's Survey123 Application.

If starting an independent program is the best option, the Forest Service Citizen Science webpage hosts a list of current projects, along with toolkits, webinars and other resources to help develop a citizen science project.

Emerging method: Chat Bots

Chat bots show potential in becoming a consistent and efficient form of data collection. A chat bot is an AI software application that can use text messages to engage visitors. They can be hosted on a variety of messaging services and social media apps. The chat bot is programmed with rules and cues, so that it can interact conversationally with users. A 2021 article by McDaniel reports on how USFS researchers teamed with National Forest managers to use chat bots via signs posted at trailheads. The signs prompted visitors to message with a chat bot to report the number of cars in the parking lot. Text

messages were sent to an automated system that stored the response in a project database for later analysis. Chat bots also have the capacity to provide more survey questions if the visitor chooses to continue to engage. This type of automated messaging also presents an opportunity to distribute a variety of information alongside the survey questions, including ways for the visitor to get involved in wilderness stewardship or stay updated on wilderness news.

Figure 7. Use of a Chat Bot to collect data from visitors on car counts

Implementation

Citizen Science

1. Develop specific research questions and a data collection protocol.
    - Consult with data manager to plan out what data standards will need to be met.
2. Engage with partners to see how this effort could be coordinated with their current projects and volunteer base.
    - If it is appropriate to develop a separate project for data collection, consider engaging recreationists, youth groups, adjacent landowners, local government, or universities.
3. Organize a news release about the proposed project via email announcements, webinars, or social media.
4. Let people know how they can engage with your agency
5. Prepare a report after the work is completed, so volunteers can see the fruit of their work.

Chat Bots

1. Design a sequence for the research questions.
    - Consider how the visitor will interact with the chat bot.
2. Consult with a specialist (app developer) to add rules and cues to the program.
3. Choose a messaging platform for the chatbot.
4. Set up a server for it to run from.
5. Develop a database.
    - Cloud computing software and storage services are needed.
6. Develop a data analysis protocol.

Advantages

- Citizen science can be cost effective in the long run after initial investments are made in tech and planning.
- It provides opportunities for wilderness visitors to become wilderness stewards
- Citizen science encourages engagement with partners and other community groups
- Chat bots are convenient for visitors to engage with
- The speed from data collection to storage is relatively high

Limitations

- Both citizen science and chat bots require a lot of front-end planning and input from specialists.
- It can be challenging to retain citizen scientists for long-term monitoring.

- Citizen science might not be a feasible option for managers without many partners or resources to engage visitors.
- Citizen science projects require careful consideration of data quality control and management.
- Chat bots involve costs associated with acquiring software, server space and other technology requirements.

Resources

Building a Citizen Science Project Team

CitizenScience.gov Basic Steps for Project Planning

The Complete Beginner's Guide to Chatbots

U.S. Forest Service Citizen Science Home Page

U. S. Forest Service Public Engagement Reference Guide

McDaniel, J. 2021. Using Social Media as Data to Better Understand Recreation on Public Lands. Pacific Northwest Research Station, Research Findings, Issue 238.

Social Media Data

Social media platforms and other apps contain location data shared by users. Apps like Instagram, Twitter, Facebook, and Flickr allow users to share their location using name-place location tags when they make a post. Training apps like Strava track running/biking routes that users can make public when they complete a workout. To collect publicly available geotagged posts, the Application Programming Interface (API) associated with the app can be used to mine the data. Once the geotagged posts are collected, they can be plotted on a map and the posts can be manually categorized into different recreation types using details from the images. In order to obtain a more robust dataset, it is often advised to combine data from several platforms. This is because social media platforms differ in posting frequency, post content, and primary user groups.

Social media data have been shown to positively correlate with recreational use patterns on public lands, although a recent review reported that correlations "vary substantially" (Wilkins et al. 2021). When paired with traditional counts or interviews, social media can help develop predictive models to estimate use in unmonitored sites. Social media are also useful for relative comparisons of use between sites. Although social media data are usually not robust enough to stand alone in a monitoring protocol, the data can provide a wide range of information about user behavior and activities that traditional counts cannot.

A recent study by Rice et al. (2019) explored ways managers could use Strava data to understand visitor use. The authors overlayed system trail maps with the Strava Heatmaps. This helped identify where there was off-trail and where the highest use was occurring.

"Crowdsourced data can, at the very least, provide important initial insight into visitor flows in these areas. In sum, this service, or services like it, should not be the only method managers use, but pragmatic managers and researchers should retain it in their toolbox." (Rice et al. 2019)

Working with social media data also involves ethical considerations. Although it can be useful for estimating visitation rates, drawing additional conclusions about the visitor base must be done objectively and biases must be reduced as much as possible. Overall, if concise research questions are generated and outside variables are carefully considered, social media can become one useful source for understanding use in wilderness.

Implementation

1. Design research questions and consult with a research scientist to outline the study.
2. Identify primary sources for social media data, considering both the frequency of use and type of data.
3. Use the corresponding API of the social media sites to mine the data.
4. Use "user days" of social media to estimate visitation – these count only one photo or post per visitor per day (Wilkins et al. 2021).
4. Analyze the data according to the research questions and compare to baseline counts.
5. Generate predictive models or estimations.
6. Share the results with relevant groups.

Advantages

- Useful for relative comparisons of use between sites (can categorize sites into low, medium, and high use for management decisions), particularly at broad spatial scales.
- Can be used for sites that are too difficult or too costly to monitor using traditional methods.
- Images can provide more insight about who is visiting the site, what activities happen there and help answer 'why' questions.
- Social media platforms can provide a consistent stream of data as users post in real time.

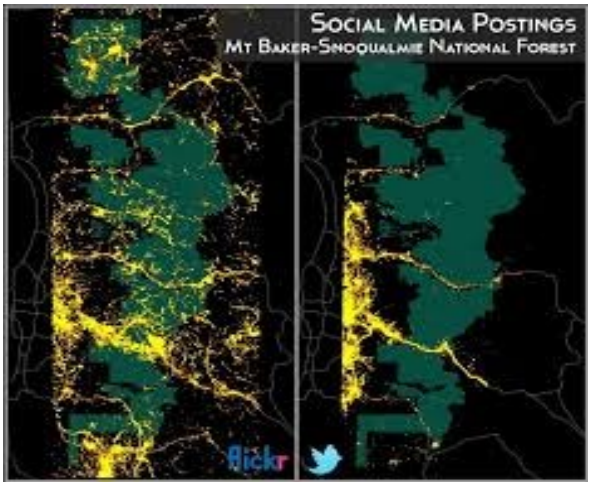

Figure 8. Wood, Spencer. Geotagged posts from Flickr and Twitter mapped on the Mt. Baker-Snoqualmie National Forest, University of Washington, U.S. Forest Service, National Park Service, WA Trails Association study.

Limitations

- Developing a monitoring protocol based on social media data requires input from a research scientist or other specialists.
- Social media platforms may change their functions and level of access to their data.
- It's well known that people who post to social media are not representative of the general visiting public. "Social media users tend to have more years of formal education, are younger, and are wealthier than the general population" (Leggett et al. 2017).

- There are many variables to consider that impact the dataset:
    - The popularity of any one platform can fluctuate
    - Different platforms are used in different ways
    - Posting behavior can be influenced by several factors: Highly social and iconic places vs. tranquil settings, hashtags and trending locations, the availability of place-name location tags for sites, personal connection to the site, population density near the site, weather, holidays, etc.

Resources

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