



Mobile Analytics vs. Traditional Surveys

A case study exploring visitation patterns and visitor demographics
at an outdoor recreation destination

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Project Overview



Study Background



Monitoring **visitor demographics and visitation patterns** is essential for decision-making in destination marketing, management, and resource planning, yet it remains an ongoing challenge.

(Liang et al., 2022; Park et al., 2020)

*Liang et al. (2022). Assessing the validity of mobile device data for estimating visitor demographics and visitation patterns in Yellowstone National Park. *Journal of Environmental Management*, 317, 115410.

Park et al. (2020). Spatial structures of tourism destinations: A trajectory data mining approach leveraging mobile big data. *Annals of Tourism Research*, 84, 102973.

Study Background



Common traditional methods for visitation and visitor demographics:

- Visitor intercept survey
- Trail counters

Challenges

- High costs
- Longer time
- Data for shorter time frames



More recently:

- Geolocation data using mobile devices with opt-in GPS

Opportunities

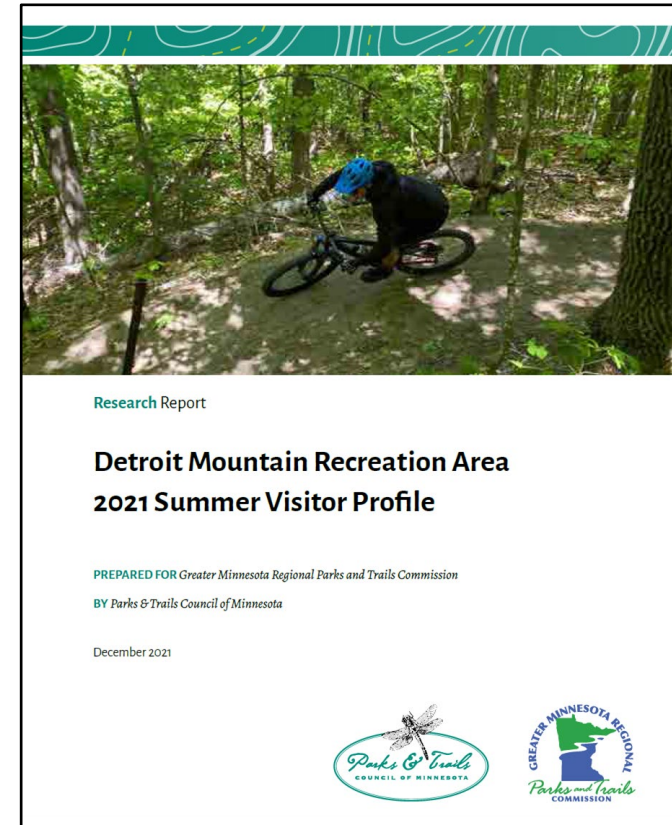
- + Simplifies data collection
- + Demographic, spatial, temporal patterns
- + Aggregated and normalized data (larger sample)

Study Background

Detroit Mountain Recreation Area 2021 Summer Visitor Profile

Parks & Trails Council of MN (2021)

- **Purpose:** Understand summer visitor characteristics and usage of DMRA's mountain biking trails
- **Traditional methods used:**
 - ✓ Automated trail counters for visit estimates
 - ✓ Intercept visitor survey for collecting trail user demographics



Study Objectives

Our interest:

If/how are traditional and mobile device data different/similar?



Goal: **Compare/differentiate** mobile device data with traditional methods in two key areas at Detroit Mt. Recreation Area:

1. Estimate of visitation numbers
2. Visitor demographics

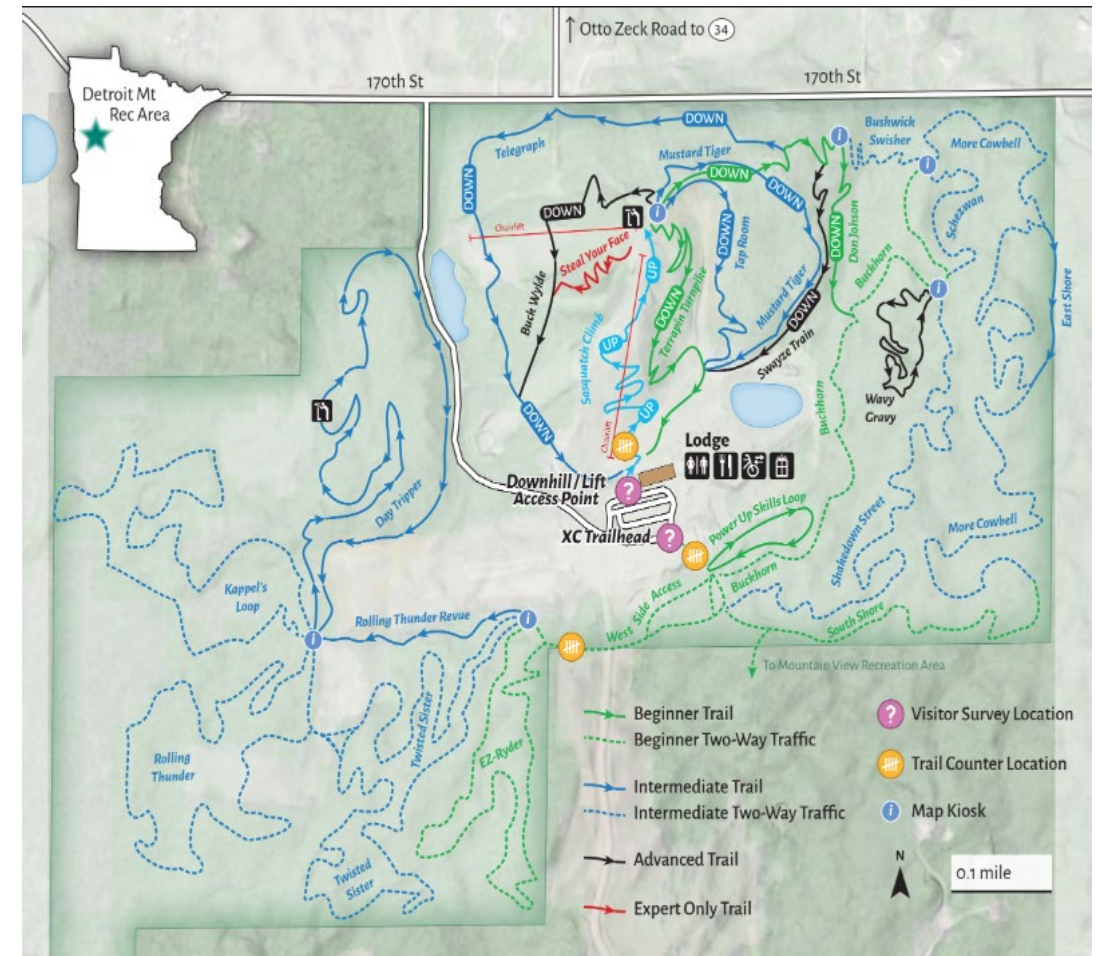


Methods

Study Site

Detroit Mountain Recreation Area (DMRA)

- **Location:**
Northwestern MN near Detroit Lakes
- **Features:**
15 mi+ cross-country & downhill mountain biking trails, 360 acres
- **Selected** for exploratory case study due to:
 - ✓ Access to visitor profile report with trail counts and survey data and mobile device data collected within the same time period



Map by Andrew Oftedal, Parks & Trails Council of Minnesota

Data from Traditional Approaches

- The Visitor Profile (Parks & Trails Council of MN, 2021) utilized two traditional methods to capture **summer usage & user demographics** at DMRA's mountain biking trails



**Automated trail
counters**

DMRA Summer 2021 Visitor Profile

(Parks & Trails Council of MN, 2021)



Visitor survey



Data from Traditional Approaches



**Automated
trail counters**

**DMRA Summer
2021 Visitor
Profile**

(Parks & Trails Council of MN, 2021)

- **Automated trail counters** collected data on:
 - Total traffic, travel direction, and hourly/weekly visit patterns
- **Installed at three locations** across the cross-country mountain biking trail system:
 - Trailhead, between parking area/trail, and trail junctions (with varied durations)
- **Recorded entry/exit of trail users**
(May 29 – Sept. 6, 2021)
 - Reflects summer visitors and peak mountain biking season

Data from Traditional Approaches



**Visitor
survey**

DMRA Summer 2021 Visitor Profile

(Parks & Trails Council of MN, 2021)

- **Systematic intercept visitor survey** examined:
 - Visitor demographics
 - Trail experience
 - Rider characteristics
 - Trail tourism and trip planning
- **Administered** using electronic tablets during high/low-use periods throughout day/week
- Total of **116 surveys collected**
(June 30 – Sept. 18, 2021)



Mobile Device Data

- Two mobile analytics platforms, **Placer.ai** and **StreetLight**, were used to analyze mobile device data and compare with trail counts/visitor survey data from the Summer 2021 Visitor Profile.



Mobile Device Data

- **Placer.ai** provides visitation data, demographics, and trade area analysis for retail businesses
- Uses anonymized/aggregated location data from **mobile apps**
- Provides **inferred demographic reports** based on Census Block Group (CBG) level
- **Analysis in this study** used Placer.ai data from:
 - May 29 – Sept. 6, 2021 (visit estimates)
 - June 30 – Sept. 18, 2021 (demographics)



Placer.ai



Mobile Device Data

- **StreetLight** provides traffic-volume estimates for all vehicles using GPS/location-based services (LBS) data sources -> **Counts the # of vehicles**
- Provides **inferred demographic reports** based on Census Block Group (CBG) level
- **Analysis in this study** used StreetLight data from:
 - May 29 – Sept. 6, 2021 (visit estimates)
 - June 30 – Sept. 18, 2021 (demographics)



Data Analysis

Placer.ai data

- **Selected** and verified Points of Interest (POI) for validity
- **Created** polygon features around the entire DMRA for sufficient sample size
- **Analyzed** total estimate, temporal patterns (hourly, daily, weekly), and demographics

StreetLight data

- **Selected** and validated POI
- **Created** polygon features around DMRA visitor parking lot and examined vehicle trips ending within the polygon
- **Adjusted** vehicle counts by applying median of three passengers per vehicle*

*Explore Minnesota Tourism. (2020, March). 2019 Traveler profile: Research report. https://mn.gov/tourism-industry/assets/2019%20Traveler%20Profile%20MN%20Year%20End%20Report_tcm1135-499988.pdf.

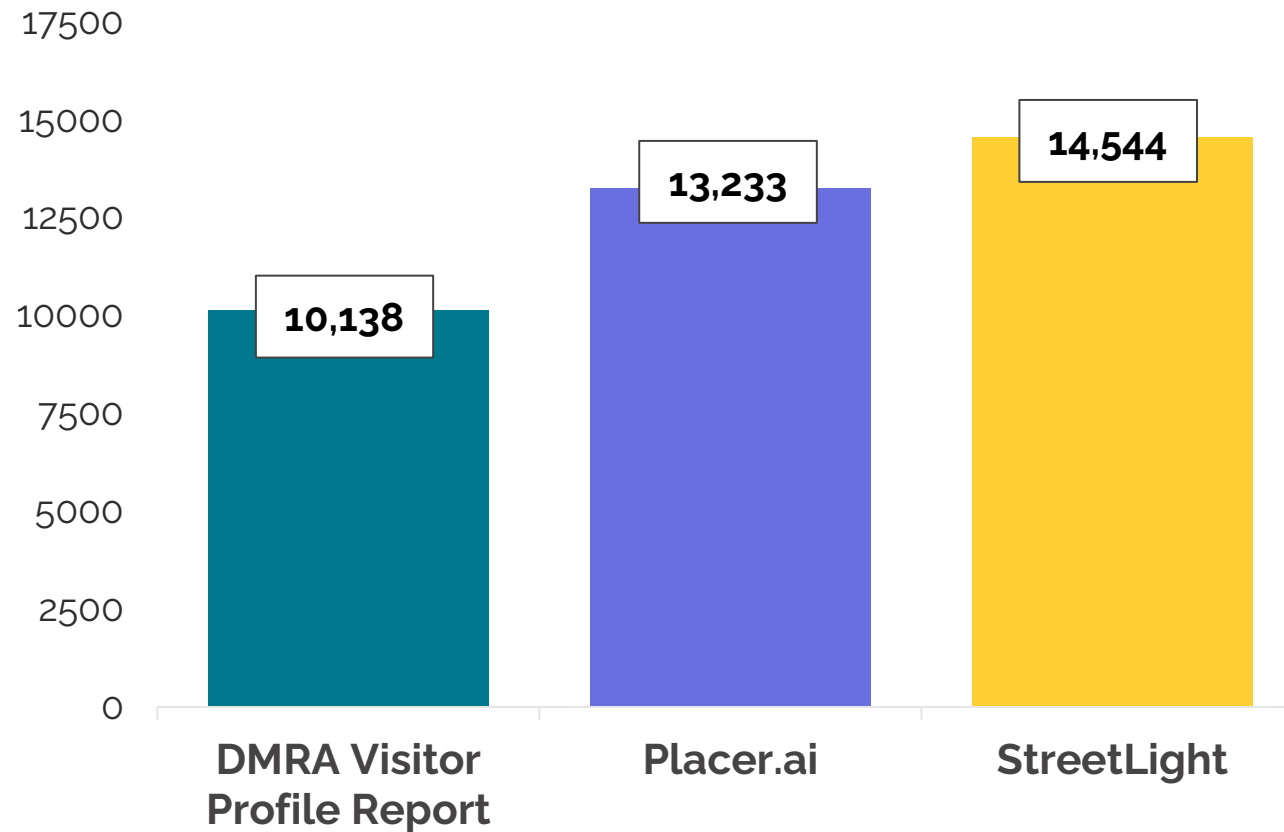
Data Analysis

For comparison:

- SPSS was used for descriptive statistics, cross-tabulations, and statistical significance testing, including paired-sample T test and chi-square test, to identify differences

Key Findings

Total Estimated Number of Visits across Datasets



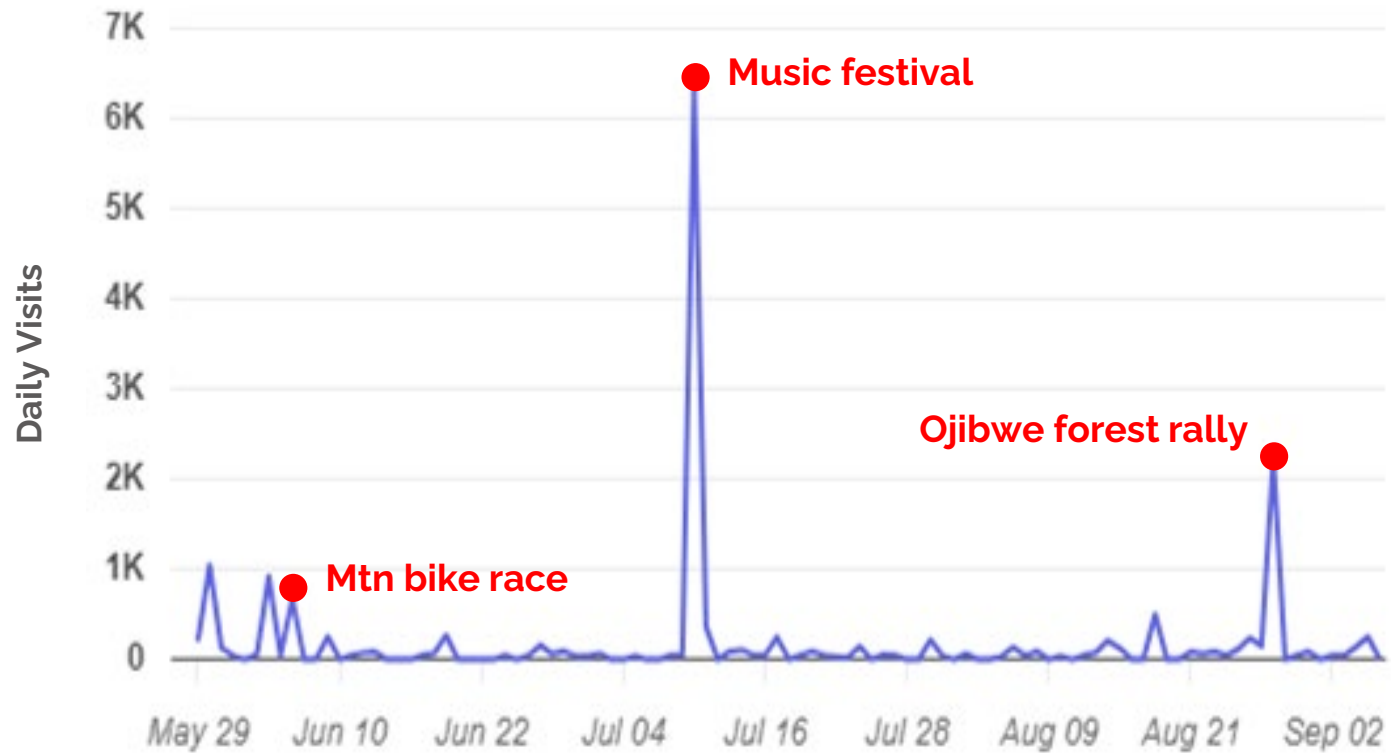
*Data collected May 29 – Sept. 6, 2021

Total Estimated Number of Visits across Datasets

- Summer 2021 visitor profile recorded 10,138 visits
- Both mobile analytics platforms showed slightly higher visit counts
- Cross dataset comparison **did not reveal** any statistically significant differences
- To analyze this data further, we focused on daily/weekly visitation patterns

Zooming In: Daily Visit Trends

Daily visits by Placer.ai



*Data collected May 29 – Sept. 6, 2021

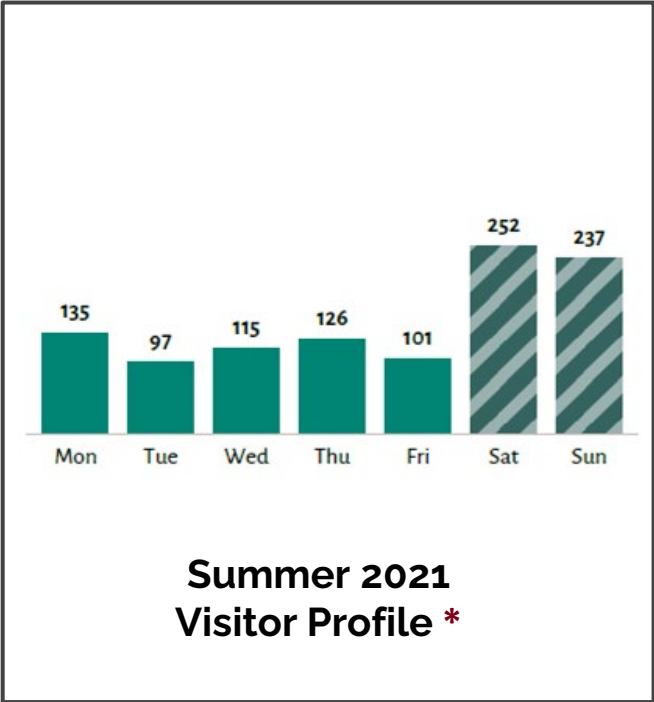
Zooming In: Daily Visit Trends

- **Placer.ai data:** Unusually high counts recorded, coinciding with special events (e.g., mountain bike race, music festival, cultural gathering)
- Large events bring many visitors but skew average daily visitation estimates

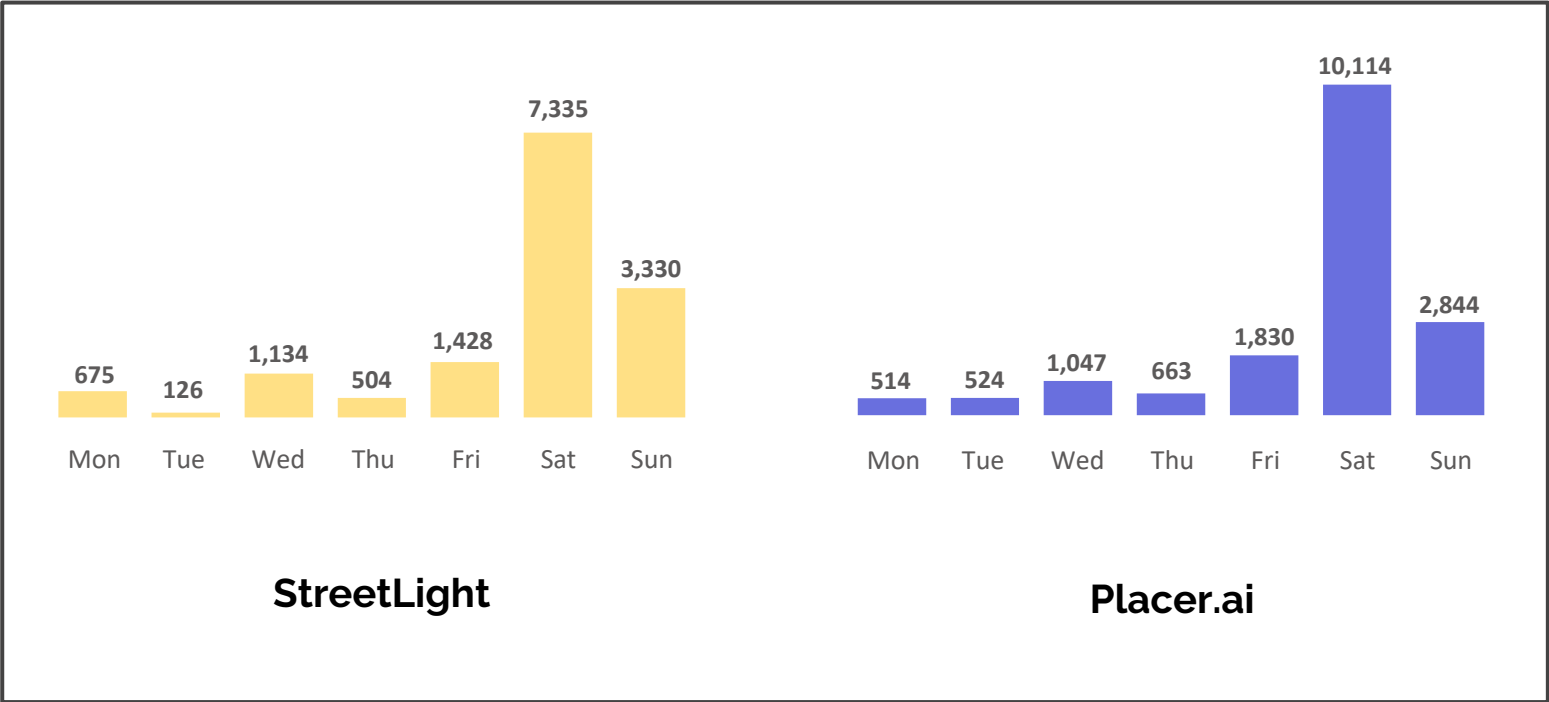


Summer 2021 Visitor Profile includes special events in overall visitation analysis but excludes them from daily/hourly averages

Day of Week Patterns across Datasets



VS



*Note: Total summer average daily traffic at cross-country trailhead (excludes special events)

*Data collected May 29 – Sept. 6, 2021

Day of Week Patterns across Datasets

- **Consistent pattern** across datasets—Saturday is the busiest day
- Overall, weekends busier than weekdays
 - ✓ **Summer 2021 visitor profile:** On average, weekends 2.1x busier than weekdays
 - ✓ **StreetLight & Placer.ai:** On average, weekends 7x busier than weekdays

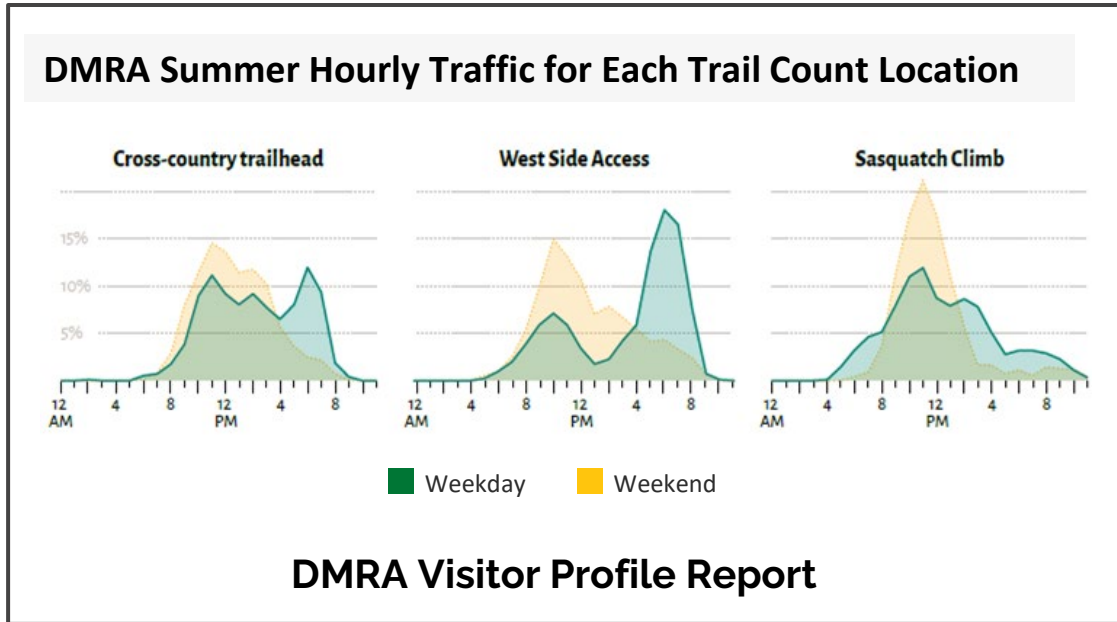
Day of Week Patterns across Datasets

***Note:** Why are mobile analytics numbers **higher**?

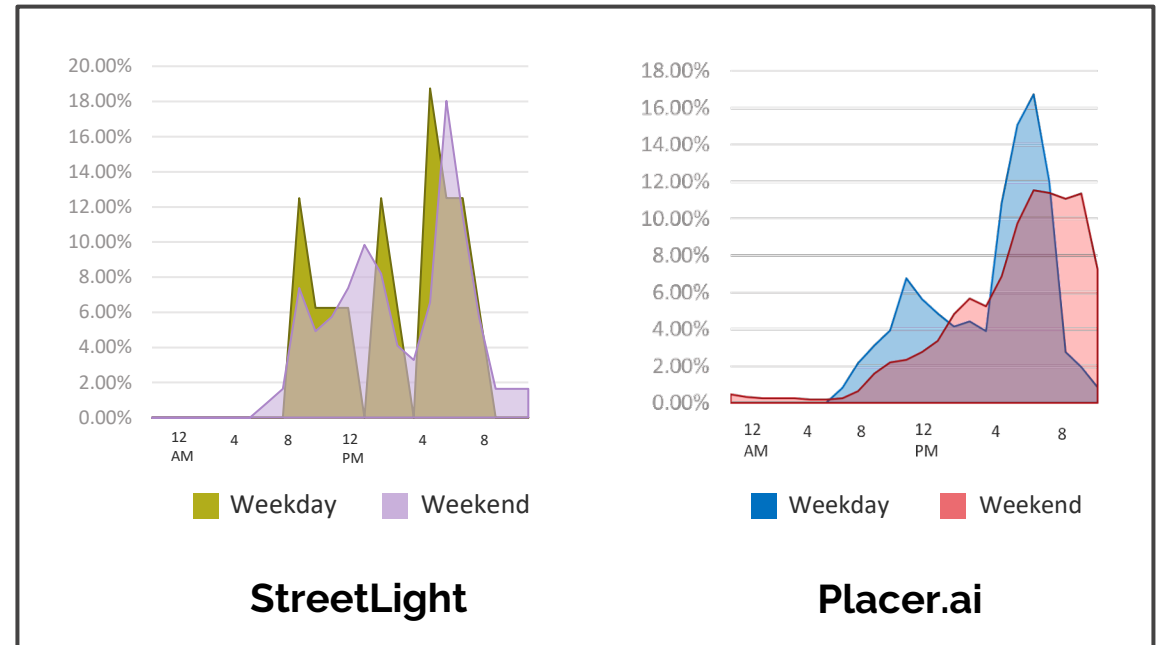
- **Summer 2021 Visitor Profile:**

1. Special/large events excluded from daily/hourly traffic estimates
2. Trail counters only at cross-country trail system
3. Weekend downhill trails accessible by ski lift may result in higher mobile data numbers
4. Mobile analytics polygons vary across platforms

Hourly Visit Patterns across Datasets



VS



*Data collected May 29 – Sept. 6, 2021

Hourly Visit Patterns across Datasets

- Overall, DMRA's summer hourly visit patterns vary on weekends and weekdays
- **Summer 2021 visitor profile**
 - ✓ *Weekday*: Reflective of work schedules, with peaks before/after work hours
 - ✓ *Weekend*: Peaks in late morning, with most traffic before 5 p.m.
- **Placer.ai:**
 - ✓ Like visitor profile: *Weekday* traffic peaks in morning, larger peak around 4 p.m.
 - ✓ Unlike visitor profile: *Weekend* traffic starts to slow in morning, with evening peak from 7 p.m. to 10 p.m.

Hourly Visit Patterns across Datasets

- **StreetLight:**

- ✓ Like visitor profile:

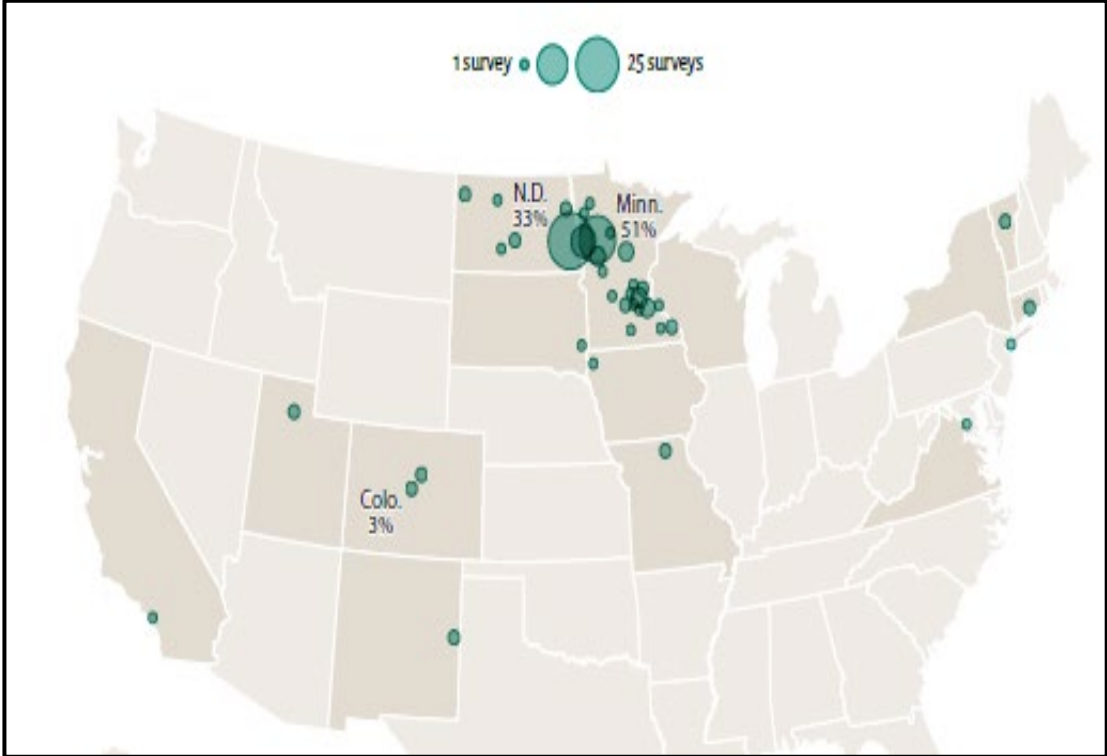
- *Weekday*: Peaks in the morning around 9 a.m. and early evening around 5 p.m.
- *Weekend*: Higher traffic compared to weekdays; rapid increase starting around 9 a.m.

- ✓ Unlike Visitor Profile:

- *Weekday*: Traffic begins at 9 a.m., remains steady 10 a.m. - noon, small peak at 2 p.m., large peak at 6 p.m.; people remain until midnight

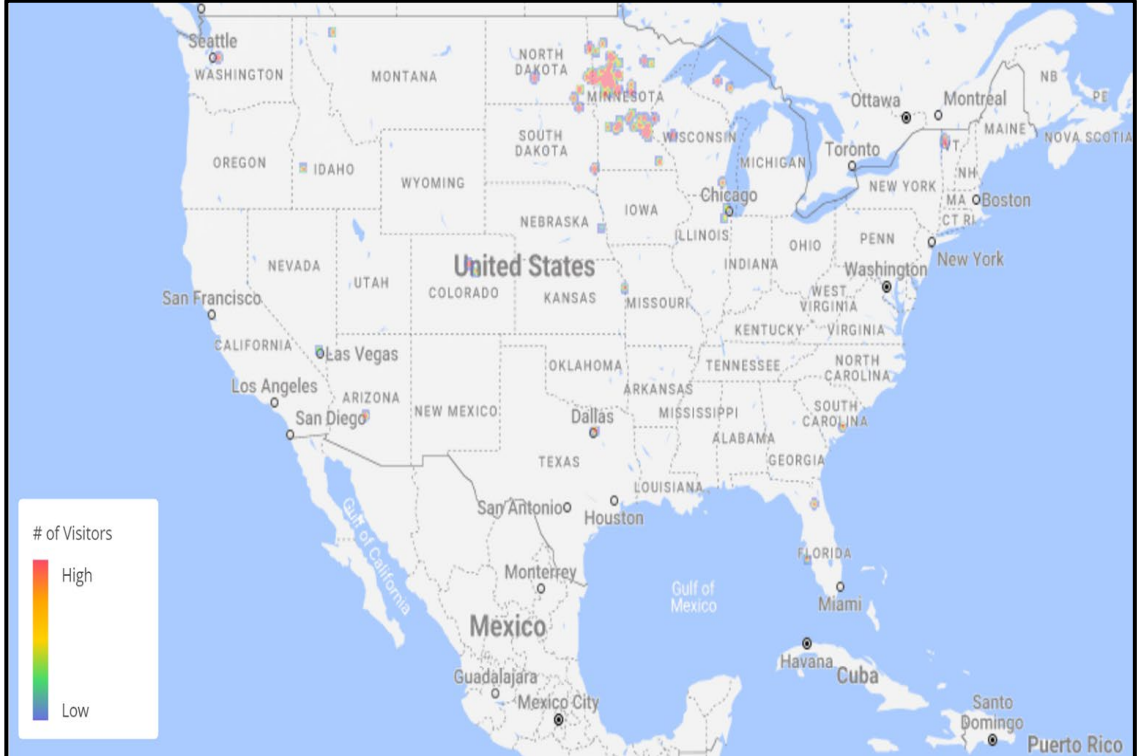
***Note**: Special events usually occur around dinner time on weekends, potentially affecting data from StreetLight and Placer.ai

Comparing Visitor Origins (National Map)



**Summer 2021 Visitor Profile:
Survey results (n=111)**

VS



**Placer.ai: Trade area by home location
(Heatmap)**

*Data collected June 30 – Sept. 18, 2021

Comparing Visitor Origins (National Map)

Summer 2021 Visitor Profile

- Map shows survey respondents' home locations as circles (zip codes)
- DMRA's mountain biking trails attract visitors from diverse locations:
 - ✓ 14 states + 1 territory (n=111)
 - ✓ Visitors from as far as California, Connecticut, and the U.S. Virgin Islands
 - ✓ Majority from Minnesota and North Dakota
- The COVID-19 pandemic limited international travel during summer 2021, resulting in all surveyed visitors being from the U.S.

Comparing Visitor Origins (National Map)

Placer.ai – Trade area by home location

- DMRA attracts visitors from 16 states, including Washington, Vermont, and Florida
- Similar to visitor profile: Minnesota and North Dakota are DMRA's primary markets
- Unlike visitor profile: no visitors from California, Connecticut, or the U.S. Virgin Islands

*Note

- ✓ Trade area: Geographic areas generating visitation based on where people live or work
- ✓ Home locations: Aggregated inferred estimates of at least 50 visitors, randomly placed within census blocks for privacy (not actual addresses)

Comparing Visitor Origins (Regional Map)

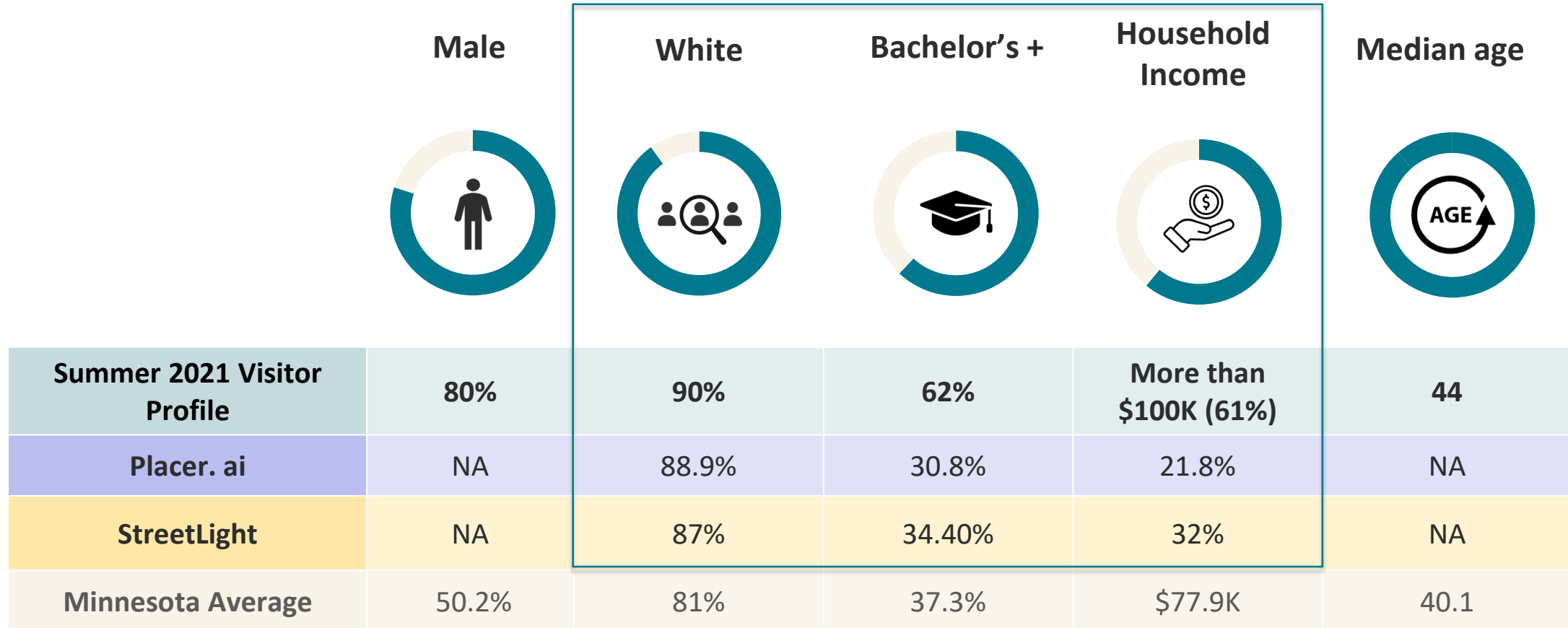
Summer 2021 Visitor Profile

- Top 3 visitor origins:
 - ✓ Fargo-Moorhead (34%), Detroit Lakes-Frazee (18%), Twin Cities (12%)
- Fargo-Moorhead was the most frequent origin for day trippers (7%)
- Twin Cities accounted for largest share of overnight visitors (22%)

Placer.ai

- Top three visitor origins:
 - ✓ Detroit Lakes (21%), Moorhead (7.2%), Frazee (4.8%)
- Within 50 miles of DMRA: Detroit Lakes (37%) and Moorhead (12.7%) were top markets
- Beyond 50 miles of DMRA: leading markets were West Fargo (8.5%), Grand Forks (4.8%)

Visitor Demographics



*Note: The highlighted box indicates statistically significant differences

Visitor Demographics

- **Summer 2021 Visitor Profile**

- ✓ Majority of DMRA's mountain biking trail visitors: male, white, highly educated, higher incomes
- ✓ Higher rates in all categories compared to mobile device data and state average

- **Mobile device data** showed statistically significant differences compared to visitor survey on:

- ✓ Race
- ✓ Education
- ✓ Income level

Visitor Demographics

- Differences in visitor demographics could result from...
 - **Visitor survey**
 - Exclusive to cross-country mountain biking trails
 - On-site data collection of individual demographic characteristics
 - **Mobile data**
 - Does not distinguish visitors' trip purpose
 - Provides aggregated/approximated information at the Census Block Group level



Discussion

Key Takeaways

Mobile data offers meaningful insights

- Enhances understanding of overall visitation and visitor demographics
- Could offer detailed results at a granular level

Variation across data sources

- Visitation pattern of a specific zone or attraction may not align with those of the entire destination and could be influenced by multiple factors:
 - ✓ Platform bias due to data restrictions
 - ✓ Differences in selected points of interest (POI) or polygon locations
 - ✓ Visitor motivation/trip purpose

Key Takeaways

Inferred demographics data differs from intercept survey data

- Mixed results from comparing visitor demographic data
- Possible limitations of only using mobile data to answer demographic-related questions
- Need context—local or expert knowledge is critical

Interpret results with caution

- Consider potential external factors (e.g., large events skew visitation volume)
- Best to avoid relying solely on one data source → cross-referencing is a good practice



Thank you!

Questions?

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