Leigh and String Lakes Visitor Use Study at Grand Teton National Park

2017 Data Collection Summary

Natural Resource Report

ON THIS PAGE
North Jenny Lake Road, approaching String Lake
JENNA BAKER

ON THE COVER
String Lake (southern end)
JENNA BAKER

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Natural Resource Report

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Executive Summary

From 2014 to 2016, Grand Teton National Park (GRTE) experienced a 17 percent increase in visitation. Within this period, the String and Leigh Lake (SLL) area of the park experienced a nearly 30 percent increase in visitation (NPS Visitor Use Statistics, 2017). The SLL area is located north of Jenny Lake in GRTE and can be accessed via three parking lots located along String Lake Road. String Lake is a shallow, easy-to-access lake that is encircled by an easy, and stunning, day hike. The String Lake Road parking lots also serve as an access point to Leigh Lake, located a mile north of String Lake. Leigh Lake is a popular destination for both backcountry and water-based recreationists. In response to the recent and rapid increase in use at SLL, researchers from Oregon State University, Pennsylvania State University, and Utah State University conducted an integrated, interdisciplinary study during the summer/fall of 2017 to examine aspects of visitor use and experience within the SLL area. Study technicians collected data from mid-July through early September 2017. Results from the 2017 data collection effort are presented in this report. Many of the results are stratified by weekday and weekend days as well as the summer (July 15 – August 15) and shoulder (August 16 – September 11) sampling seasons.

To estimate total visitor use in the area, study technicians installed automatic trail counters and vehicle tube counters. Additionally, study technicians conducted physical parking lot counts along String Lake Road. GPS-based tracking techniques of both vehicles and pedestrians (hikers, beach-goers, etc.) examined the behaviors and use-patterns of visitors in the SLL area. Recreation ecology techniques measured the extent and level of resource impact in the SLL area resulting from visitor use. Observational measures recorded visitor counts, activity types, and behaviors of interest (ex: behaviors violating Park regulations and/or principles of Leave No Trace) at key areas along the eastern shore of String Lake. Finally, a qualitative approach – interviews of visitors to the SLL area – provided a greater understanding of the social components of the SLL system.

Visitor Use Levels

Across the entire sampling period (July 15 – September 8), on average, daily traffic on String Lake Road is between 1,200 and 1,300 vehicles per day. However, the percentage of traffic flow into and from String Lake Road varies between the summer season and shoulder season. During the summer season, String Lake Road traffic accounts for approximately 35 – 40% of the traffic flow on Jenny Lake Road (two-way section). During the shoulder season, traffic on String Lake Road is between 60 – 64% of the total traffic flow on the Jenny Lake Road (two-way).

Approximately 70 – 90 vehicles per hour travel in each direction on String Lake Road. GPS-based tracking data estimates an average group size of 3 to 4 visitors per vehicle in the SLL area. Based on the observed traffic flow (70 to 90 vehicles/hour into the SLL area) and group size per vehicle (3 to 4 visitors); an average of approximately 210 – 360 visitors enter the SLL area per hour during the summer season.

In terms of parking lot use within the SLL area, on average, the number of cars parked within the SLL system (all three parking lots combined) during the summer season varies between 132 – 150 vehicles. During the shoulder season, total parked cars in the SLL system range between 145 – 156 vehicles. These counts do not include vehicles parked along Jenny Lake Road when parking lots are filled within the SLL system. Along the Jenny Lake Road, average roadside parking counts varied between 12 – 34 vehicles during the summer sampling period, and as many as 77 vehicles during the shoulder sampling period.

Overall, visitor use estimation techniques demonstrate that weekend use is slightly higher than weekday use in the SLL area. Interestingly, use levels remain relatively consistent throughout the summer season and shoulder season. All visitor use estimation techniques, as well as parking lot counts, indicate that use in the SLL area peaks between 11am and 3pm. A bump in traffic on String Lake Road is seen at 3pm as a small influx of vehicles enter into String Lake Road later in the afternoon.

Visitor Use Patterns and Associated Impacts

On average, visitors spend between 3 and 4 hours in the SLL area. Most visitors do not drive around searching for parking but are able to find parking in the first lot they drive to; the majority of visitors drive directly to, and park within, the North Lot. The movement of visitors as measured by GPS-based tracking of pedestrians is incredibly varied; this is likely a reflection of the plethora of trails that can be accessed from the SLL area. However, general trends demonstrate that many visitors remain relatively close to the parking lot where they started their visit and recreate along the eastern shore of String Lake. Visitors who begin their visit to the SLL area from the South Lot display the most variety in visitor behavior.

The northeastern shore of String Lake is observed as the busiest area in the SLL area. This location has the highest density of GPS-based tracking points, the highest counts via automatic trail counters, and the highest counts from observations of visitors. The eastern shore of String Lake has the highest visitor use compared to nearby locations and trail systems (such as Paintbrush Canyon and the String Lake Loop Trail). This high level of use is reflected in the level of resource impact observed on the shoreline of String Lake. An extensive network of small, highly impacted visitor-created sites and trails are located along the eastern shore of String Lake. A total of 1.7 miles (2,743 meters) of visitor-created trails are mapped just along the String Lake Loop trail with the majority occurring on the eastern shoreline. A total of 51,000 square feet (4741 square meters) of visitor-created sites are found along the eastern shore of String Lake equaling approximately one acre of impacted vegetation and soil. Comparatively, the rest of the String Lake Loop Trail has very low levels of resource impact.

Visitor Observations

The majority of visitors (80%) observed along the eastern shore of String Lake use the area to hike, sit (or 'beach'), and picnic. These activities vary in frequency in certain areas (or sub-zones) along

the eastern shore, with the northern end experiencing more 'beachers' and picnickers, and the southern end experiencing more hikers. Of the people who use String Lake for water-based activities, the most common activities are stand-up paddleboarding and kayaking, together accounting for up to 70% of water-based activities. Both stand-up paddleboarding and kayaking almost tie in popularity, with each individual activity accounting for about 30-35% of total water-based use.

Study technicians observed and recorded Behaviors of Interest (BOI) along the eastern shore of String Lake. BOI include any person violating GRTE rules and regulations and/or Leave no Trace Principles, and people engaging in any behavior that may negatively impact another user's experience. The most frequent behaviors are improper food storage (i.e. leaving food unattended), loud human-caused noise making, hiking off trail, and lacking a *visible* personal floatation device while on a watercraft. Each behavior accounts for about 20% of rule-breaking behavior. These behaviors are more prominent in the earlier part of the sampling season (mid-July through mid-August). Interestingly, as the sampling season progresses into mid-August, the frequency of improper food storage decreases to 7%, while loud human-caused noise increases to 33%.

Qualitative Interviews

A total of 62 semi-structured interviews were conducted across the 2017 sampling period in the SLL area. Results indicate that visitors enjoy the SLL area for the variety of settings it has to offer and the diversity of activity options available. Visitors of SLL have various motivations for participating in activities at SLL area. Interview respondents who have been visiting String Lake for more than ten years note the growing number of new uses for the area, particularly stand-up paddleboarding, beaching, and photography. The vast majority of local visitors are aware of increased use, and many of the first-time visitors are also aware of the limited parking and populated beach area. Interestingly, few non-local visitors plan their trip to the SLL area prior to arriving in GRTE.

The level of displacement, either to or away from SLL, reflects the visitors' lack of knowledge of parking capacity and potential for crowding. Respondents reported being displaced from Jenny Lake to String Lake and from String Lake to Leigh Lake due to crowding. Despite this reporting, study technicians were unable to assess whether visitors were displaced from the SLL area to other areas of the park.

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List of Commonly Used Terms and Acronyms

BOI – Behaviors of Interest

NPS – National Park Service

PAOT – People at One Time

GRTE - Grand Teton National Park

Shoulder sampling period – sampling period from August 16 to September 11, 2017

SLL – String and Leigh Lakes

Summer sampling period – sampling period from July 15 to August 15, 2017

Introduction

National Park Service (NPS) units have seen a significant increase in visitation in recent years. In 2016, Grand Teton National Park (GRTE) received over four million recreational visits, with 61 percent of those visits occurring during the months of June, July, and August (NPS Visitor Use Statistics, 2017). Given the rising numbers of visitation, there is concern that popular areas of the park may become even more crowded, possibly degrading park resources and visitor experiences. Managing for increased use, as well as new forms of recreation, in national parks is a growing issue of concern for agencies. The location of GRTE has long made it a popular stop-over destination for recreationists and vehicle tourists. Yet in recent decades, the easily accessible lakes and alpenglow views of the Tetons have become an attraction all to themselves.

Recently, staff of GRTE have observed an increase in use that the String and Leigh Lake (SLL) area of the park. From 2014 to 2016, visitation in the area increased 30 percent, while visitation in the national park as a whole increased 17 percent (NPS Visitor Use Statistics, 2017). SLL are located north of Jenny Lake and accessed via three parking lots, and associated trailheads, located on String Lake Road (Figure 1). The SLL areas provide ample recreation opportunities for both water-based and land-based recreational activities. This location is popular for a diversity of user groups: non-motorized boaters, hikers, backpackers, and picnickers. The area has been popular among hikers and canoers/kayakers for many years and remains so today. However, the increase of new uses, such as stand-up paddleboarding, add a layer of complexity to the management of the lakes.

Both lakes are within recommended wilderness and the trailheads for these two lakes provide access to popular backcountry destinations in GRTE. The popular eastern shore of String Lake is adjacent to String Lake Road. String Lake is surrounded by the 3.7 mile String Lake Loop Trail, a popular and easy hike with sweeping views of the lake and the Teton Range. The parking area of String Lake Road provides access to the Leigh Lake Trail, a 0.9 mile path that leads to the southern edge of Leigh Lake with connections to the Valley Trail and Paintbrush Canyon Trail. The southern parking lot on String Lake Road provides access to Jenny Lake via the String Lake Trail. From any of the parking lots, Trapper Lake, Bear Paw Lake, and Holly Lake can be accessed through slightly more strenuous day hikes. Additionally, Laurel Lake and Hanging Canyon can be reached via social trails and serve as popular hiking destinations.

Leigh Lake cannot be accessed via motor vehicle, thus providing a more backcountry experience. It can be reached by either hiking the Leigh Lake Trail (0.9 miles) or paddling from String Lake and portaging to Leigh Lake (~1 mile). The western shore of Leigh Lake hosts four backcountry canoe campsites. The eastern shore has a group camping site accessed via the Valley Trail. Climbers and mountaineers can also access Mount Moran by hiking or paddling to its base at the northwest corner of Leigh Lake.

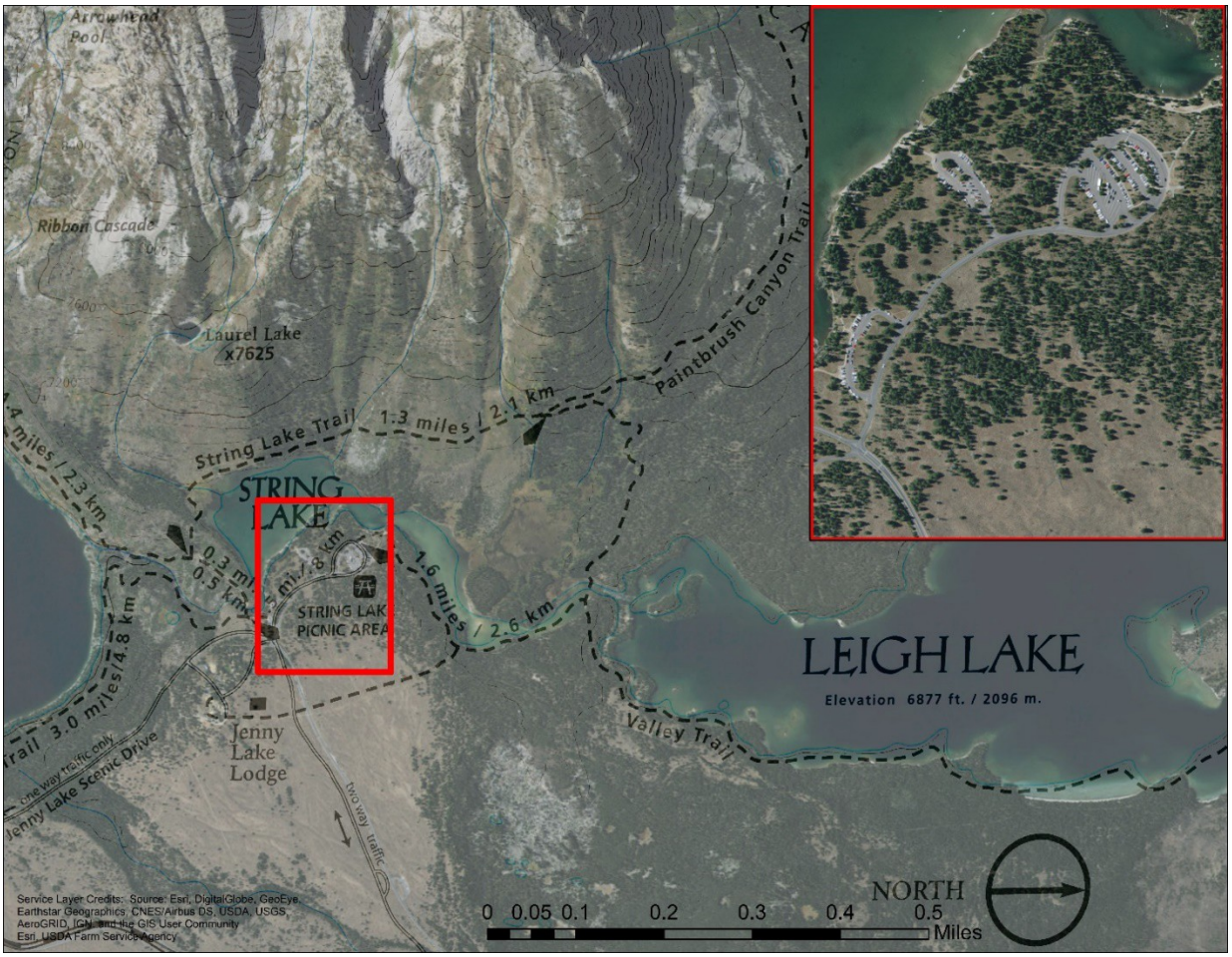

Figure 1. A map of the greater String and Leigh Lake Area with an inset of String Lake Road. Jenny Lake and the Jenny Lake trail system is located directly south of String Lake.

Between July 15 and September 11, 2017, a comprehensive, interdisciplinary study was conducted to understand visitor use at SLL. This project is part of a two-year study focusing on the social, ecological, and transportation dynamics and characteristics of the SLL areas. The goal of the 2017 data collection is to measure visitors use levels, patterns, and behaviors, examine current resource conditions, and begin to understand aspects of the visitor experience at SLL. Thus, the study employs visitor use estimation techniques, measures of parking behavior and use levels, qualitative interviews, GPS-based tracking techniques of both pedestrian visitors and vehicles, visitor observations, and an inventory of resource impacts. The qualitative portion of the study seeks to understand what factors draw the visitors to SLL as opposed to other settings, develop indicators of quality related to visitor experiences, and gain insight into what effect the influx of visitation is having on visitor experience in the SLL area.

This technical report summarizes the methods, results, and key findings from the 2017 data collection effort. This study was conducted by a collaborative team composed of researchers from Oregon State University, Penn State University, and Utah State University. All the data presented in this report were collected and analyzed by this research team. Individuals at GRTE assisted with the installation of trail counters and vehicle tube counters. A total of six trail counters were installed, three owned by GRTE (Jenny Lake Junction, String Lake Northeast Shore, and String Lake South Shore), and three owned by Oregon State University. The data from all counters were analyzed by Oregon State University. The data, both quantitative and qualitative, collected in 2017 and summarized in this report will inform the second field season during the summer of 2018.

Methods

Understanding visitor use at SLL requires an integrated, interdisciplinary approach. Thus, this study combines methodology from the fields of recreation ecology and social science. Individual methodologies are described in detail in the following sections and Table 1 summarizes the breadth of techniques used in the summer and fall of 2017.

Study Area

The focus of the 2017 data collection season was in the SLL parking lots, trailheads, and surrounding trail systems. For the first year of the visitor use study, a substantial amount of data collection focused on the eastern shore of String Lake (Figure 1). However, data was collected via trail counters, recreation ecology assessments, and GPS-based tracking for surrounding areas such as the String Lake Loop Trail, and key locations near Leigh Lake. Visitors who participated in the GPS-based tracking portion of the study may have also hiked into nearby locations that are accessible from the String Lake Loop Trail such as Paintbrush Canyon and into the Jenny Lake trail system.

Sampling Periods

The 2017 data collection season for the SLL Visitor Use Study started with study technician training on July 15. Data collection began on July 17 and continued through September 8 with the field season officially completing on September 11. Except for the qualitative interviews, all other data collection techniques were stratified by two data collection periods: the first data collection period (referred to as the "summer sampling period") extended from July 15 through August 15; the second data collection period (referred to as the "Shoulder sampling period") extended from August 16 through September 11. Not all data collection methods occurred on all days of the 2017 field season. Refer to Appendix A for a complete schedule of sampling methods. Past studies in GRTE, at other locations in the park, had found that visitor use levels dropped off starting in mid-August – these past studies informed the August 15th cut-off date and naming convention of "summer" and "shoulder" season for the sampling periods in this study (Monz et al., 2014). For the purposes of this report, results from most of the data collection techniques are generalized to represent the overall data collection period

(July 15– Sept 8), the summer sampling period (July 15 – Aug 15), or the shoulder sampling period (Aug 16 - Sept. 8). Sampling dates and times were randomly selected and stratified to ensure a representative sample of mornings and afternoons, as well as weekday and weekend data collection (see Appendix A). Morning sampling times occurred from 8:00am to 12:00pm, and afternoon sampling times occurred from 12:00pm to 4:00pm. During afternoon GPS-pedestrian sampling days, sampling times extended to as late as 6:00pm.

Notes on Methodology:

1) In July 2017, at the peak of the recreation season, the NPS closed String Lake Road to roadside parking for safety purposes. Parking within designated spots within the three parking lots remained open, as did parking along Jenny Lake Road. Additionally, whenever volunteers in the area determined that the lots were at capacity, they placed a sign on the entrance to String Lake Road reporting that the parking lots were full. Despite the sign being installed, visitors were still allowed to enter the road and look for any open spot. If a designated parking space was not available, visitors were instructed to park on the Jenny Lake Road and walk into the SLL area. Additionally, construction activities were continuing at South Jenny Lake thereby limiting the parking capacity at Jenny Lake, a highly popular attraction in GRTE. With decreased parking capacity at Jenny Lake, visitors may have been displaced to String Lake where there is also trail access to Jenny Lake (see Figure 1). These two events - installing Parking Lot Full sign at String Lake and construction at Jenny Lake – may have impacted visitor behavior and use within the SLL system.

2) On August 21, 2017 there was a total solar eclipse that passed through GRTE. It was anticipated that visitor use on the days leading up to the event would be unusually high. To avoid introducing an outlier data point, or interfere with the visitor experience during the eclipse, no data was collected on August 20 or August 21.

Table 1. Matrix of data collection methodology, sampling approach, and sampling locations utilized in 2017 data collection effort.

Method Type	Information Need	Data Collection Method	Sampling Approach	Sampling Location
Transportation Focused	Designated Parking Lot Accumulation	Observational Counts	Stratified Random Sampling	All three parking lots: North Lot, Boat Launch, and South Lot
	Undesignated or Illegal Parking	Observational Counts	Stratified Random Sampling	All three parking lots: North Lot, Boat Launch, and South Lot; conducted during designated parking lot accumulation counts.
	Parking Lot Retention	GPS-based Tracking	Stratified Random Sampling	Sampling at entrance of String Lake Road
	Vehicle Use Levels	Tube Counters	Continuous Throughout Season	Tubes placed on Jenny Lake Road two-way portion, one-way portion, and on String Lake Road.
Social Science Focused	Visitor Counts & Activity Types	Counts via On-site Observations	Stratified Random Sampling (limited)	Sampling at delineated zones along the eastern shore of String Lake.
	Visitor Non-Compliant Behavior	Counts via On-site Observations	Stratified Random Sampling (limited)	Sampling at delineated zones along the eastern shore of String Lake.
	Visitor Use Estimation	Automatic Trail Counters	Continuous	Six Counter Locations: String Lake at NE Shore, SE Shore, and South Shore; Leigh Lake Portage; Jenny Lake Junction; Paintbrush Canyon
	Visitor Access, Behavior, and Movement	GPS-based Tracking	Stratified Random Sample of Pedestrians	Sampling at entrances at all three parking lots
	Visitor Experience	Qualitative interviews	Stratified Random Sample by User Group	Sampling at delineated roam path along the String Lake lakeshore.
Recreation Ecology/Resource Impact	Resource Impacts on Lakeshores	Sub-meter GPS; ocular estimation	Census	Eastern shore of String Lake
	Resource Impacts on/adjacent to Trails	Sub-meter GPS; ocular estimation	Census	String Lake Loop Trail
	Resource Impacts from Parking	Sub-meter GPS; ocular estimation	Census	Sampling at all three parking areas
	Resource Impacts from Camping	Sub-meter GPS; ocular estimation	Census	Two backcountry campsite locations along Leigh Lake. Campsite # 15 & 16

Vehicle Use Estimation

MetroCount directional tube counters recorded the number and direction of vehicles on roads surrounding SLL (MetroCount, 2015; Xia and Arrowsmith, 2008). These tube counters were placed at three locations around the study area.

MetroCount locations:

1. North Jenny Lake Junction Road, south-west of the Cathedral Group Turnout
2. String Lake Road
3. One-way section of Jenny Lake Road, south of the Jenny Lake Lodge

MetroCounters collected vehicle counts and vehicle direction data 24 hours per day during the study period. The tube counters were provided by Grand Teton National Park who also assisted with installation. Research technicians managed data downloads, MetroCount maintenance, troubleshooting, and data summary with support from GRTE staff. MetroCount software was used to produce summary data that was analyzed and compiled by research technicians. A high accuracy Trimble GPS unit mapped the exact location of each MetroCount (Figure 2).

Visitor Use Estimation

Automatic trail counters collected visitor use counts along trails. Trail counters consisted of one Diamond brand counter and five TRAFx counters that were installed in camouflaged locations along the String Lake loop trail and at trail junctions around SLL (Diamond Traffic Products, 2016; TRAFx, 2017). The exact location of each trail counter was mapped with a high accuracy Trimble GPS unit (Figure 2).

The trail counters collected data 24 hours a day throughout the study period and data were aggregated into hourly bins. Study technicians calibrated the counters in hourly segments throughout the study period (Pettebone et al., 2010). Calibration times were randomly stratified across different times of day to control for various levels of use. Calibration techniques consisted of recording the number and direction of pedestrians walking past the counter. These calibrations were used to determine any trail counter error. Research technicians uninstalled and downloaded data from three trail counters upon completion of the study period. The raw data from GRTE counters was sent to research technicians for analysis. Due to battery failure, the trail counter located at the trail junction of the Leigh Lake portage only contains data from July 20 to August 13.

Figure 2. Map of trail counter and MetroCounter locations in SLL study area.

Photo 1. Field technicians install camouflaged TRAFx trail counter at the String Lake south shore location (JENNIFER GARDNER).

Parking Lot Counts

Study technicians collected data on parking lot use levels at SLL using methods from similar studies (Lawson et al., 2003, Monz et al., 2010). Parking lot sampling days occurred in tandem with pedestrian GPS-tracking and vehicle GPS-tracking sampling days. GPS-tracking days were determined using a stratified random sample that included weekdays, weekends, mornings, and afternoons.

String Lake Road contains three designated parking areas labeled in this report as the "South Lot", "Boat Launch", and the "North Lot" (Figure 3). *Designated parking* was defined as any parking spot that was demarcated with two parallel white lines to indicate an available spot. *Undesignated parking* was defined as areas along a curb within the parking area that do not have any red marking or signs indicating that the location was a 'no-parking' zone. *Illegal parking* was defined as areas in the parking lot with red marking, cones, and/or signage indicating 'no-parking'.

Study technicians counted the number vehicles in each parking lot every half hour and recorded the number of vehicles parked in designated spaces, undesignated spaces, and illegal spaces. Within designated parking areas study technicians recorded the number of local vehicles, number of bicycles present, number of cars waiting for a parking spot (i.e. looping around), number RV's, number of vehicles with a trailer and trailer type, number of motorcycles, number of government or NPS vehicles, and number of research vehicles. Photographs were taken at the beginning of every parking lot count.

It is important to note, that for the purposes of this study, "local" vehicles were narrowing defined to vehicles with WY-22 license places and no obvious barcode (which often indicate a rental car). Individuals may consider themselves locals to the area and not drive a vehicle with a WY-22 license plate. However, since the methodologies employed in this study were largely observational – the concept of "local" vehicles was operationalized as something that could be easily observed and documented in the field.

On high visitor use days when the parking lots were full, GRTE staff put up a 'Parking Lot Full' sign at the entrance of String Lake Road. Overflow vehicles were encouraged by GRTE staff to park along the shoulder of Jenny Lake Road. The Jenny Lake Road roadside parking lot counts were conducted every half hour starting on the hour during vehicle GPS-tracking days. Due to limitations in the number of field staff available and safety concerns, roadside parking lot counts did not occur during the pedestrian GPS-tracking days.

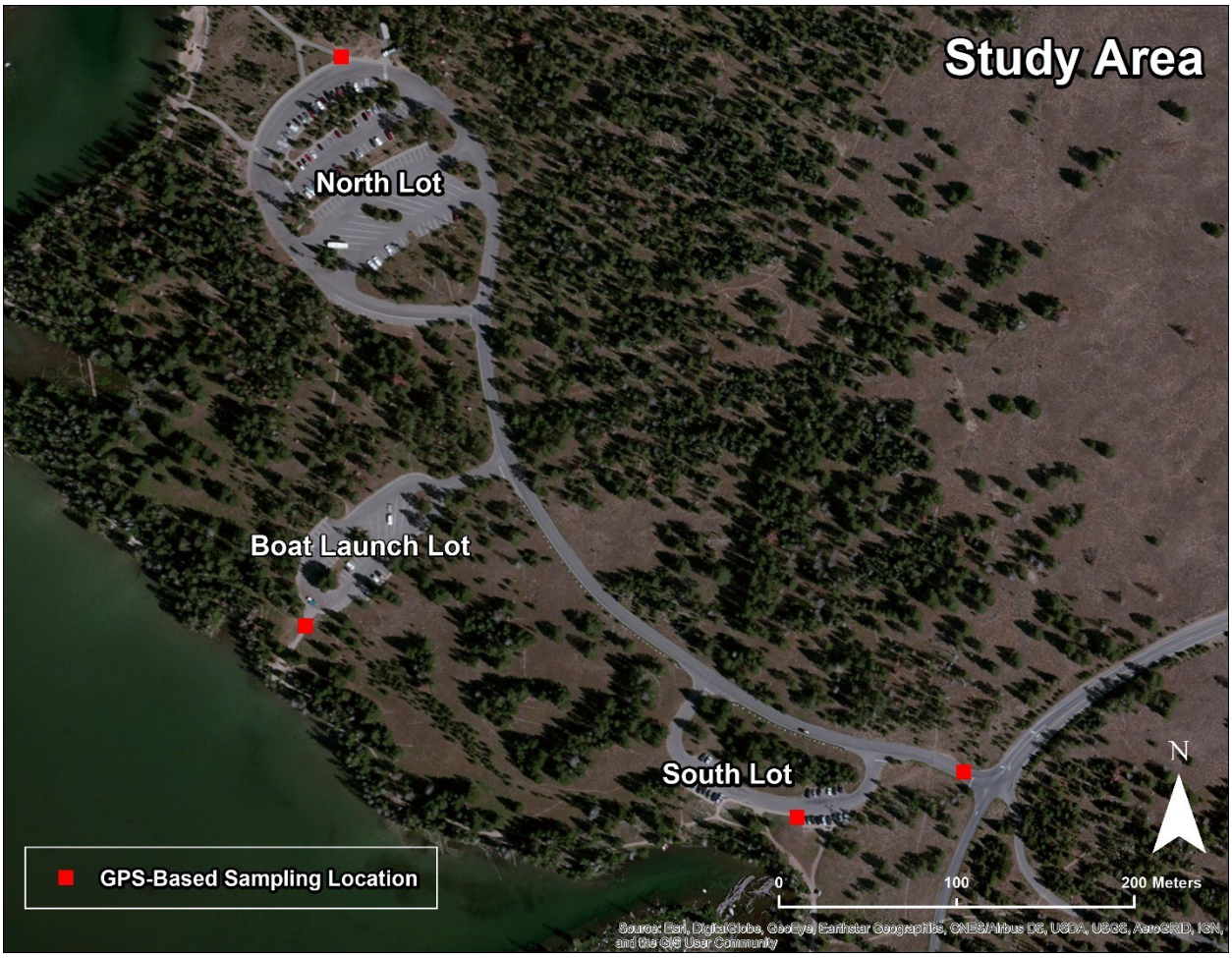

Figure 3. Map of String and Leigh Lake study area parking lots and locations where GPS units were handed out to pedestrians or vehicles during GPS-based sampling.

Photo 2. Study technician conducts a parking lot count at the Boat Launch parking lot (JENNA BAKER).

Vehicle Parking and Use Patterns

Vehicle movement and use patterns were examined using GPS-based methodologies (D'Antonio et al., 2010; Hallo et al., 2012). Study technicians deployed Garmin eTrex 10 units to a random sample of visitors in their vehicles as they entered into String Lake Road. Sampling days were determined using a stratified random sample to ensure a representative sample of weekends, weekdays, and times of day. To reduce selection bias, study technicians used a systematic random sampling technique to intercept a vehicle. At the beginning of each hour, study technicians closed his/her eyes to select five numbers on a random number table. Random number tables were printed onto 8.5 x 11 sheets of paper with several columns of numbers listed randomly from one to sixty. The five randomly selected numbers indicated the time (in minutes) for researcher to intercept the next vehicle. For example, if the number selected was five, and the researcher began at noon, he/she would intercept the first vehicle at12:05 or after. If the next random number selected was 23, the researcher would not intercept the next vehicle until 12:23 or after. In this way, three to five GPS units would be deployed during each sampling hour to ensure an equal number of GPS tracks were collected across the sampling times.

Upon vehicle interception, passengers were instructed to keep a GPS unit in their vehicle while parked in the SLL area. Overnight users were excluded from the study due to difficulties with GPS battery life and logistical complications with collecting the GPS units.

During the vehicle intercept, information was also recorded on the number of people in the vehicle, if the vehicle plates were local/non-local, and trip destination. "Local vehicles" were defined as vehicles with a WY-22 county license plate *without* a rental company sticker adhered to the vehicle. Local rental car companies confirmed the use of a bar code sticker as a way to identify rental vehicles (Monz et al., 2010). Therefore, any vehicle with a WY-22 plate and a bar-code sticker was considered as "non-local." Due to limitations in number of available GPS units and staff size, vehicle GPS-tracking did not occur on days when pedestrian GPS-tracking occurred.

Upon exiting the SLL area, motorists returned GPS units to a study technician or at a drop box located at the String Lake Road exit. Erroneous data points were eliminated from the GPS data prior to analysis. Points that were removed included those that were collected while the GPS unit remained in the drop box, GPS points collected outside the String Lake Road area, and points that resulted from general GPS error (ex: random point in the lake). On days when the 'Parking Lot Full' sign was in use, research technicians did not deploy GPS units to vehicles but continued to randomly sample vehicles to collect information on local/non-local vehicle status, number of people in vehicle, and trip destination.

Photo 3. Field staff intercept a vehicle on String Lake Road (JENNA BAKER).

Pedestrian Use Patterns

Researchers examined pedestrian use patterns using GPS-based methodologies (D'Antonio et al., 2010; Hallo et al., 2012). Garmin eTrex 10 units were given to a random sample of visitors at the three parking lots located along String Lake Road: the South Lot, the Boat Launch, and the North Lot. Using a random number table, a set number of GPS units were deployed during each sampling hour to reduce selection bias, and ensure an equally distributed number of GPS tracks. This random number table was used in the same way as vehicle GPS-tracking: study technicians randomly selected 7 numbers on the table which indicated the minute on the hour for the next intercept of a pedestrian for GPS-unit deployment. Sampling days were determined using a stratified random sample across weekends, weekdays, mornings, and afternoons to ensure a representative sample.

All GPS units were given to day-users prior to beginning their activity in the study area. A study technician intercepted a pedestrian and asked if they would be willing to carry a GPS unit while recreating. For every GPS unit deployed, information was recorded on number of people in the group, activity type (see Table 2) and intended destination. Only one GPS unit was given per group and only a person 18 years or older could carry the GPS unit. GPS units were only deployed to visitors who were planning on returning to their vehicle or mode of transport upon completion of their visit that same day. Backpackers and shuttle users were excluded from the study due to difficulties with GPS battery life, and complications with retrieving the GPS units. People using String Lake to kayak, canoe, raft, or stand-up paddleboard were also excluded from the study because the GPS units were potentially not equipped for sustained water damage. However, "beach users" and picnickers that remained stationary along the shoreline, but intended to go in and out of the water throughout their visit, were included in the study and asked to keep the GPS unit on shore.

Upon completion of their visit to String Lake, pedestrians returned the GPS units to a study technician or at drop box located at the exit of String Lake road (the same drop box for vehicle GPS-tracking). Visitors who declined to participate in the study were recorded along with their reasons for declining and estimated group size. Due to limitations on the number of GPS units available and staff size, pedestrian GPS-tracking did not occur on days when vehicle GPS-tracking occurred. GPS tracks were cleaned of erroneous points or obvious outliers before data analysis. Calibration techniques were employed with the use of a high accuracy Trimble GPS unit that served to determine the level of positional error associated with the Garmin eTrex 10 units.

Visitor Observations - Activity Types

Field staff collected data on visitor use and visitor activity types using methodology inspired from similar studies (Reed et al., 2007; Walden-Schreiner and Leung, 2012; Evenson et al., 2015). Direct observations of visitors were chosen in order to dynamically and unobtrusively capture behavior, proportions of different activity types, and use levels along a complex, and densely populated section of String Lake.

Sampling days occurred on weekends, weekdays, mornings, and afternoons to ensure a representative sample. Observation zones were divided into four primary zones that stretched from the Leigh Lake trailhead (north end) to the String Lake trailhead sign (south end). Zone 1 was the northern-most zone, Zone 2 was the picnic area at the North Lot, Zone 3 stretched along the middle section of trail, and Zone 4 was the southern-most zone. Each zone was divided into two subzones that delineated the north and south ends within the individual zone. Zone 1, Zone 3, and Zone 4 included water viewsheds (Figure 4) where observations of activity-types on the water were recorded. For a table of water-based activity types, see Table 3.

At the beginning of every fifteen minutes on the hour, study technicians systematically walked a predetermined rove path within each zone. Study technicians scanned the trail, area around the trail, and shoreline, and recorded the total number of people at one time (PAOT counts) within each zone.

For each individual counted, gender, activity, whether or not the individual was in a group, estimated group size, and location of visitor in the zone was recorded. This process was repeated every fifteen minutes on top of the hour for four consecutive hours. Study technicians visited water viewsheds while on their systematic rove and documented the number of people observed in the water and their activity type. Due to limitations with the human sight range, gender and group status were not recorded at water viewsheds. Study technicians remained unobtrusive and inconspicuous during observations in an effort to observe unaltered behavior. However, signage was placed along the study area disclosing to visitors that a visitor experience study was in progress (Figure 5). All zone boundaries, water view shed locations, and rove paths were mapped with a high accuracy Trimble GPS unit.

Figure 4. Map of observation zones (shown in green), viewshed observation points, and observation roves in String Lake observation study area.

Table 2. Land-based activity type definitions

Activity Type	Definition
Boat Prep	Stand up paddle board
	Kayak
	Canoe
	Raft
Hike	Walking
	Hiking
	Backpacking[A]
Other[B]	Hammock
	Guitar
	Fish
	Swim prep
	Sleep
Photo	Taking a photo
Picnic	Eating
Play	Children running around
	Playing a game
Sit	Sitting/lounging along shore ("Beaching")
	Sitting on camp chair
Stand	Sightseeing
	Standing
Wade	Wading along shoreline

[A] Within the 'Hiking' category, backpackers accounted for less than 1% of total hikers.

[B] The 'Other' category was determined from activities that accounted for less than .5% of total activity types.

Table 3. Water-based activity type definitions

Activity Type	Definition
Canoe	Traveling in or paddling in a canoe
Float	An inflatable object a person sits on while floating in water
Kayak	Traveling in or paddling in a kayak
Other	Sculling Pontoon Pedal Board
Raft	Traveling in or paddling in a raft
Rock	People recreating on the large rock located in the middle of String Lake
SUP	Stand Up Paddleboard
Swim	Swimming in String Lake
Unknown	Vessel type unknown
Wade	Wading along shoreline

* The 'Other' category was determined from activities that accounted for less than .5% of total activity types.

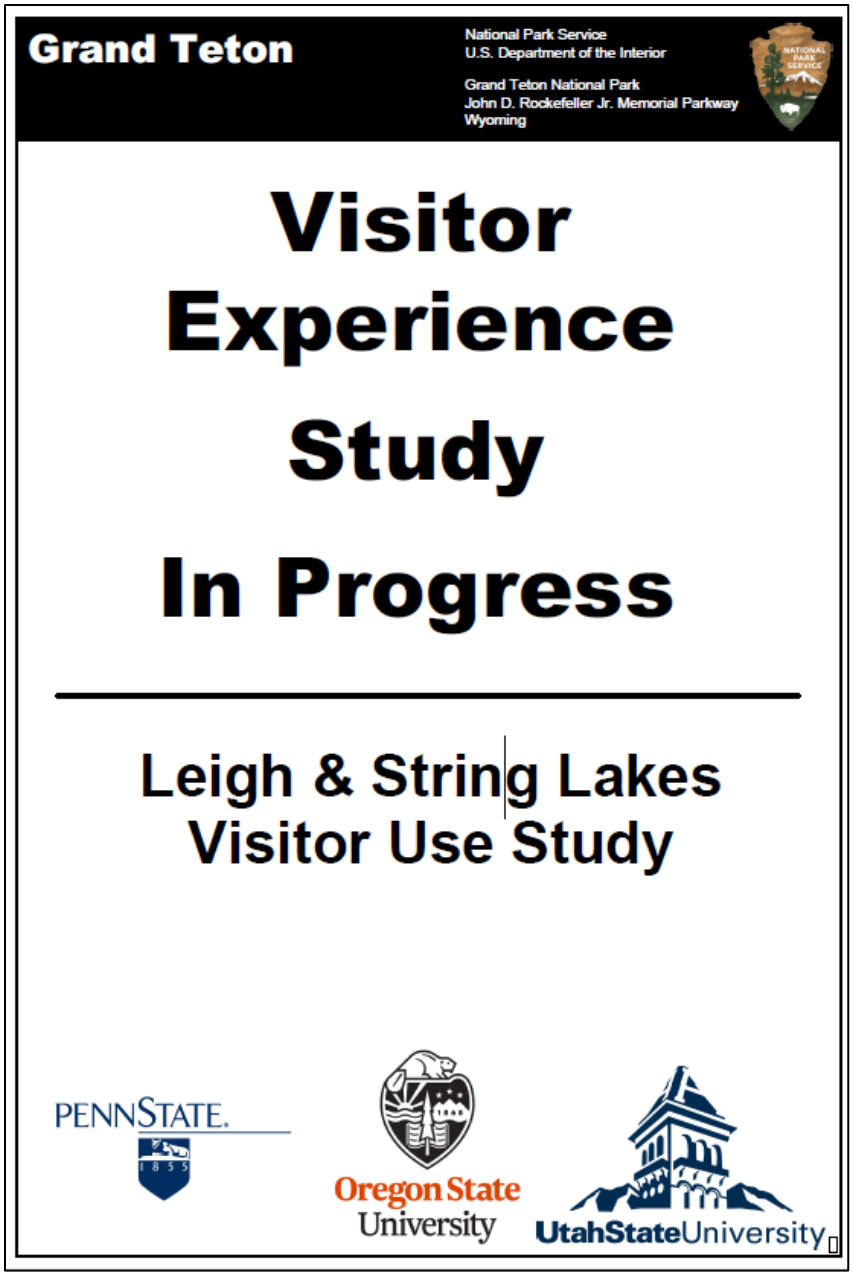

Figure 5. Signage placed along observation study area disclosing to visitors a study was in progress.

Visitor Observations – Behaviors of Interest

Study technicians collected data on visitor behavior using methodology inspired from similar studies (Reed et al., 2007; Walden-Schreiner and Leung, 2012; Evenson et al., 2015). Direct observations of visitors were chosen in order to dynamically and unobtrusively capture behavior and use levels along a complex, and densely populated section of String Lake.

Sampling days were conducted using a stratified random sample across weekends, weekdays, mornings and afternoons to ensure a representative sample. Observation zones were divided into four primary zones that stretched from the Leigh Lake trailhead (north end) to the String Lake trailhead sign (South end). Zone 1 was the northern-most zone, Zone 2 was the picnic area at the North Lot, Zone 3 stretched along the middle section of trail, and Zone 4 was the southern-most zone. Each zone was divided into two subzones that delineated the north and south ends within the individual zone (Figure 4). Zone 1, Zone 3, and Zone 4 included water viewsheds. Observations of behavior on the water were recorded from these viewsheds.

At the top of every hour on the hour, research technicians systematically walked a predetermined rove path within each zone. Study technicians scanned the trail, area around the trail, and String Lake shoreline and recorded the total number of people at one time (PAOT counts) within each zone. In between the PAOT counts, study technicians selected pre-determined areas within each sub-zone to unobtrusively scan and observe Behaviors of Interest (BOI) defined as violations of Park rules and regulations, failing to observe Leave no Trace principles, or any other observed behavior that may detract from other visitors' experience (Table 4). Information was recorded on the exact time of observed behavior, location in zone, number of people engaged in behavior, and description of behavior observed. During BOI observations, signage was installed along the study area disclosing to visitors that a visitor experience study was in progress (Figure 5). All zone boundaries and rove paths were mapped with a high accuracy Trimble GPS unit (Figure 4).

Table 4. Behaviors of Interest definitions

Observed Behavior	Definition
Dog	Dog observed along trail
Food	Improper food storage
	Food left unattended
Harassing Wildlife	Disrupting wildlife
	Getting too close to wildlife
Human-Caused Noise	Excessive yelling
	Loud vehicle noise (car alarm, diesel idling, honking)
	Inflating/deflating water craft
	Loud music or technological noise
No Visible PFD	Lacking visible personal floatation device on water craft
Obstructing Trail	Obstructing trail by standing in trail for prolonged periods of time
	Leaving large object in middle of trail (watercraft, strollers etc)
Off -Trail	Walking off-trail and/or using a visitor-created trail
Other	Behavior that does not fall under available definitions
Resource Damage	Taking/displacing natural materials (pinecones, sticks, rocks)
	Breaking sticks, scratching into trees
	Throwing rocks, sticks

Inventory of Resource Impacts

Study technicians used a sub meter accuracy Trimble GPS unit to map and classify resource conditions in key areas surrounding SLL. The following areas were mapped and resource impacts were classified:

* String Lake shoreline impacts from String Lake trailhead to Leigh Lake trailhead and along the entirety of the String Lake Loop Trail.
* Picnic areas and impacts surrounding picnic areas.
* Resource impacts along String Lake Road and the parking lots and parking lot impacts, including social trails leading out from parking lot.
* Leigh Lake campsites on the West side of Leigh Lake.

Resource impacts within these areas were mapped as either a polygon (an area of dispersed visitor use), a line feature (i.e. a trail), or point (i.e. management feature or feature of interest). All impacts were assessed for resource conditions using scale-based ratings systems. Scales included assessments of vegetation cover on- and off-site, level of mineral soil exposure, soil type, presence or absence of trash, and overall condition class. Condition classes had a range of 0 through 5 and 1-5; with 0/1 being the lowest level of resource change and 5 being the highest level of resource change. There were separate condition classes for dispersed visitor use areas (polygons) and visitor-created trails (lines). In addition, the location of trees that had been damaged from visitor use (either directly via damage or indirectly via processes such as trampling and soil erosion) were mapped. Management features (such as picnic tables, bear boxes, and signs) were also mapped and identified.

Visitor-Created Sites (polygons):

Visitor-created sites included campgrounds, picnic areas, large 'beaching' areas along the shoreline of String Lake, view sites, and/or areas around parking lots that were used for staging recreation equipment. Areas of resource change were located using foot and ground searches. Each area of impact was mapped and recorded with the Trimble GPS and photo documented with a field camera.

Resource conditions were assessed within each polygon and included percentage of vegetation cover on and off site, level of mineral soil exposure, soil type, and presence or absence of trash (Table 5). Additionally, each polygon was given a condition class that defined the level of resource change (see 807 below). Large dispersed areas of resource impacts were sometimes mapped as multiple polygons, with an additional layer being added as condition class changed throughout the polygon.

Visitor-created trails and spurs (lines):

Visitor-created trails included any linear feature that is not created by GRTE, typically referred to as 'social trails' or 'informal trails'. These areas of resource change were located using foot and ground searches. Each visitor-created trail was mapped and recorded in the Trimble GPS and photo

documented. Width and condition of visitor-created trail was recorded. The condition of the visitor-created trails was defined from the following class rating system (Table 5b).

Table 5a. Visitor-created sites condition class definitions.

Condition Class	Vegetation Damage	O Horizon Loss*	Mineral Soil Exposure	Erosion
1	Very slight <1%	None	None	None
2	Slight <10%	Surface scuffing- some loss evident	Slight <10%	None
3	Moderate 10-50%	Moderate loss evident- 10-50%	Moderate 10-50%	Slight
4	Considerable 51-90%	Considerable 51-90%	Considerable 51-90%	Some
5	Total Loss of cover >90%	Total Loss of OM	Most of site >90%	Considerable

* Surface layer of the soil which contains mostly organic material made up of dead plant and animal residues in various stages of decomposition.

Table 5b. Visitor-created trails condition class definitions.

Condition Class	Characteristics
0	Trail barely distinguishable; no or minimal disturbance of vegetation and/or organic litter.
1	Trail distinguishable; slight loss of vegetation cover and/or minimal disturbance of organic litter.
2	Trail obvious; vegetation cover lost and/or organic litter pulverized in primary use areas.
3	Vegetation cover lost and/or organic litter pulverized within the center of the tread, some bare soil exposed.
4	Nearly complete or total loss of vegetation cover and organic litter within the tread, bare soil widespread.
5	Soil erosion obvious, as indicated by exposed roots and rocks and/or gullying.

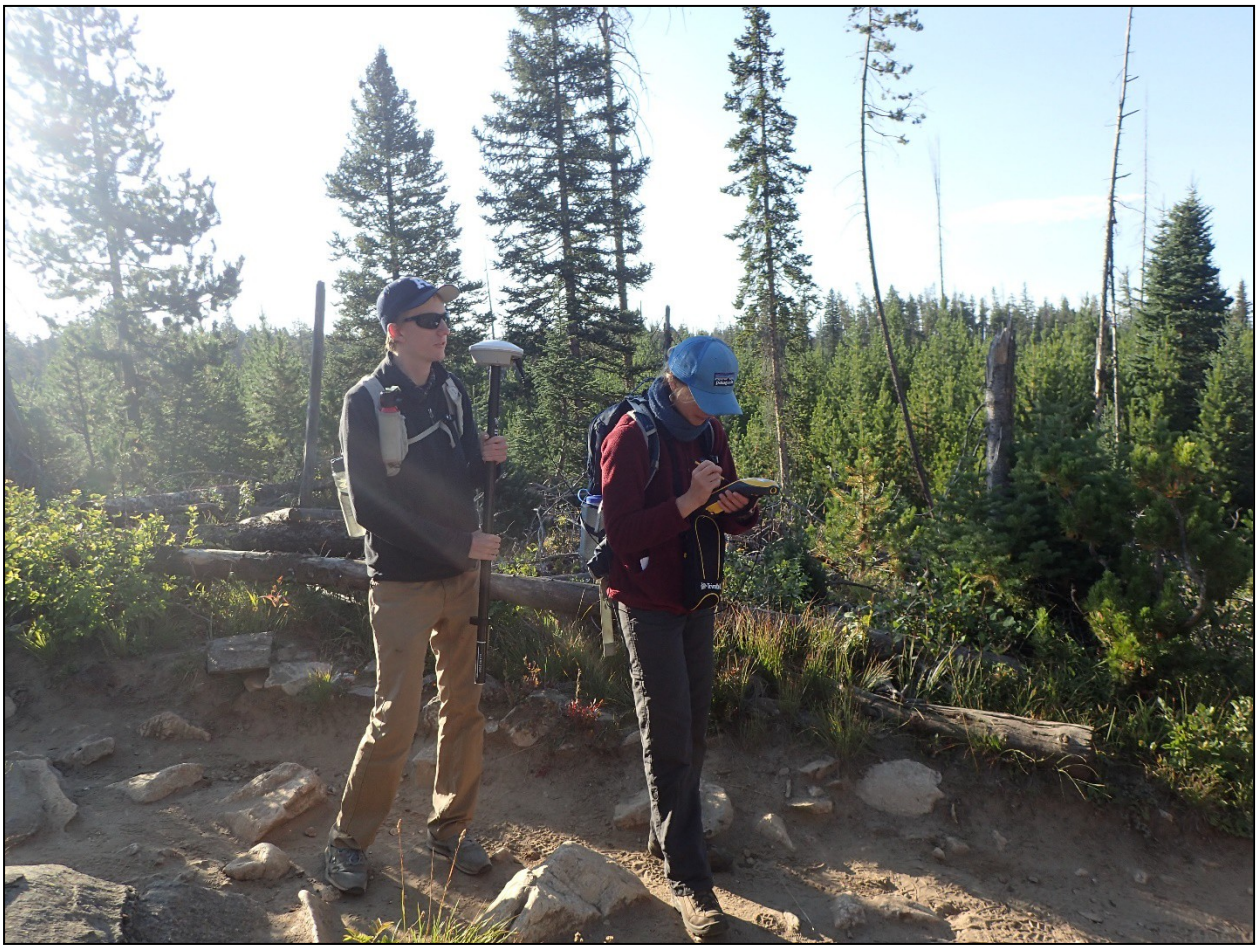

Photo 4. Study technicians map resource impacts along String Lake loop trail with a Trimble GPS (JENNIFER GARDNER).

Qualitative Interviews

The research team used a qualitative approach to examine visitor experience in the SLL area. Though a quantitative survey can provide more robust statistics of visitor motivations and attitudes, in the first year of this two-year study, interviews were administered because of the limited understanding of visitor use and experiences in the SLL. This approach was selected in order to better assess what indicators could be measured in a forthcoming quantitative survey, due to a lack of previous assessments in the area. Therefore, the qualitative results discussed here lie within a larger mixed-methods study.

A goal of the qualitative portion of this study was to understand how the density of recreationists in the SLL area affects visitor experience and movement in the area. Three overarching research questions guided the semi-structured interviews with visitors, including:

1.) What possible indicators of quality align with the social and ecological resources of the SLL area?

2.) What factors are motivating visitors to travel to SLL?

3.) What factors could be leading to benefit interference in the SLL area?

Semi-structured interviews were conducted with both day and overnight users in the SLL area. Data collection took place from July 21, 2017 to September 9, 2017 for a total of fourteen sampling days. This sampling window was selected to coincide with peak visitation to GRTE. All of the interviews took place along a predetermined route/rove that followed the section of the String Lake Loop Trail that passed along String Lake's eastern shore (Figure 6). A rove approach was selected over an interception point, due to the many access points to the area and the need to capture a variety of user groups exiting the area by way of multiple trails. In total the rove covered 1174 meters (0.73 miles) of trail, passing all six designated parking lot access points to String Lake, all popular beach areas, the canoe launch, one of two picnic areas, and access trails from Leigh and Jenny Lake. In order to reduce bias and improve validity in the interviewing process, only three trained graduate research assistants were selected to administer the interviews.

Figure 6. Map of the interview randomized rove.

Interview Sampling

As a means of randomizing the study, a series of measures were taken to reduce selection bias. The rove took place only in a north to south direction along the trail, as to best randomize the possible intercepts. At the beginning of each sampling day a random number between 1 and 20 was generated using an iPad application "The Random Number Generator" by Nicholas Dean Apps. This number determined both the start time of the sampling day and the time between rove intercepts (or "no-intercept time"). Therefore, if the random number was 14 and sampling was to begin at 8:00am, then the first rove would begin at 8:14am. After completing an interview, the interviewer would continue to rove for 14 minutes before attempting another intercept. This elapsed no-intercept time would pause if the interviewer reached the end of the designated rove before the time had expired and would then continue once the rove was begun once again at the north starting point.

Each sampling day, three to four user groups were randomly selected as for interviewing, using a random number scheme. The user groups targeted by interviews were identified by NPS staff as the primary users in the area and included day hikers, beach goers, canoeists and kayakers, paddleboarders, backpackers, and picnickers. Day hikers and beach goers were targeted approximately 50 percent more often than other user groups based on perceived use, however this perception is subject to bias.

Interview structure and post-processing

Study technicians conducted semi-structured interviews in accordance with a U.S. Federal Office of Management and Budget (OMB) approved instrument containing 36 questions. The beginning of the interview contained questions concerning visitors' travels in GRTE as a whole, with a second, larger, battery of questions about the SLL area (Appendix B). Because limited social science data collection had been done in the immediate area, questions were kept rather general in order to gain a broad understanding of visitor use, motivations, experience, and flow in the greater SLL area. Each interview was recorded on a digital voice recorder and limited demographic data (e.g. group size) was also collected via Qualtrics.

Following the 2017 field season, the interviews were transcribed using the software O-transcribe. To begin the process of coding the transcriptions, six randomly selected interviews underwent inductive open coding to gain an understanding of the general themes and patterns present therein (Gorden, 1992; Saldaña, 2016). This interpretive coding process assisted in the creation of a code book (Table 6). Most of the codes were derived from themes within responses to specific questions. For instance, the question, "How does this visit to Grand Teton National Park fit into your broader travel plans?" elicited responses reporting other national parks visited or the magnitude of the trip. Activities, destinations, and motivations were recorded in accordance to the framework of Benefits-Based Management (BBM). See Appendix C for a review of literature of BBM and other important concepts related to the qualitative portion of the study. The cast of motivations was adapted from Manning (2011, pp. 179-181). All the interviews were coded in accordance with the developed code book, and then check coding was completed by two additional individuals not directly involved with the study, a method derived from Holly, Hallo, Baldwin, and Mainella (2010). Fifty representative quotes were selected and presented to the individuals along with a map of the SLL area and the code book. The results were then discussed and revisions to both the coded transcript and code book were made.

Table 6. Qualitative Codes for String and Leigh Lake Interviews

Theme	Code
Parking and Displacement	TPK- Trouble Parking
	UAV- Unable to visit certain area
	MDP- Intersite Displaced
	IDP- Intrasite Displaced
	TDP- Temporally displaced
	CRW- Crowded
	CPE- Coped
	PLF- Parking Lot Full
	OPK- Other parking
	PHT- Photography
Conflict	CPM- Conflict with Park Management
	CWD- Human/Wildlife Conflict
	CVV- Conflicts with other visitors
Motivations	QUT- Quiet
	NSY- Noise
	EJN- Enjoy Nature/Beauty
	CRV- Creativity
	ITP- Introspection
	NTG- Nostalgia
	PFT- Physical Fitness
	RLX- Rest/Relax
	ESP- Escape/Solitude
	TCH- Teaching others/Exposure
	TMP- Temperature
	RSK- Risk Taking/Adventure
	LDP- Leadership
	LRN- Learning
	FMY- Family/friends togetherness
	MNF- Meet new people
	SFE- Safety
	ACV- Achievement
Wilderness	UMD- Untrammeled
	TMM- Trammeled
	UDV- Undeveloped
	DLD- Developed
	NRL- Natural
	ESP- Solitude (see motivations)
Activities	PNC- Picnic
	BPK- Backpacking
	HKE- Hiking
	SPB- Standup Paddleboarding
	KYK- Kayaking
	CNE- Canoeing
	BCH- Beaching
	SWM- Swimming
	WLV- Wildlife Viewing
	FSG- Fishing
	CLB- Climbing

Results

Vehicle Use Estimation

Peak Hour for Vehicle Use

Research study technicians installed MetroCount tube counters with assistance from GRTE staff in mid-July 2017 and removed the tube counters on September 8, 2017. Research technicians maintained the tube counters and analyzed all data.

The most frequent peak hour for each tube counter was determined using MetroCount software (MetroCount, 2016). At the *Jenny Lake Road MetroCount* location, west of the Cathedral Group Turnout, the peak hour during the summer sampling period on weekdays varies between 11:00am as the earliest peak hour (occurred seven times during sampling period) to 2:00pm as the latest peak hour (one time). The most frequent peak hour during the summer sampling period on weekdays is 12:00pm, which occurs ten times (Table 7). Weekend and weekday data do not vary during the summer sampling period. During the shoulder sampling period, on weekdays the peak hour for North Jenny Lake road is 11:00am, occurring six times during the sampling period. This time is also the earliest peak hour observed. On weekends during the shoulder sampling period, the most frequent peak hour is 12:00pm (three times), the earliest peak hour is 11:00am (one time) and the latest peak hour is 2:00pm (one time).

Table 7a. Peak hour of the day for vehicular traffic at the tube counter on **North Jenny Lake Road**, west of the Cathedral Group Turnout. The time reported in the table is the beginning of the peak hour and the value in parentheses is the number of times over the sampling period when that peak hour was observed.

North Jenny Lake Road		
Sampling Period	**Weekday**	**Weekend**
Summer (July 15-August 15)	12:00pm (10)	12:00pm (3)
Shoulder (August 16 - September 8)	11:00am (6)	12:00pm (3)

At the *String Lake Road* MetroCount location, installed near the entrance to String Lake Road, the peak hour during the summer sampling period (July 15- August 15) on weekdays varies between 11:00am as the earliest observed peak hour (occurs four times during sampling period) to 4:00pm as the latest peak hour (four times). The most frequent peak hour during the summer sampling period on weekdays is 3:00pm which occurs ten times over the sampling period (Table 7b). Weekends and weekdays do not vary in the frequency of peak hours. During the shoulder sampling period (August 16 – September 8), on weekdays, the peak hour for String Lake road is also 3:00pm, occurring six times during the sampling period. The earliest observed peak hour on weekdays during the shoulder sampling period is 11:00am (three times) and a maximum peak hour at 4:00pm (two times). On weekends during the Shoulder sampling period, the most frequent peak hour is 4pm (three times), the earliest peak hour is 2pm (one time) and the latest peak hour is 5pm (one time).

Table 7b. Peak hour of the day for vehicular traffic at the tube counter on **String Lake Road**, near the entrance point. The time reported in the table is the beginning of the peak hour and the value in parentheses is the number of times over the sampling period when that peak hour was observed.

String Lake Road		
Sampling Period	**Weekday**	**Weekend**
Summer (July 15-August 15)	3:00pm (10)	3:00pm (2)
Shoulder (August 16 - September 8)	3:00pm (6)	4:00pm (3)

At the *Jenny Lake Road One-Way* MetroCount location, installed just south of the Jenny Lake Lodge, the peak hour during the summer sampling period on weekdays varies between 12:00pm as the earliest peak hour (occurs four times during sampling period) to 2:00pm as the latest peak hour (three times). The most frequent peak hour during the summer sampling period on weekdays is 1:00pm which occurs five times over the sampling period (Table 7c). The earliest observed peak hour is 11:00am (one time) and the maximum observed peak hour is 3:00pm (one time). On weekends during the shoulder sampling period, the most frequent peak hour is 2:00pm (four times), which is also the maximum peak hour. The earliest peak hour observed is 12:00pm (one time).

Table 7c. Peak hour of the day for vehicular traffic at the tube counter on the **Jenny Lake Road One-Way**, south of the Jenny Lake Lodge. The time reported in the table is the beginning of the peak hour and the value in parentheses is the number of times over the sampling period when that peak hour was observed.

Jenny Lake Road One-Way		
Sampling Period	**Weekday**	**Weekend**
Summer (July 15-August 15)	1:00pm (5)	2:00pm (3)
Shoulder (August 16 - September 8)	1:00pm (6) 2:00pm (6)	2:00pm (4)

Average Daily Vehicle Counts

Average vehicle use levels at the North Jenny Lake Road tube counter range from an average of 3,246 vehicles per day during the summer sampling period to 2,014 vehicles per day during the shoulder sampling period. Average vehicle use levels at the String Lake tube counter range from an average of 1,308 vehicles/day during the summer sampling period to 1,204 vehicles per day during the shoulder sampling period. At the Jenny Lake One-Way tube counter location, vehicle use ranges from 1,337 vehicles per day during the summer sampling period to 1,310 per day during the shoulder sampling period (Table 8 and Figures 7a – 7c).

The North Jenny Lake Road MetroCounter records significantly higher average daily vehicle use compared to both MetroCounters at String Lake Road and the Jenny Lake Road One Way. It is important to note that the rubber tubes for the MetroCounter on the Jenny Lake Road One-Way were

damaged from August 9 – August 17 and no data was recorded during this time. The lack of data during this time may explain the discrepancy in average daily visitor use levels between North Jenny Lake Road and the Jenny Lake One-Way. All locations show an increase in average daily visitor use on the weekends compared to the weekdays, for both summer and shoulder sampling periods.

Table 8. Average number of vehicles per day (± 1 standard deviation) at each MetroCounter location during both sampling periods, separated by season, and weekends/weekdays

MetroCount Location	Sampling Period	Average # of Vehicles/Day (± SD) All Days	Average # of Vehicles/Day (± SD) Weekdays	Average # of Vehicles/Day (± SD) Weekends
North Jenny Lake Road	Summer	3246 (±1054)	3111 (±1070)	3601 (±987)
	Shoulder	2014 (±445)	1879 (±413)	2398 (±292)
	Overall	2701 (±1038)	2560 (±1038)	3085 (±969)
String Lake Road	Summer	1308 (±134)	1289 (±137)	1358 (±120)
	Shoulder	1204 (±231)	1163 (±245)	1546 (±162)
	Overall	1262 (±189)	1232 (±200)	1342 (±128)
Jenny Lake Road One Way*	Summer	1337 (±79)	1319 (±54)	1378 (±118)
	Shoulder	1310 (±319)	1222 (±322)	1321 (±146)
	Overall	1322 (±243)	1264 (±247)	1469 (±163)

*Due to damaged tube lines, the Jenny Lake Road One Way MetroCounter did not collect data from August 9th through August 17th.

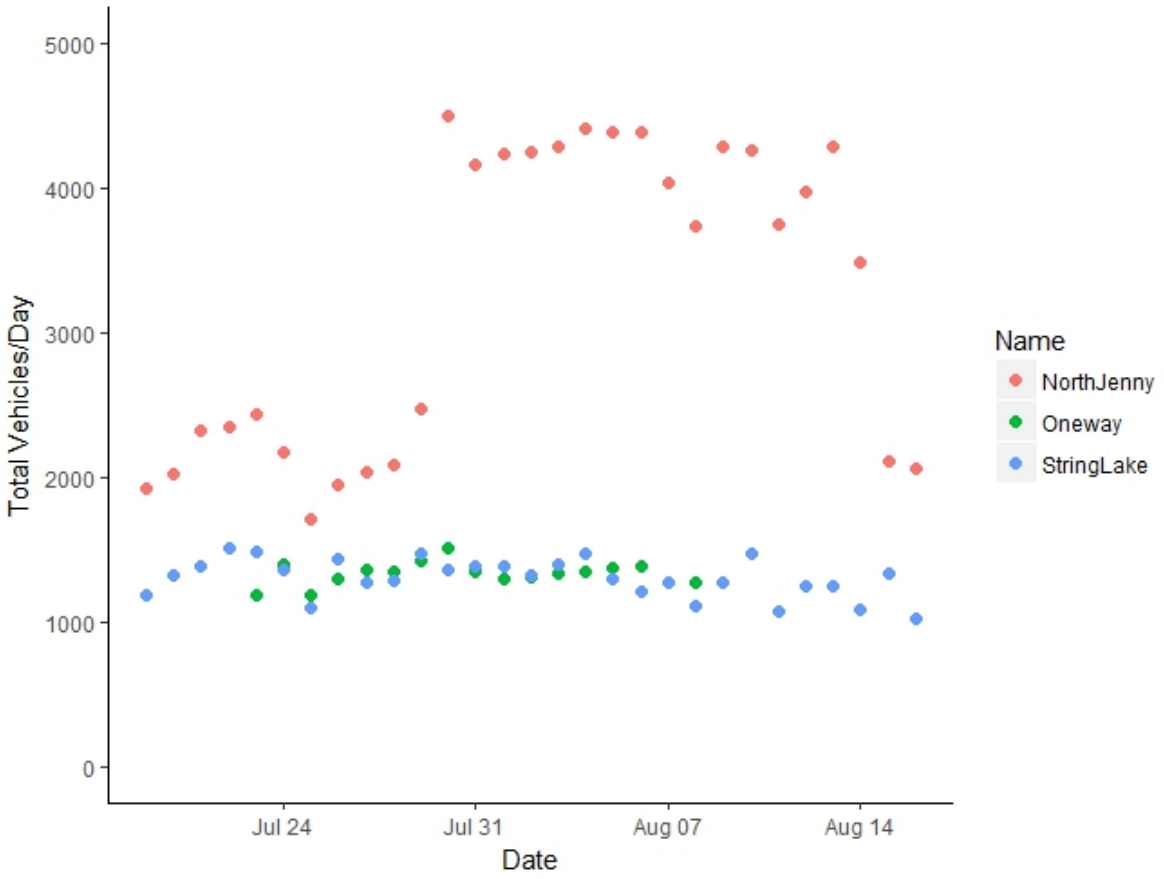

Figure 7a. Daily vehicle counts across the summer sampling period (July 15 – August 15) at all three MetroCounter locations. Jenny Lake One Way tube malfunction resulted in no data from August 9 through August 17.

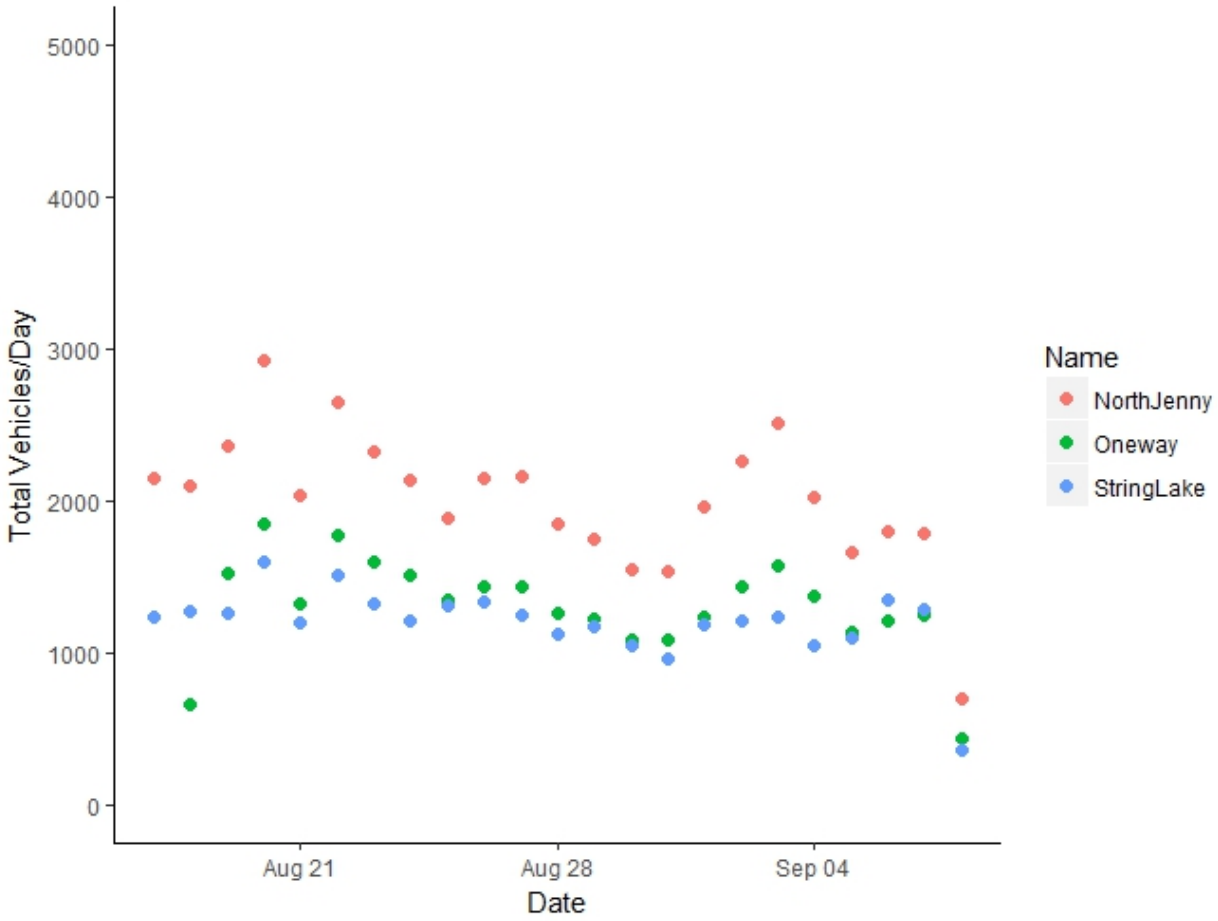

Figure 7b. Dailyvehicle counts across the shoulder sampling period (August 16 – September 8) at all three MetroCounters. Jenny Lake One Way tube malfunction resulted in no data from August 9 through August 17.

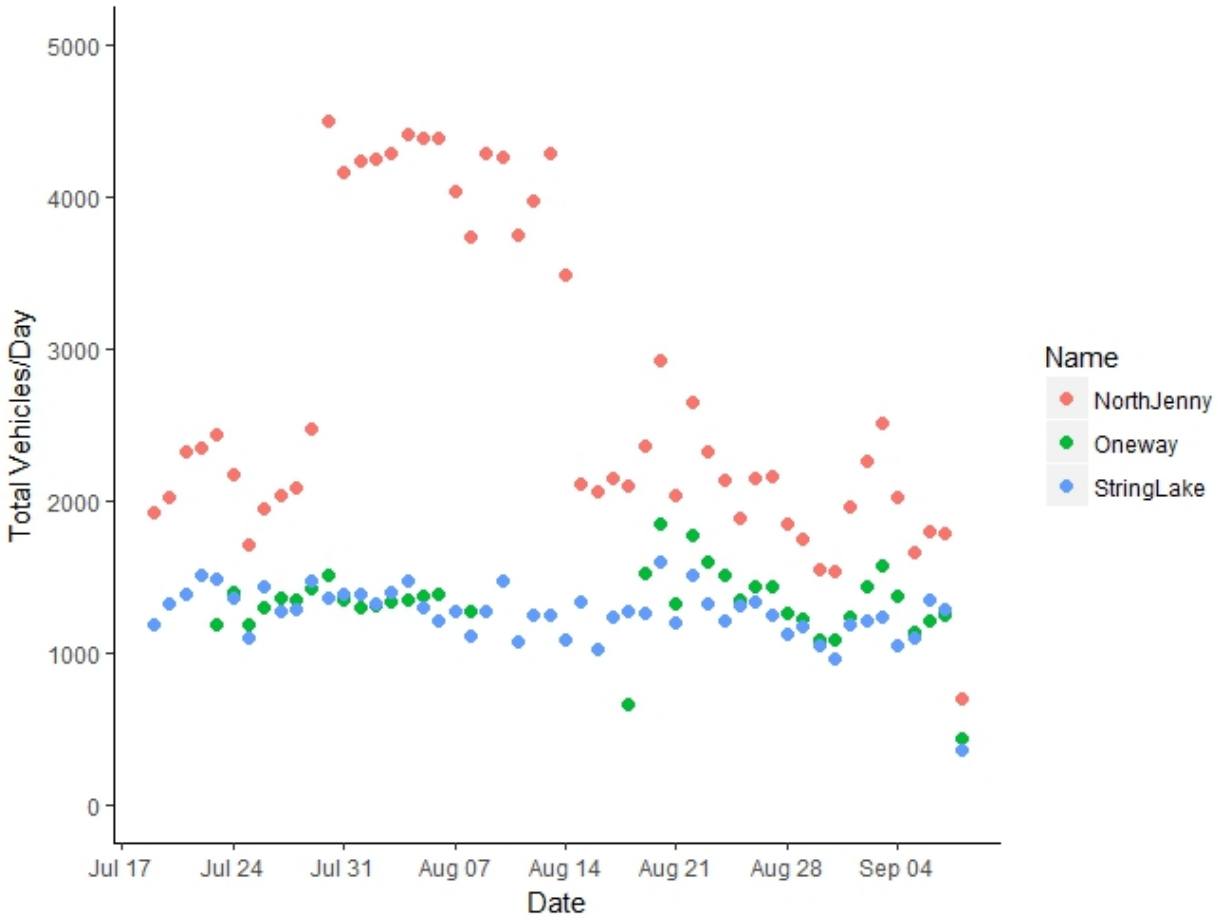

Figure 7c. Dailyvehicle counts across both sampling periods (July 15 – September 8) at all three MetroCounters. Jenny Lake One Way tube malfunction resulted in no data from August 9 through August 17.

Directional Traffic Flow

Figures of daily directional flow for each individual counter in the SLL study area for each sampling period can be found in Appendix D. The following figures display the average *hourly* vehicle counts by direction (northbound/southbound or eastbound/westbound) for the three tube counters installed in the SLL study area. The table below includes both sampling periods (summer and shoulder) and weekdays and weekends (Table 9). The figures below are separated by season, weekdays and weekends (Figures 8a – 8d). For a full table of averages and standard deviations of average hourly vehicle counts by direction, see Appendix E.

On average, during the summer sampling period, traffic heading westbound on North Jenny Lake Road peaks at 11:00am on both weekends and weekdays, with an average of 310 vehicles on weekdays, and 355 vehicles on weekends (Table 9 and Figure 8a – 8b). Note: westbound traffic on North Jenny Lake Road are vehicles driving *towards* the Teton Range. After 11:00am, westbound traffic then gradually decreases as eastbound traffic then increases. The peak hour for vehicles heading eastbound on North Jenny Lake Road on weekdays is 4:00pm, with an average of 72

vehicles recorded during that hour. On weekends, the average peak hour moves to 5:00pm, with an average of 81 vehicles recorded during that hour.

During the shoulder sampling period, vehicle use on North Jenny Lake road does not vary significantly from summer season trends. However, the *total* number of vehicles during the shoulder season is substantially lower than (Table 9 and Figure 8c-8d). Interestingly, the surge in use on North Jenny Lake road from July 30 to August 14 is unique from vehicle use trends on String Lake Road and the Jenny Lake Road One-Way during that time. It is important to note that the Jenny Lake Road One-Way tube counter was not collecting data from August 9 through August 17. Research technicians calibrated the MetroCounters and determined the MetroCounters were highly accurate during the field season. This anomalous spike in use on North Jenny Lake road cannot be explained with the data available. Further, this variation in use drives up the standard deviation for North Jenny Lake Road average daily vehicle counts, as well as increases the divide between summer use levels and shoulder use levels.

The String Lake Road average peak hour for vehicles driving westbound on weekdays during the summer sampling period (towards String Lake) is the same as North Jenny Lake Road with a peak hour of 11:00am and an average of 83 vehicles driving westbound during this hour (Table 9 and Figure 7a). Traffic flow decreases to between 60 and 66 vehicles per hour from12:00pm to 2:00pm hours. Interestingly, westbound traffic on String Lake Road during weekdays experiences another slight peak during the 3:00pm hour with an average of 76 vehicles, followed by a decrease in westbound traffic. Weekend summer sampling period vehicle behavior is similar, with the westbound peak hour occurring slightly earlier in the day at 10:00am (89 vehicles) followed by a small dip in traffic levels, then leading to another gradual rise in number of vehicles around the 3:00pm hour. The number of vehicles heading eastbound (leaving the SLL area) peak at 3:00pm on weekdays with 73 vehicles. On weekends, the average peak hour for vehicles driving eastbound moves to slightly later in the day, at 4:00pm with 74 vehicles (Figure 8b).

During the shoulder sampling period, vehicle use on String Lake Road is similar to summer sampling period levels, with the exception of weekend use (Table 9 and Figure 8d). During the shoulder sampling period on weekends, the peak hour for vehicles heading westbound moves to much later in the day, at 3:00pm with 76 vehicles. However, this may be explained by a similar occurrence of two peak hours with a second, slightly smaller, peak hour at 10:00am (73 vehicles). Eastbound weekend traffic during the shoulder sampling period rises gradually beginning at 8:00am and peaks at 5:00pm, with an average of 85 vehicles.

Along the Jenny Lake Road One Way, the average peak hour during the summer sampling period for vehicles heading Southbound occurs slightly later in the day, around 1:00pm on weekdays and 2:00pm on weekends (Table 9 and Figure 8a – 8b). These times are the same for both the summer sampling period and the shoulder sampling period. Unlike use along North Jenny Lake Road, slightly *more* vehicles are recorded during the shoulder sampling period (Table 9 and Figure 8c-8f). From August 9 to August 17, the tubes for the MetroCounter on Jenny Lake Road One Way were broken, therefore no data was recorded during this time.

Interestingly, on the Jenny Lake Road One Way, there are a few records of vehicle traffic going in the opposite direction of the one-way traffic (i.e. northbound). There is a bicycle lane on the one-way road that visitors will use in both directions. Therefore, bicyclists may be accounting for the one or two small bumps in northbound use (see Figures 8a – 8f). However, it is important to note that on August 15, when study technicians were doing routine MetroCount maintenance and download, a vehicle drove in the northbound direction along the one-way road. Study technicians were wearing reflective safety vests and safely flagged down the vehicle, informing the driver of the one-way road. The driver did not know it was a one-way and immediately turned around.

Table 9. Average peak hour at each MetroCounter location during both sampling periods and direction of vehicles, stratified by weekdays and weekends. The number in parentheses is the average number of vehicles observed during that peak hour.

MetroCount Location	Sampling Period	Direction	Average Peak Hour (average # vehicles observed) Weekdays	Average Peak Hour (average # vehicles observed) Weekends
North Jenny Lake Road	Summer	Westbound Eastbound	11:00am (310) 4:00pm (72)	11:00am (355) 5:00pm (81)
	Shoulder	Westbound Eastbound	1:00pm (192) 4:00pm (45)	12:00pm (241) 4:00pm (61)
	Overall	Westbound Eastbound	11:00am (256) 4:00pm (61)	11:00am (302) 4:00pm (71)
String Lake Road	Summer	Westbound Eastbound	11:00am (83) 3:00pm (73)	10:00am (89) 4:00pm (74)
	Shoulder	Westbound Eastbound	11:00am (83) 3:00pm (78)	3:00pm (76) 5:00pm (85)
	Overall	Westbound Eastbound	11:00am (83) 3:00pm (75)	10:00am (82) 5:00pm (78)
Jenny Lake Road One Way	Summer	Northbound Southbound	NA 1:00pm (154)	NA 2:00pm (170)
	Shoulder	Northbound Southbound	NA 1:00pm (167)	NA 2:00pm (185)
	Overall	Northbound Southbound	NA 1:00pm (161)	NA 2:00pm (178)

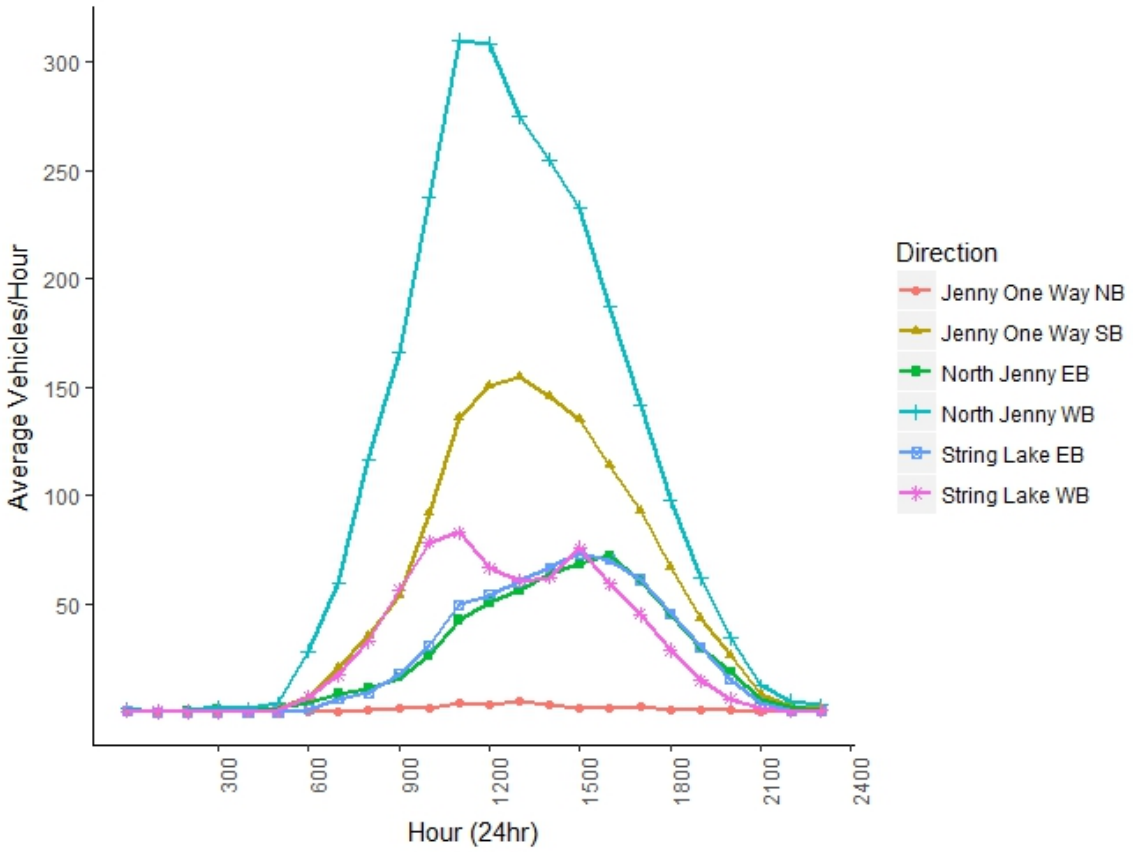

Figure 8a. Average hourly directional counts for all three MetroCounters placed in the String Lake study area during the summer sampling period (July 15 – August 15) on **weekdays**. NB = northbound, SB = southbound, EB = eastbound, WB = westbound. String Lake WB are vehicles driving towards the North Lot, String Lake EB are vehicles driving towards the exit. Jenny Lake One Way tube malfunction resulted in no data from August 9 to August 17.

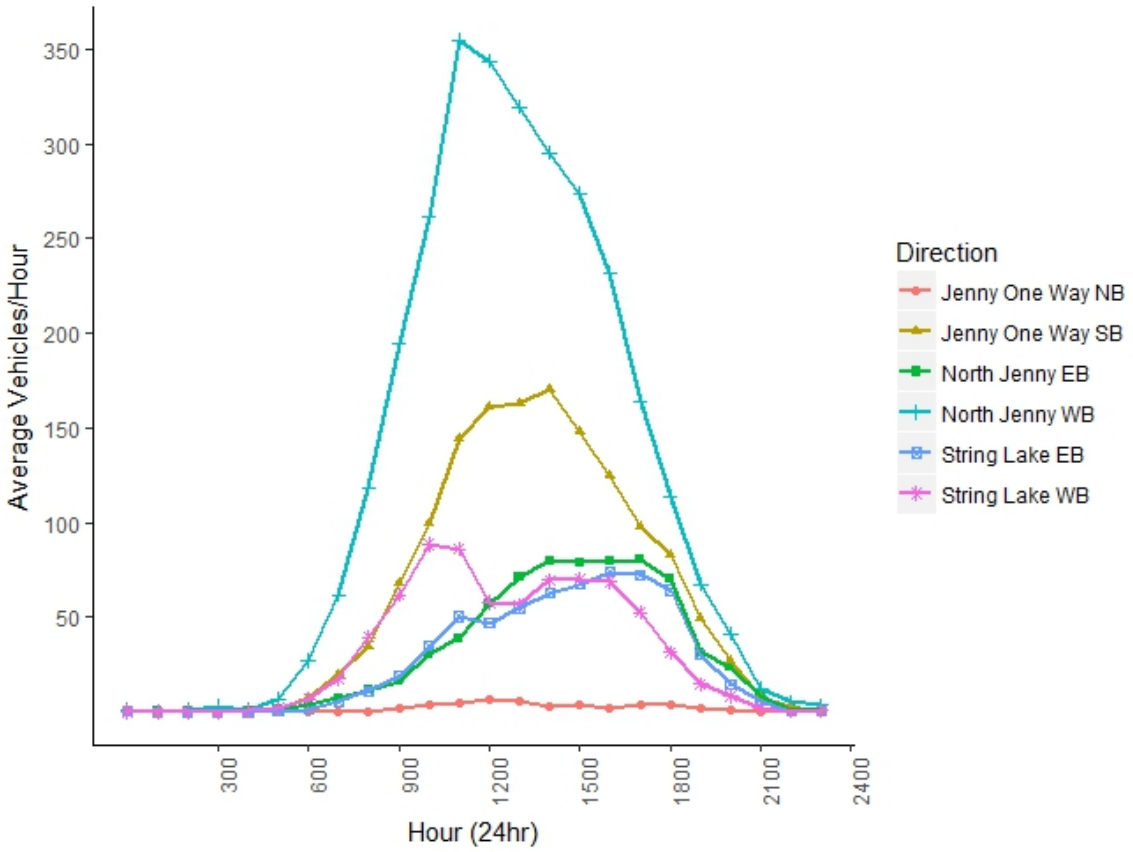

Figure 8b. Average hourly directional counts for all three MetroCounters placed in the String Lake study area during the summer sampling period (July 15 – August 15) on **weekends**. NB = northbound, SB = southbound, EB = eastbound, WB = westbound. String Lake WB are vehicles driving towards the North Lot, String Lake EB are vehicles driving towards the exit. Jenny Lake One Way tube malfunction resulted in no data from August 9 to August 17.

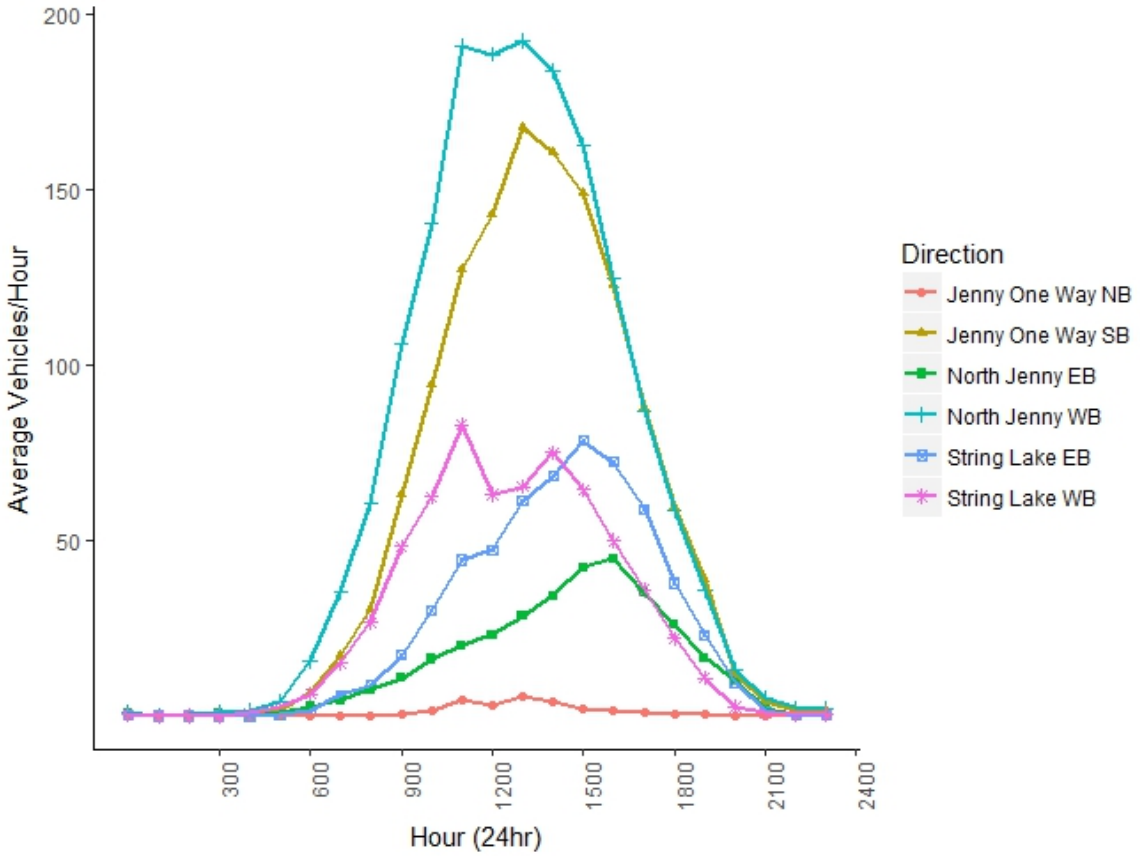

Figure 8c. Average hourly directional counts for all three MetroCounters placed in the String Lake study areas during the shoulder sampling period (August 16 – September 8) on **weekdays**. NB = northbound, SB = southbound, EB = eastbound, WB = westbound. String Lake WB are vehicles driving towards the North Lot, String Lake EB are vehicles driving towards the exit. Jenny Lake One Way tube malfunction resulted in no data from August 9 to August 17.

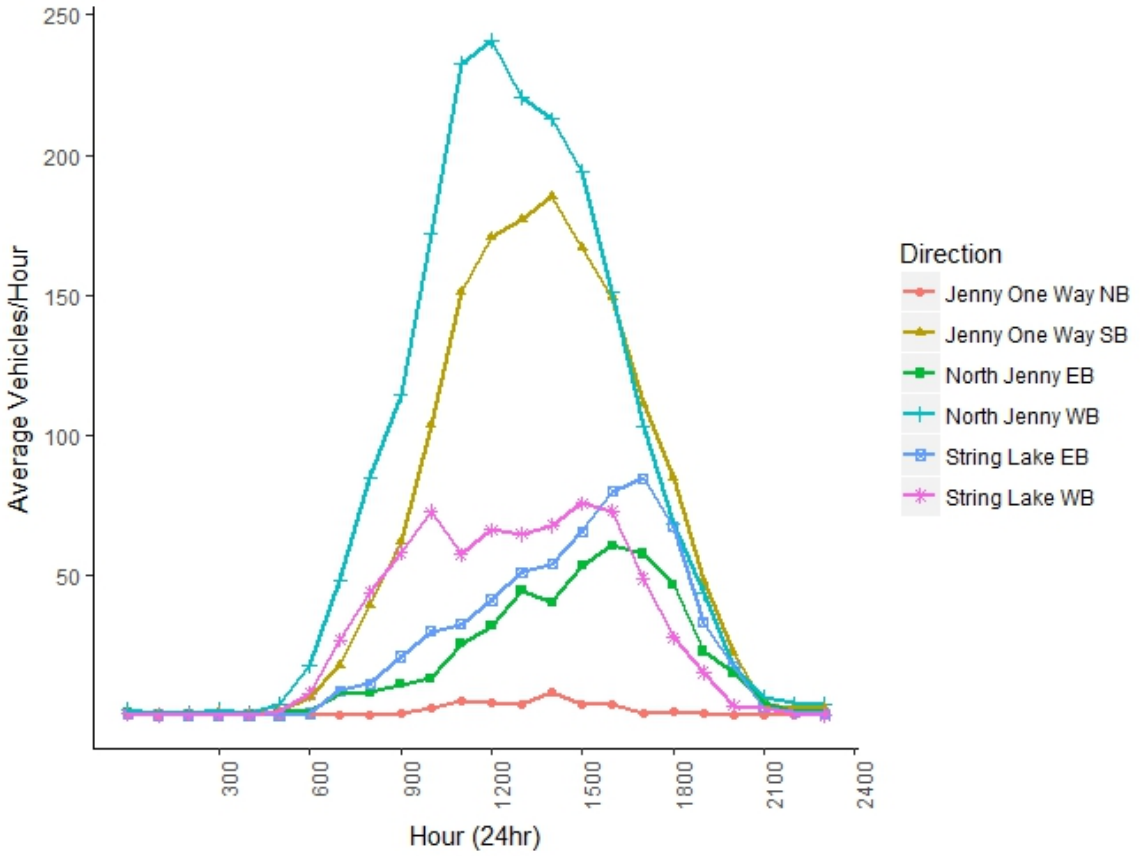

Figure 8d. Average hourly directional counts for all three MetroCounters placed in the String Lake study areas during the shoulder sampling period (August 16 – September 8) on weekends. NB = northbound, SB = southbound, EB = eastbound, WB = westbound. String Lake WB are vehicles driving towards the North Lot, String Lake EB are vehicles driving towards the exit. Jenny Lake One Way tube malfunction resulted in no data from August 9 to August 17.

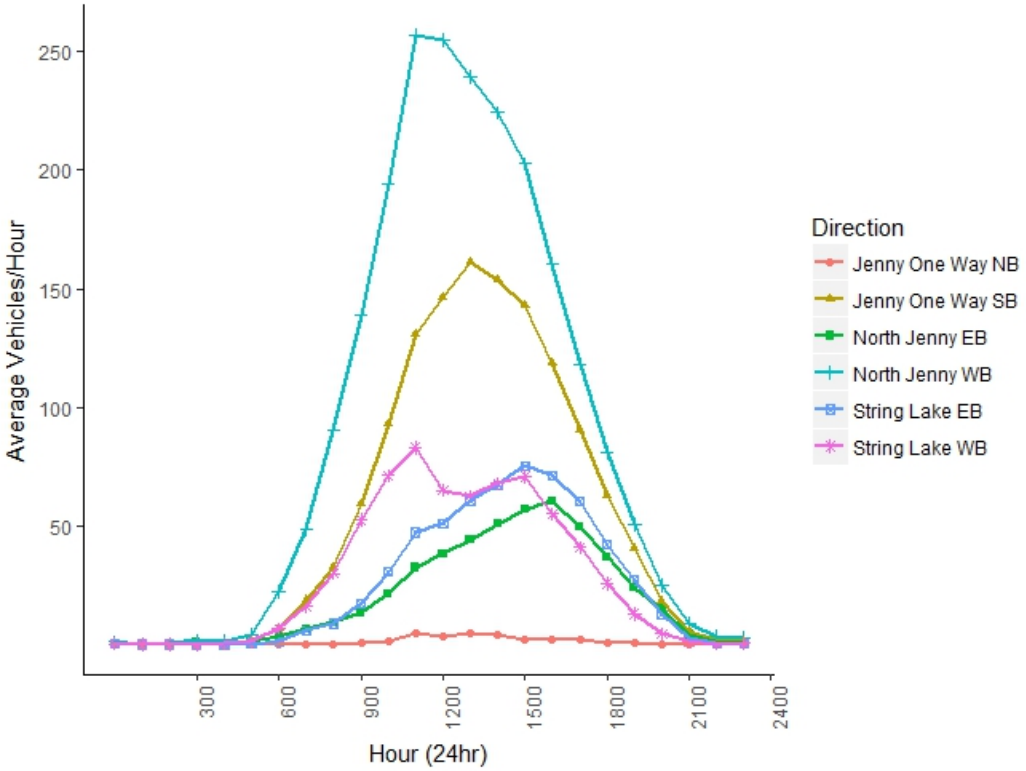

Figure 8e. Average hourly directional counts for all three MetroCounters placed in the String Lake study areas across both sampling periods (July 15 – September 8) on **weekdays**. NB = northbound, SB = southbound, EB = eastbound, WB = westbound. String Lake WB are vehicles driving towards the North Lot, String Lake EB are vehicles driving towards the exit. Jenny Lake One Way tube malfunction resulted in no data from August 9 to August 17.

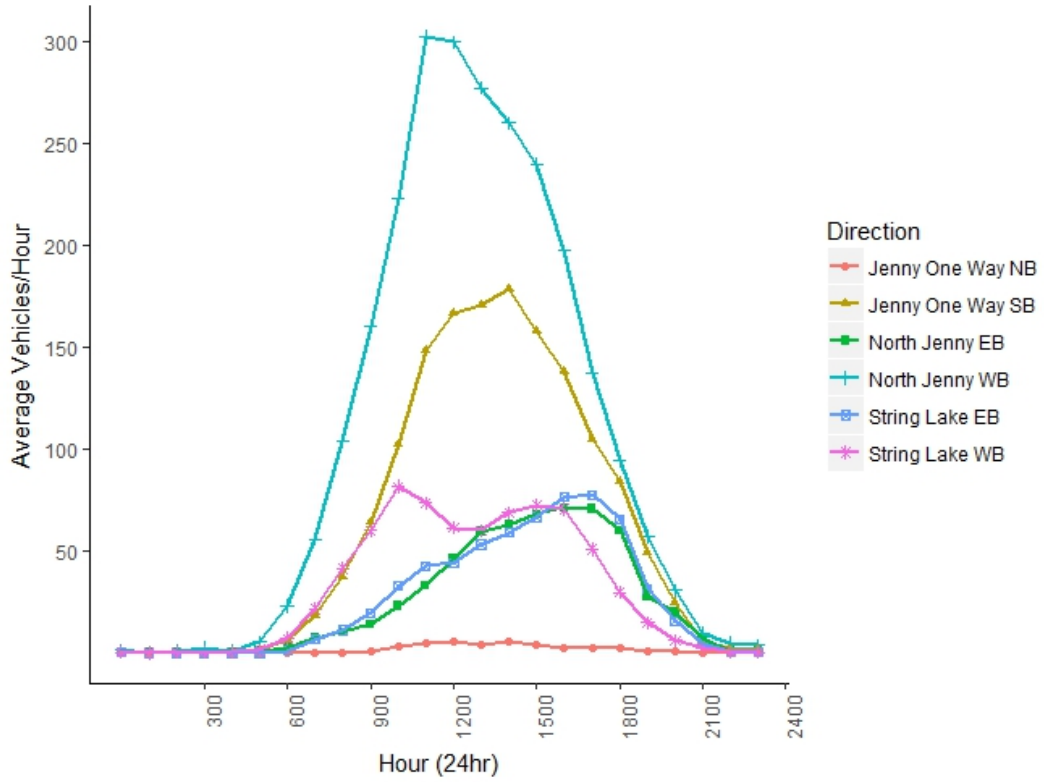

Figure 8f. Average hourly directional counts for all three MetroCounters placed in the String Lake study areas across both sampling periods (July 15 – September 8) on **weekends**. NB = northbound, SB = southbound, EB = eastbound, WB = westbound. String Lake WB are vehicles driving towards the North Lot, String Lake EB are vehicles driving towards the exit. Jenny Lake One Way tube malfunction resulted in no data from August 9 to August 17.

Visitor Use Estimation

Counter Error Calculations

Study technicians and GRTE staff installed six automatic trail counters throughout the SLL area. The automated trail counters provide an estimate of visitor use within the study area (Figure 2). To determine the level of error associated with the counters, manual counts conducted by study technicians in the field were compared to automatic counts from the counters. The level of error (or correction factor) associated with each counter are listed in Table 10. Since the trail counters used in this study cannot determine direction of travel, directional summaries from the manual counts are presented in Table 10. Calibration procedures were also conducted at two MetroCount tube counters to determine if there was error associated with these counters (Table 10). The MetroCount tube counters were very accurate and rarely missed counting a vehicle.

Table 10. Summary of manual counts at each of the six automatic trail counters and two of the tube counters installed in the SLL area. The correction factor is an indicator of the level of error associated with each counter.

Counter Location	Average Frequency Away from Parking Areas	Average Frequency Towards Parking Areas	Correction Factor
NE String Lake Shore	49%	51%	1.45
SE String Lake Shore	57%	43%	1.27
South String Lake	31%	69%	1.72
Jenny Loop Connector	48%	52%	0.85
Portage to Leigh Lake	49%	51%	1.52
Paintbrush Canyon	52%	48%	1.06
String Lake Rd (MetroCount)	49%	51%	1.08
N. Jenny Lake Rd (MetroCount)	89%	11%	1.02

Daily Visitor Use

Table 11 summarizes the average visits per day per counter for all six trail counters in the SLL area. The data is stratified by weekend and weekdays as well as the two sampling periods (summer and shoulder). The values presented are total "visits" (or total counts) from that counter and these values have been corrected for counter error using the correction factor presented in Table 10. Hourly summaries for each counter are presented in Appendix F. It is important to note that the Leigh Lake Portage trail counter stopped collecting data mid-August. Therefore, there is no shoulder season data from this trail counter location. Additionally, since the shoulder season use levels were slightly lower than summer, the overall, weekend, and weekday daily averages for the Leigh Lake Portage counter may be slightly inflated.

Overall, the trail counter installed along the NE shore of String Lake has the highest level of use with, on average, 851 visits per day. The next busiest trail counter location is the Leigh Lake Portage followed by the Jenny Lake Junction, SE shore of String Lake, and Paintbrush Canyon counters (in that order). The Paintbrush Canyon trail counter has the lowest level of use across the entire study with, on average, 160 visits per day. Weekend use is slightly higher than weekday use at all counters except for the counter along the South shore of String Lake. At the South shore counter, use is approximately the same on weekdays and weekends (Table 11). On average, visits to the SLL area are slightly higher during the summer sampling period compared to the shoulder sampling periods but often only by 100 visits or less across each counter (Table 11).

Table 11. Summary of average visits per day across both sampling periods (summer and shoulder) and weekdays and weekend days for all six trail counters installed in the SLL area. Values are corrected for error using correction factor from Table 10.

Averages:	String Lake NE Shore	String Lake SE Shore	String Lake South Shore	Jenny Lake Junction	Leigh Lake Portage	Paint-brush Canyon
Visits/Day	851.19	556.82	194.11	624.12	872.27	160.12
(± SD)	(± 147.24)	(± 165.95)	(± 44.48)	(± 150.73)	(± 256.28)	(± 48.14)
Weekday Visits/Day	834.78	525.84	192.32	618.49	832.22	144.43
(± SD)	(± 147.62)	(± 166.73)	(± 45.62)	(± 112.74)	(± 284.13)	(± 40.87)
Weekend Visits/Day	890.76	638.71	198.38	637.71	962.38	201.57
(± SD)	(± 142.82)	(± 137.77)	(± 42.78)	(± 221.11)	(± 158.45)	(± 41.68)
Summer Season Average Visits/Day	905.13	608.15	203.37	658.39	872.27	161.11
(± SD)	(± 109.13)	(± 154.70)	(± 36.62)	(± 136.20)	(± 256.28)	(± 41.15)
Shoulder Season Average Visits/Day	789.26	499.08	184.85	584.78	N/A	159.00
(± SD)	(± 159.24)	(± 158.59)	(± 49.20)	(± 156.38)	N/A	± 54.70

Figure 8a shows average, **visits per hour summarized by date** for all six trail counters across the entire summer and shoulder sampling periods. Tables of these hourly averages can be found in Appendix G. The main conclusion from these hourly averages by day is that hourly use varies considerably from day-to-day. However, easily identifiable peaks are seen around the eclipse (August 21), August 26 (a Saturday after a fee-free day), and Labor Day weekend. Figure 9a also shows that the String Lake South Shore and Paintbrush Canyon trail counters have considerably lower hourly use across the entire data collection period compared to the other four counters installed in the SLL area.

Figure 9b shows the hourly visits per counter across a day so that peak times of visitor use can be identified. Overall, across all counters, the busiest time in the SLL area is between 11:00am and 2:00pm/3:00pm. An increase in visitor counts is seen across the area starting at around 8:00am/9:00am, with a steady climb until the 11:00am hour. Visitor use remains at its highest between 11:00am and 2:00pm with visitor use beginning to drop off between 2:00pm and 3:00pm. From 3:00pm until 6:00pm, use continues to drop off steadily. This daily pattern of visitor use levels does not vary between summer and shoulder seasons (Figures 9c – 9d).

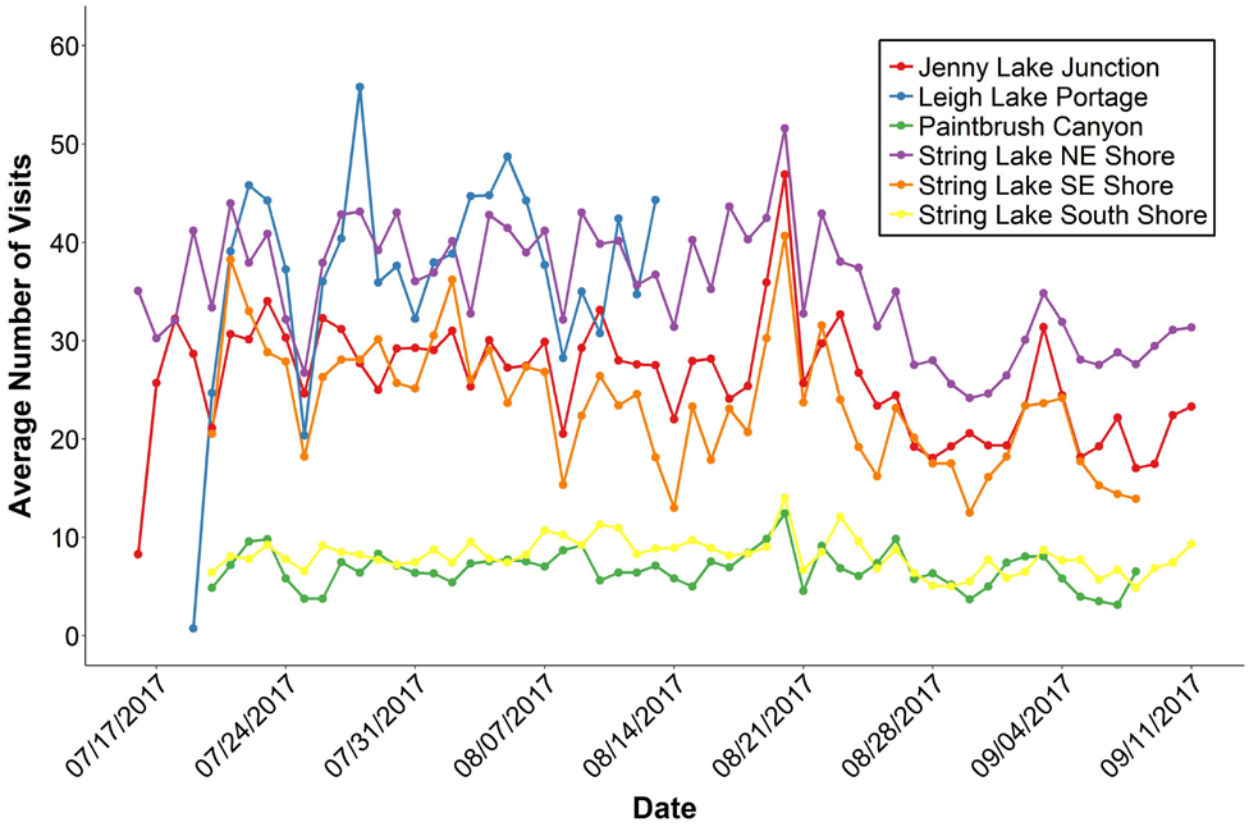

Figure 9a. Average hourly counts of visits by day for every day during the data collection season for all six trail counters that were installed in the SLL area. Values are corrected for error using correction factor from Table 10.

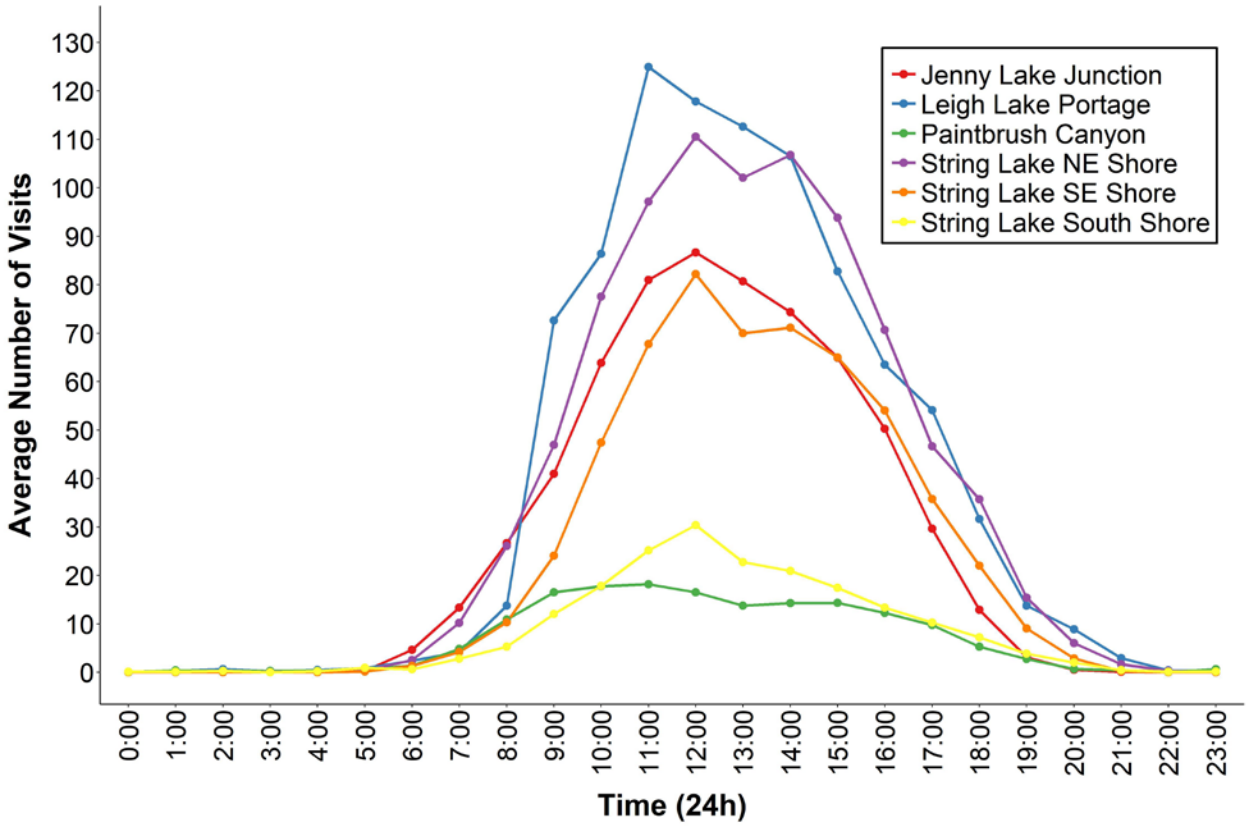

Figure 9b. Overall, average number of visits per counter across the day for all counters in the SLL area. Values are corrected for error using correction factor from Table 10.

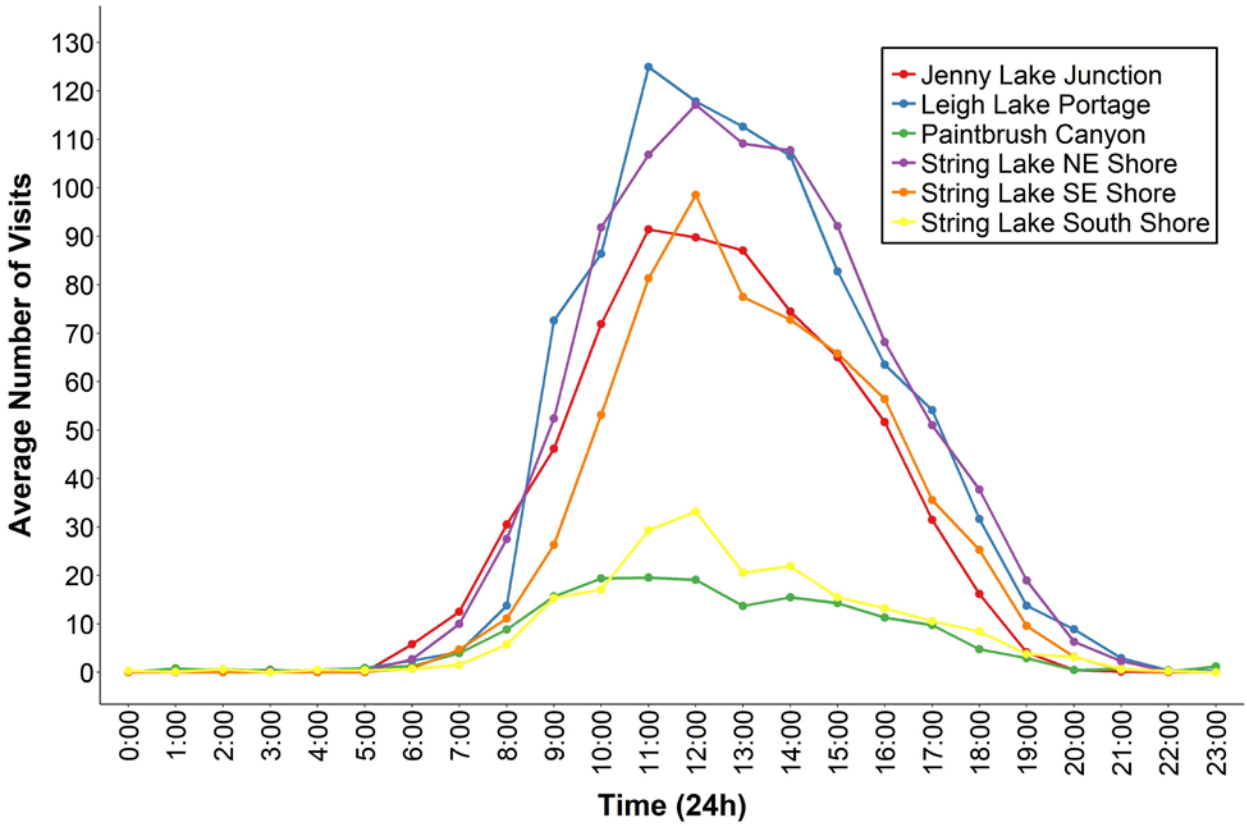

Figure 9c. Average number of visits per counter across the day for all counters in the SLL area for the **summer** season. Values are corrected for error using correction factor from Table 10.

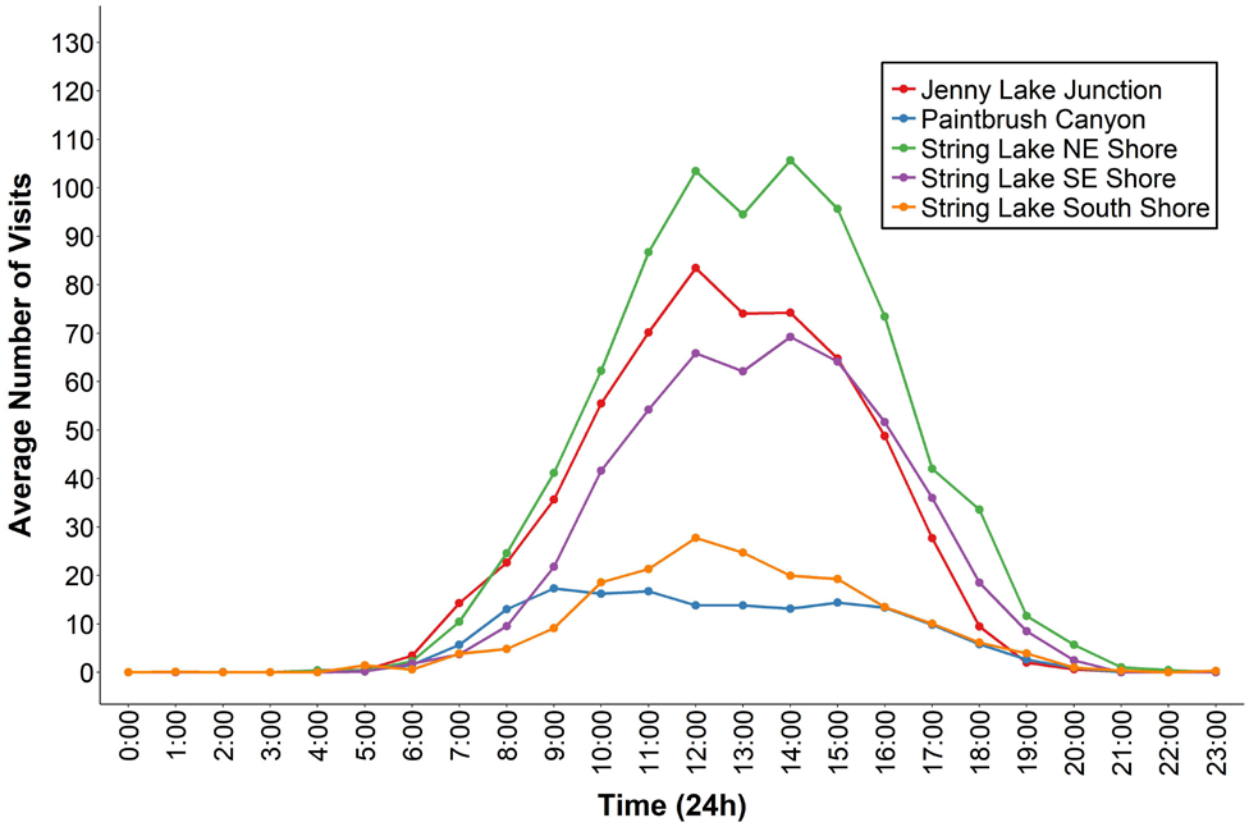

Figure 9d. Average number of visits per counter across the day for all counters in the SLL area for the **shoulder** season. Values are corrected for error using correction factor from Table 10.

Because trail counters were mostly located in front country locations during the 2017 data collection effort, GRTE staff provided estimates of backcountry use for locations that can be accessed via the SLL area (Table 12). Use estimates for August are presented in Table 12 but these likely reflect use in July as well. Although July use may have been lower than August use in 2017 due to a high snowpack; in average years, July and August total use numbers are relatively equal (source: personal communication from GRTE staff).

Table 12. Estimate of total number of people backpacking in each of the backcountry locations for the month of August.

Location	# of People
North Fork Cascade	558
North Fork Cascade Group site	248
Upper Paintbrush	465
Lower Paintbrush	372
Holly Lake	279
Holly Lake Groupsite	248
Outlier Site	90
Leigh Lake Campsites	651
Leigh Lake Groupsite	248

Parking Lot Use Estimation

Along String Lake Road, three designated parking lots provide access to String Lake, Leigh Lake, and the Jenny Lake trail. Additionally, these parking lots may serve as an access point to Paintbrush Canyon, Cascade Canyon, Bearpaw Lake and Trapper Lake. String Lake Road contains three designated parking areas labeled as the South Lot, Boat Launch, and the North Lot (Figure 3).

Designated parking within these parking lots is defined as any parking spot demarcated with two parallel white lines to indicate an available spot. *Undesignated parking* is defined as areas along a curb within the parking area that do not have any red marking or signage indicating the location is a 'no-parking' zone. *Illegal parking* is defined as areas in the parking lot that have red marking, cones, and/or signage indicating 'no-parking'. During the 2017 sampling period, on high visitor use days when the parking lots were full, GRTE personnel put up a 'Parking Lot Full' sign at the entrance of String Lake Road. Overflow vehicles were encouraged by GRTE personnel to park along the shoulder of Jenny Lake Road.

Study technicians counted the number vehicles in each parking lot every half hour and recorded the number of vehicles parked in designated spaces, undesignated spaces, and illegal spaces. Within designated parking areas field staff recorded the number of local vehicles, number of bicycles present, number of cars waiting for a parking spot (i.e. looping around), number of RV's, number of vehicles with a trailer and trailer type, number of motorcycles, number of government or NPS vehicles, and number of research vehicles. Photographs were taken at the beginning of every parking lot count.

Maximum and Average Daily Use

Study technicians recorded the total number of vehicles parked in each parking lot throughout the sampling season. These numbers are stratified by weekends and weekdays and averaged to indicate average use levels within each parking lot. It is important to note the variability in the total number of designated spaces along the parking lots on String Lake Road, specifically at the North Lot and Boat Launch. Due to the presence of long trailer spaces, at times up to three compact vehicles can park in these spaces. Therefore, the designated parking capacity within the North Lot and Boat Launch

varies depending on the types of vehicles parking in the lots. The South Lot does not contain trailer spaces, therefore the total number of designated spaces in the South Lot hits capacity at 29 vehicles. To better visualize designated parking space capacity, please see Table 13 which contains the average number of vehicles and the maximum number of vehicles observed in designated parking spaces within the String Lake Road parking lots.

Overall, across all parking lots, there is higher vehicle parking use on weekends than on weekdays with an average of 132 – 145 vehicles in designated spaces on weekdays, and 150 – 166 vehicles in designated spaces on weekends. The North Lot has the highest average number of vehicles in designated spaces with an average ranging from 88 - 93 vehicles on weekdays and 98 - 106 vehicles on weekends. The Boat Launch averages between 24-25 vehicles in designated spaces on weekdays and 28-33 vehicles on weekends. At the South Lot, vehicles parked in designated spaces averages between 25-26 vehicles on weekdays and 26-27 vehicles on weekends. Along the roadside, an average of 12 vehicles are parked along the road on weekdays, and an average of 34 – 77 vehicles are parked along the road on weekends.

To understand parking lot capacity, the **maximum** number of vehicles observed at one time is listed in Table 13. Across all parking lots on String Lake Road, the highest maximum number of vehicles observed in designated parking spaces is 193 vehicles. The North Lot has the highest capacity for vehicles at one time with an observed maximum of 139 vehicles parked in the lot. The South Lot has the lowest capacity for vehicles with an observed maximum of 29 vehicles in designated parking spaces. The Boat Launch has an observed maximum of 39 vehicles parked in the lot. Note that the maximum number of vehicles represents vehicles in **designated** parking spaces; these numbers do not include the number of vehicles in undesignated spaces (see Table 14 for undesignated parking numbers). Along North Jenny Lake Road, a maximum of 93 cars were observed along the roadside. Interestingly, there is variation in the maximum number of designated parking spaces at the Boat Launch and North Lot parking lots. This variation may be explained by the presence of large parking spaces that can accommodate vehicles with trailers and/or RV's. Therefore, there may be times when more (or less) vehicles are able to park within these larger parking spaces (Photo 5). At the South Lot there are no available trailer/RV parking spaces, therefore the maximum number of vehicles recorded is constant across the sampling periods.

Table 13. Average number of vehicles observed (± 1 standard deviation) and maximum number of vehicles observed in **designated** parking areas per day for each sampling period stratified by weekdays and weekends.

Location (# of available lined parking spaces)	Sampling Period	Average # of Vehicles (± Standard Deviation) Weekdays	Maximum # of Vehicles Weekdays	Average # of Vehicles (± Standard Deviation) Weekends	Maximum # of Vehicles Weekends
North Lot (103 lined parking spots)	Summer	88 (±31)	139	98 (±26)	132
	Shoulder	93 (±27)	127	106 (±29)	136
Boat Launch (31 lined parking spots)	Summer	25 (±11)	38	28 (±10)	41
	Shoulder	24 (±11)	39	33 (±11)	46
South Lot (29 lined parking spots)	Summer	25 (±5)	29	26 (±4)	29
	Shoulder	26 (±5)	29	27 (±4)	29
Roadside	Summer	12 (±20)	57	34 (±33)	93
	Shoulder	NA	NA	77 (±11)	90
All Designated Lots Combined (133 lined parking spots)	Summer	132 (±26)	170	150 (±28)	182
	Shoulder	145 (±31)	183	166 (±35)	193

*Note: the discrepancies in maximum number of vehicles in the North Lot and Boat Launch is due to designated trailer spaces. Sometimes multiple vehicles park in a 'trailer' parking spot. Other times, only one vehicle will park in a trailer spot. There are no designated trailer parking spaces in the South Lot.

Photo 5. Example of multiple vehicles in long trailer spaces in North Lot (MICHAEL HILMES).

The **average** number of vehicles observed parking in **undesignated** parking spaces were observed and stratified by weekend and weekdays and then averaged across each sampling period (Table 14). For all parking lots along String Lake Road, the average number of vehicles in undesignated parking spaces ranges between 11 – 17 vehicles. Within those parking lots, the Boat Launch has the highest average number of vehicles in undesignated spaces on both weekdays and weekends, with an average of 7 to 11 vehicles in undesignated spaces. The North Lot had the lowest average number of vehicles in undesignated parking spaces, with an average ranging from 1 to 2 vehicles. The South Lot has an average range between 3 to 4 vehicles in undesignated parking spaces across both sampling periods.

The **maximum** number of vehicles parked in **undesignated** parking spaces are listed in Table 14. Across all parking lots on String Lake Road, the maximum number of vehicles observed in undesignated parking spaces is 36 vehicles. The Boat Launch has the highest capacity for vehicles in undesignated spaces, with a maximum of 26 vehicles. At the South Lot, the maximum number of vehicles observed in undesignated spaces is 10 vehicles. The North Lot contains the lowest maximum number of vehicles in undesignated parking spaces with an observed maximum of 6 vehicles.

Table 14. Average number of vehicles (± 1 standard deviation) and maximum number of vehicles observed in **undesignated** parking spaces per day for each sampling period, stratified by weekdays and weekends.

Location	Sampling Period	Average # of Vehicles Undesignated Parking (± Standard Deviation) Weekdays	Maximum # of Vehicles Undesignated Parking Weekdays	Average # of Vehicles Undesignated Parking (± Standard Deviation) Weekends	Maximum # of Vehicles Undesignated Parking Weekends
North Lot	Summer	1 (±1)	4	2 (±2)	6
	Shoulder	1 (±1)	3	1 (±1)	5
Boat Launch	Summer	8 (±7)	21	11 (±8)	26
	Shoulder	7 (±5)	17	11 (±7)	26
South Lot	Summer	4 (±3)	10	3 (±3)	7
	Shoulder	4 (±5)	8	3 (±4)	8
All Designated Lots Combined	Summer	12 (±10)	30	16 (±11)	34
	Shoulder	11 (±7)	24	17 (±10)	36

Photo 6. Vehicles in undesignated spaces in South Lot (JENNA BAKER).

The maximum number of vehicles parked in **illegal** spaces are listed in Table 15. Across all parking lots on String Lake Road, the maximum number of vehicles observed in illegal parking spaces at one time is 7 vehicles. During the summer sampling period, the North Lot recorded the highest number of vehicles in illegal parking spaces with a maximum of 5 vehicles parked illegally. The South Lot recorded a maximum of 3 vehicles parked illegally.

Table 15. Maximum number of vehicles observed at one time in **illegal** parking spaces for each study period stratified by weekdays and weekends.

Location	Sampling Period	Maximum # of Vehicles Illegal Parking Weekdays	Maximum # of Vehicles Illegal Parking Weekends
North Lot	Summer	5	2
	Shoulder	2	2
Boat Launch	Summer	1	3
	Shoulder	1	1
South Lot	Summer	1	1
	Shoulder	3	3
All Designated Lots Combined	Summer	6	4
	Shoulder	3	7

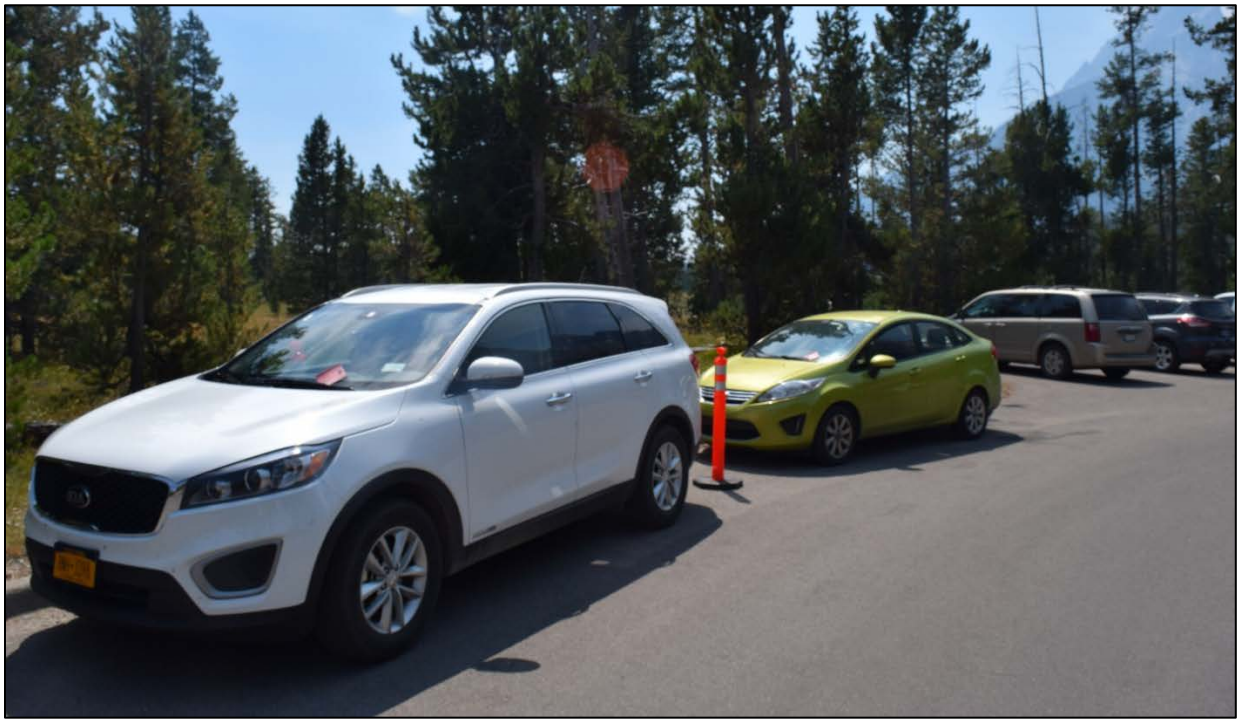

Photo 7. Two vehicles in illegal parking spaces in South Lot (JENNA BAKER).

Local Use in Designated Parking Areas

Study technicians recorded vehicles that contained a WY-22 license plates (without a rental sticker) as 'local'. Table 16 demonstrates the frequency of local vehicles observed across the sampling period within each parking lot location, stratified by weekends and weekdays. Across all parking lots and sampling seasons, the frequency of local use is higher during the weekends representing 19% - 20% of vehicles parked. During weekdays, the frequency of local use drops to 11% - 12%. The Boat Launch lot has the highest frequency of local use among all parking lots during both weekdays and weekends. A range of 13% to 20% park in the Boat Launch on weekdays, and 28% to 31% park in the Boat Launch on weekends.

Table 16. Frequency of **local vehicles** parking in designated parking areas across sampling period. Table separated by parking lot location and days of week.

Parking Lot	Sampling Period	Frequency (%) Local Vehicles Weekdays	Frequency (%) Local Vehicles Weekends
North Lot	Summer	10%	17%
	Shoulder	9%	17%
Boat Launch	Summer	13%	28%
	Shoulder	20%	31%
South Lot	Summer	16%	21%
	Shoulder	7%	29%
Roadside	Summer	14%	15%
	Shoulder	NA	10%
All Designated Lots Combined (including Roadside)	Summer	12%	19%
	Shoulder	11%	20%

Parking Lot Use by Hours of Day

Every half hour, field staff recorded the total number of vehicles in each parking lot along String Lake Road. These totals are averaged across both sampling periods to demonstrate times of peak use (Table 19) and how use within the designated parking areas varies across a day. Across all sampling periods, vehicle use of the North Lot (Figures 10a – 10b), Boat Launch (Figures 10c- 10d), and South Lot (Figures 10e – 10f) is greatest from 11:00am to 3:00pm. Between 11:00am and 3:00pm, across all parking lots, use plateaus, suggesting that the parking lots remain relatively full during these time periods. The South Lot fills earlier in the day (closer to 9:30am or 10:00am), while the North Lot and Boat Launch fill up closer to 11:00am or 11:30am.

There are two small spikes in use at 5:30pm at the North Lot and Boat Launch. It is important to note that the sample size is small at 5:30pm, with n=1 at the North Lot and Boat Launch. At the North Lot and the Boat Launch, weekend use is slightly higher than weekday use. At the South Lot, weekend and weekday use do not vary. Tables accompanying the graphs are shown with standard deviation and sample size in Appendix H.

North Jenny Lake *Roadside* parking use spikes from zero to 72 vehicles at 12:00pm, then peaks to 89 vehicles at 1:00pm on the weekends (Figures 10g – 10h). On weekdays, there is a similar trend, but with fewer total average vehicles. On weekends, vehicle use spikes at 1:00pm with 56 vehicles and stays in the 50's until 3:00pm before dropping. During the shoulder season, data was only collected from 1:00pm to 4:00pm. Due to limitations with the number of staff and safety concerns, the sample size for the North Jenny Lake Road Parking area is smaller than the North Lot, Boat Launch, and Boat Launch sample sizes. However, staff did record 'casual' roadside counts when departing the study area (Table 18).

Table 17. Average peak time for parking lot use at each parking lot location. Numbers in parentheses are the average number of vehicles recorded during that time. Numbers are rounded to the nearest whole number.

Location	Sampling Period	Peak Time for Parking Lot Use (Average # of Vehicles)
North Lot	Summer	12:00pm (118)
	Shoulder	1:30pm (118)
Boat Launch	Summer	11:30am(36)
	Shoulder	1:00pm(36)
South Lot	Summer	11:30am (29)
	Shoulder	1:30pm (29)
Roadside	Summer	12:30 (89)
	Shoulder	2:00 (87)

North Lot Hourly Graphs

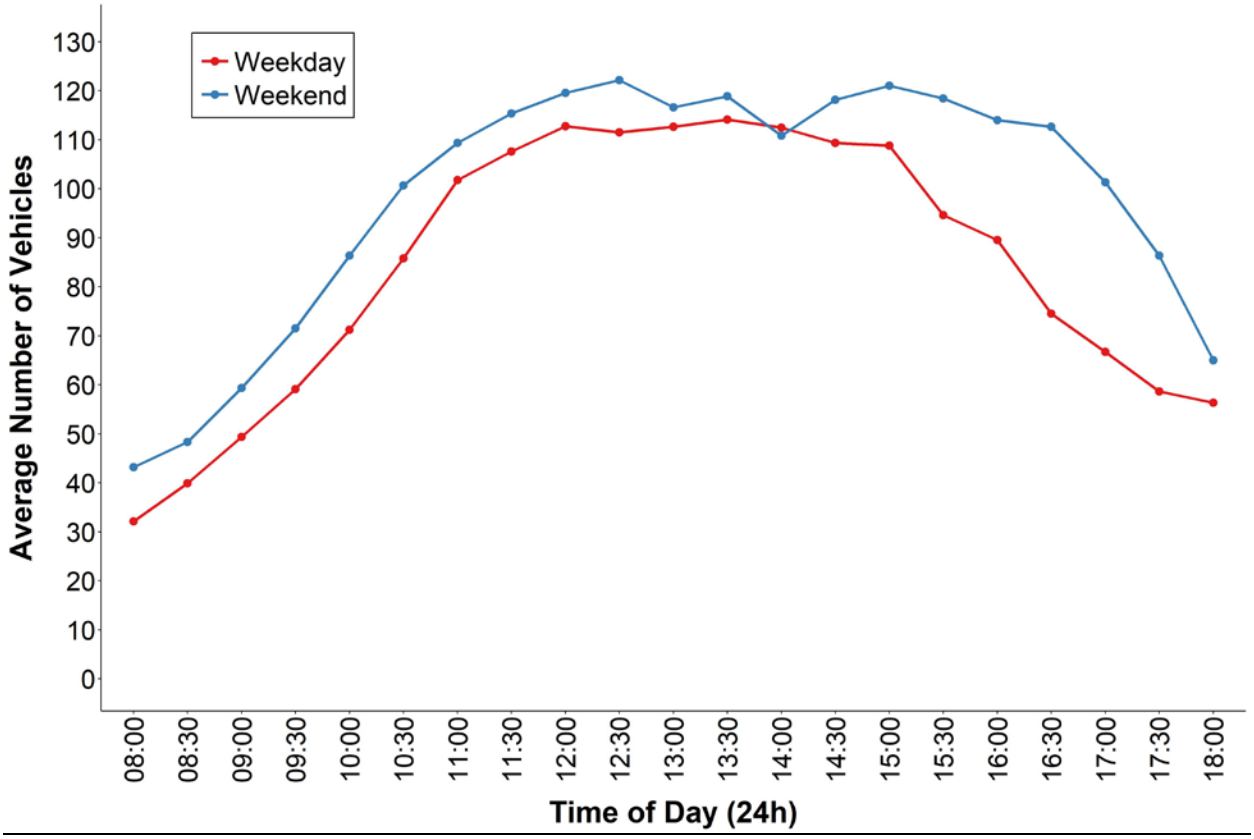

Figure 10a. Average number of vehicles parked in designated parking in North Lot, stratified by weekends and weekdays. For a full list of averages and standard deviations, see Appendix H.

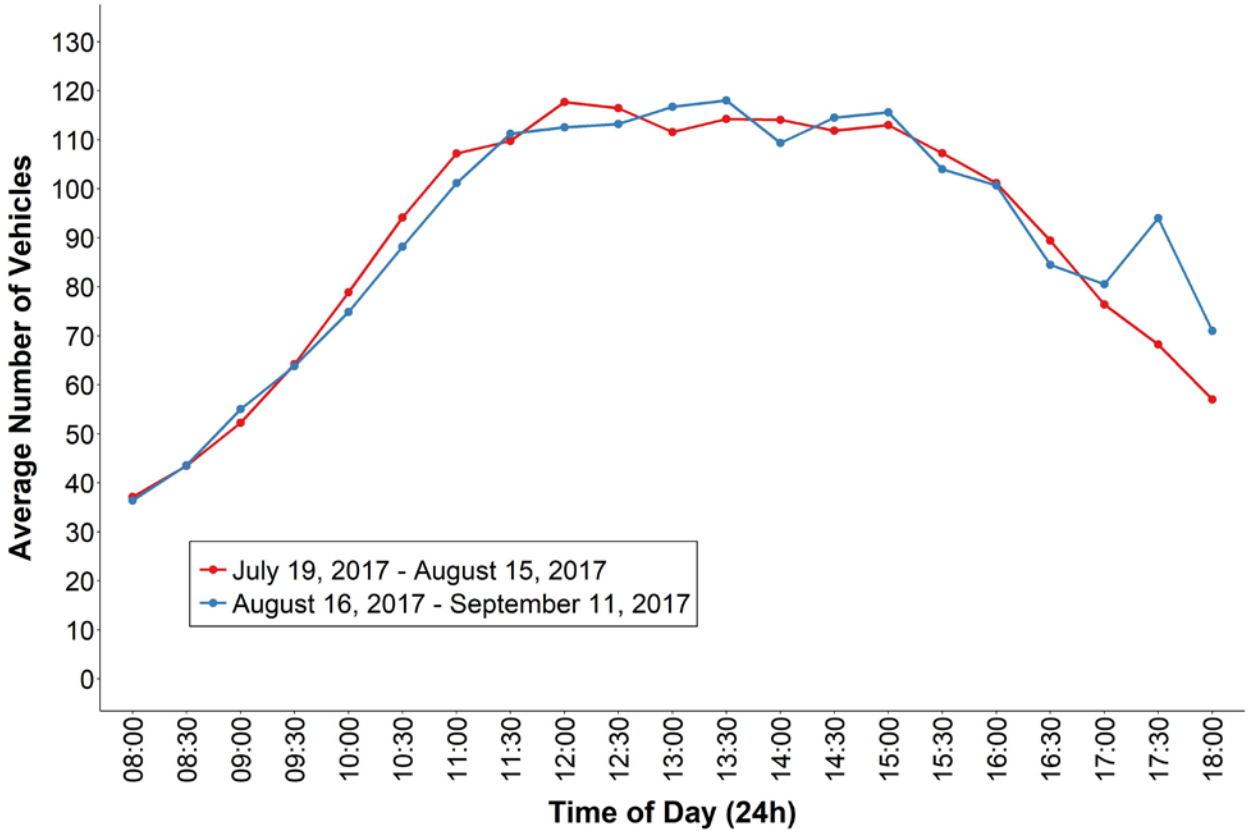

Figure 10b. Average number of vehicles parked in designated parking in North Lot, stratified by summer season and shoulder season. For a full list of averages and standard deviations, see Appendix H.

Boat Launch Hourly Graphs

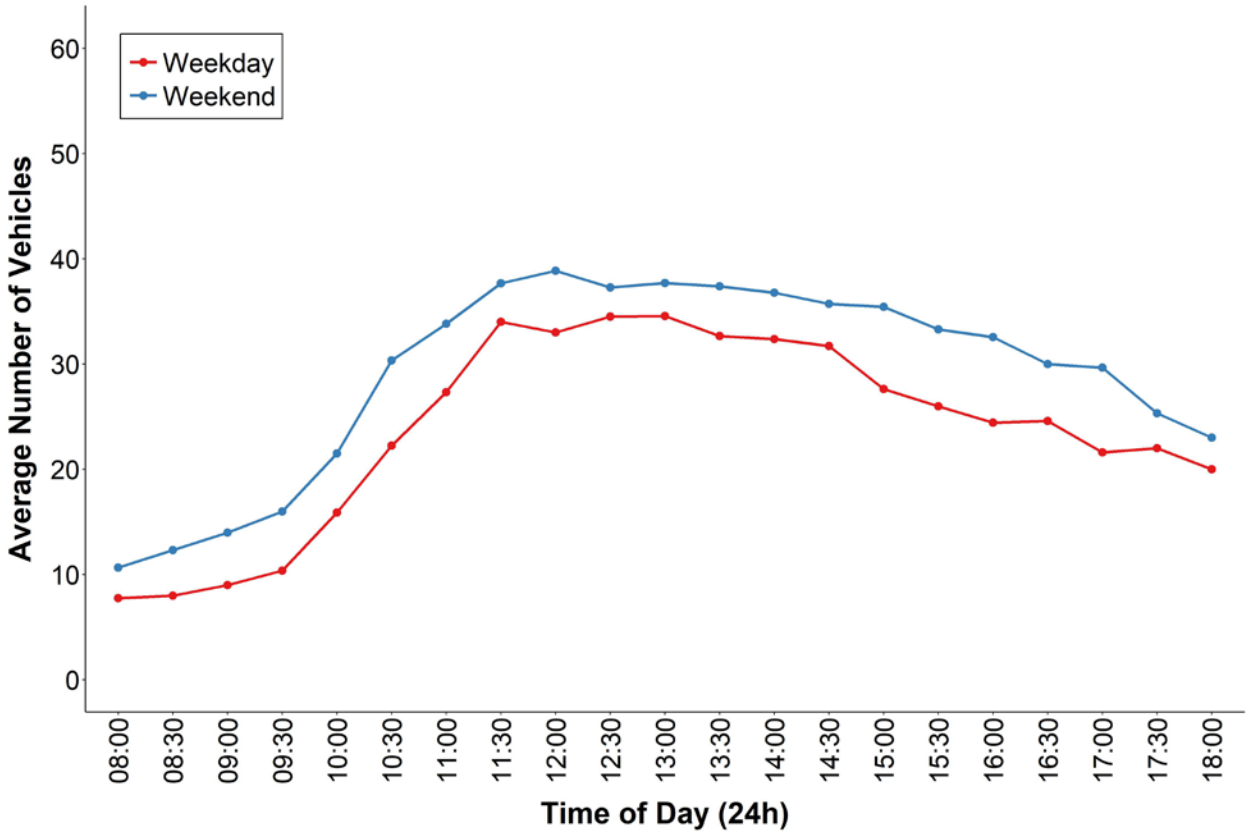

Figure 10c. Average number of vehicles parked in designated parking in Boat Launch, stratified by weekends and weekdays. For a full list of averages and standard deviations, see Appendix H.

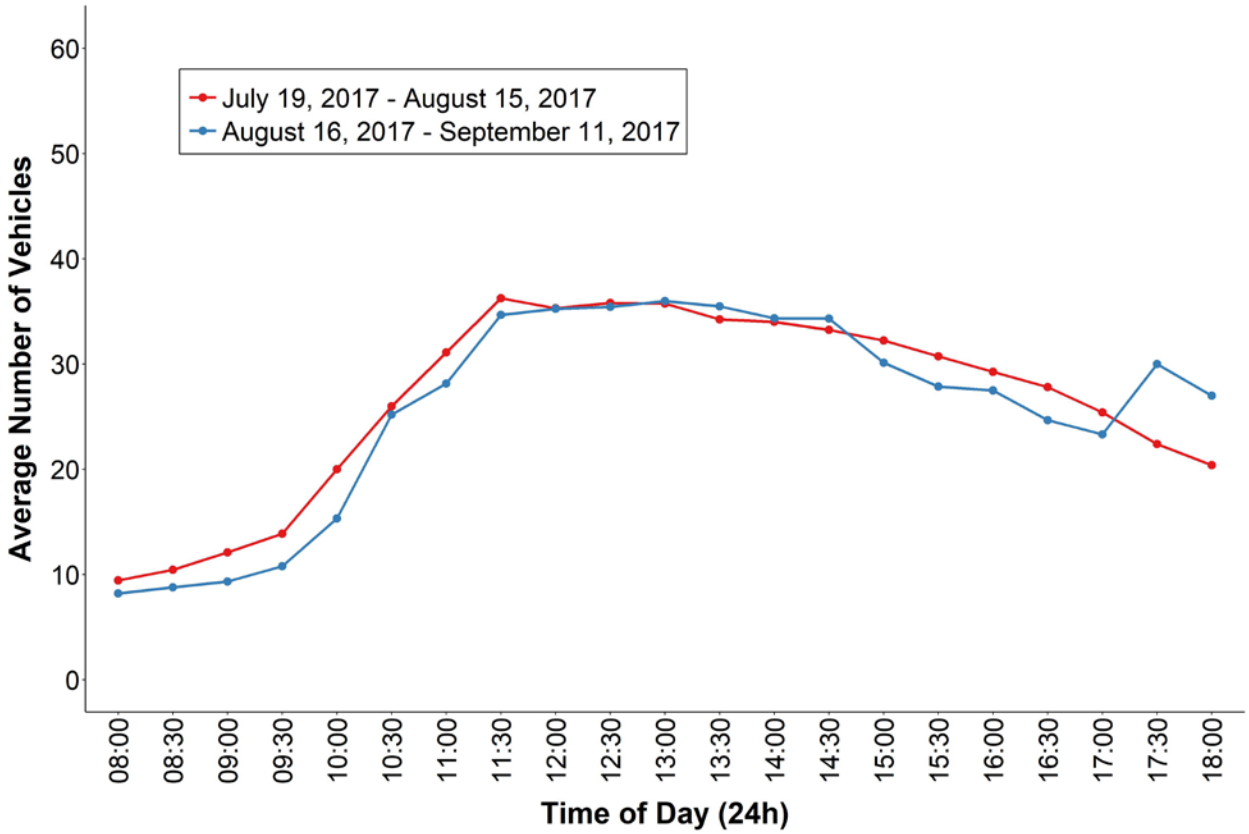

Figure 10d. Average number of vehicles parked in designated parking in Boat Launch, stratified by summer season and shoulder season. For a full list of averages and standard deviations, see Appendix H.

South Lot Hourly Figures

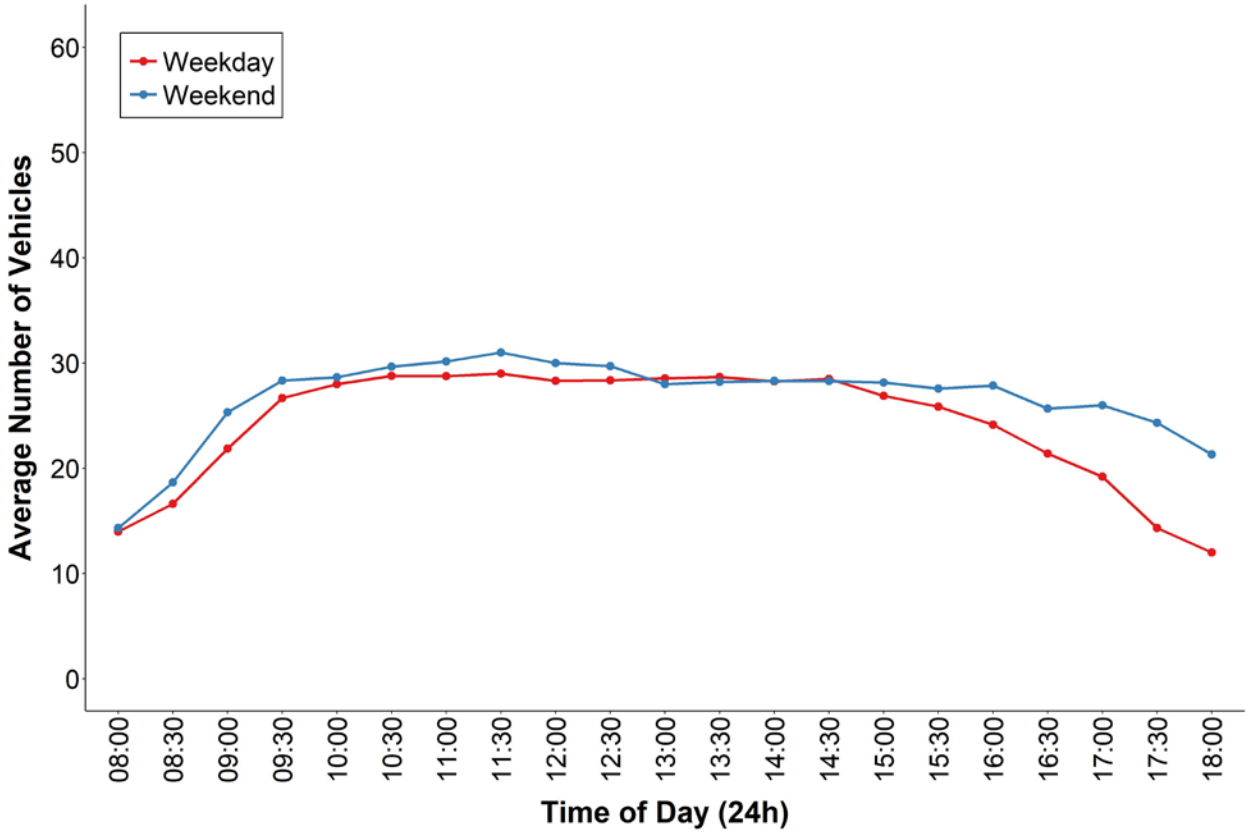

Figure 10e. Average number of vehicles parked in designated parking in South Lot, stratified by weekends and weekdays. For a full list of averages and standard deviations, see Appendix H.

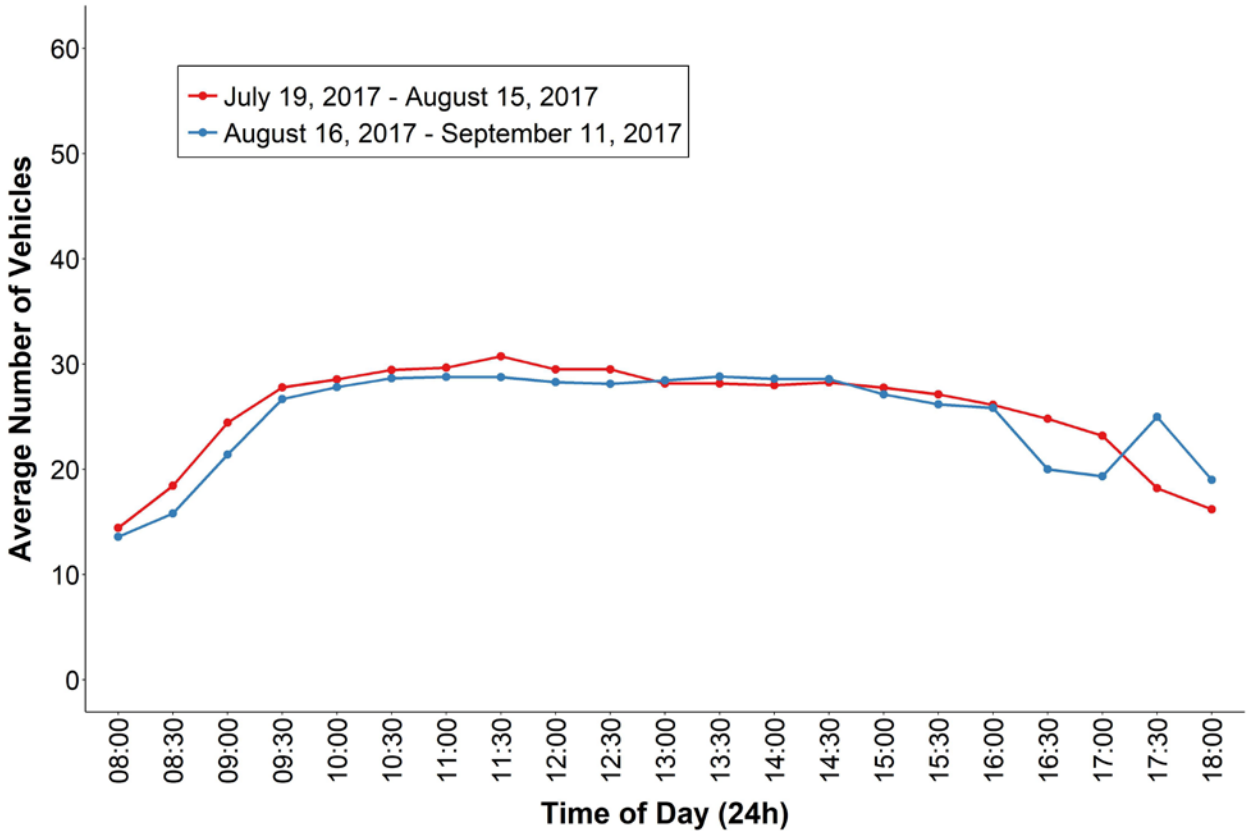

Figure 10f. Average number of vehicles parked in designated parking in South Lot, stratified by summer season and shoulder season. For a full list of averages and standard deviations, see Appendix H.

Jenny Lake Road Hourly Figures and Tables

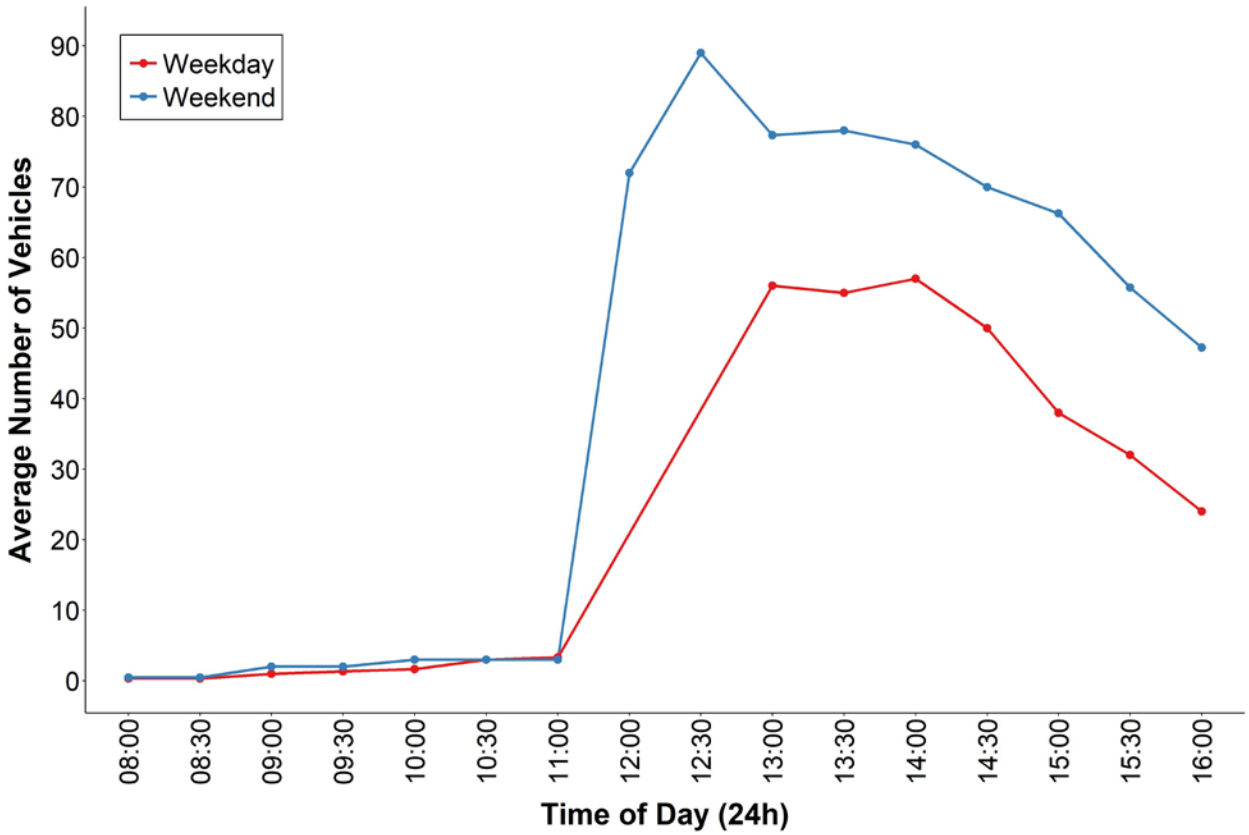

Figure 10g. Average number of vehicles parked along North Jenny Lake Road, stratified by weekends and weekdays. For a full list of averages and standard deviations, see Appendix H.

Photo 8. Vehicles along North Jenny Lake Road. Photo captured at the exit of String Lake Road, looking east. Photo taken August 6, 2017 at 3:09pm (JENNA BAKER).

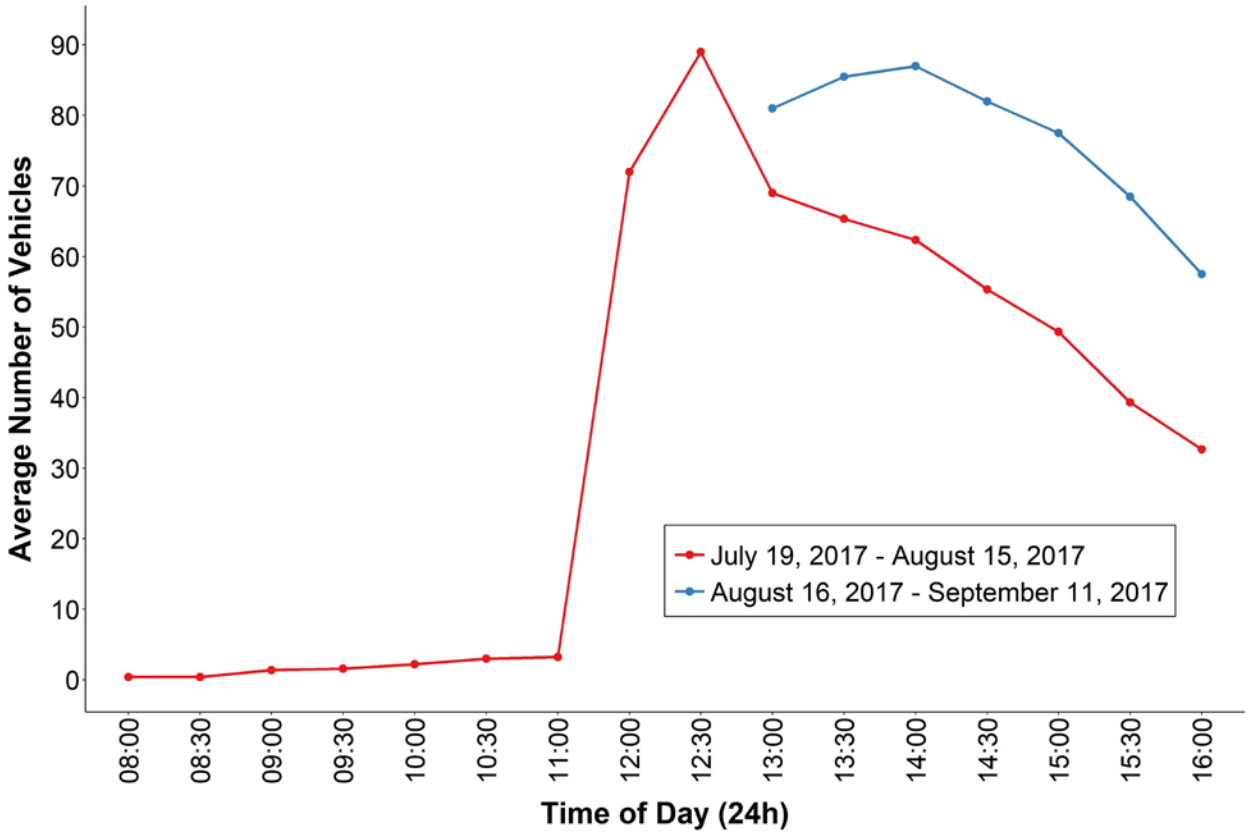

Figure 10h. Average number of vehicles parked along North Jenny Lake Road, separated by summer season and shoulder season. For a full list of averages and standard deviations, see Appendix H.

Photo 9. Vehicles along North Jenny Lake Road. Photo captured on North Jenny Lake Road, looking West. Photo taken September 3, 2017 at 2:07pm (JENNA BAKER).

Table 18. 'Casual' North Jenny Lake Road vehicle counts. Research staff counted the number of vehicles on North Jenny Lake Road when leaving the study area.

Date	Time (24hr)	# of Vehicles Counted
7/21/2017	18:00	4
7/23/2017	14:15	56
7/26/2017	14:40	1
7/28/2017	16:30	20
7/30/2017	16:17	19
7/31/2017	18:16	5
8/5/2017	14:10	54
8/9/2017	14:16	9
8/12/2017	16:15	13
8/26/2017	18:20	5
8/29/2017	13:47	5

Vehicle Parking and Use Patterns

GPS-based tracking of vehicles estimates the parking behavior and amount of time visitors spend in the SLL area. On vehicle sampling days, study technicians intercepted visitors in their vehicle as they were turning onto String Lake Road. Study technicians asked visitors to keep a GPS unit in their vehicle for the duration of their visit to the SLL area. The parking behavior of visitors was extracted from the GPS tracks and these GPS tracks were examined to determine how long vehicles remained parked in each of the three parking lots (North Lot, Boat Launch, and South Lot). To reduce the impact of outliers, vehicles that remained within a parking lot for less than 5 minutes were not included in the retention time calculations, but were instead tallied.

Response Rate and Data Summary

Between mid-July through early September a total of 167 GPS tracks were collected of vehicle use in the SLL area. Vehicle GPS tracked had a 96% response rate and the average group size of participants was approximately 3 visitors (Table 19). Of the visitors tracked during the vehicle GPS tracking portion of the study, 76% were non-local (vehicles that did not have a WY-22 license plate or had a WY-22 license plate with rental car stickers). Locals (vehicles with WY-22 license plates with no rental stickers) made up 16% of the sample of GPS tracks of vehicles. Very few visitors did not participate in the vehicle GPS tracking portion of the study, but the reasons for not participating were varied and no single reason dominated.

Table 19. Summary of response rate by parking lot for GPS-based tracking of vehicles.

Location	Response Rate	Average Group Size (± Standard Deviation)	% Local	% Non-Local	% NA
String Lake Road	97%	2.9 (± 2.1)	16%	76%	8%*

*NA values are due to vehicles not having a detectable license plate and/or researcher uncertainty.

Parking Behavior and Retention Time

The GPS tracks collected from vehicles entering String Lake Road reveal that the majority (82% overall) of visitors park in the first parking lot they drive to (Table 20). Across all sampling periods, most visitors drive straight to the North Lot and park within the North Lot. During the shoulder sampling period, 62% of the vehicles tracked exhibit this behavior. The second most frequently observed parking behavior overall, and particularly during the summer sampling period, is driving straight to the South Lot and parking within that lot. However, during the shoulder sampling period, the behavior of driving to the South Lot first and parking there has the lowest frequency (13%) (Table 20). The Boat Launch is the third most frequently parked in lot overall, and during the summer sampling period. Across the entire study, 10% of visitors drive straight to the Boat Launch and remain parked there for the duration of their visit. Overall, and across both the summer and shoulder sampling periods, less than 25% of the GPS tracks from vehicles show behavior where visitors drive between parking lots before parking. Of visitors that drive between the three parking

lots before parking, the most frequently observed behavior (across all sampling periods and overall) is driving to the South Lot, leaving, driving to the North Lot, and parking within the North Lot (Table 20).

Table 20. Frequencies and counts of GPS tracked vehicle behaviors observed in the SLL area.

Behavior	Overall: Frequency (%) of Behavior	Overall: Number of Cars Exhibiting Behavior	Summer: Frequency (%) of Behavior	Summer: Number of Cars Exhibiting Behavior	Shoulder: Frequency (%) of Behavior	Shoulder: Number of Cars Exhibiting Behavior
North Lot (NL)	52%	87	48%	54	61%	33
Boat Launch (BL)	11%	19	10%	11	15%	8
South Lot (SL)	19%	31	21%	24	13%	7
NL → BL	2%	3	3%	3	0%	0
NL → SL	2%	3	4%	4	0%	0
BL → NL	1%	1	1%	1	0%	0
BL → SL	0%	0	0%	0	0%	0
SL → NL	7%	12	8%	9	6%	3
SL→ BL	4%	6	4%	4	4%	2
NL → BL	1%	1	1%	1	0%	0
BL→SL →NL	1%	1	1%	1	0%	0
N/A	1%	2	1%	1	2%	1

Vehicles GPS tracked in the SLL area remain in the area for an average of 3 to 4 hours (Table 21). Total time spent parked in the North Lot does not vary by season, with vehicles remaining in the lot for approximately 4 hours. The South Lot has the second longest retention time for vehicles; with averages between 3.5 and 4 hours. During the shoulder sampling period, the South Lot has the longest retention time of the three parking lots in the SLL area. Across all seasons, average time spent in the Boat Launch by GPS tracked vehicles is approximately 3 hours. During the summer sampling period, the North and South Lots have the highest number of vehicles that were observed to spend less than 5 minutes in the parking lot (13 and 19 vehicles GPS tracked respectively) (Table 21). These behaviors may have been the result of visitors dropping off others in their party or visitors searching for parking spots.

Table 21. Time spent in the three parking lots in the SLL area across the entire study period, summer sampling period, and shoulder sampling period. SD = standard deviation.

Parking Lot	Overall Average (h:mm)	Overall ± SD (h:mm)	Overall Sample Size (n)	Overall #Vehicles Omitted	Summer Average (h:mm)	Summer ± SD (h:mm)	Summer Sample Size (n)	Summer # Vehicles Omitted*	Shoulder Average (h:mm)	Shoulder ± SD (h:mm)	Shoulder Sample Size (n)	Shoulder # Vehicles Omitted
North Lot	3:59	± 2:57	84	14	4:02	± 2:55	57	13	3:54	± 2:59	27	1
Boat Launch	3:01	± 2:12	31	2	3:06	± 2:17	21	1	2:49	± 1:57	10	1
South Lot	3:34	± 2:30	36	19	3:28	± 2:35	32	19	4:25	± 1:20	4	0

*Vehicles that were in a parking lot for less than 5 minutes were omitted from the time calculations

Use Patterns

Study technicians used GPS tracking points collected from the vehicles in the SLL area and analyzed them using a Kernel density procedure to detect if any patterns of parking behavior could be observed visually. These maps are shown in Figures 11a- 11c. The densities reflect the size of the parking lots with the highest densities of points appearing in the North Lot, followed by the South Lot, and finally the Boat Launch. The density maps also give some indication where within each parking lot visitors tend to park. In the North Lot visitors tend to park close to the picnic and trailhead area. In the Boat Launch, visitors tend to park most frequently in the middle of the parking lot when these spots were available. And in the South Lot, visitors tend to park close to the trailheads most frequently. Little differences in overall density patterns were observed between the summer and shoulder sampling periods (Figures 11b – 11c). A slight difference is noted in the North Lot, where during the summer sampling period more vehicles park further from the picnic/trailhead location as compared to the shoulder sampling period (Figures 11b – 11c).

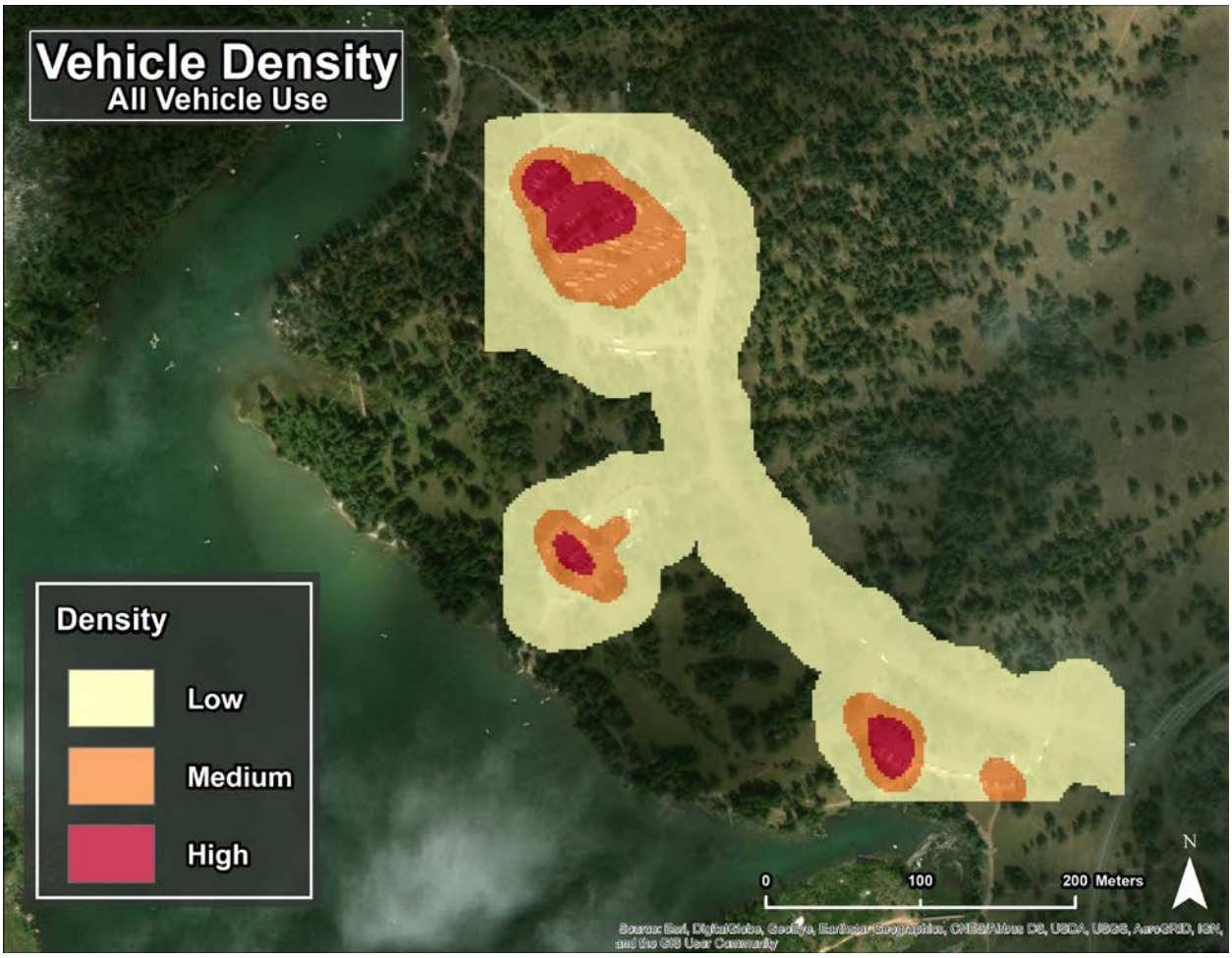

Figure 11a. Density of tracking points collected from vehicles in the SLL area across the entire study period.

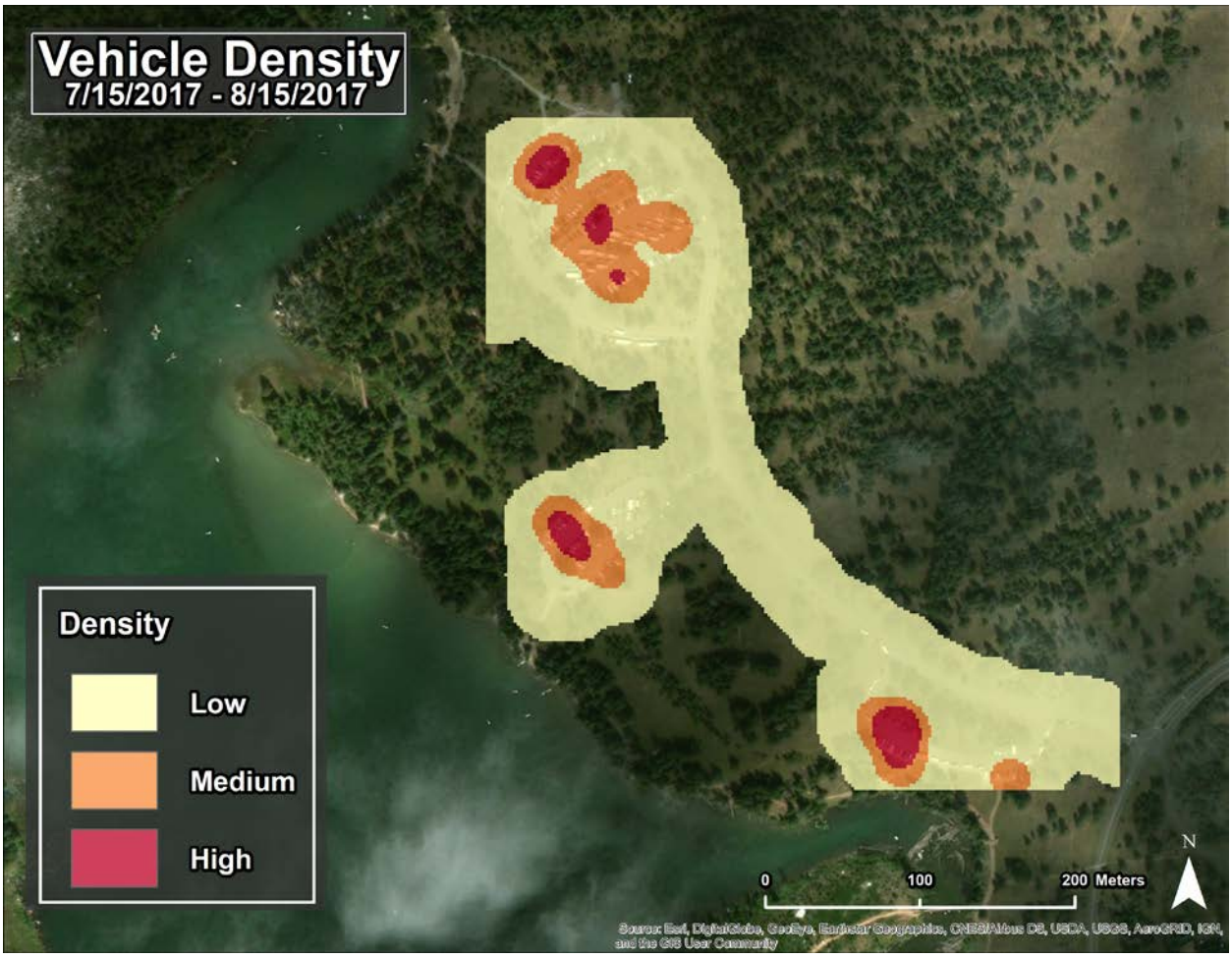

Figure 11b. Density of tracking points collected from vehicles in the SLL area for the summer sampling season.

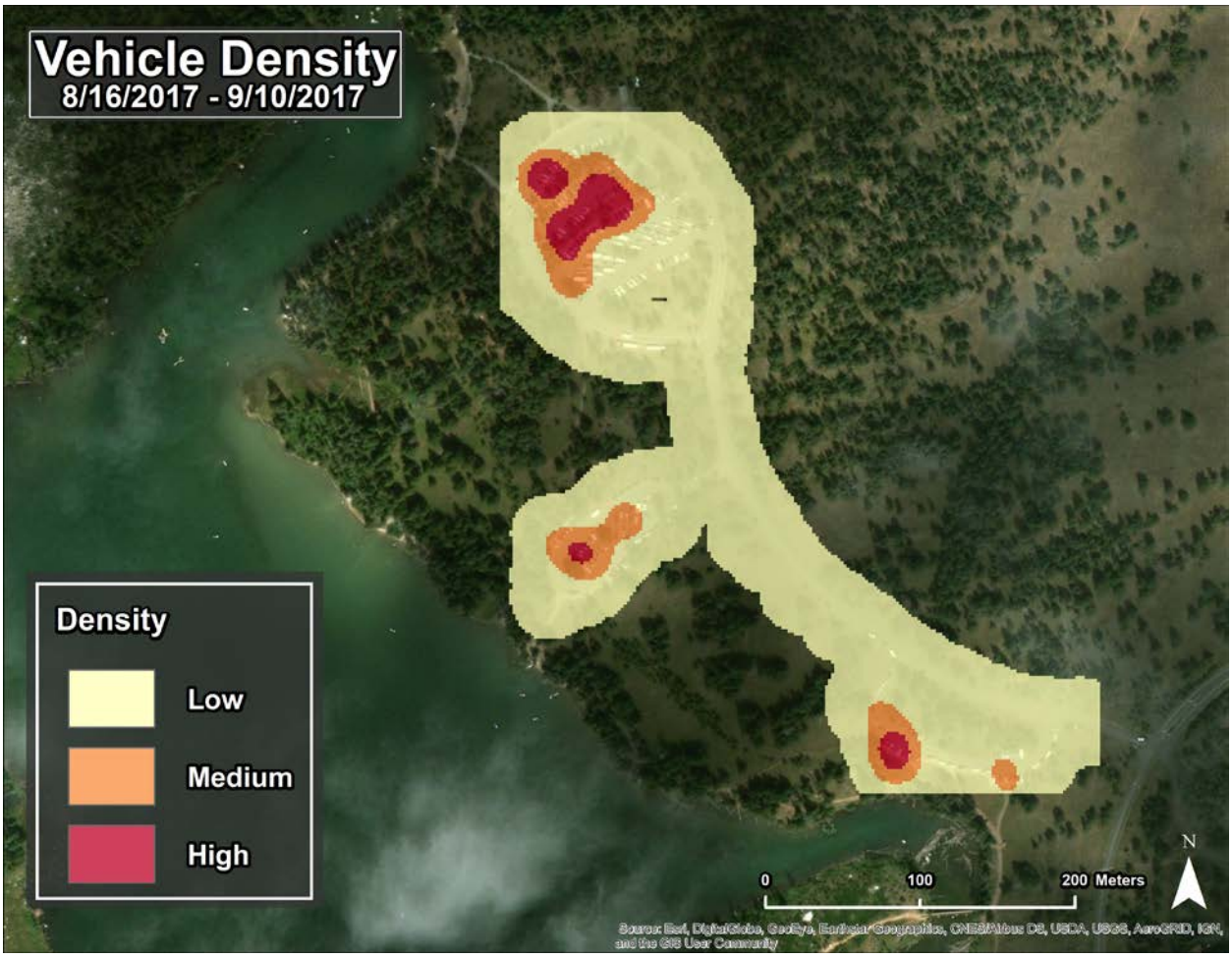

Figure 11c. Density of tracking points collected from vehicles in the SLL area for the shoulder sampling season.

Road Closure Scenario

During the summer of 2017, use in the SLL area increased drastically and for safety reasons, during very busy periods of the day, volunteers would sometimes "close" String Lake Road by placing a "Parking Lot Full" sign at the road entrance. See Table 22 for a summary of known road closures for July.

Table 22. Summary of road closure information extracted from volunteer communication via WhatsApp for July 2017. *August 2017 summary is forthcoming.*

Date	Start Time	End Time
7/6/2017	N/A	N/A
7/7/2017	13:30	N/A
7/8/2017	4:30	N/A
7/8/2017	11:30	N/A
7/9/2017	12:30	N/A
7/9/2017	12:30	N/A
7/13/2017	12:15	5:00
7/14/2017	"Late AM"	N/A
7/16/2017	11:24	3:20
7/18/2017	N/A	3:00
7/19/2017	11:30	3:30
7/20/2017	N/A	N/A
7/21/2017	10:45	4:30
7/23/2017	11:30	5:15
7/24/2017	11:00	2:30
7/26/2017	11:30	1:00
7/27/2017	N/A	2:20
7/28/2017	11:15	N/A
7/29/2017	11:00	N/A
7/30/2017	11:45	3:40
7/31/2017	11:30	2:40

On sampling days when GPS-based tracking of vehicles was occurring, study technicians did not deploy GPS units during periods of road closure (see Table 22 and the sampling schedule in Appendix A). Instead, the random intercept procedure was maintained but study technicians counted the number of individuals in each car and recorded whether the car was local or non-local. This procedure was used to minimize lost GPS units and to provide some measure of the number of visitors impacted by the road closure. It is important to note that the road closures did not happen every time GPS-based tracking of vehicles occurred or during the entire sampling period for a GPS-based tracking day. See Table 23 for a summary of road closure times and data collected during GPS-based tracking of vehicle sampling days.

The limited amount of data collected during the road closure shows that, on average, vehicles arriving during the closure contained 3 visitors (Table 23). Most vehicles were non-local. Many of the closures occurred during afternoon sampling times and in a 2 to 2.5 hour period of road closure, often, approximately 75 visitors would be influenced by the road closure (approximately 30 – 35 people per hour). It is important to know that this sampling was opportunistic in nature, fairly limited, and not a random sample.

Table 23. Summary of data collected when road closures on String Lake Road as a result of full parking lots occurred during GPS-based tracking of vehicles.

GPS Tracking During Road Closure	Start Time – End Time	Total People Counted	Average Group Size	% Local	% Non-local	% NA
7/22/2017	NA	85	3	21%	79%	0%
8/2/2017	13:09-13:58	17	3.4	0%	100%	0%
8/6/2017	13:19-16:00	70	3.3	4%	87%	9%
8/19/2017	13:18-15:58	74	3.4	23%	77%	0%
8/23/2017	13:29-13:35	5	1.6	33%	67%	0%
9/3/2017	13:35-15:57	76	3.6	33%	67%	0%

Pedestrian Use Patterns

Response Rate and Data Summary

Study technicians used GPS-based tracking techniques to measure the behavior of pedestrian day-users in the SLL areas (example: hikers and/or people using the shoreline). Visitors were randomly intercepted at the three main parking lots along String Lake Road. Maps of the results from the GPS tracking data are summarized by overall use, sampling season (summer and shoulder), and by the trailhead where the GPS unit was handed out. This section contains key maps visualizing the behavior and use patterns of visitors in the SLL Area, additional maps are found in Appendix I.

Between mid-July 2017 and early Sept 2017, a total of 662 GPS tracks were collected from pedestrian visitors to the SLL area. A total of 10 tracks were lost in the field or had to be removed during the data cleaning process for a final sample size of 652 tracks that were analyzed for visitor behavior patterns. Calibration techniques indicated that positional error for the GPS tracks collected at SLL was relatively low; 1.18 meters on average. The overall response rate of the study was 89%, with the South Lot having a slightly higher response rate than the other two parking lots (Table 24a). The most frequently reported reasons for not participating in the study are listed in Table 24b. On average, the group size of participants varied between 3.2 and 4.3 people (2); with an overall average of 3.6 (+/- 4.5) visitors per group.

Table 24a. Summary of response rate by parking lot for GPS-based tracking or pedestrians.

Location	Number of GPS Tracks Collected	Response Rate	Average Group Size (± SD)	Level of GPS Error (m)
North Lot	282	87%	3.5 (± 2.5)	1.77
Boat Launch	172	87%	4.3 (± 8.1)	0.98
South Lot	208	91%	3.2 (± 2.0)	0.81

Table 24b. Summary of more frequently cited reasons visitors did not want to carry a GPS unit during their visit to the SLL areas.

Location	Reason	# of Groups
North Lot	Not interested	5
	Leaving	2
	Too much responsibility	2
Boat Launch	Not interested	4
	Language Barrier	3
South Lot	Language Barrier	3
	Returning to car	2
	"No Thank You"	2

Pedestrian Use Patterns

To visualize the overall density of recreation use, researchers analyzed the GPS tracks (in the form of points) collected from visitors to the SLL areas in ArcMap using a Kernel density procedure. The following Figures 12a – 12d are maps showing areas of high, medium, and low densities of use from visitors who start their trip at one of the three parking lots along String Lake Road. During the 2017 study, GPS units were not given to recreationists who were staying overnight in the backcountry or who were planning on spending their visit on the water. Therefore, water and overnight use is not shown on these maps. A small number of visitor did end up taking the GPS unit onto String and/or Leigh Lakes; a density map of the subset of these tracks is found in Appendix I.

Overall, a variety of recreation use patterns were observed in the SLL area (Figure 12a). While the majority of recreation density is observed on the eastern shore of String Lake, visitors do recreate around Jenny Lake, up to Bearpaw and Trapper Lakes, into Paintbrush and Cascade Canyons, and some visitors start at String Lake and took the shuttle boat across Jenny Lake. These overall use patterns do not vary by summer or shoulder sampling periods (Appendix I). Use patterns do vary slightly by parking lot location. For GPS tracks which start at the North Lot along String Lake Road, the highest density of use occurs on the northeast shore of String Lake (Figure 12b). Of the GPS tracks collected at the North Lot, no visitor hiked the loop around Jenny Lake from this starting location or took the shuttle boat across Jenny Lake. For GPS tracks that started at the Boat Launch, the highest density of recreation use occurs near the boat launch area (Figure 12c). The greatest variety of visitor behavior is observed in the GPS tracks collected from recreationists who start their visit at the South Lot along String Lake Road (Figure 12d). For these GPS tracks, the highest densities of use occurs at the southeastern shore of String Lake, towards the bridge which heads to the Jenny Lake trail junction, and along the northeast shore of String Lake.

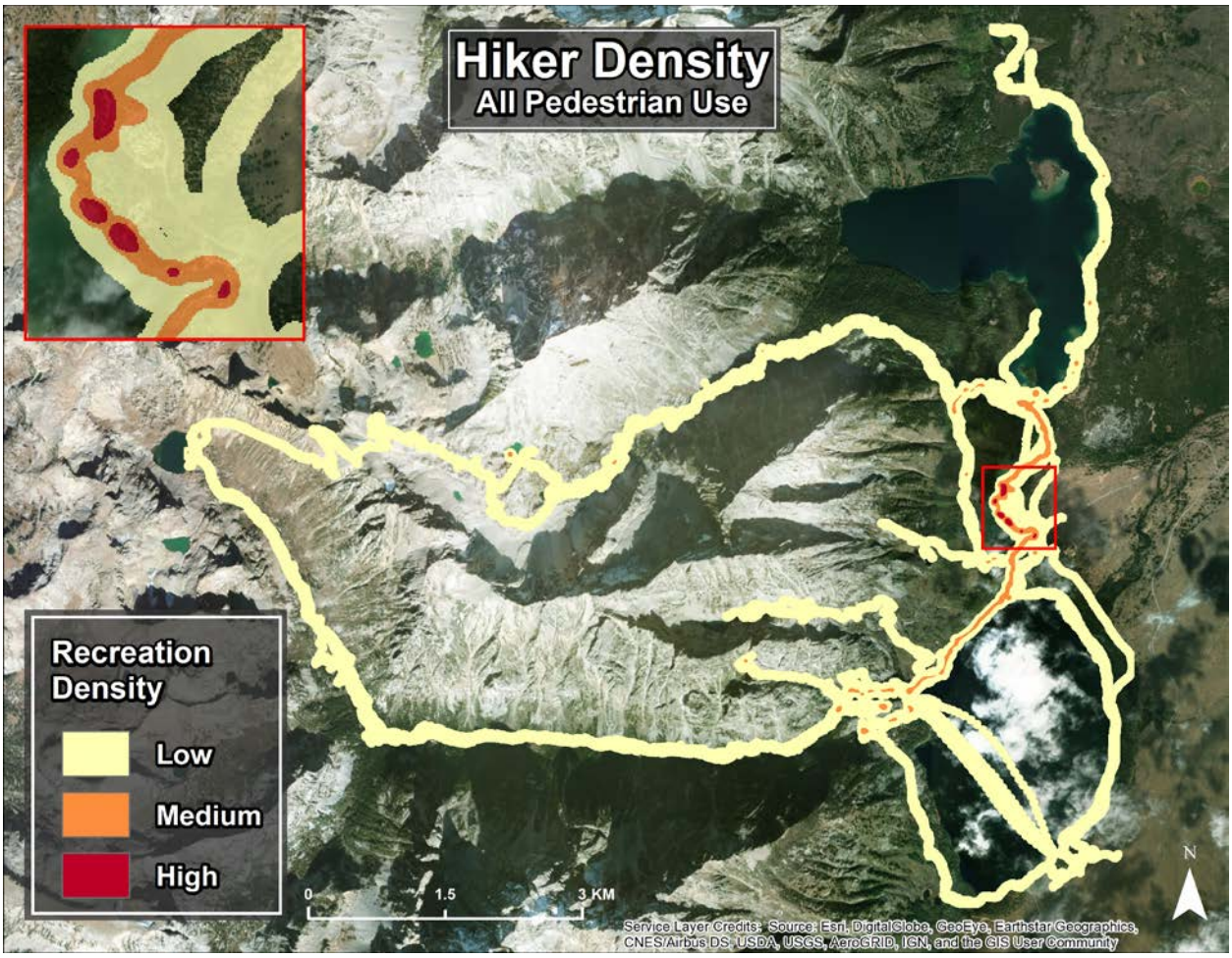

Figure 12a. Density of recreation use for the entire sampling season (July 15 – September 8, 2017) for visitors that started their trip at the String and Leigh Lake area.

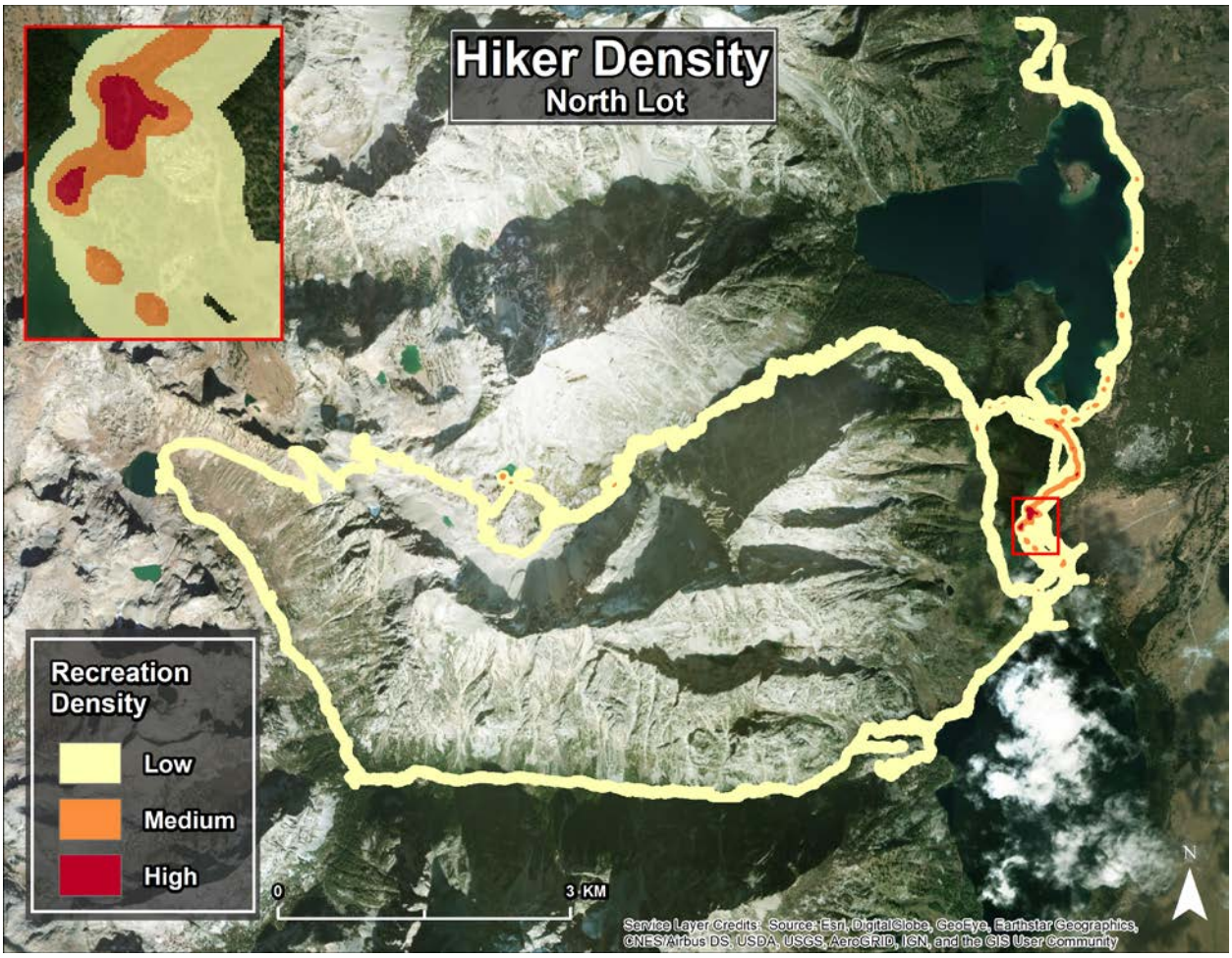

Figure 12b. Density of recreation use for the entire sampling season from GPS tracks collected from visitors starting at the North Lot along String Lake Road.

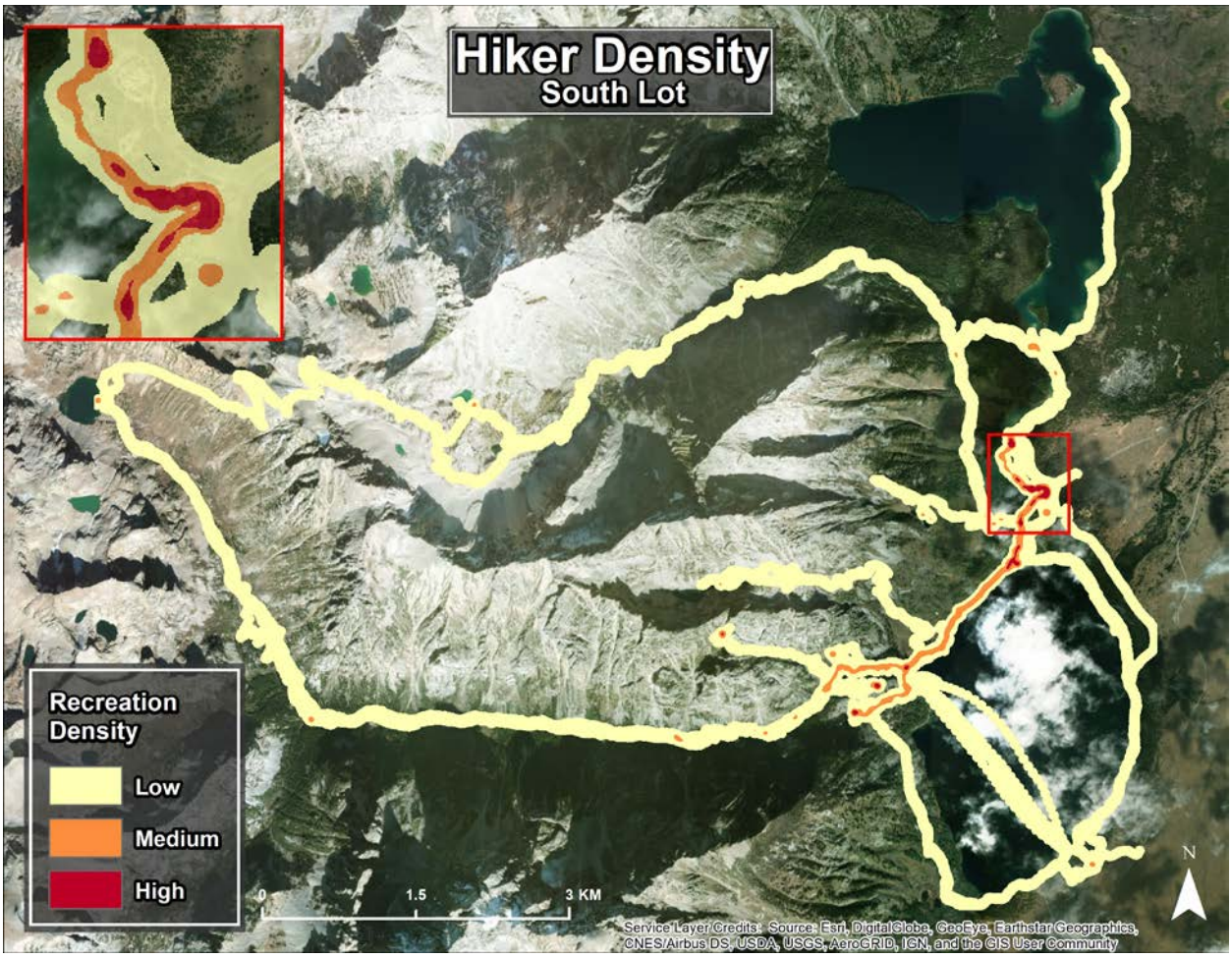

Figure 12c. Density of recreation use for the entire sampling season from GPS tracks collected from visitors starting at the South Lot along String Lake Road.

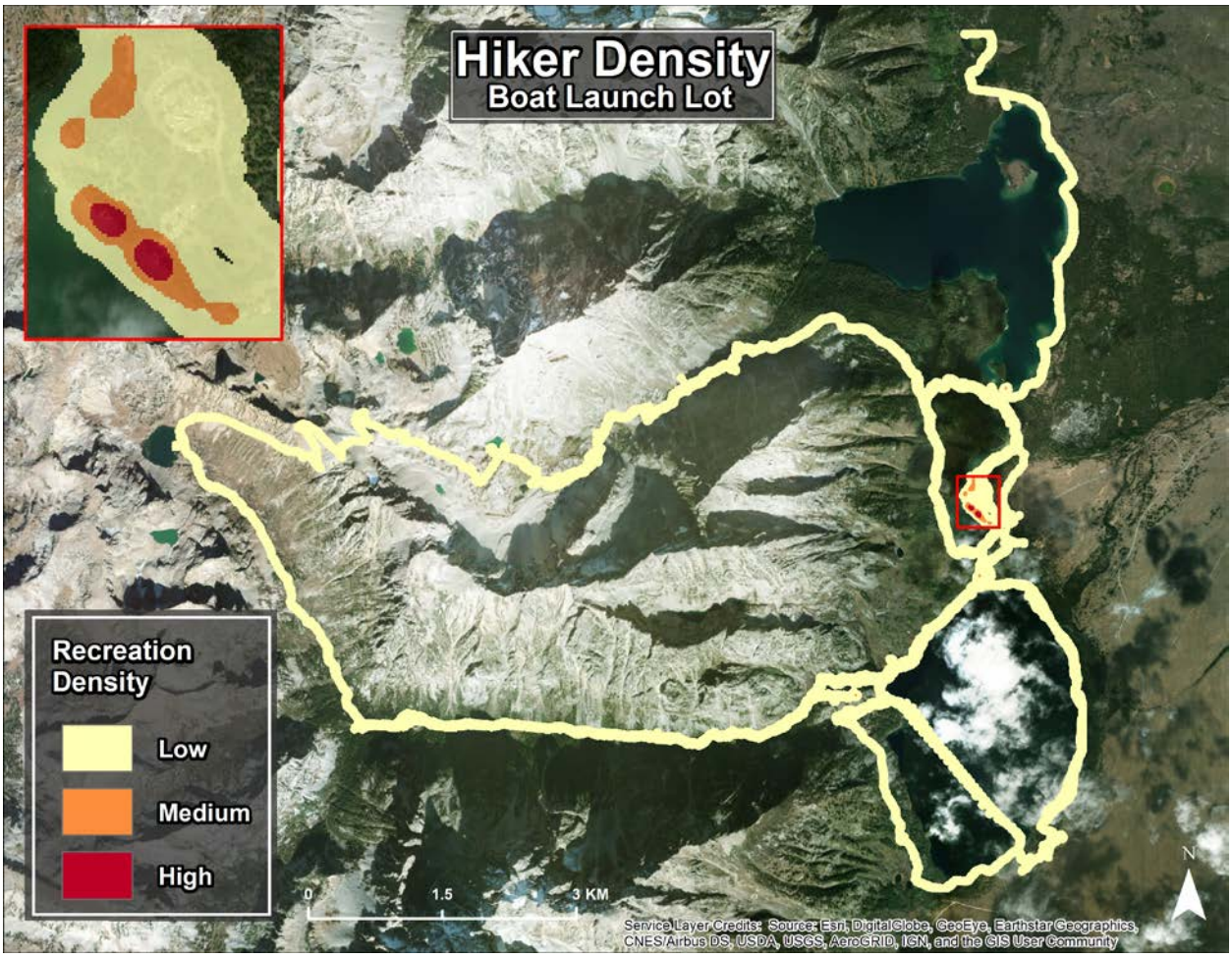

Figure 12d. Density of recreation use for the entire sampling season from GPS tracks collected from visitors starting at the Boat Launch Lot along String Lake Road.

The percentage of pedestrian GPS tracks that visited or entered key locations of interest in SLL area are summarized in Table 24c The eastern shoreline of String Lake was broken into zones for visitor observations (Figure 12e) and these same observation zones were used to understand the frequency of pedestrian visitors to different areas along the shoreline of String Lake (Figure 12f). The frequency of visitation to locations of interest does not vary considerably between the summer and shoulder sampling seasons. Slightly more visitors hike to Jenny Lake and around String Lake via the Loop Trail during the shoulder season as compared to the summer season (Table 24c). Overall, Zones 1 and 4 (see Figure 4) are the most frequently visited areas of the shore of String Lake by pedestrian visitors. Approximately 90% of visitors tracked visit Zone 1 during their visit and almost 96% of visitors enter Zone 4. Almost half of the visitors tracked hike on the trail to Leigh Lake (which does require moving through Zone 1). Of all the visitors tracked during the study, 45% hike from the SLL area to the Jenny Lake trail system (which requires moving through Zone 4). Overall, 23% of visitors hike to the west side of String Lake via the Loop Trail – with more visitors doing this hike during the shoulder season. The least visited locations by pedestrians starting at the SLL area are Paintbrush Canyon (7%), Trapper Lake (2%), and the Jenny Lake Shuttle Boat (2%).

The percentage of pedestrians that visited or entered key locations of interest also varies by the starting location of the hiker (Table 24d). Of the visitors that start their hike in the North Lot, 90% visit Zone 1 (which they must cross through to go to other locations), 35% visit the Zone 2 Picnic area, and fewer than 1/3 visit any other location of interest. Of visitors that start their hike at the Boat Launch parking lot, 92% visit Zone 4 North (which they must visit to enter any other location of interest). The next most frequented locations from the Boat Launch lot are Zone 3 and Zone 1; indicating that most visitors that start at the Boat Launch remain on the eastern shore of String Lake. From the South Lot, 97% of visitors enter Zone 4 South and over half hike to the Jenny Lake Loop. Less than 1/3 of the visitors that start at the South Lot visit any other location of interest. The majority of visitors that hike to Leigh Lake start at the North Lot (22%). Paintbrush Canyon, Trapper Lake, and the shuttle boat across Jenny Lake were the least visited locations.

The GPS tracks were also analyzed to determine, on average, how long visitors spent in each observation zone along the shoreline of String Lake (Table 24e). On average, across all seasons and all zones, visitors spend on average less than 10 minutes in any given observation zone. This indicates that most visitors that were GPS tracked are moving through the zones and not lingering for very long. Visitors spend the most time in Zone 1 (North and South) and Zone 4 North. These zones, in addition to the Picnic Zones, also had the highest standard deviation. The variability in these data suggest that some visitors do spend significantly more time in these zones.

Figure 12e. Map of observation zones (shown in green), viewshed observation points, and observation roves in String Lake observation study area.

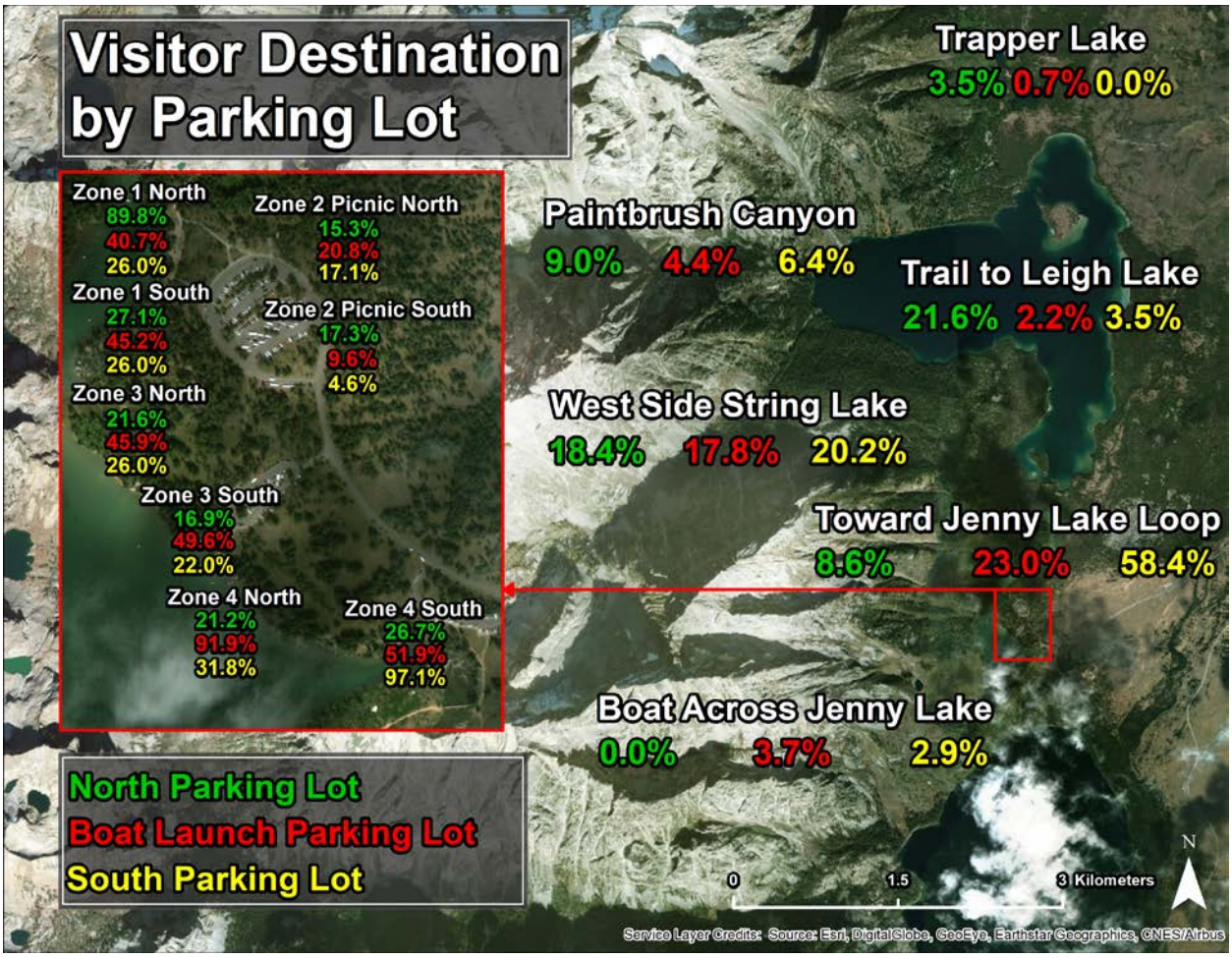

Figure 12f. Map of frequency of visitation to key locations of interest for GPS tracked visitor in the SLL area.

Table 24c. Frequency of visitation to key locations of interest for GPS tracked visitors in SLL area.

Location of Interest	All Summer Season GPS Tracks	All Shoulder Season GPS Tracks	Overall
Zone 1 North	60%	57%	59%
Zone 1 South	31%	33%	31%
Zone 2 Picnic North	15%	21%	17%
Zone 2 Picnic South	13%	8%	12%
Zone 3 North	29%	30%	29%
Zone 3 South	25%	29%	26%
Zone 4 North	38%	50%	42%
Zone 4 South	48%	66%	54%
Paintbrush Canyon	7%	9%	7%
Trail to Leigh Lake	42%	58%	47%
West Side of String Lake	19%	33%	23%
Boat Across Jenny Lake	2%	1%	2%
Toward Jenny Lake Loop	39%	58%	45%
Trapper Lake	2%	1%	2%

Table 24d: Frequency of visitation to key locations of interest for GPS tracked visitors in SLL area summarized by visitor starting location.

Location of Interest	North Lot (N = 255)	Boat Launch Lot (N = 135)	South Lot (N = 173)
Zone 1 North	90%	41%	26%
Zone 1 South	27%	45%	26%
Zone 2 Picnic North	35%	3%	2%
Zone 2 Picnic South	17%	10%	5%
Zone 3 North	22%	46%	26%
Zone 3 South	17%	50%	22%
Zone 4 North	21%	92%	32%
Zone 4 South	27%	52%	97%
Paintbrush Canyon	9%	4%	6%
Trail to Leigh Lake	22%	2%	3%
West Side of String Lake	18%	18%	20%
Boat Across Jenny Lake	0%	4%	3%
Toward Jenny Lake Loop	9%	23%	58%
Trapper Lake	4%	1%	0%

Table 24e: Averages and standard deviation of the amount of time GPS tracked visitors spend in each observation zone along the String Lake shoreline.

Observation Zone Location	Summer Season Mean hh:mm	Summer Season Standard Deviation hh:mm	Summer Season Sample Size (N)	Count of Summer Season Pedestrian Omitted*	Shoulder Season Mean hh:mm	Shoulder Season Standard Deviation hh:mm	Shoulder Season Sample Size (N)	Count of Shoulder Season Pedestrian Omitted	Overall Mean hh:mm	Overall Standard Deviation hh:mm	Overall Sample Size (N)	Count of Overall Pedestrian Omitted
Zone 1 North	0:06	0:20	345	41	0:05	0:11	192	16	0:06	0:17	537	57
Zone 1 South	0:06	0:14	199	18	0:04	0:09	85	5	0:06	0:12	284	23
Zone 2 Picnic North	0:02	0:09	68	36	0:00	0:01	44	17	0:01	0:07	112	53
Zone 2 Picnic South	0:06	0:14	61	15	0:02	0:05	20	2	0:05	0:13	81	17
Zone 3 North	0:03	0:04	199	16	0:07	0:27	97	9	0:04	0:16	296	25
Zone 3 South	0:07	0:20	172	15	0:02	0:05	94	9	0:05	0:17	266	24
Zone 4 North	0:08	0:27	261	23	0:05	0:14	148	15	0:07	0:23	409	38
Zone 4 South	0:05	0:14	408	28	0:03	0:06	202	20	0:04	0:12	610	48

Visitor Observations

Note: It is important to note the exploratory nature of the observational methodology employed along the String Lake observation study area. In the first year of this two-year study, these observational methods served to provide insight in the general behaviors and activity types of visitors at SLL, ultimately informing methodology for year-two of sampling. Observers did not undergo inter-observer reliability tests, but the same observers were assigned to the same zones to allow for some consistency between observations within a zone. The numbers and figures below succeed in representing general trends and numbers along String Lake, but the exploratory nature of the employment of these methods should also serve as a caveat for the reader. Additionally, during the shoulder sampling period, due to complications in the field, several hours of data are missing. These gaps in data are disclosed below.

Activity Types (land-based)

Direct observations of visitors serve to dynamically and unobtrusively capture the proportions of different activity types along a complex and densely populated section of String Lake. Observations occurred along a portion of the String Lake trail with the northern-most edge of observations at the Leigh Lake trailhead sign and the southern-most edge at the String Lake trailhead sign (Figure 13).

Due to the fluid and dynamic nature of the SLL observation area, study technicians recorded a person doing a non-active activity as ‘sitting’ or ‘standing’. The purpose of documenting these activities is to illuminate what a visitor may experience while visiting the SLL observation area. Please see Table 25 for a full list of definitions of each activity type.

Study technicians walked a systematic rove every 15 minutes on the hour and recorded the activity type and the number of people engaged in the activity. Definitions of activity types are explained in Table 2. During the summer sampling period on both weekdays and weekends, the majority of String Lake visitors are hiking (34% on weekdays and 32% on weekends) (Table 25a and Figure 13a). On weekdays, the second most frequent activity is picnicking, accounting for 29% of visitor activity, followed by sitting (or ‘beaching’), accounting for 14% of visitor behavior (Figure 13b). These rankings are switched on weekends with the second most frequent activity being sitting (26%) followed by picnicking (20%) (Figure 13c).

The observation study area is also divided into four zones. The frequency of activity types varies within each zone. Along the northernmost zone, Zone 1, the most common activity type is sitting (or ‘beaching’), and hiking, each accounting for about 30% of activity. On weekends, sitting in Zone 1 is more frequent than hiking. As expected, the most frequent activity in the picnic area is picnicking, accounting for 90% of activity across the entire sampling period. Zone 3 experiences the highest frequency of hikers (60%). The southern-most edge of the observation study area, Zone 4, also has hiking as the most frequent activity type (50%). For tables and figures of activity proportions by zone, see Appendix J.

Figure 13. Map of observation zones (shown in green), viewshed observation points, and observation roves in String Lake observation study area.

Table 25. Land-based activity type definitions

Activity Type	Definition
Boat Prep	Stand up paddle board
	Kayak
	Canoe
	Raft
Hike	Walking
	Hiking
	Backpacking[A]
Other[B]	Hammock
	Guitar
	Fish
	Swim prep
	Sleep
Photo	Taking a photo
Picnic	Eating
Play	Children running around
	Playing a game
Sit	Sitting/lounging along shore (“Beaching”)
	Sitting on camp chair
Stand	Sightseeing
	Standing
Wade	Wading along shoreline

[A] Within the ‘Hiking’ category, backpackers accounted for less than 1% of total hikers.

[B] The ‘Other’ category was determined from activities that accounted for less than .5% of total activity types.

Table 25a. Total number of people observed and the frequency of different activity types during the summer sampling period, stratified by weekdays and weekends.

Location	Activity Type	# of counts	Frequency (%)
All Zones (all days of week)	Boat Prep	305	6%
	Hike	1634	33%
	Other	136	3%
	Photo	117	2%
	Picnic	1240	25%
	Play	114	2%
	Sit	969	20%
	Stand	319	6%
	Wade	129	3%
	Total	**4,963**	
All Zones (weekdays)	Boat Prep	221	8%
	Hike	880	34%
	Other	50	2%
	Photo	73	3%
	Picnic	769	29%
	Play	80	3%
	Sit	363	14%
	Stand	153	6%
	Wade	36	1%
	Total	**2,625**	
All Zones (weekends)	Boat Prep	84	4%
	Hike	754	32%
	Other	86	4%
	Photo	44	2%
	Picnic	471	20%
	Play	34	1%
	Sit	606	26%
	Stand	166	7%
	Wade	93	4%
	Total	**2,338**	

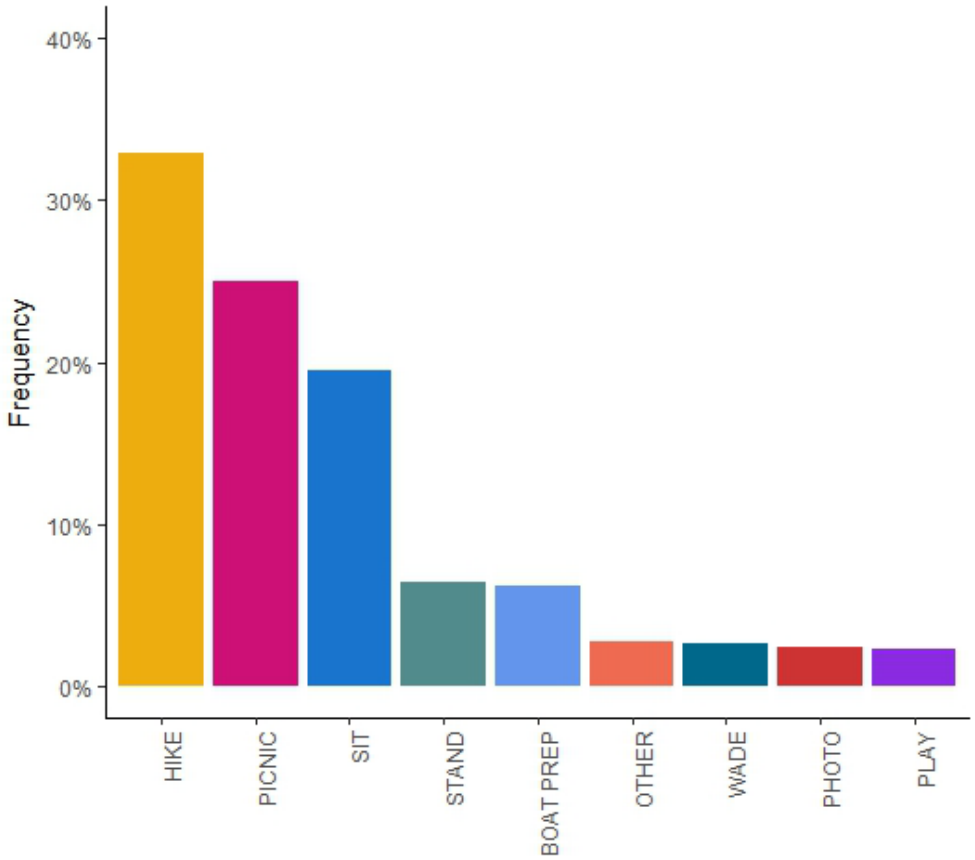

Figure 13a. Frequency (in %) of observed activity types during the summer sampling period (July 15 – August 15) among all observation zones in the study area.

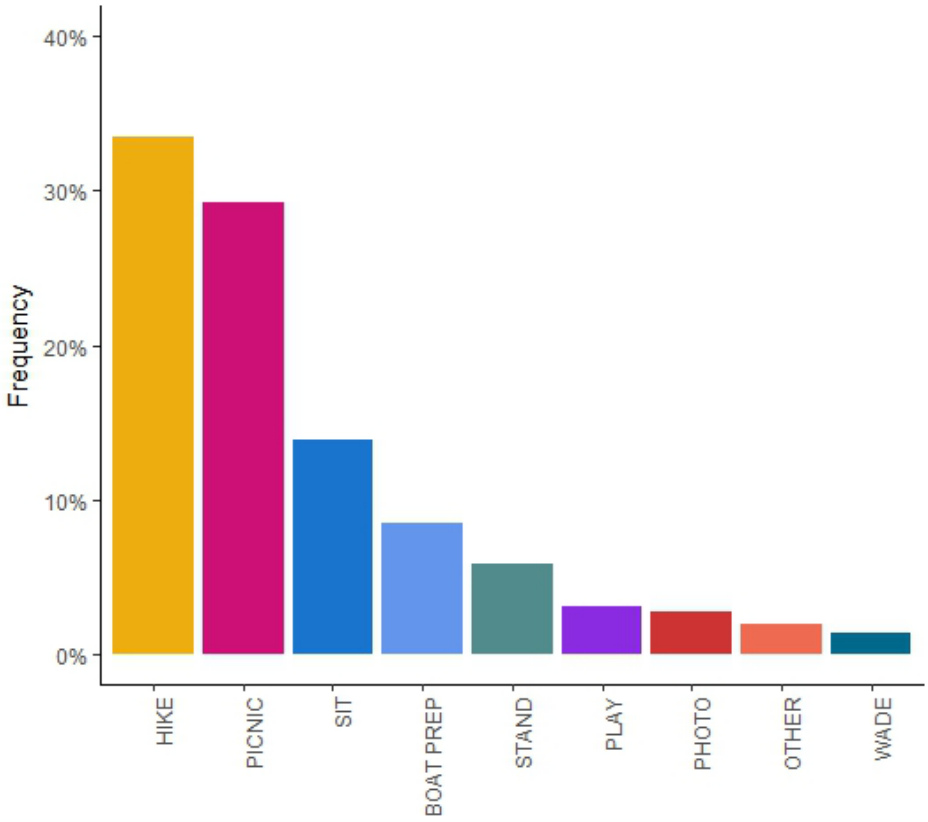

Figure 13b. Frequency (in %) of observed activity types during the summer sampling period (July 15 – August 15) on **weekdays** among all observation zones in the study area.

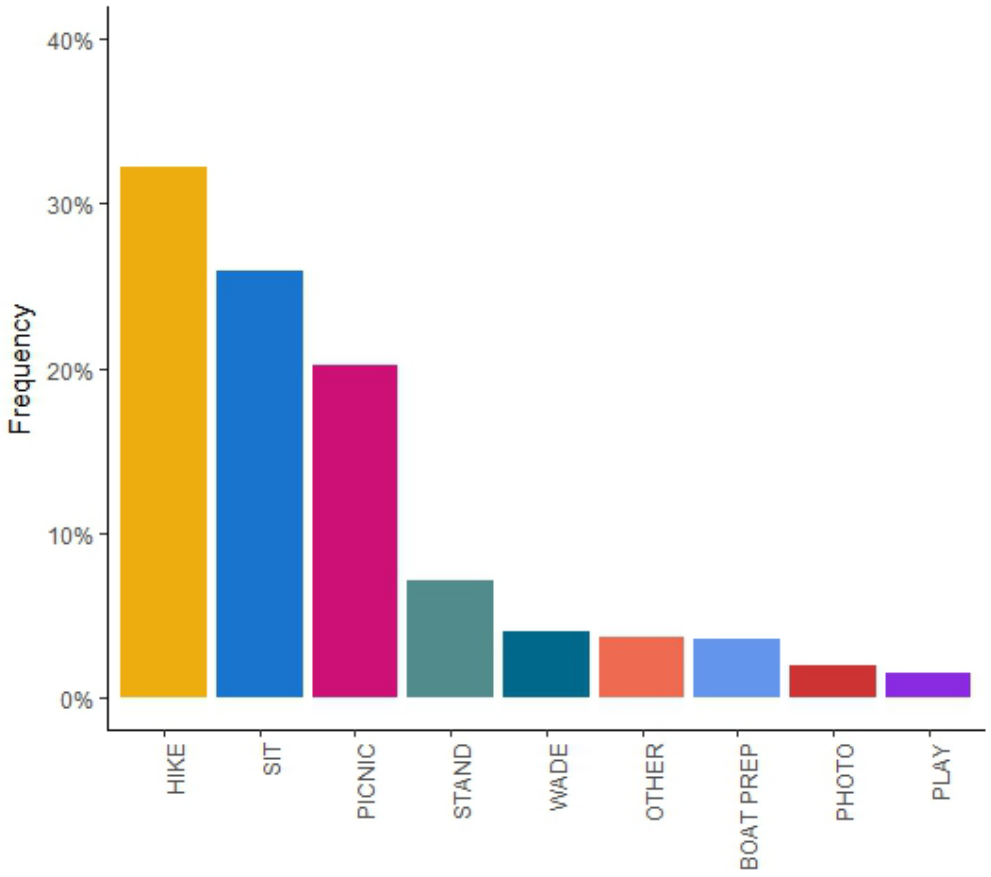

Figure 13c. Frequency (in %) of observed activity types during summer sampling period on **weekends** among all observation zones in the study area.

Photo 10. Visitors sitting and wading along the shoreline of String Lake. Photo captured in Zone 3 (JENNIFER GARDNER).

During the shoulder sampling period, proportions of activity types are different compared to the summer sampling period, particularly on the weekends (Table 25b and Figures 13d- 13f). On weekends during the shoulder sampling period, the most frequent activity type is sitting, accounting for 29% of visitor activity (Figure 13f). The second most frequent activity is hiking (25%), followed by standing (15%). Interestingly picnicking is the fourth most frequent activity, accounting for 13% of activity types. On weekdays, hiking is the most frequent activity (36%), followed by picnicking (26%), and standing (12%) (Figure 13e).

Overall, across both sampling periods, hiking is the most frequent activity type in the SLL observation study area, accounting for 31% of total activity. The second most frequent activity types are sitting and picnicking, both accounting for 21% of total activity in SLL. For a full table of overall activity types, stratified by weekend and weekday use, see Table 25c. For accompanying graphs, see Figures 13g – 13i.

Table 25b. Total number of people observed and the frequency of different activity types during the shoulder sampling period (August 16 – September 8), separated by weekends and weekdays.

Location	Activity Type	# of counts	Frequency (%)
All Zones (all days of week)	Boat Prep	125	3%
	Hike	1,251	28%
	Other	111	2%
	Photo	168	4%
	Picnic	748	17%
	Play	21	0%
	Sit	1,044	23%
	Stand	624	14%
	Wade	359	8%
	Total	**4,451**	
All Zones (weekdays)	Boat Prep	34	3%
	Hike	482	36%
	Other	19	1%
	Photo	66	5%
	Picnic	352	26%
	Sit	139	10%
	Stand	154	12%
	Wade	83	6%
	Total	**1,329**	
All Zones (weekends)	Boat Prep	91	3%
	Hike	769	25%
	Other	92	3%
	Photo	102	3%
	Picnic	396	13%
	Play	21	1%
	Sit	905	29%
	Stand	470	15%
	Wade	276	9%
	Total	**3,122**	

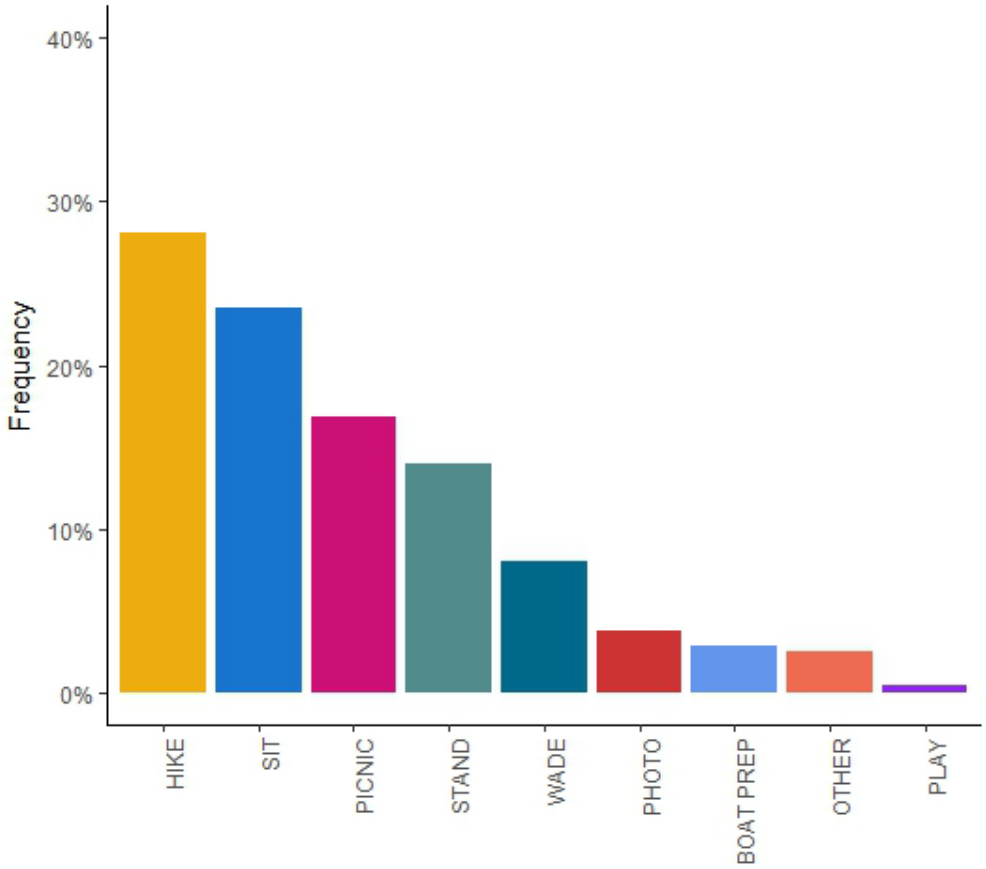

Figure 13d. Frequency (in %) of observed activity types during shoulder sampling period (August 16 – September 8) among all observation zones in the study area.

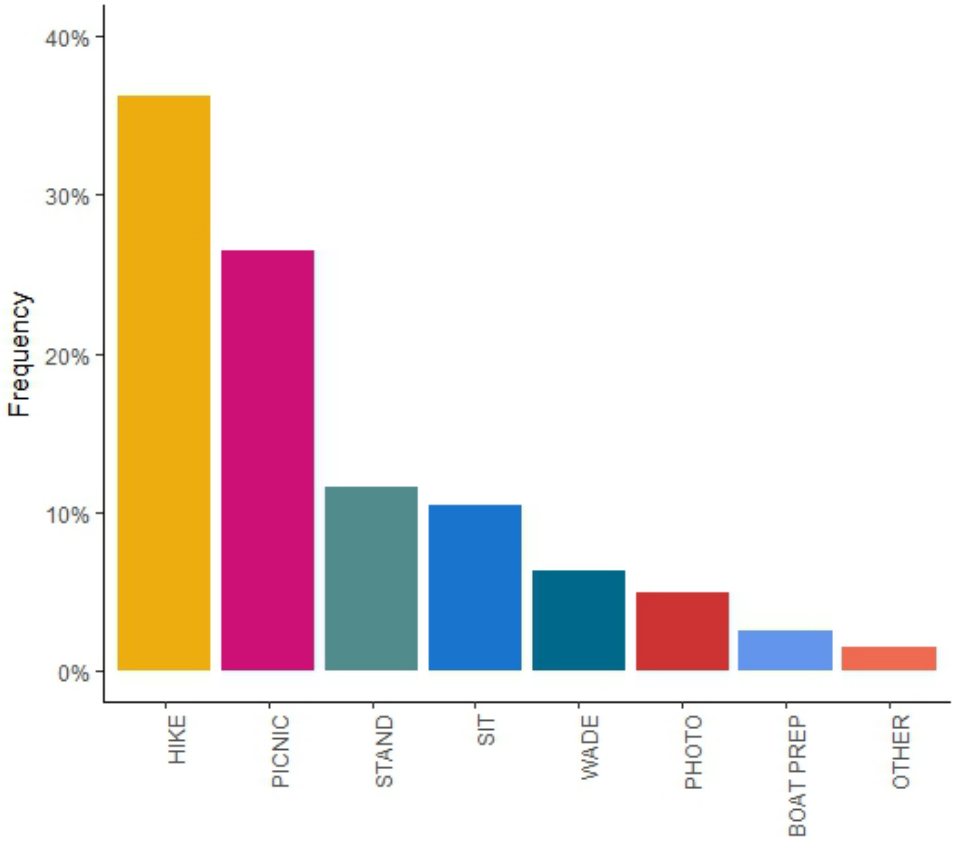

Figure 13e. Frequency (in %) of observed activity types during shoulder sampling period (August 16 – September 8) **weekdays** among all observation zones in the study area.

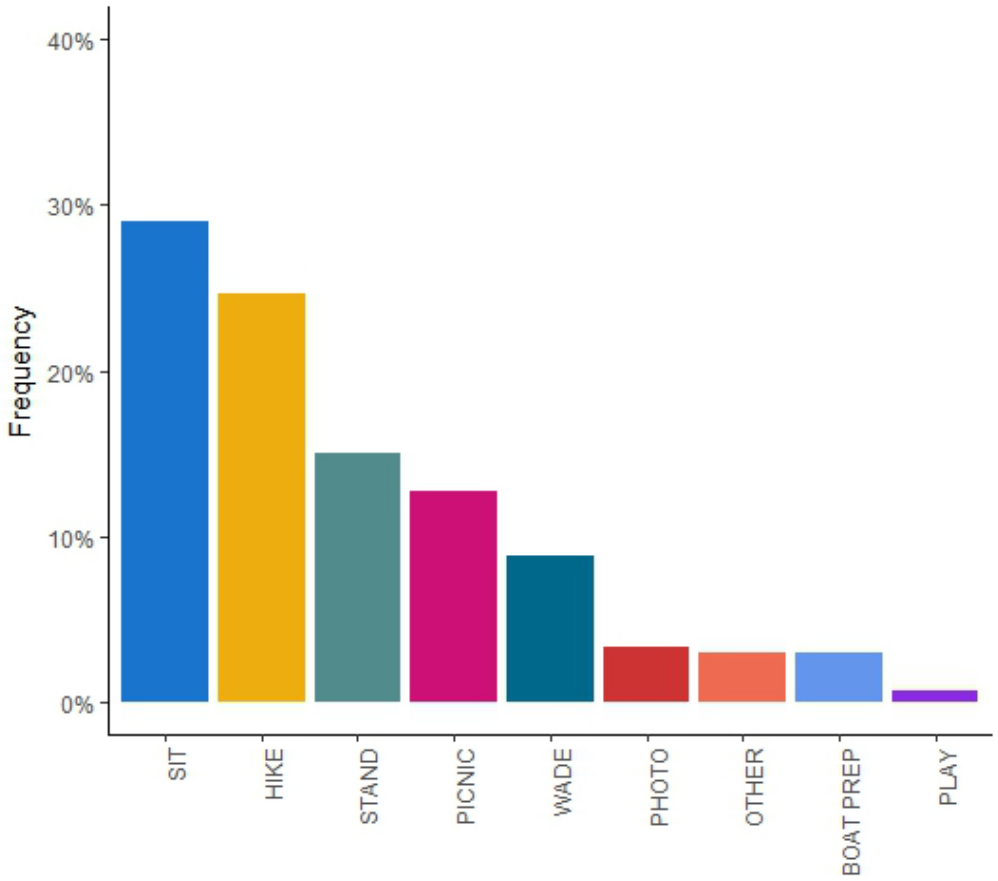

Figure 13f. Frequency (in %) of observed activity types during the shoulder sampling period on **weekends** among all observation zones in the study area.

Table 25c. Total number of people observed and the frequency of different activity types across all sampling seasons (July 15 – September 8), separated by weekends and weekdays.

Location	Activity Type	# of counts	Frequency (%)
All Zones (all days of week)	Boat Prep	430	5%
	Hike	2885	31%
	Other	247	3%
	Photo	285	3%
	Picnic	1988	21%
	Play	135	1%
	Sit	2013	21%
	Stand	943	10%
	Wade	488	5%
	Total	**9,414**	
All Zones (weekdays)	Boat Prep	255	6%
	Hike	1362	34%
	Other	69	2%
	Photo	139	4%
	Picnic	1121	28%
	Play	80	2%
	Sit	502	13%
	Stand	307	8%
	Wade	119	3%
	Total	**3,954**	
All Zones (weekends)	Boat Prep	175	3%
	Hike	1523	28%
	Other	178	3%
	Photo	146	3%
	Picnic	867	16%
	Play	55	1%
	Sit	1511	28%
	Stand	636	12%
	Wade	369	7%
	Total	**5,460**	

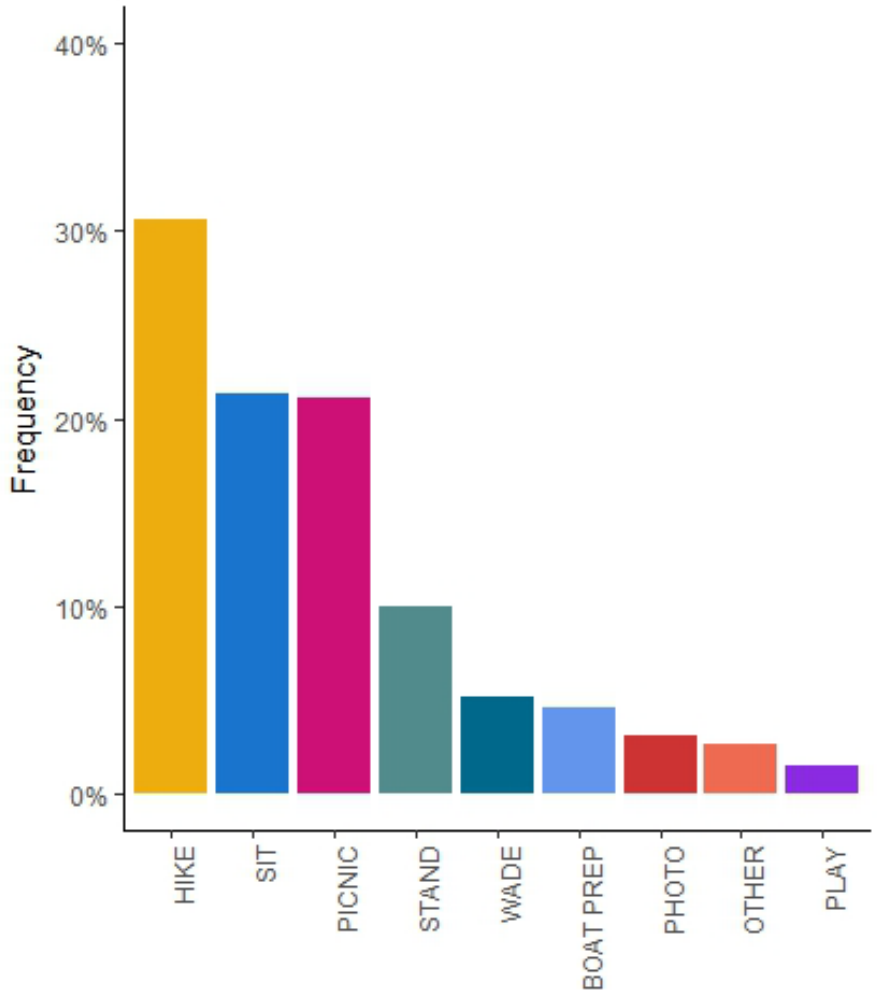

Figure 13g. Frequency (in %) of observed activity types across both sampling periods (July 15 – September 8), on all days of the week, throughout all observation zones in the study area.

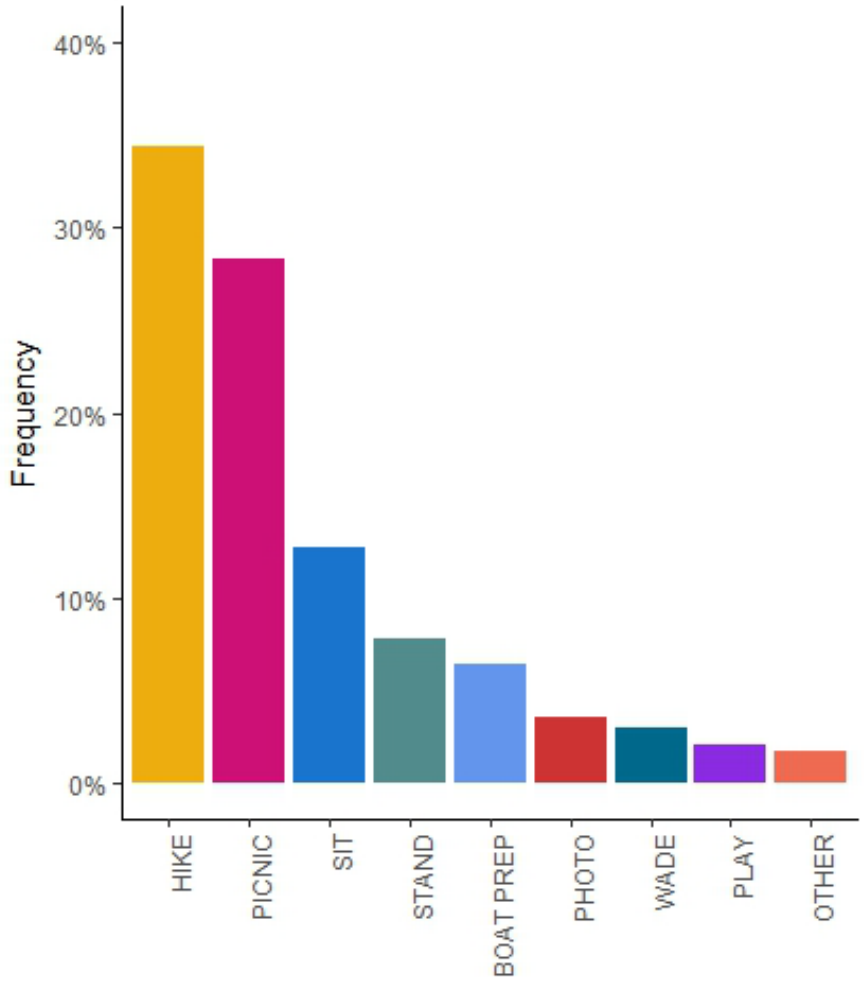

Figure 13h. Frequency (in %) of observed activity types across both sampling periods (July 15 – September 8), on weekdays, throughout all observation zones in the study area.

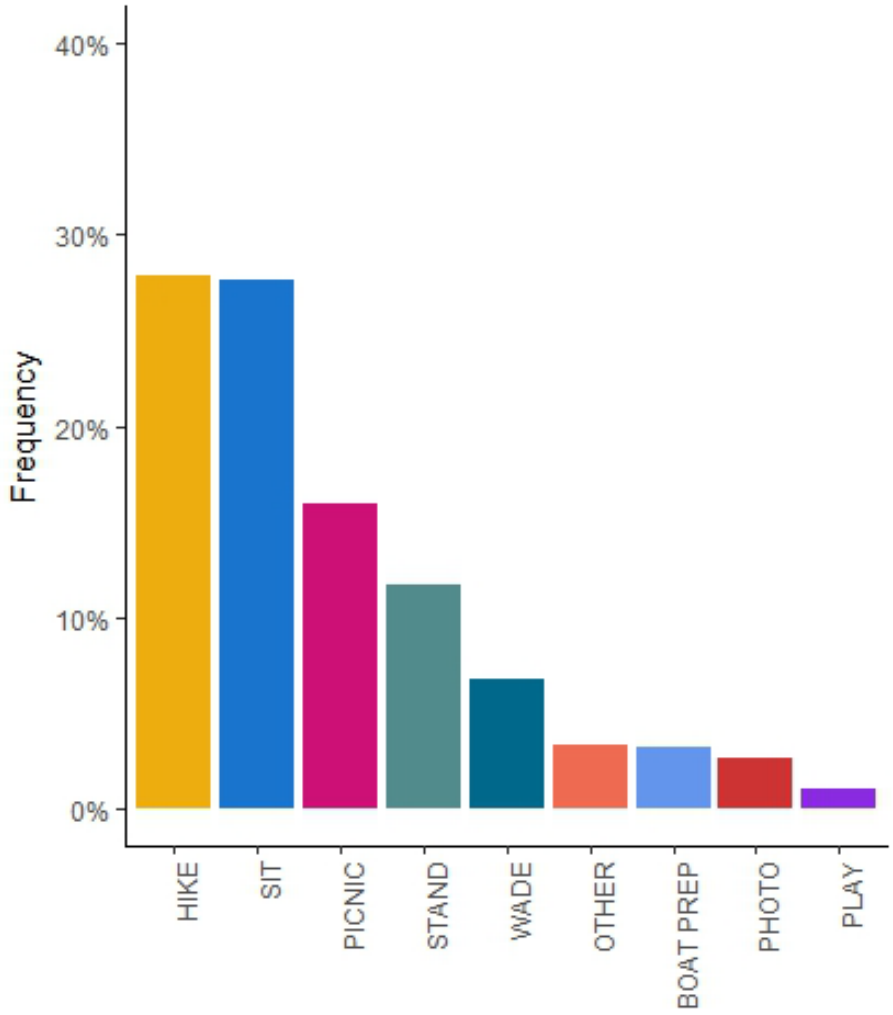

Figure 13i. Frequency (in %) of observed activity types across both sampling periods (July 15 – September 8), on weekends, throughout all observation zones in the study area.

Photo 11. A pair of hikers along the String Lake Trail in Zone 1 (JAKE GOTTSCHALK).

Activity Types (water-based)

Study technicians observed water activity types from viewsheds located along the observation zone study area (Figure 14). There are a total of four viewsheds that run north to south, with Zone 1 as the northernmost zone, and Zone 4 as the southernmost zone. From the water viewshed vantage point, study technicians recorded the number of people observed in the water and their activity type. Definitions of water-based activity types are explained in Table 26.

Water-activity does not vary significantly by zone. For all water zones, stand-up paddleboarding and kayaking are the most frequent activity types. However in Zone 1, stand-up paddleboarding is more frequent compared to any other activity types in that zone, accounting for 42% of water activity during the summer season. Interestingly, the frequency of canoeing decreases in all zones from the summer season to the shoulder season. See Appendix K for water activity-types by zone.

Across all zones, during the summer sampling period activity type frequencies vary slightly between weekdays and weekends (Table 26a and Figures 14a – 14c). For both weekends and weekdays, stand-up paddling boarding and kayaking are the most frequently observed activity, with stand-up paddling boarding accounting for 34% of activity on weekdays (Figure 14b) and 41% of activity on the weekends (Figure 14c).

Kayaking accounts for 35% of activity on weekdays and 22% on weekends. On weekdays, the third most frequent activity is swimming (10%) followed by canoeing (6%). On weekends, canoeing occurs more frequently, accounting for 16% of water-based activity. On the weekends, the proportion of swimming activity drops to 5%.

Figure 14. Map of observation zones (shown in green), viewshed observation points, and observation roves in String Lake observation study area.

Table 26. Water-based activity type definitions

Activity Type	Definition
Canoe	Traveling in or paddling in a canoe
Float	An inflatable object a person sits on while floating in water
Kayak	Traveling in or paddling in a kayak
Other	Sculling Pontoon Pedal Board
Raft	Traveling in or paddling in a raft
Rock	People recreating on the large rock located in the middle of String Lake
SUP	Stand Up Paddleboard
Swim	Swimming in String Lake
Unknown	Vessel type unknown
Wade	Wading along shoreline

* The 'Other' category was determined from activities that accounted for less than .5% of total activity types.

Table 26a. Total number of people engaging in water-based activity, and frequency of activity during the summer sampling period. Results separated by all days, weekends, and weekdays.

Location	Activity Type	# of counts	Frequency (%)
All Zones (all days of week)	Canoe	204	14%
	Float	82	6%
	Kayak	351	24%
	Other	8	1%
	Raft	2	0%
	Rock	42	3%
	Stand-up Paddleboard	571	39%
	Swim	89	6%
	Unknown	8	1%
	Wade	93	6%
	Total	**1,450**	
All Zones (weekdays)	Canoe	18	6%
	Float	11	4%
	Kayak	104	35%
	Other	6	2%
	Rock	17	6%
	Stand-up Paddleboard	102	34%
	Swim	31	10%
	Wade	10	3%
	Total	**299**	
All Zones (weekends)	Canoe	186	16%
	Float	71	6%
	Kayak	247	21%
	Other	2	0%
	Raft	2	0%
	Rock	25	2%
	Stand-up Paddleboard	469	41%
	Swim	58	5%
	Unknown	8	1%
	Wade	83	7%
	Total	**1,151**	

Photo 12. Visitors engaging in water-based activities on String Lake. Photo captured from Zone 1 water view shed (JAKE GOTTSCHALK).

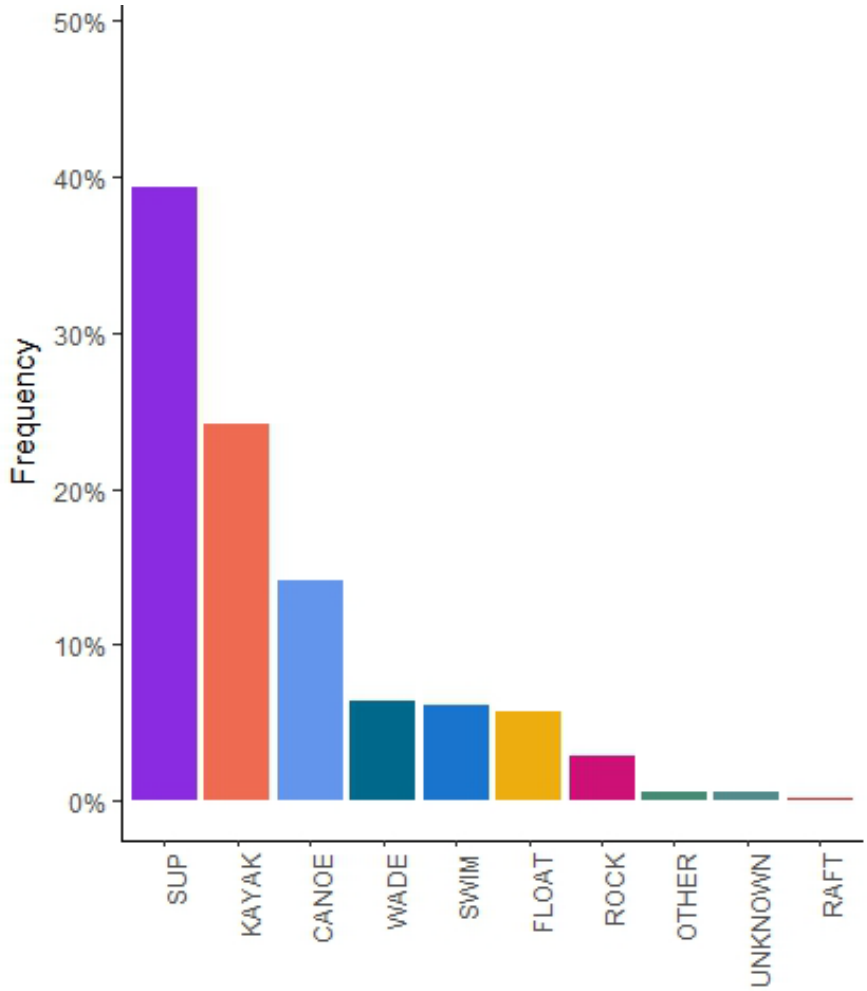

Figure 14a. Frequency of water-based activity types during the summer sampling period (July 15 – August 15) on all days of the week.

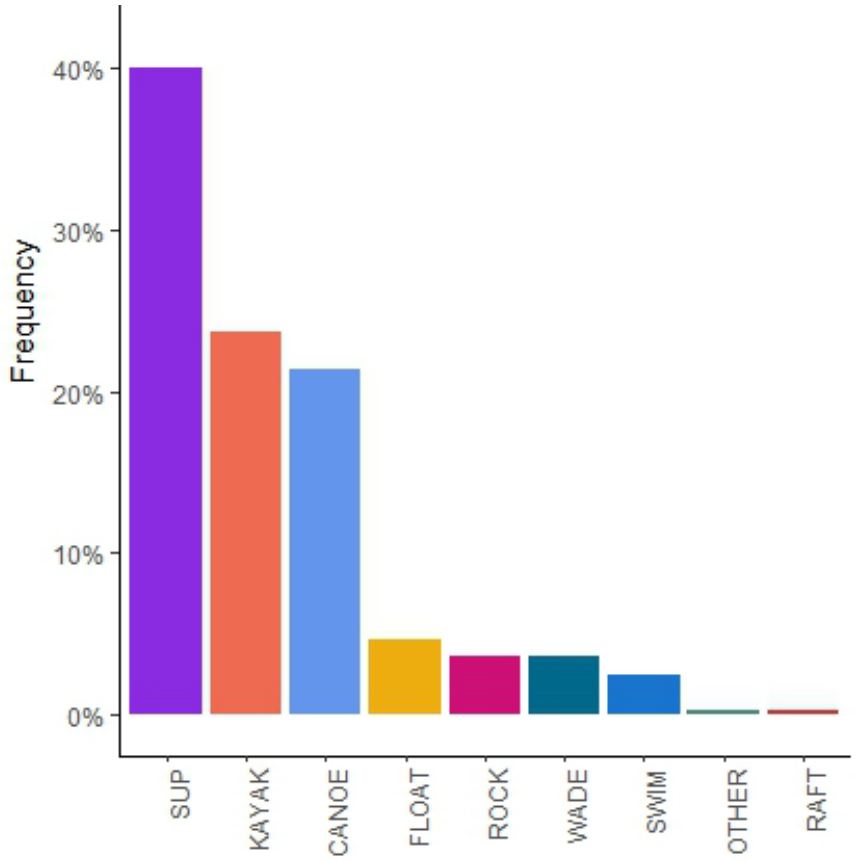

Figure 14b. Frequency of water-based activity types during the summer sampling period (July 15 – August 15) on weekdays.

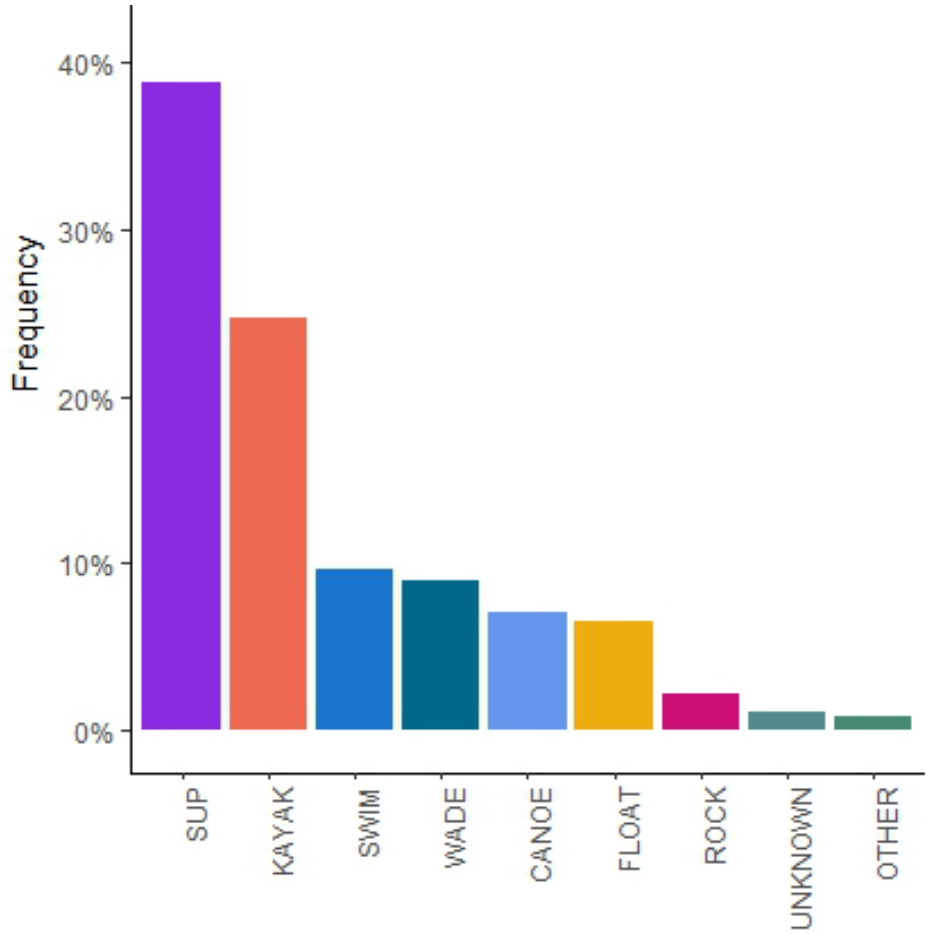

Figure 14c. Frequency of water-based activity types during summer sampling period (July 15 – August 15) on weekends.

During the shoulder sampling period the proportion of activity types between weekdays and weekends does not vary (Table 26b and Figures 14d – 14f). However, there are significantly more *total* people recorded on the water during the weekend (875 people recorded) in comparison to the weekday (196 people recorded). Field staff sampled equally on weekdays and weekends, mornings and afternoons, therefore the factors influencing the increase in weekend water-based use is unknown. On weekends and weekdays, together both kayaking and stand-up paddleboarding account for over 60% of activity, again being the top two most frequent activity types observed on String Lake (Figures 14e – 14f). The third most frequent activity type during the shoulder sampling period is swimming, with 8% of water-based users engaging in swimming on weekdays, and 9% engaging in swimming on weekends.

Overall, across all zones and sampling periods, stand-up paddleboarding accounts for 37% of water-based use in the SLL observation study area. Kayaking is the second most popular water-based activity, accounting for 29% of water-based use. For a list of frequencies of water-based use across both sampling periods, see Table 26c and Figures 14g – 14i.

Photo 13. Kayakers on String Lake. Photo captured from water viewshed at north end of Zone 4 (JENNA BAKER).

Table 26b. Total number of people engaging in water-based activity, and frequency of activity during shoulder sampling period. Results stratified by all days of week, weekdays, and weekends.

Location & Time of Week	Activity Type	# of Counts	Frequency (%)
All Zones (all days of week)	Canoe	63	6%
	Float	62	6%
	Kayak	385	36%
	Raft	42	4%
	Rock	42	4%
	Stand-up Paddleboard	366	34%
	Swim	98	9%
	Unknown	8	1%
	Wade	5	0%
	Total	**1071**	
All Zones (weekdays)	Canoe	15	8%
	Float	15	8%
	Kayak	95	48%
	Rock	2	1%
	Stand-up Paddleboard	36	18%
	Swim	33	17%
	Total	**196**	
All Zones (weekends)	Canoe	48	5%
	Float	47	5%
	Kayak	290	33%
	Raft	42	5%
	Rock	40	5%
	SUP	330	38%
	Swim	65	7%
	Unknown	8	1%
	Wade	5	1%
	Total	**875**	

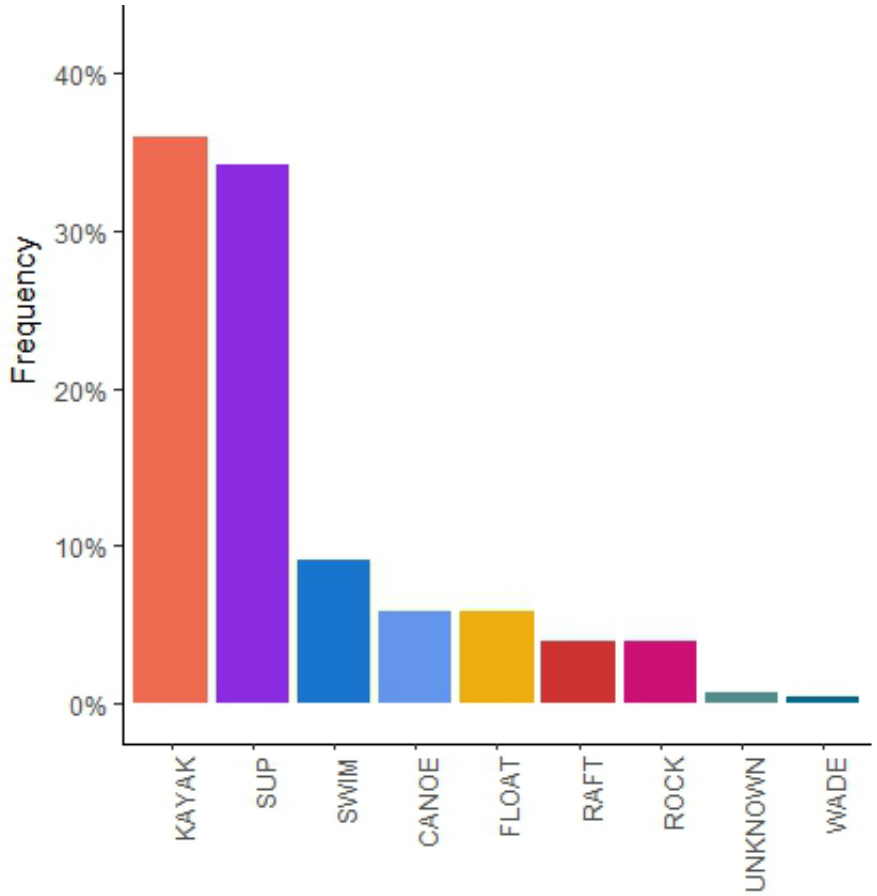

Figure 14d. Frequency of water-based activity types during shoulder sampling period (August 16 – September 8) along observation zone study area.

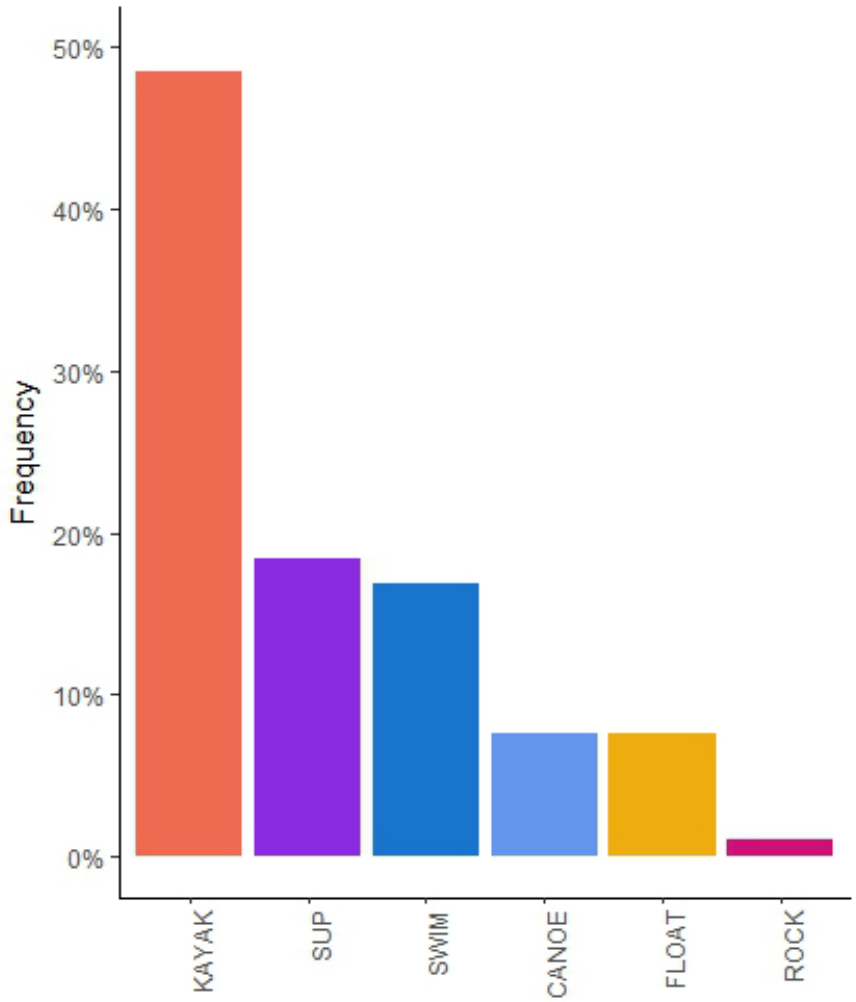

Figure 14e. Frequency of water-based activity types during shoulder sampling period (August 16 – September 8) on **weekdays** along observation zone study area.

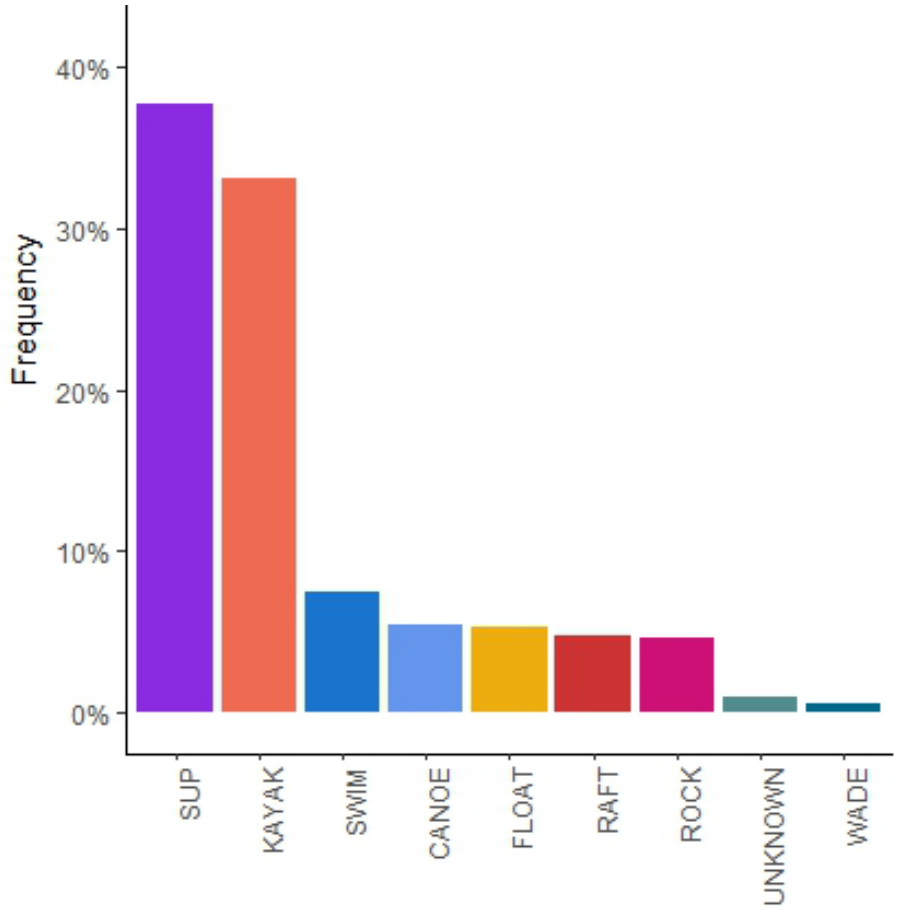

Figure 14f. Frequency of water-based activity types during shoulder sampling period (August 16 – September 8) on weekends along observation zone study area.

Table 26c. Total number of people engaging in water-based activity, and frequency of activity across all sampling periods (July 15 – September 8). Results stratified by all days of week, weekdays, and weekends.

Location & Time of Week	Activity Type	# of Counts	Frequency (%)
All Zones (all days of week)	Canoe	267	11%
	Float	144	6%
	Kayak	736	29%
	Other	8	0%
	Raft	44	2%
	Rock	84	3%
	Stand-up Paddleboard	937	37%
	Swim	187	7%
	Unknown	16	1%
	Wade	98	4%
	Total	**2521**	
All Zones (weekdays)	Canoe	166	18%
	Float	48	5%
	Kayak	262	29%
	Other	2	0%
	Raft	2	0%
	Rock	28	3%
	Stand-up Paddleboard	318	35%
	Swim	50	6%
	Wade	26	3%
	Total	**902**	
All Zones (weekends)	Canoe	101	6%
	Float	96	6%
	Kayak	474	29%
	Other	6	0%
	Raft	42	3%
	Rock	56	3%
	Stand-up Paddleboard	619	38%
	Swim	137	8%
	Unknown	16	1%
	Wade	72	4%
	Total	**1619**	

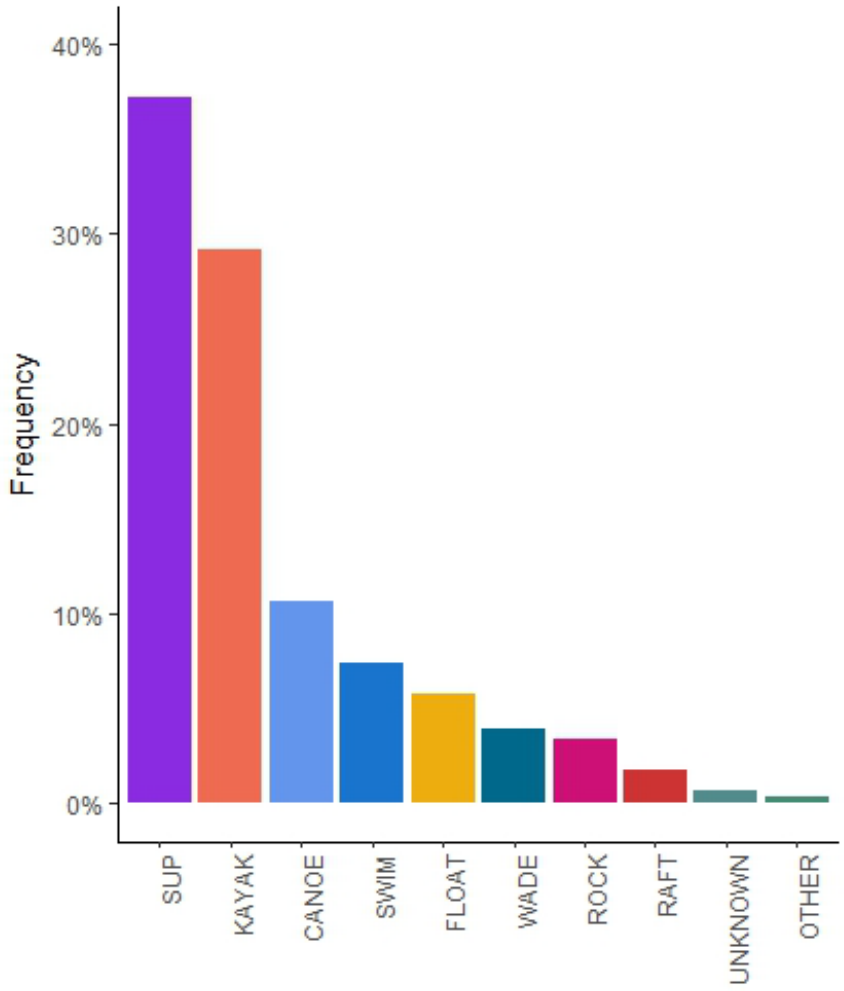

Figure 14g. Frequency of water-based activity across both sampling periods (July 15 – September 8), on all days of the week along observation zone study area.

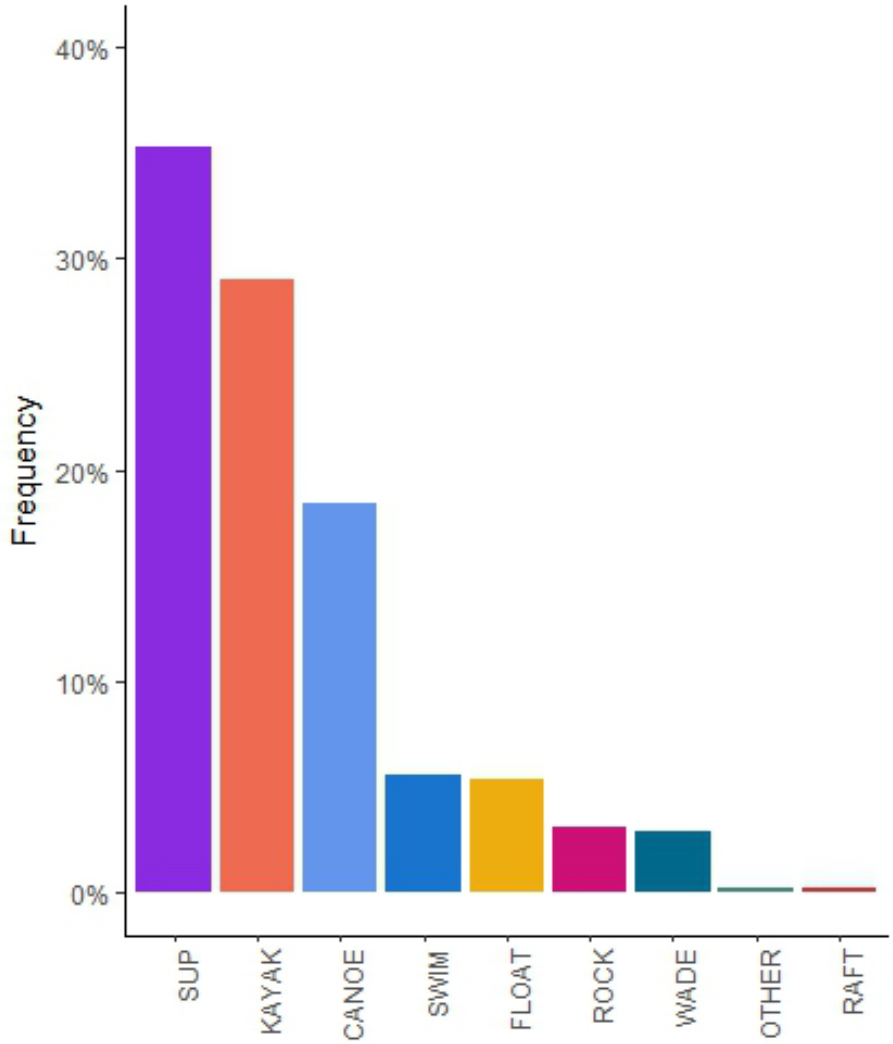

Figure 14h. Frequency of water-based activity types across both sampling periods (July 15 – September 8), on **weekdays** along observation zone study area.

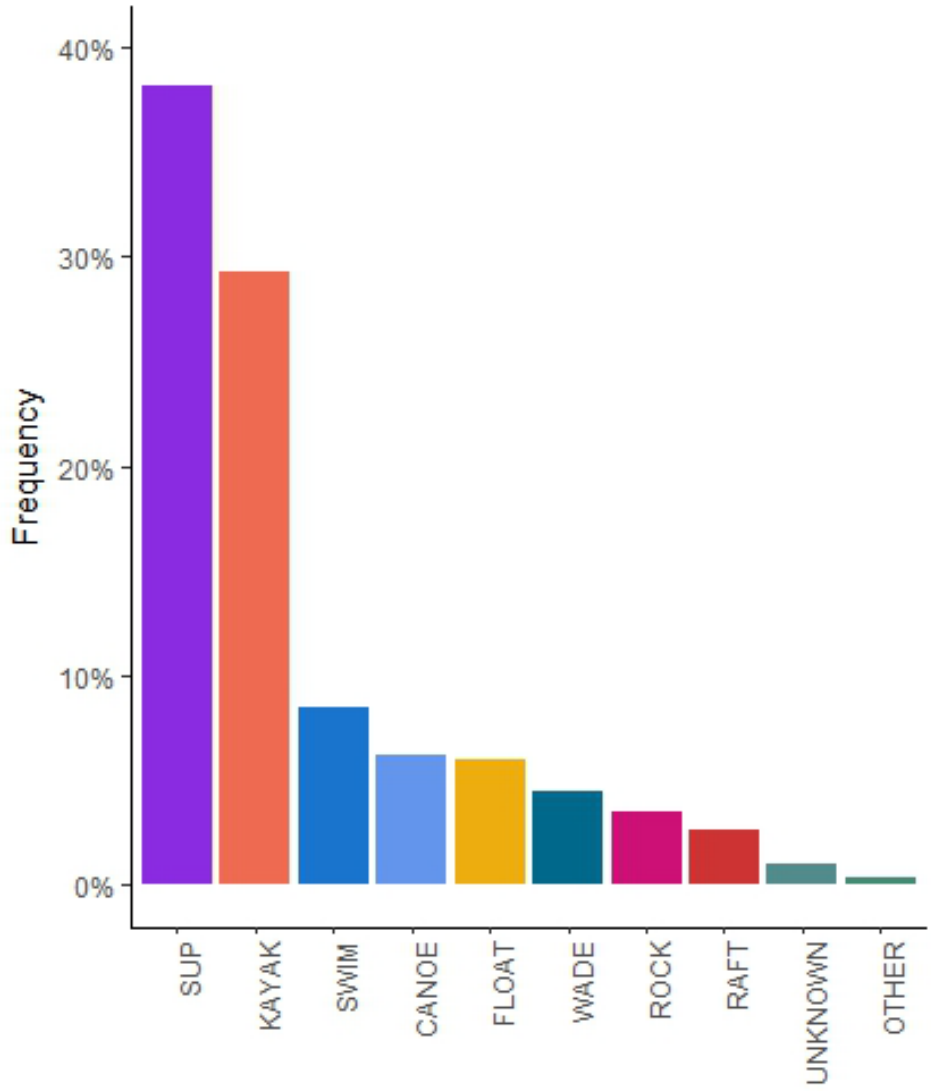

Figure 14i. Frequency of water-based activity types across both sampling periods (July 15 – September 8) on weekends along observation zone study area.

People at One Time Counts

Study technicians recorded the total numbers of visitors within each zone at the beginning of every hour while also recording activity types and behavioral observations. People at One Time Counts (PAOT) provide an estimate of how many people visit the eastern shoreline of String Lake (observation study area) simultaneously (Figure 4). The distribution of people along the observation study area of String Lake is not evenly distributed; there is a high degree of spatial variability with large groups of people clustered in certain zones and more spread out in other zones. To allow for an accurate representation of total numbers of people in the observation study area at one time, the average number of people were calculated within each zone. The averages within each zone were then added together, ultimately allowing for a more accurate estimate of total use.

The tables and graphs below represent the total average number of people observed within each zone at the beginning of the hour between the hours of 8:00am and 4:00pm. These counts include the total number of people observed both on land and in the water. Tables and graphs are separated by the summer sampling period and the shoulder sampling period. Values within each sampling period are separated by all days of the week, weekends, and weekdays.

The northernmost zone, Zone 1, is the most populated zone in the SLL observation study area. During the summer sampling period, Zone 1 visitation rises quickly beginning at 9:00am and peaks at 12:00pm with an average of 81 people observed at one time in the zone. After 12:00pm, visitation remains high until declining at 3:00pm. Within Zone 2, 3, and 4 during the summer sampling period, visitation peaks at 1:00pm. At its peak, Zone 2 has an average of 16 people at 1:00pm and Zone 3 has an average of 25 people at 1:00pm. However, in Zone 2, visitation slowly decreases after 2:00pm while Zone 3 experiences a more dramatic drop in use after 2:00pm. Zone 4 has a little more variation in use, and is the second most populated zone. Visitation in Zone 4 begins to rise after 10:00am, and peaks at 1:00pm with an average count of 45 people. Use remains high until 4:00pm. For a full table of PAOT averages and standard deviations by zone see Appendix L.

During the summer sampling period across all days of the week, the observation study area experiences a steady rise in visitation from 10:00am to 1:00pm, peaking at 1:00pm with an average of 163 people observed at one time (Table 27a and Figure 15a). Visitation plateaus and oscillates up and down from 1:00pm to 3:00pm before decreasing to 106 people at 4:00pm. Similar trends occur on weekdays and weekends with use increasing until 1:00pm, then oscillating in use numbers before decreasing at 4:00pm (Figure 15b). However, on weekends during the summer season, the average PAOT count experiences a sudden increase at 3:00pm with 177 people observed, before dropping to 139 people at 4:00pm. For PAOT graphs and tables that separate water use and land use counts, see Appendix L.

Table 27a. Total number of people counted at the beginning of each hour along the observation zone study area (see map) during the summer sampling period. Numbers include people observed in the water. For tables and figures of averages and standard deviations separated by zone, see Appendix K.

Location & Time of Week	Time	Average # of People in All Zones (including water-based users)
All Zones (all days of week)	8:00	9
	9:00	23
	10:00	64
	11:00	126
	12:00	150
	13:00	163
	14:00	158
	15:00	161
	16:00	106
All Zones (weekdays)	8:00	12
	9:00	28
	10:00	70
	11:00	155
	12:00	135
	13:00	170
	14:00	174
	15:00	134
	16:00	77
All Zones (weekends)	8:00	5
	9:00	22
	10:00	59
	11:00	107
	12:00	150
	13:00	156
	14:00	139
	15:00	177
	16:00	139

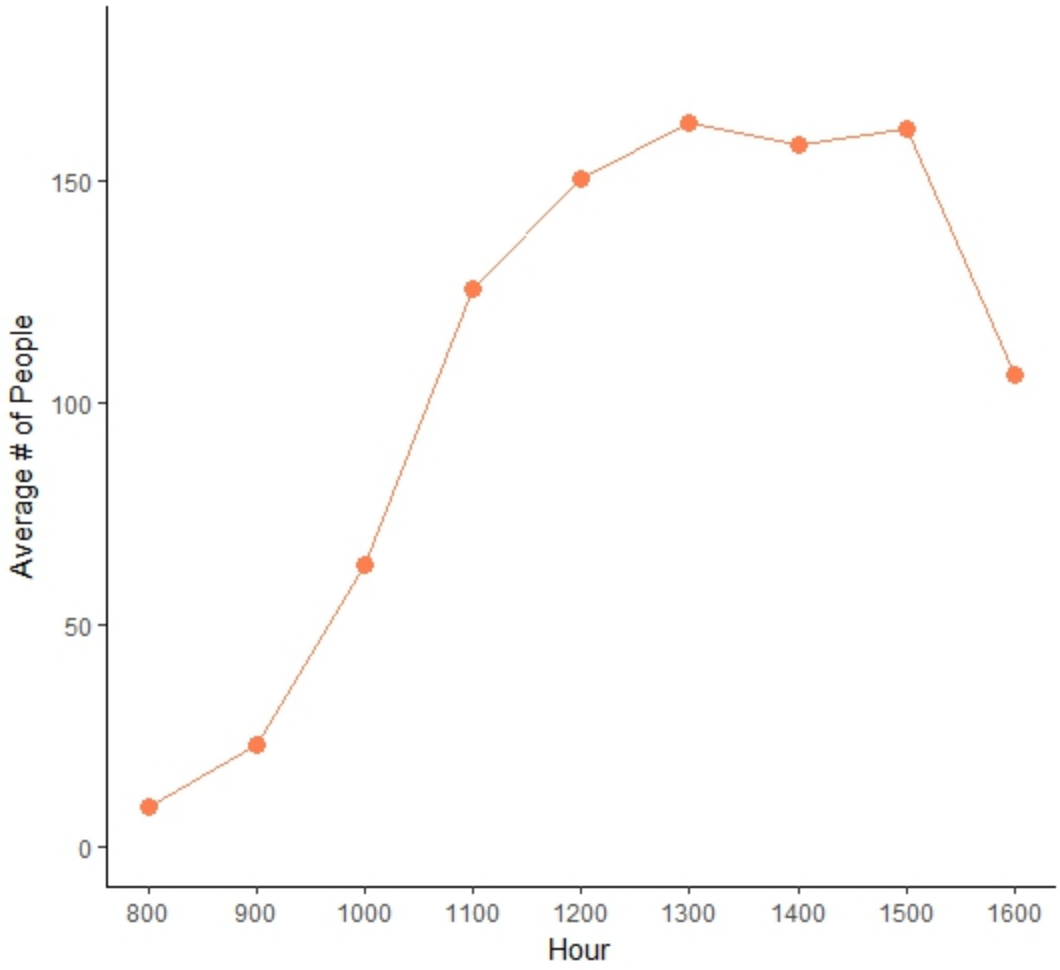

Figure 15a. Average number of people observed at one time in all zones in the String Lake observation zone study area during the summer sampling period (July 15 – August 15).

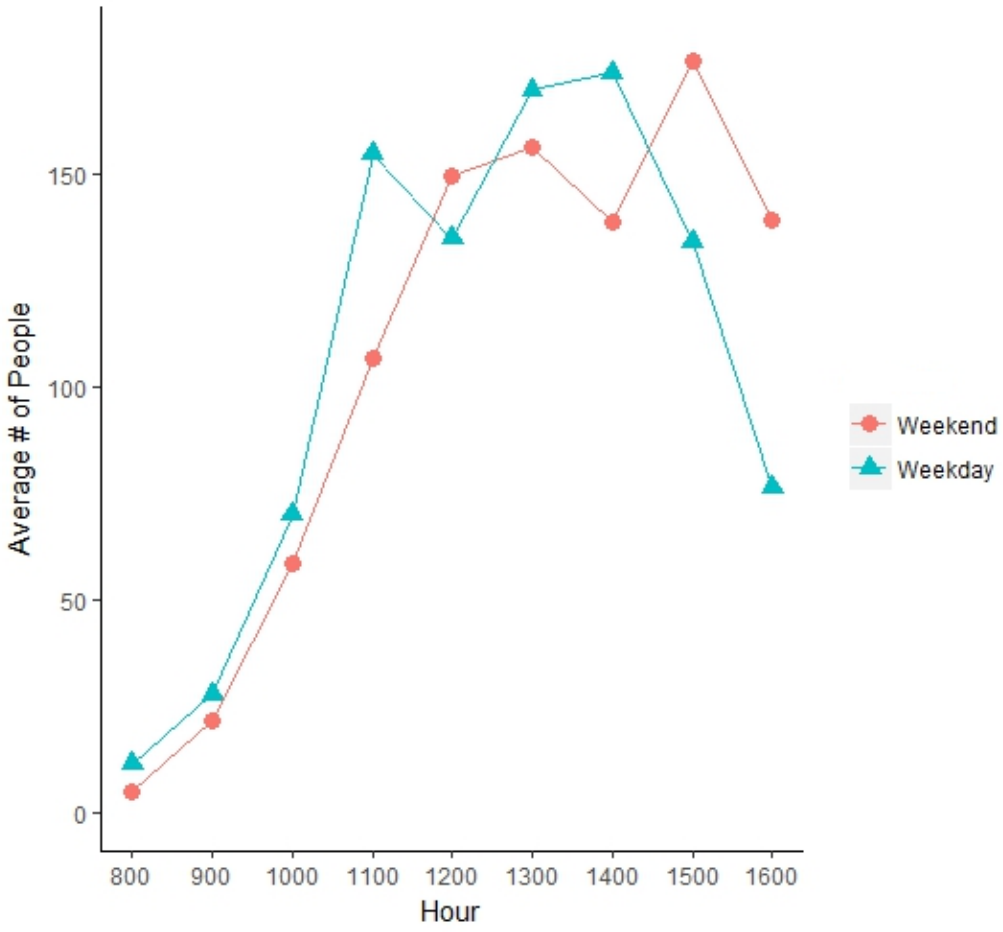

Figure 15b. Average number of people observed at one time in all zones of the String Lake observation zone study area during the summer sampling period (July 15 – August 15), stratified by weekends and weekdays.

During the shoulder sampling period, use begins to rise at 10:00am (Table 27b and Figure 15e) and peaks to 103 people at 1:00pm. Visitor use remains high from 1:00pm to 4:00pm and does not decline during this time. Shoulder season weekend and weekday PAOT counts show similar trends with use rising around 10:00am and peaking at 1:00pm. There are more total people recorded on weekends than weekdays during the shoulder season (Figure 15d). Additionally, at 3:00pm on weekends, the PAOT count jumps to 206 people. This sudden peak in use may be explained by data that is missing from the times preceding and following 3:00pm. Therefore, several afternoon shoulder sampling period PAOT counts should be considered with caution. Due to unanticipated complications in the field, Zone PAOT counts are missing data during the following times and from the following locations:

* 1:00pm on weekends (missing data from Zone 1)
* 3:00pm on weekends (missing data from Zones 1-2)
* 4:00pm on weekdays (missing data from Zones 2-4)
* 4:00pm on weekends (missing data from Zone 1)

Considering these missing values, it can be assumed that the actual PAOT values at 1:00pm, 2:00pm, and 4:00pm during the shoulder sampling period are *higher* than what is represented in the tables and graphs in this report. For PAOT graphs and tables that separate water use and land use counts, see Appendix L.

Table 27b. Total number of people counted at the beginning of each hour along the String Lake observation study area (see map) during the shoulder sampling period. Numbers include people observed in the water. For tables and figures of averages and standard deviations, separated by zone, see Appendix K.

Location & Time of Week	Time	Average Total # of People in All Zones
All Zones (all days of week)	8:00	4
	9:00	20
	10:00	35
	11:00	56
	12:00	92
	13:00	103
	14:00	102
	15:00	114
	16:00	111
All Zones (weekdays)	8:00	2
	9:00	17
	10:00	32
	11:00	40
	12:00	79
	13:00	85
	14:00	79
	15:00	60
	16:00[A]	7
All Zones (weekends)	8:00	6
	9:00	24
	10:00	37
	11:00	72
	12:00	102
	13:00[B]	116
	14:00[C]	98
	15:00	206
	16:00[D]	104

[A] One of the four zones at 4:00pm on weekdays has recorded data (Zone 1)

[B] Three of the four zones at 1:00pm on weekends have recorded data (Zone 2,3,4)

[C] Two of the four zones at 2:00pm on weekends have recorded data (Zone 3,4)

[D] Three of the four zones at 4:00pm on weekends have recorded data (Zone 2,3,4)

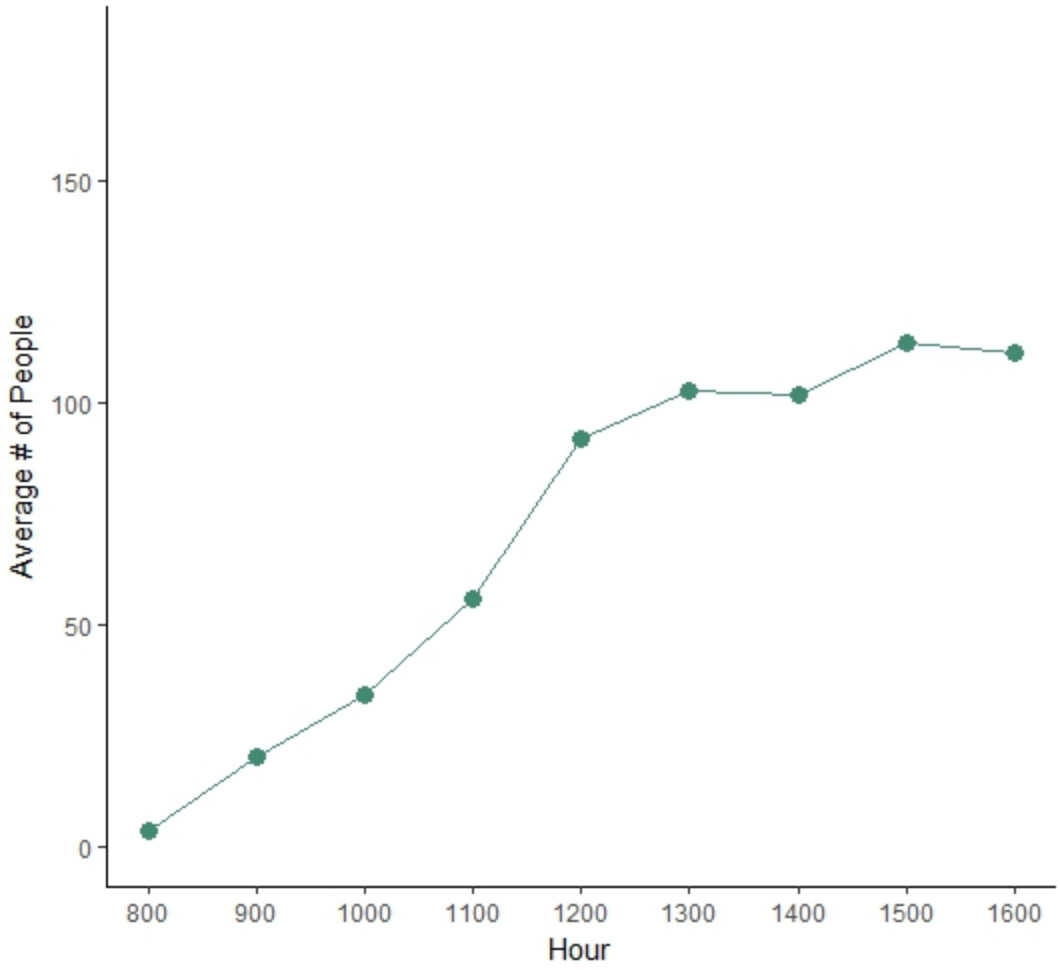

Figure 15c. Average number of people at one time in all zones in the String Lake observation zone study area during the shoulder sampling period (August 16 – September 8) on all days of the week.

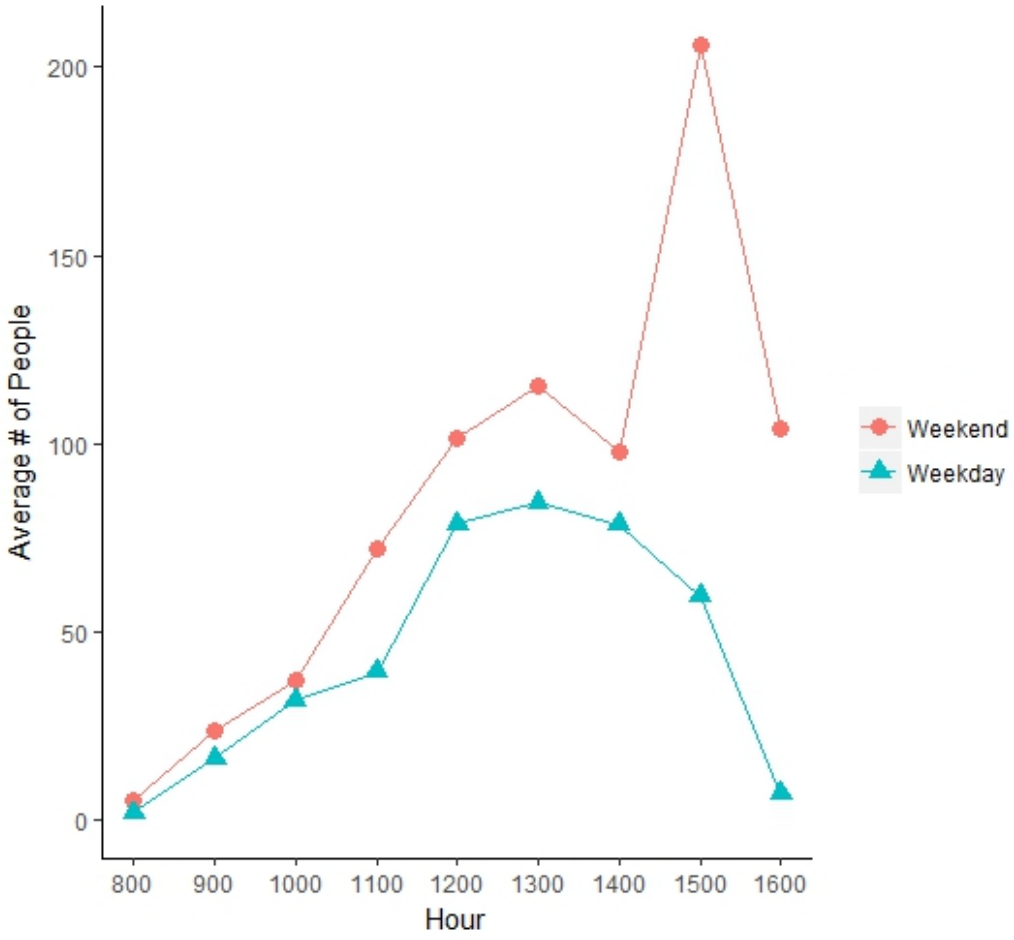

Figure 15d. Average number of people at one time in all zones in the String Lake observation zone study area during the Shoulder sampling period (August 16 – September 8), stratified by weekdays and weekends.

Observed Behaviors of Interest

Study technicians recorded observations of visitors engaging in Behaviors of Interest (BOI), defined as any behavior that violates Park rules and regulations, Leave No Trace Principles, or behavior that may detract from other visitors' experience. Observations occurred in the SLL study area, with the northern-most edge of observations at the Leigh Lake trailhead sign and the southern-most edge at the String Lake trailhead sign (Figure 4).

Note: In terms of documenting BOI, the intention is to provide a general highlight of certain behaviors that may be of interest to GRTE managers, or that the researcher's believe may detract from a visitor's experience. These behaviors are not necessarily illegal or non-compliant. For example, some of these observed behaviors, such as lacking a visible personal floatation device on watercraft, do not necessarily mean that the individual definitively did *not* have a watercraft in their vessel, but rather indicate that this personal floatation device was not *visible* to the observer. Other recorded behaviors illuminate situations where the visitor experience may be diminished, such as loud human-caused noise. However, documenting this behavior is subject to observer interpretation and defining it can be ambiguous. In the case of documenting loud human-caused noise, we attempted to mitigate the ambiguity of this behavior by providing examples within our protocols of what constitutes loud human caused noise, such as playing speakers, shouting across the lake, or using a generator to blow up a stand-up paddleboard. Please refer to Table 28a to see a full list of the definitions and conditions we used to record BOI.

Table 28a. Behaviors of Interest definitions

Observed Behavior	Definition
Dog	Dog observed along trail
Food	Improper food storage
	Food left unattended
Harassing Wildlife	Disrupting wildlife
	Getting too close to wildlife
Human-Caused Noise	Excessive yelling
	Loud vehicle noise (car alarm, diesel idling, honking)
	Inflating/deflating water craft using a generator
	Loud music or technological noise
No Visible PFD	Lacking visible personal floatation device on water craft
Obstructing Trail	Standing for prolonged period of time in middle of trail
	Large object stationary in middle of trail (water-craft, strollers, bikes)
Off -Trail	Walking off-trail and/or using a visitor-created trail
Other	Behavior that does not fall under available definitions
Resource Damage	Taking/displacing natural materials (pinecones, sticks, rocks)
	Breaking sticks, scratching into trees
	Throwing rocks, sticks

Frequencies of BOI are calculated from the observed behavior type (i.e. going off-trail) divided by the total number of people engaging in all types of behaviors of interest. Therefore, the frequencies do not represent the total number of people recreating in the String Lake observation study area. Due to the complexity of the system and minimal research staff, we were unable to calculate the percentage of total users of String and Leigh Lake observation study area who were participating in BOI.

Observation areas were divided into zones which were further divided into sub-zones. Across the sampling period the two most frequent BOI in Zone 1 are people lacking a visible personal floatation device for those on watercraft (30% - 35% of behavior) and people going off trail (23% - 30% of behavior). Later into the sampling period, there is a higher frequency of loud human-caused noise in Zone 1 (25%). Zone 2 also experiences a high frequency of people going off the designated String Lake Loop trail, particularly during the summer sampling period, accounting for 54% of behavior. Loud human-caused noise increases in Zone 2, and in the shoulder season it accounts for 60% of behavior. Zone 3 experiences loud human caused noise as the most frequent BOI, particularly during the summer sampling period, accounting for 45% of behavior; this behavior is followed by trail obstruction (31%) and resource damage (18%). Zone 4 experiences variation in behavior across the sampling periods. During the summer season, lack of visible personal floatation device (20%) and human-caused noise (28%) are the most frequent BOI. However, the shoulder season sees similar trends to those in Zone 3, with trail obstruction (27%) and resource damage (19%) as the top two BOI. For tables and figures of behavior by zone, see Appendix M.

Across all zones during the summer sampling period, the most frequent BOI are people not carrying visible personal floatation devices on watercraft, accounting for 24% of behavior (Table 28c and Figure 16a). The second and third most frequent BOI are improper food storage (22%) and loud human caused noise (20%). Weekdays follow similar trends with the top three behaviors of interest being improper food storage (25%), lack of visible personal floatation device (24%), and loud human caused noise (19%) (Figure 16b). Interestingly, on weekends the most frequent BOI is people going off-trail, which accounts for 25% of behavior (Figure 16c).

Overall, across all zones and sampling periods, the most frequent BOI is loud human-caused noise (23%), followed by lack of a visible personal floatation device (20%), and improper food storage (18%). See Table 28c and Figures 16g-16i for overall BOI frequencies.

Table 28b. Table of observed Behaviors of Interest (BOI), number of people engaging in behavior, and frequency (%) of behavior during the summer sampling period in all zones in the String Lake observation study area.

Location	Observed Behavior	# of counts	Frequency (%)
All Zones (all days of week)	Dog	19	2%
	Food Storage	272	22%
	Harassing Wildlife	25	2%
	Human Caused Noise	246	20%
	No Visible PFD	294	24%
	Obstructing Trail	14	1%
	Off-Trail	236	19%
	Other	36	3%
	Resource Damage	78	6%
	Total	**1,220**	
All Zones (weekdays)	Dog	15	2%
	Food Storage	166	25%
	Harassing Wildlife	23	3%
	Human Caused Noise	127	19%
	No Visible PFD	160	24%
	Obstructing Trail	12	2%
	Off-Trail	99	15%
	Other	28	4%
	Resource Damage	36	5%
	Total	**666**	
All Zones (weekends)	Dog	4	1%
	Food Storage	106	19%
	Harassing Wildlife	2	0%
	Human Caused Noise	119	21%
	No Visible PFD	134	24%
	Obstructing Trail	2	0%
	Off-Trail	137	25%
	Other	8	1%
	Resource Damage	42	8%
	Total	**554**	

Photo 14. Food left unattended on String Lake. Photo captured in Zone 4 (JENNA BAKER).

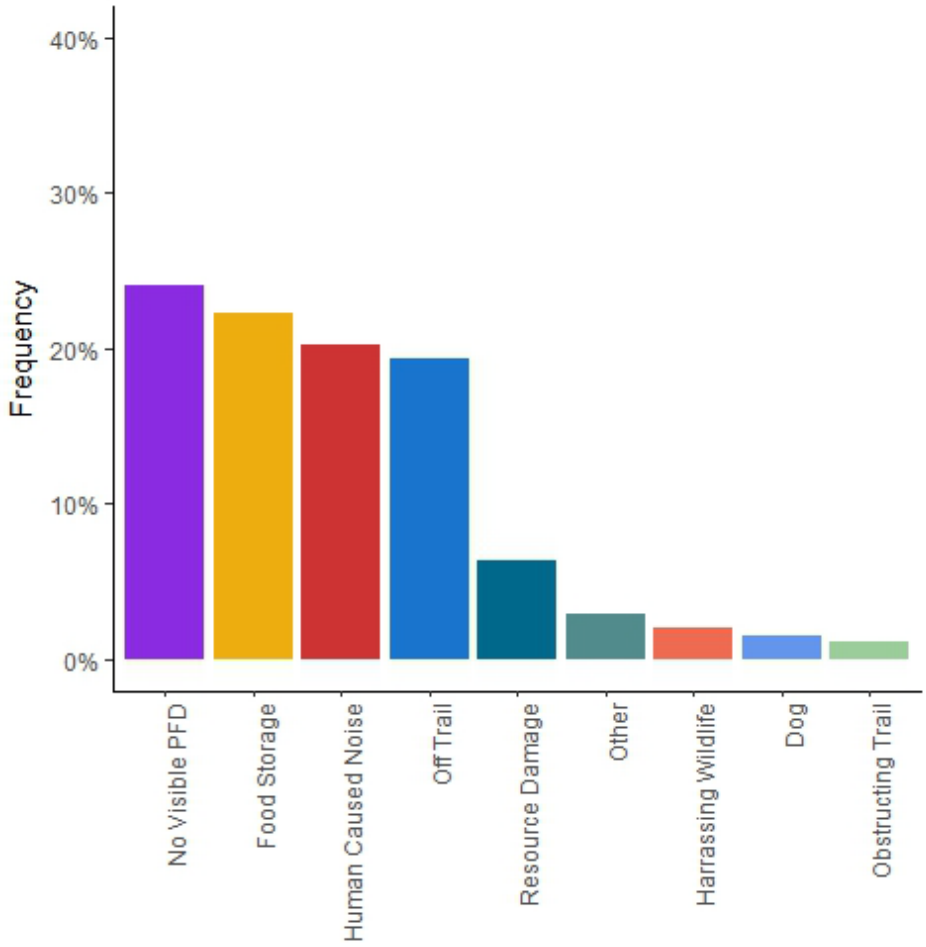

Figure 16a. Frequency of Behaviors of Interest during summer sampling period (July 15 – August 15) on all days of the week in all zones in the String Lake observation study area.

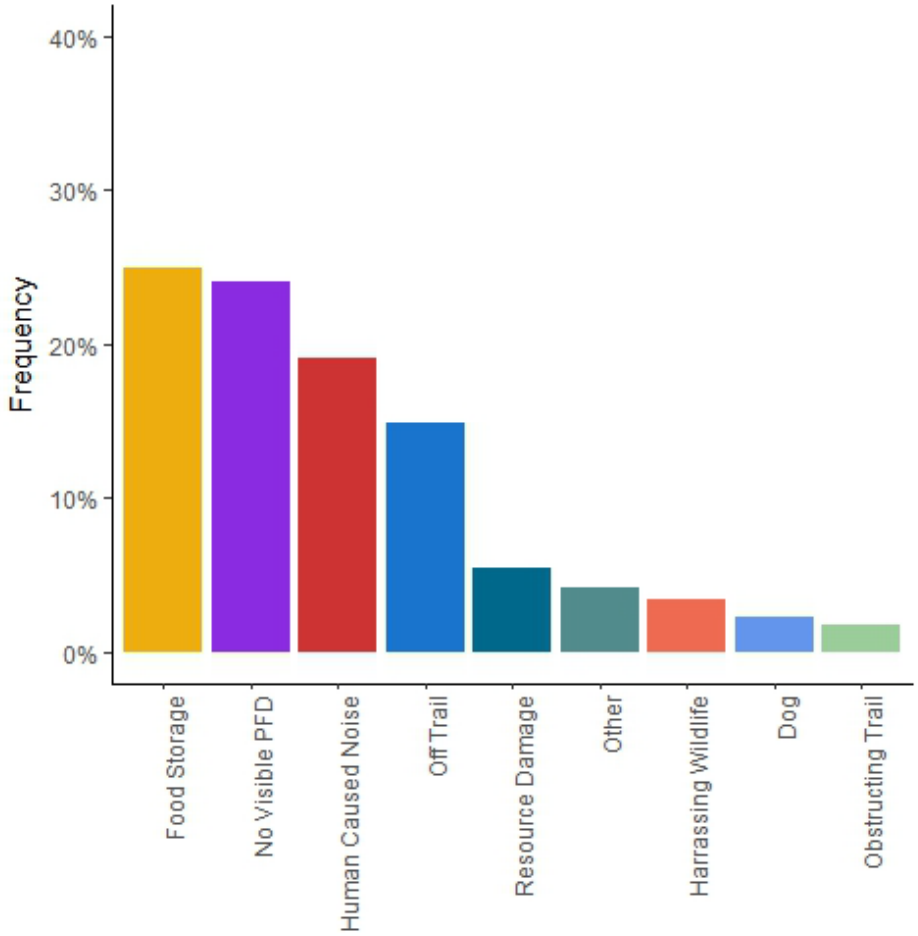

Figure 16b. Frequency of Behaviors of Interest during summer sampling period (July 15 – August 15) on **weekdays** and in all zones in the String Lake observation study area.

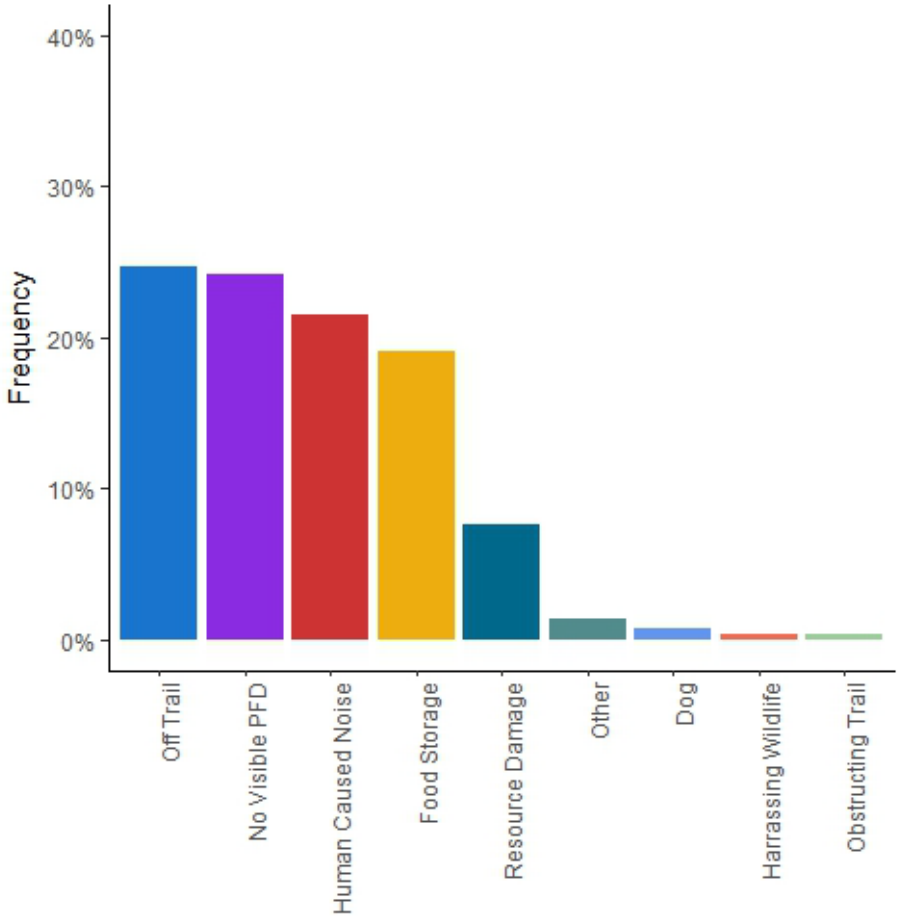

Figure 16c. Frequency of Behaviors of Interest during summer sampling period (July 15 – August 15) on weekends and in all zones in the String Lake observation study area.

Shoulder sampling period BOI trends are slightly different compared to those observed during the summer sampling period. There is a higher proportion of people going off-trail and/or obstructing the trail during the shoulder sampling period than during the summer sampling period (Table 28d and Figure 16d). On all days of the week, the most frequent BOI is loud human-caused noise, accounting for 32% of non-compliant behavior. Interestingly, the frequency of improper food storage drops significantly from summer sampling period to shoulder sampling period, accounting for only 6% of BOI during the shoulder sampling period. Weekday and weekend behaviors vary during the shoulder sampling period: on weekdays, the second most frequent behaviors are obstructing the trail and going off-trail, both accounting for 17% of behavior (Figures 16e – 16f). On weekends, the second most frequent BOI are dogs observed along trail (14%) and lack of visible personal floatation device (11%).

Table 28c. Table of observed Behaviors of Interest (BOI), number of people engaging in behavior, and frequency (%) of behavior during the shoulder sampling period in all zones in the String Lake observation study area.

Location	Observed Behavior	# of counts	Frequency (%)
All Zones (all days of week)	Dog	30	7%
	Food Storage	28	7%
	Human Caused Noise	134	33%
	No Visible PFD	37	9%
	Obstructing Trail	55	13%
	Off-Trail	57	14%
	Other	22	5%
	Resource Damage	47	11%
	TOTAL	**410**	
All Zones (weekdays)	Dog	6	2%
	Food Storage	16	7%
	Human Caused Noise	76	32%
	No Visible PFD	19	8%
	Obstructing Trail	41	17%
	Off-trail	40	17%
	Other	15	6%
	Resource Damage	28	12%
	TOTAL	**241**	
All Zones (weekends)	Dog	24	14%
	Food Storage	12	7%
	Human Caused Noise	58	34%
	No Visible PFD	18	11%
	Obstructing Trail	14	8%
	Off-trail	17	10%
	Other	7	4%
	Resource Damage	19	11%
	TOTAL	**169**	

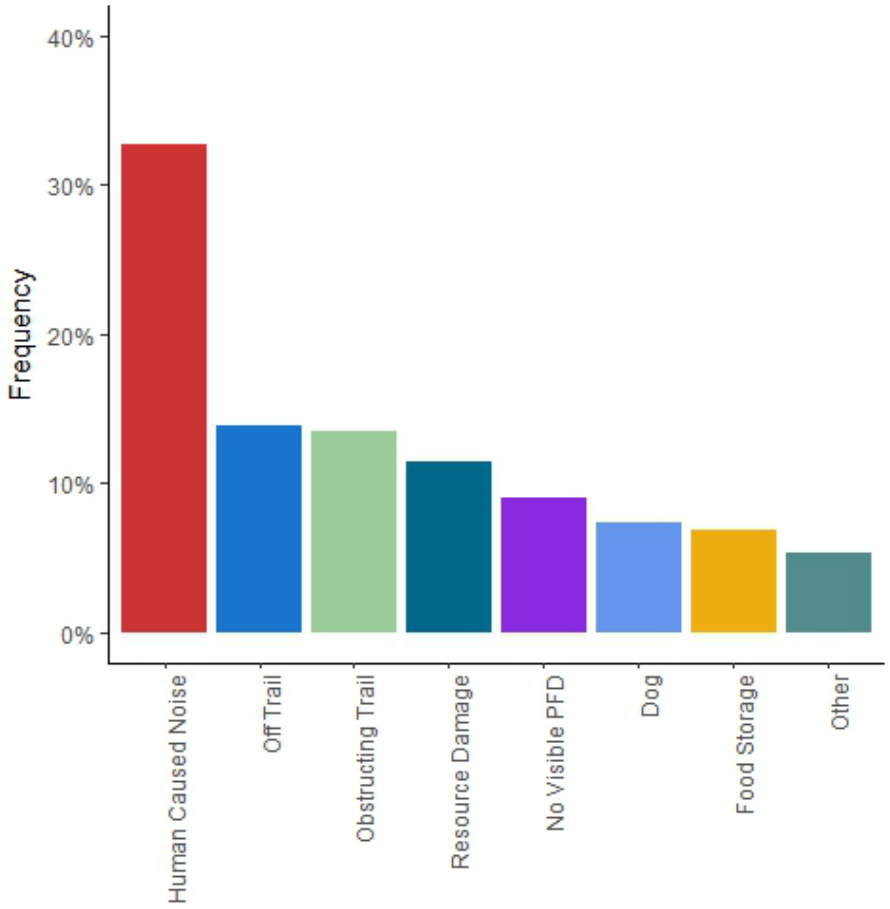

Figure 16d. Frequency of Behaviors of Interest during shoulder sampling period (August 16 – September 8) on all days of the week and in all zones in the String Lake observation study area.

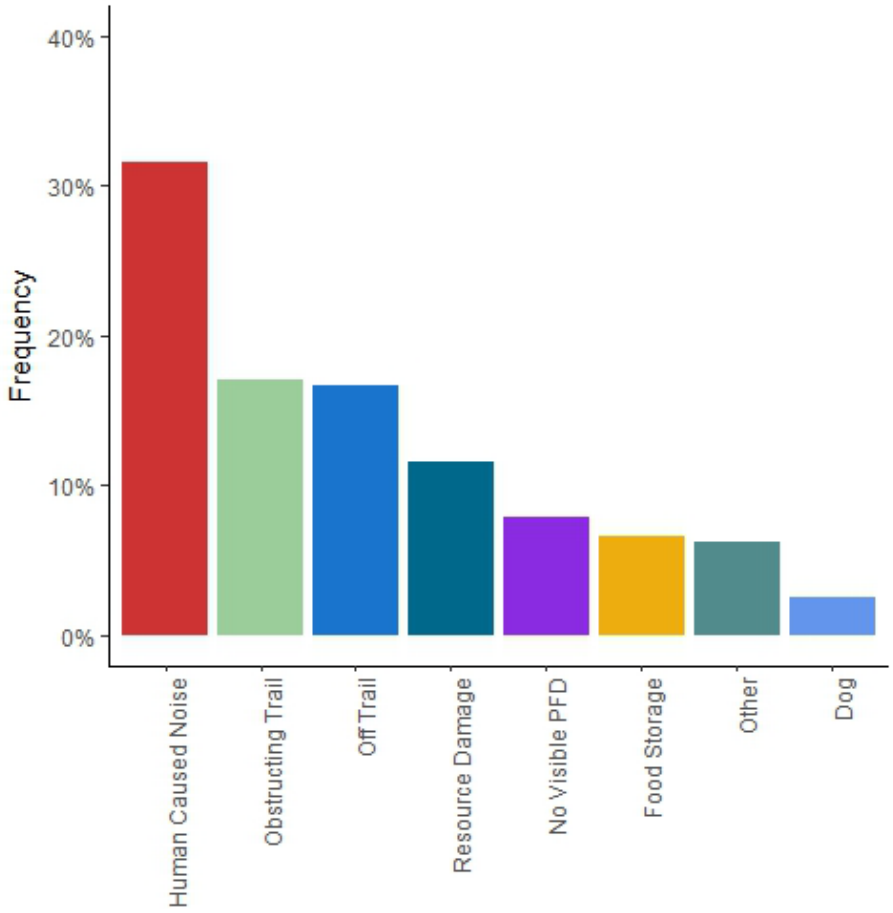

Figure 16e. Frequency of Behaviors of Interest during shoulder sampling period (August 16 – September 8) on **weekdays,** and in all zones in the String Lake observation study area.

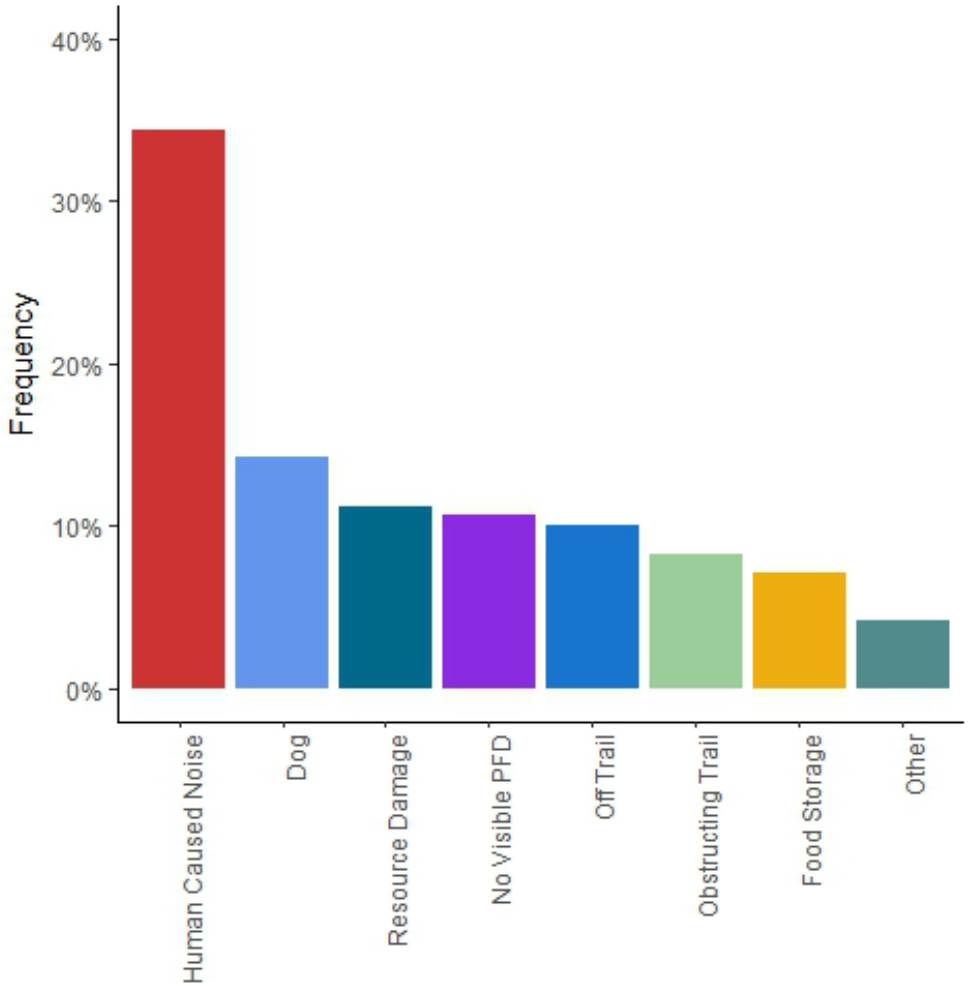

Figure 16f. Frequency of Behaviors of Interest during shoulder sampling period (August 16 – September 8) on **weekends**, and in all zones in the String Lake observation study area.

Table 28d. Table of observed Behaviors of Interest (BOI), number of people engaging in behavior, and frequency (%) of behavior across both sampling periods (July 15 – September 8) in all zones in the String Lake observation study area.

Location	Observed Behavior	# of counts	Frequency (%)
All Zones (all days of week)	Dog	49	3%
	Food Storage	300	18%
	Harassing Wildlife	25	2%
	Human Caused Noise	380	23%
	No Visible PFD	331	20%
	Obstructing Trail	69	4%
	Off Trail	293	18%
	Other	58	4%
	Resource Damage	125	8%
	Total	1630	
All Zones (weekdays)	Dog	21	2%
	Food Storage	182	20%
	Harassing Wildlife	23	3%
	Human Caused Noise	203	22%
	No Visible PFD	179	20%
	Obstructing Trail	53	6%
	Off Trail	139	15%
	Other	43	5%
	Resource Damage	64	7%
	Total	907	
All Zones (weekends)	Dog	28	4%
	Food Storage	118	16%
	Harrassing Wildlife	2	0%
	Human Caused Noise	177	24%
	No Visible PFD	152	21%
	Obstructing Trail	16	2%
	Off Trail	154	21%
	Other	15	2%
	Resource Damage	61	8%
	Total	723	

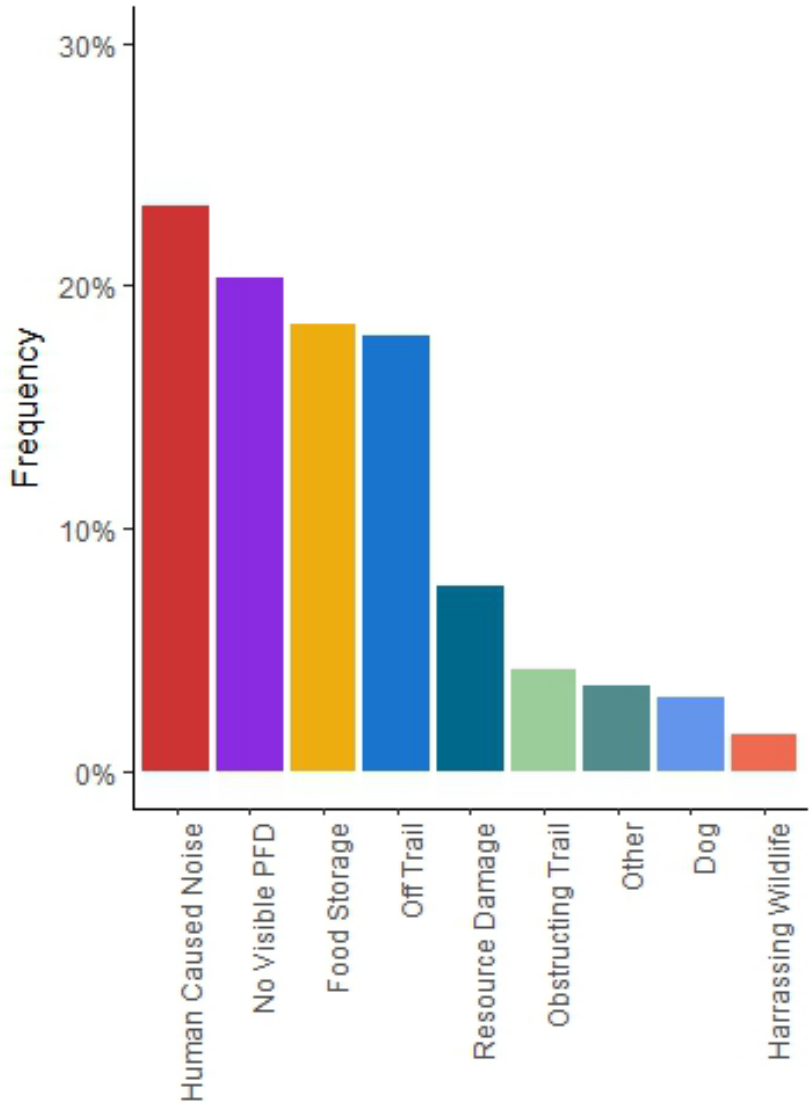

Figure 16g. Frequency of Behavior of Interest across all sampling periods (July 15 – September 8) on all days of the week, and in all zones in the String Lake observation study area.

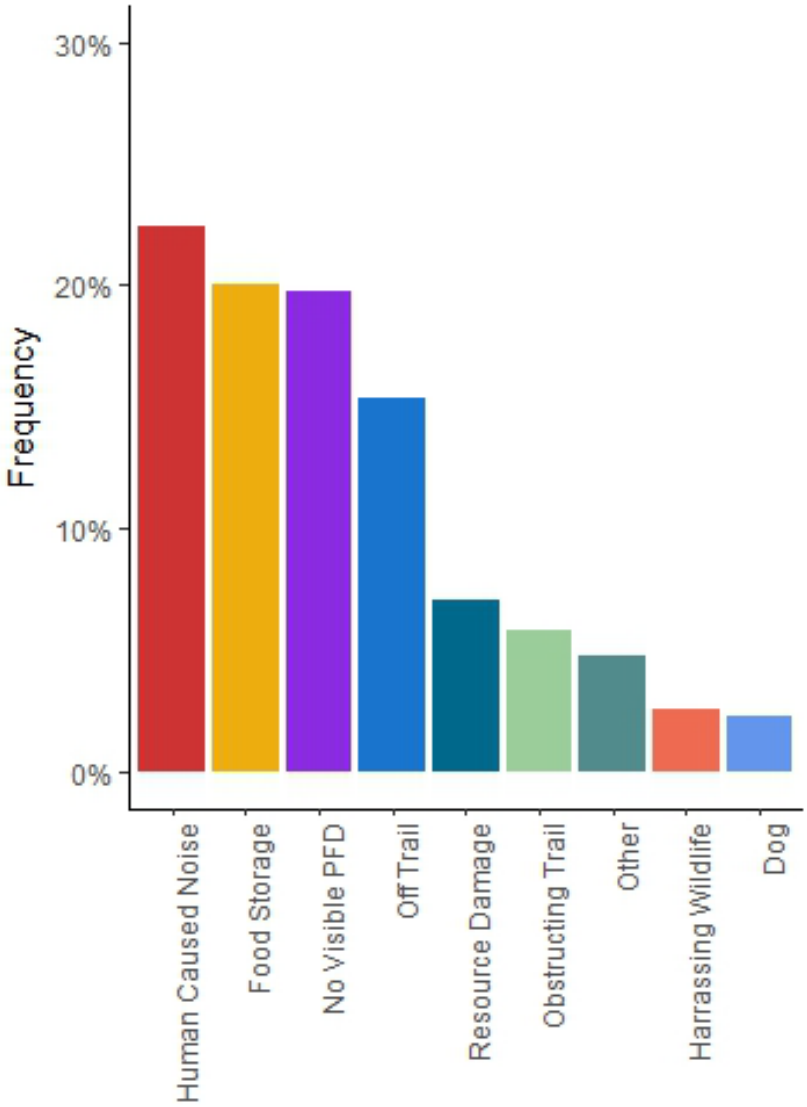

Figure 16h. Frequency of Behavior of Interest across all sampling periods (July 15 – September 8) on weekdays, and in all zones in the String Lake observation study area.

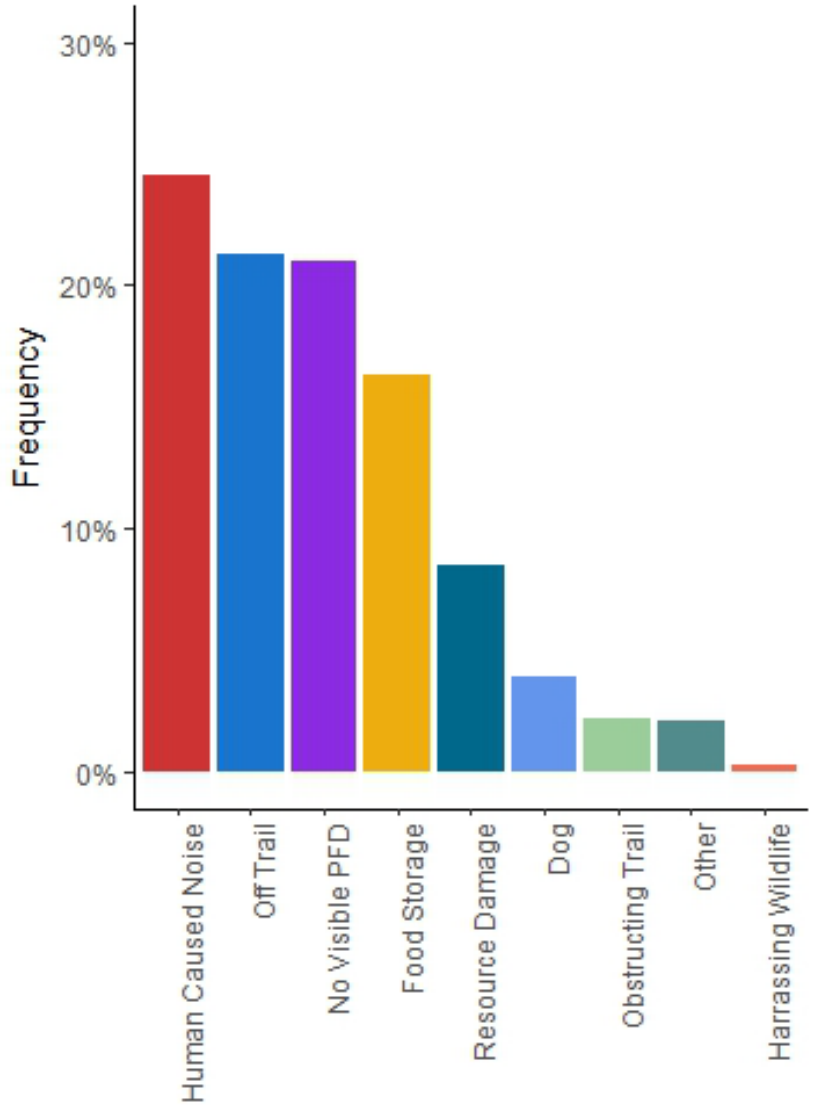

Figure 16h. Frequency of Behavior of Interest across all sampling periods (July 15 – September 8) on weekends, and in all zones in the String Lake observation study area.

Bear Spray Statistics

Throughout the entire sampling period, 81% of visitors in the String Lake observation study area were observed ***without*** visible bear spray.

A note on protocol: If one person in a group was carrying bear spray, study technicians considered everyone in the group to have bear spray. For example, if one person out of a group of six people was carrying bear spray, the technician recorded all six individuals as having bear spray. If no one in a group of six people was carrying bear spray, the technician recorded all six individuals as not carrying bear spray. Research technicians included children as individuals. Therefore, the statistics below represent total ***individuals*** and not total groups.

- Total number of individuals counted in observation study area: 12,111 individuals
- Number of individuals counted ***without*** visible bear spray: 9,835 individuals
- Frequency of individuals ***without*** visible bear spray in String Lake observation study area: 81%

Inventory of Resource Impacts

Study technicians conducted foot searches throughout the SLL area to locate and identify resource impacts, such as visitor-created trails and sites resulting from visitor use. Additionally, trees that appeared to be damaged from recreation use, or because of serious erosion caused by recreation use, were located as well. Study technicians mapped resource impacts with a high-accuracy GPS unit and summarized impacts in terms of their location, extent, and level of impact (Table 29 and Figures 17a – 17c). The definitions of these resource impacts and the conditions classes used to describe the level of impact are found in the methods section of this report. Resource impacts were mapped throughout the entire SLL area and summarized by sub-areas (see Table 29).

The majority of resource impacts are observed along the eastern shore of String Lake between the North Lot and the South Lot; maps of these impacts are shown in this report (Figures 17b – 17c). Impacts specifically associated with: the parking lots in the SLL area, two campsites located along Leigh Lake, and a summary of impacts associated with the picnic areas accessed via the North Lot of SLL are located in Appendix N. Resource impacts were also mapped at two campsites along Leigh Lake (Table 29 and Appendix N). These impacts were recorded to provide baseline data for GRTE and will not be discussed in detail in this report.

Resource impacts associated with the parking lots consist of an extensive visitor-created trail network and few visitor-created sites (Table 29 and Appendix N). The visitor-created trails associated with the parking lots in SLL are also the longest in terms of average and total length. However, these visitor-created trails have the lowest average condition class rating. Therefore, the parking lot impacts are mostly long, visitor-created trails that have low levels of impact (Table 29). For the picnic area-related impacts, these consist of mostly highly impacted, large visitor-created sites (Table 29). The 20 visitor-created sites associated with the picnic area, together, equal the largest total area of visitor- created sites in the SLL study site. These sites have on average the second highest condition class rating (3.7 out of 5) for visitor-created sites and the highest average level of soil exposure. An extensive network of visitor-created trails are also observed connecting the numerous visitor-creator sites in the picnic area (Table 29 and Appendix N).

Study technicians mapped resource impacts along the entire extent of the String Lake Loop Trail (Appendix N). However, the majority of visitor-created trails and visitor-created sites are located along the eastern shore of String Lake proximate to the three parking lots used to access the SLL area (Figures 17b – 17c). A total of 128 visitor-created sites were found, mapped, and measured along the String Lake Loop trail. All but one of these visitor-created sites is located on the eastern shore of String Lake. In terms of level of impact, these visitor-created sites are individually relatively small but have the highest condition class rating and vegetation loss (Table 29). A total of 285 visitor-

created trails are located along the String Lake Loop trail totaling 2,743 meters (1.7 miles). On average, these visitor-created trails are shorter than those found in other areas of the SLL study site but have the highest average condition class rating comparatively (Figures 17b - 17c). Along the String Lake Loop trail, 97 damaged trees are located – most of these occur on the eastern shore of String Lake (Table 29). Overall, the impacts along the eastern shore of String Lake consist of a large number of impacts which are small in terms of individual extent but have high levels of ecological impact.

Photo 15. Dispersed visitor use area near Boat Launch (JENNA BAKER).

Table 29. Summary of extent and level of resource impacts that result from visitor use mapped in the SLL area. CC = condition class rating.

Location Name	# Sites	Average (±SD) CC Sites	Average (±SD) Veg Loss	Average (± SD) Mineral Soil Exposure	Average (±SD) Area (m^2)	Total Area (m^2)	# Visitor-Created Trails	Average (±SD) CC Visitor-Created Trails	Average (±SD) Length (m)	Total Length (m)	# Spurs	# Damaged Trees
String Lake Parking	19	2.41 (± 0.62)	20% (± 33%)	20% (± 51%)	34 (± 55)	654	68	2.35 (± 0.99)	27 (± 31)	1816	1	0
String Lake Picnic Areas	20	3.70 (± 0.57)	51% (± 18%)	78% (± 22%)	81 (± 85)	1692	85	2.61 (± 0.74)	13 (± 9)	1091	0	1
String Lake Loop Trail	128	3.73 (± 1.05)	59% (± 21%)	73% (± 25%)	37 (± 48)	4741	285	2.79 (± 0.96)	10 (± 8)	2743	0	97
Leigh Lake Campsites	14	3.58 (±- 0.51)	55% (±- 8%)	50% (± 33%)	51 (± 50)	771	29	2.72 (± 0.80)	16 (± 11)	470	0	4

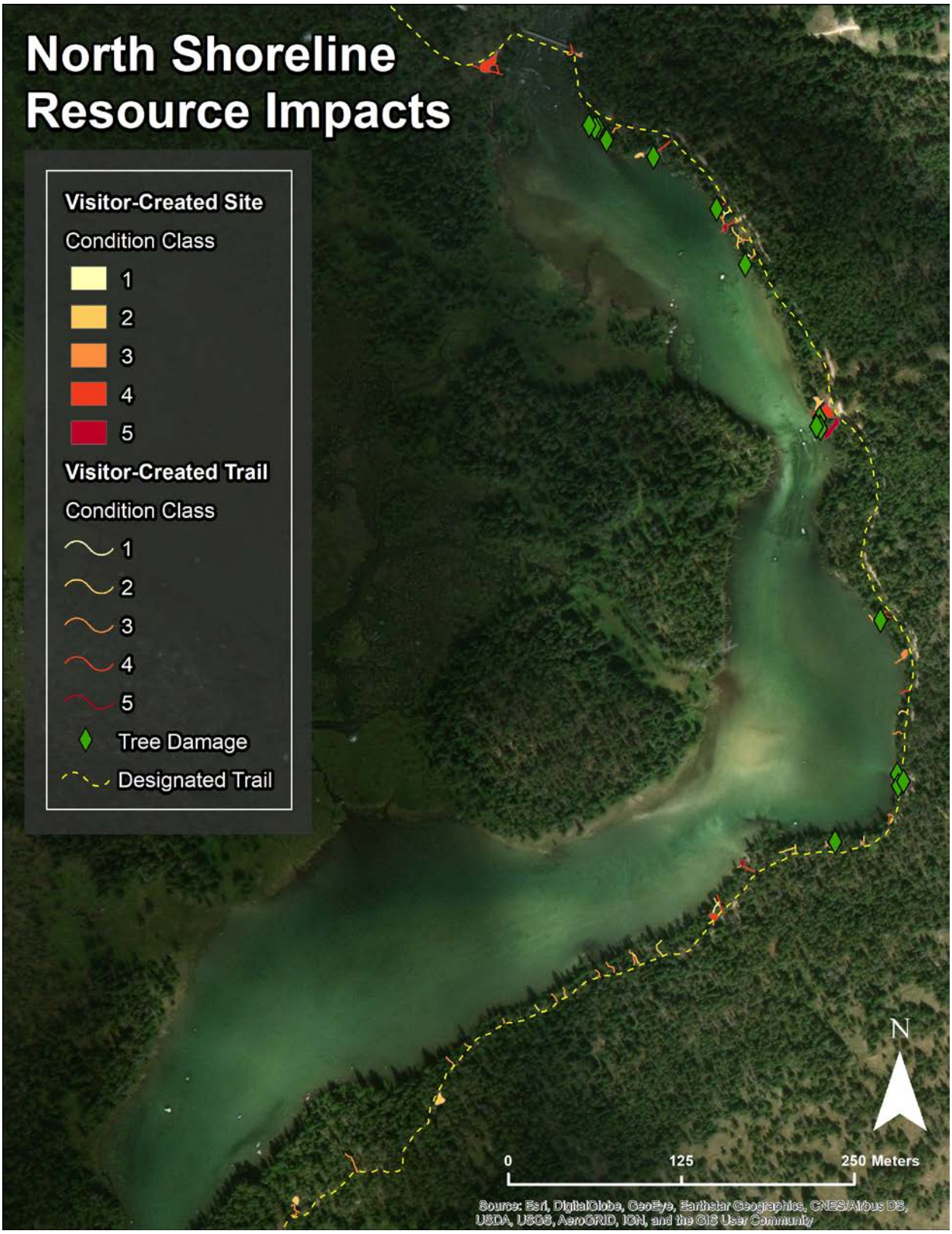

Figure 17a. Map of resource impacts symbolized by condition class rating for impacts north of the North Lot parking area in the SLL area.

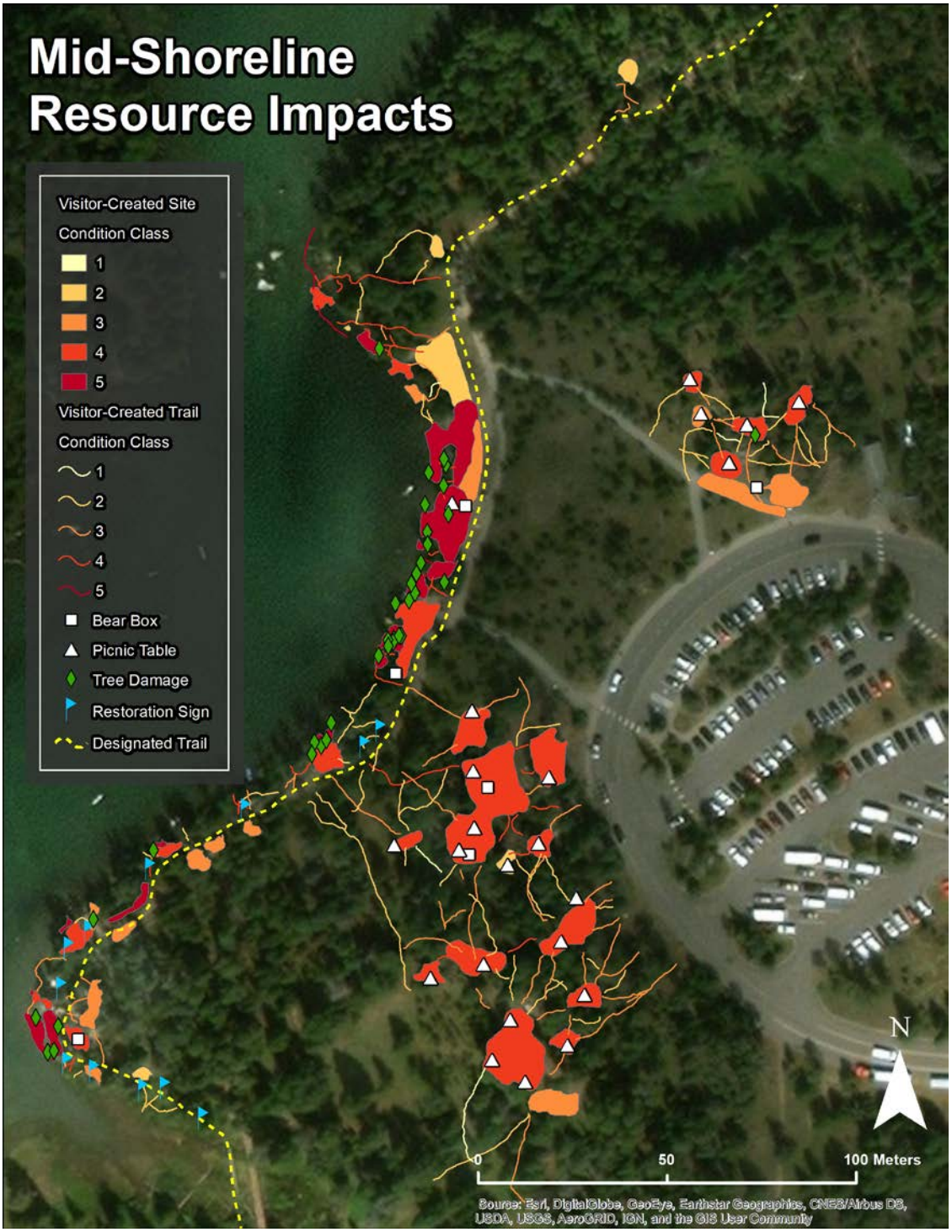

Figure 17b. Map of resource impacts symbolized by condition class rating for impacts associated with the North Lot parking area in the SLL area.

Photo 16. Visitor-created trail near North Lot picnic area (JENNA BAKER).

Figure 17c. Map of resource impacts symbolized by condition class rating for impacts along the more southern portion of String Lake near the Boat Launch and South Lot parking areas.

Photo 17. Damaged trees in SLL study area (JENNA BAKER).

Figure 17d is a histogram summarizing the condition class ratings for each type of resource impact mapped in the SLL area. Overall, there are fewer visitor-created sites found in the SLL area than there are visitor-created trails. However, these sites are more frequently observed to have higher levels of impact. Most visitor-created sites are assigned a condition class rating of 3, 4, or 5. There are 438 visitor-created trails located and mapped in the SLL area specifically (not including those associated with campsites along Leigh Lake). Most of these visitor-created trails are assigned a condition class of 2, 3, or 4 – indicating a lower level of resource impact compared to the visitor-created sites in the SLL area.

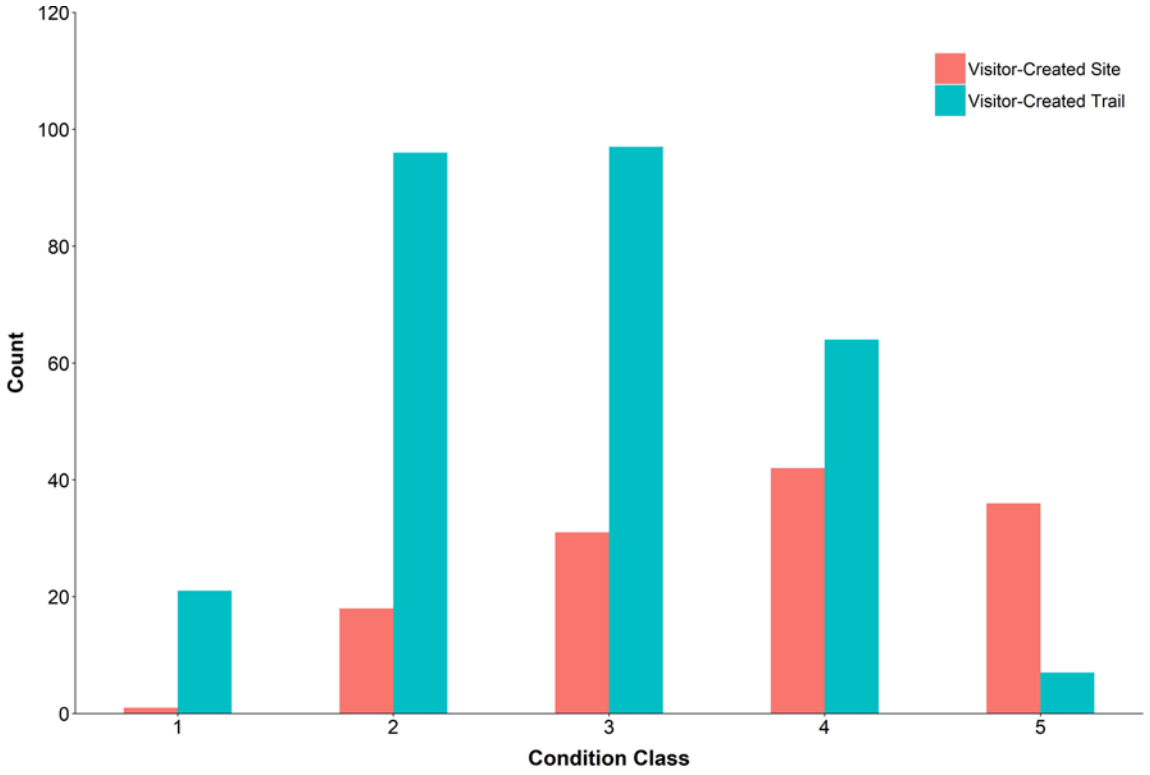

Figure 17d. Histogram of assigned condition class ratings for visitor-created trails and visitor-created sites located and mapped in the SLL area.

Qualitative Interviews

Note on tables in this section: In previous sections of this report, results have often been reported in frequencies (percentages). Results are presented in table format as “occurrences”. Occurrences are the gross amount of reportings of an attribute (i.e. the number of respondents who started their daily travel in Jackson or the number respondents who visited the SLL area to experience solitude). In the context of this report, occurrences differ from frequency in that the former is a gross number and the latter is a percentage.

Visitor Travel Plans

Of the GRTE visitors interviewed, 21 of the 62 respondents were visiting the park for the first time. 9 of the respondents were locals, living within an hour of SLL, with 8 of those living in Teton County, WY. Thirteen respondents self-identified as being locals. Of the non-local visitors, 21 visitors acknowledged that GRTE was the primary destination in their trip, while 28 regarded it was one of multiple national parks they were visiting during their current trip. The median respondent age was 46 years old. The median amount of adults per group was 2 (mean=3.67) and the median amount of children in a group was zero (mean=1.33).

Thirty-two respondents were visiting the SLL area for the first time on the day of the interview. Respondents visited from 24 different states, including Washington D.C., and seven different countries (5 continents), excluding the United States (Figure 18a).

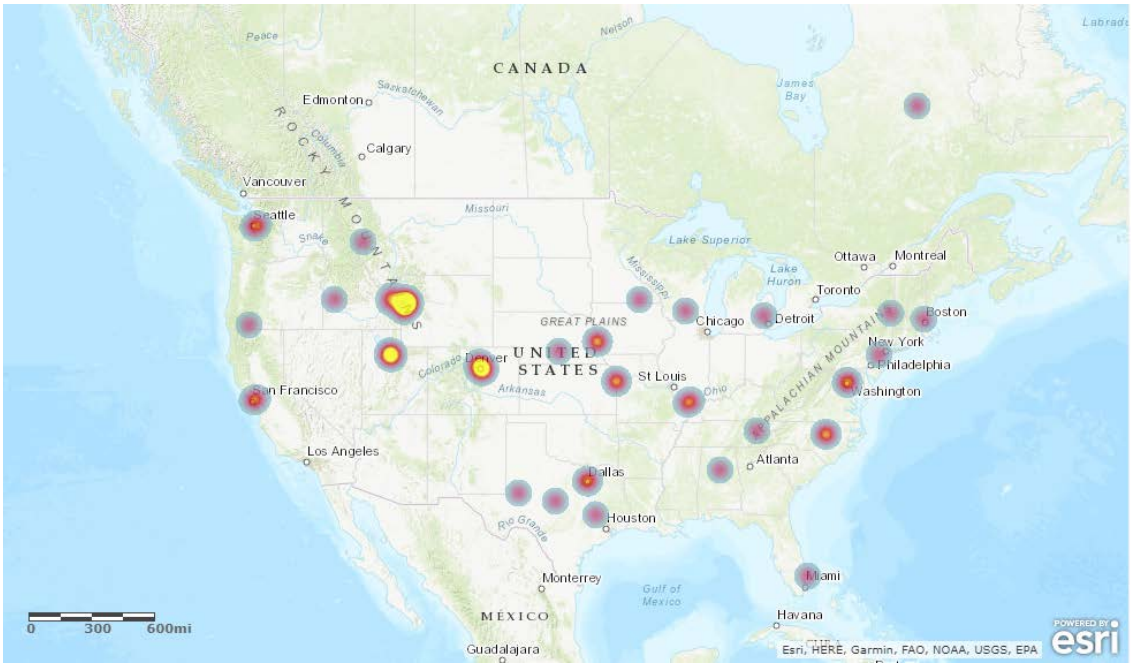

Figure 18a. Heat map distribution of respondent home zip codes.

Twenty-two respondents stayed within GRTE on the night before visiting SLL, while forty of the respondents stayed outside of the park boundaries. Fifteen of the participants began their travel on the day of their visit in Jackson, WY, while five respondents started their travel in Teton Village,

WY. Figure 18b demonstrates the distribution of locations in which respondents started their travel on the day of their visit to SLL.

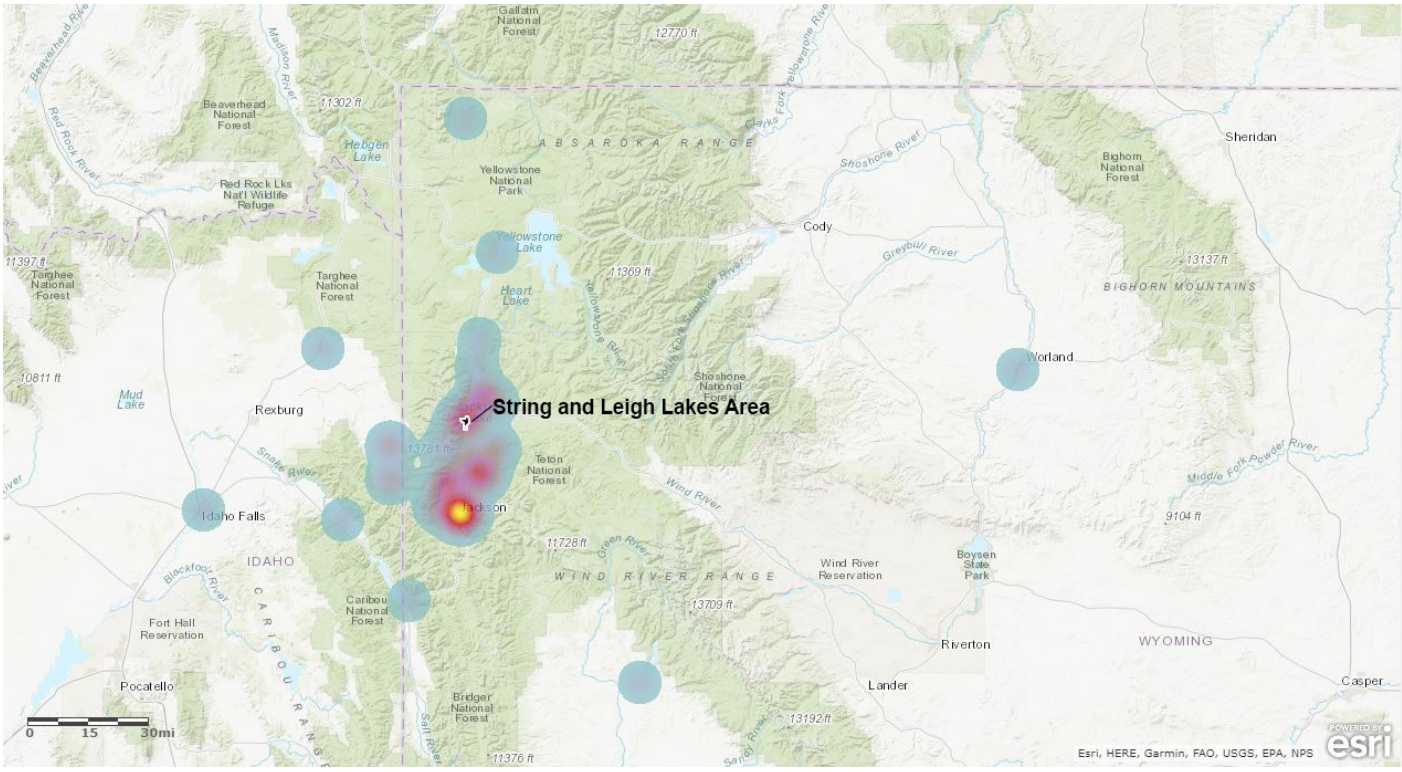

Figure 18b. Heat map of respondents' daily start of travel.

Length of Stay

The median number of nights stayed within a 3-hour drive of GRTE was 5 (mean=8.45). This excludes local visitors, as defined by primary zip-code (Teton County).

Time Spent

The median time spent in the SLL area by respondents was 3.25 hours (mean=9.55) with a maximum of 72 hours and a minimum of 1 hour.

Visitor Communication

Fifty-six respondents reported that the language they used to communicate within their group was English, while 2 visitors cited Spanish as their primary language and the four remaining visitors used French, Dutch, Czech, or Hebrew.

Primary Source of Information

Respondents most often relied on previous experience when planning their trips to both GRTE and the SLL area. Excluding respondents who had previously visited GRTE or the SLL area, however, visitors most often used NPS sources. Respondents often used www.nps.gov/grte for planning their trips to GRTE, broadly, suggesting attempted planning efforts prior to entering the park (Table 30a). With concern to their visit to SLL, respondents more often used NPS print publications than the website, suggesting more spontaneity in their decision to visit SLL (Table 30b).

Table 30a. Distribution of Respondents' Primary Sources of Information for Visit to GRTE

Primary Source of GRTE Information	Occurrences
Prior Knowledge	13
NPS.gov	12
Family or Friends	8
Travel Guide Book	7
NPS Publications/Maps	5
Park Staff	4
Other websites	4
Employer (other than NPS)	2

Table 30b. Distribution of Respondents' Primary Sources of Information for Visit to String and Leigh Lakes

Primary Source of SLL Information	Occurrences
Prior Knowledge	14
NPS Publications/Maps	11
NPS.gov	9
Family or Friends	8
Park Staff	5
Travel Guide Book	4
Other websites	1

Poor Information Sources

Four respondents reported that their primary sources were lacking in some way. The most common complaint (3 of the 4 complaints) was that the park map was not detailed enough in the SLL area. One such example noted a lack of detail in the uni-grid map:

"The National Geographic Map was probably the best written material. Like the park's maps were not that detailed, the ones you get when you drive into the entrance." – Respondent 170731_003

Primary Destinations and Other Destinations Visited

String, Jenny, and Leigh Lakes were reported as the most popular primary destinations of participants in the SLL area, respectively (Table 31). It should be noted that sampling took place along the String Lake shoreline, perhaps skewing the distribution of destinations. Bearpaw Lake, Trapper Lake, Colter Bay, the Teton Crest Trail, Inspiration Point, Cascade Canyon, Jackson (WY), Jackson Lake Lodge, Paintbrush Canyon, and the Craig Thomas Discovery & Visitor Center were identified as a primary destination by one respondent each.

Within the SLL area, the majority of respondents targeted the greater SLL area as their primary destination, with others dispersing to Leigh and Jenny Lakes (Table 31b). The most common destinations within GRTE visited outside the SLL area by respondents on the day of their interview were those lakes that bookend SLL: Jenny and Jackson (Table 31c).

Table 31a. Distribution of Respondents' Primary Destinations in GRTE

Primary Destination in GRTE	Occurrences
String Lake	31
Jenny Lake	8
Leigh Lake	7

Table 31b. Distribution of Respondents' Primary Destinations within the String and Leigh Lakes (SLL) area

Area within SLL	Primary Destination	Occurrences
String Lake	Beach	14
	Lake	9
	Picnic Area	6
	Loop Trail	3
Leigh Lake	Leigh Lake	10
	Bear Paw Lake	4
	Patrol Cabin	2
	Trapper Lake	1
	Outlet Stream	1
Jenny Lake	Jenny Lake	3
	Boat Dock	1
Other	Paintbrush Canyon	2
	Teton Crest Trail	1

Table 31c. Distribution of Respondents' Other Destinations in GRTE on day of interview

Other Destinations in GRTE on day of interview	Occurrences
Jenny Lake	8
Jackson Lake (including Colter Bay)	8
Signal Mountain	4
Rockefeller Preserve	3
Oxbow Bend	2
Snake River Access	2
Gros Ventre Area	2

Parking

Eighteen respondents reported the parking lot full sign being up at the entrance to String Lake Road upon their arrival, yet only 8 respondents parked along Jenny Lake Road (the others found parking in one of the three parking lots along String Lake). Only two respondents cited the construction at South Jenny Lake as a factor that made parking unavailable in that area. The North Lot and Boat Launch

lots were the most common parking areas among respondents, however they are also the largest two parking lots in the SLL area and the most favored by water-based recreationists due to their watercraft access (Table 32).

Table 32. Distribution of Areas in the SLL area in which Respondents parked

Area Parked	Occurrences
North Lot	21
Boat Launch	20
Jenny Lake Road	8
South Lot	7

Activities

Though we sought to interview day hikers, picnickers, stand-up paddleboarders, canoeists, kayakers, backpackers, and beach users, we also coded for all activities participated in among groups, due to the reality that many groups participated in more than one form of recreation (Table 33).

Table 33. Distribution of All Activities in which Respondents' Participated

Activity	Occurrences
Day Hiking	30
Picnic	18
Wildlife Viewing	18
Swimming	17
Stand-up Paddleboarding	12
Canoeing	8
Backpacking	8
General Beaching	6
Kayaking	6
Photography	6
Fishing	3
Climbing/Bouldering	2

Photo 18. Stand-up paddleboarders on String Lake. Photo captured in Zone 4 (JENNA BAKER).

Signage

Seventeen respondents reported issues or complaints about signage in either the larger GRTE or the SLL area. Some visitors were confused about the "North Jenny Lake" parking lot signage, noting that it sits on the banks of String Lake:

"It was more for Jenny Lake, we thought we'd have access to it here, based on signage. But once we got down here we realized there was no access but another lake." – Respondent 170729_004

Other respondents noted the lack of detailed amenities located at each parking area:

"We saw the canoe launching sector, and after that I knew that the picnic sector would be over there. But the beach not indicated at all. We didn't see the sign." – Respondent 170731_002

and

"R: I read signs that said what you can't do, but I didn't see much more of that. That's something that I've seen in some of the campgrounds as well or some area that you have a list of things you can't do. So, what can I do in this washing sink? I: Signs not saying what amenities are here. Just what's not here, what's not allowed? R: Yes, exactly." – Respondent 170809_004

Others found the trail kiosks and signage to be either lacking or misleading. One such response noted issues with the Leigh Lake Trailhead kiosk:

“I think the kiosks are a little bit lacking. I walked in and go, "Okay where are we going to find information about what's available as far as what trails go where and what's a map of the area?" We also didn't know what was in store when we continued on past Leigh Lake. We didn't know how long we would be hiking” – Respondent 170729_006

Conflict

Three types of conflict were identified in the interviews: conflict with park management or policies, human/wildlife conflict, and conflict with other visitors. In total, 14 instances of conflict were identified (Table 34).

Table 34. Distribution of Types of Conflict Experience by Respondents

Type of Conflict	Occurrences
Park Management	7
Human/Wildlife	4
Other Visitors	3
Total	**14**

The most common user conflict existed between canoeists and stand-up paddleboarders. One canoeist went as far as to propose a ban against conflicting users:

“You know I will admit I try not to be too judgmental. String Lake has gotten so noisy. So unbelievably noisy. I personally think even though this is really awful. The only way to deal with it, is to ban stand ups, they have taken over the lake. They come with a certain attitude: “I'm at the beach. I'm hanging out. I'm getting sun.” SLL has totally shifted. It's madness out here. Fortunately, you can head over to Leigh and escape it if you go way back by Moran because no one wants to paddle that far.” – Respondent 170726_005

No large mammals were reported to have conflicted with respondents, however one family did have a negative encounter with a bird:

“During our picnic one of them left a sandwich on a plate, they were all kind of sitting here, and bird flew down and snatched the sandwich.” – Respondent 170721_003

Conflicts with park management or park polices ranged from backcountry fire restrictions to parking regulations. One respondent found issue with the location of the water craft inspection station:

“This new water check point's a pain in the ass. You have to loop around and go back to Moose there. They're doing a water craft check now. There's a water craft check station that's specially new this year.” - Respondent 170814_004

Wilderness

The Wilderness Act of 1964 outlines a number of qualities that are inherent to the federally defined characteristics of wilderness: “to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable”, “outstanding opportunities for solitude or a primitive and unconfined type of recreation”, and “where the earth and its community of life are untrammeled by man” (Wilderness Act of 1964). Portions of the SLL area lie within recommended wilderness, and therefore beckon inquires of wilderness quality. Within our interview, we asked respondents what role wilderness played in their reasons for visiting the area. Coding responses to this question and others, we identified visitors’ identification of either the presence or absence of wilderness characteristics (Table 35). The interviews suggest that Leigh, Bear, and Trapper Lakes offer more of a wilderness experience than String Lake. A number of respondents noted the lack of other visitors at Leigh Lake, for example:

“When we got to Leigh Lake we had the, just the point there where the portage spot is, completely to ourselves. Just the two of us, we only stayed for five minutes. But it was completely our own for that five minutes, which was nice.” – Respondent 170824_003

Others noted whether the untrammeled nature of the resources in the SLL area:

“You get an appreciation of the fact that they sort of set this land aside for people who live here to take advantage of and to get a feel for what things were like in this country. And I think this meets a lot of those expectations cause you get out into it. And you're walking a path and its quiet and just having the woods around is pretty awesome.” - Respondent 170731_009

Yet, respondents also noted the lack of wilderness at String Lake, specifically:

“I don't come here for wilderness. This is very far from it. String Lake is probably the second busiest, today it really isn't bad, but on for the most part, I know that String Lake is very busy so my expectations coming here were not to find wilderness.” – Respondent 170824_005

In terms of development, respondents reported pleasure with the lack of facilities in the area. One such respondent positively noted the lack of change in development in the SLL area over three decades:

“I'm just really glad those campsites we were a part of have been exactly the same since I've lived here for 30 years. That makes me really happy. I'm not big on facilities. I don't like that they have done more additive facilities. I am a wilderness person. To me the less facilities the better.” – Respondent 170726_005

Still others found the SLL area to be more developed:

"This is not wilderness. If you want wildness you need to go out a little deeper into the park." – Respondent 170725_004

Table 35. Distribution of Wilderness Characteristics and Characteristic Shortcomings Reported by Respondents in the SLL Area

Wilderness Characteristics and Shortcomings	Occurrences
Solitude	17
Untrammeled	9
Undeveloped	9
Developed	4
Natural	3
Trammeled	1

Facilities

Fifteen respondents referenced some element of the trails, parking lot infrastructure, or other facilities in the SLL area that could be improved. These responses ranged from trail erosion to a lack of soap in the bathrooms. Some respondents found the String Lakeshore to have signs of human impact:

"It wasn't great. There was a lot of trash and stuff." – Respondent 170729_009

Others found shortcomings with concern to the SLL area facilities:

"At the lake we found only one table for picnic." – Respondent 170731_002

and

"I wish there was more than one bathroom. There's the one bathroom at the other parking lot. This parking lot just has the porta potties. It would be nice if there were more bathrooms." – Respondent 170805_003

Motivations

Using the Recreation Experience Preference (REP) scales related to visitor motivations put forth by Manfredo, Driver, and Tarrant (1996), we coded respondents' reported motivations for their visits to the SLL area. In doing so, we recorded all reported motivations, allowing for more than one to be reported. In Table 36, the motivations are paired with a representative quote that was coded, along with the number of occurrences.

Table 36. Distribution of all motivations for visiting SLL area reported by respondents and representative quotes for motivation.

Motivation	Representative Quote	Occurrences
Enjoy Nature/Beauty	*"The views and having that stream right next to my site while I'm falling asleep is something else"* – Respondent 170805_002	45
Escape/Solitude	*"That's kind of the whole reason. To get away from the city and enjoy some time away"* – Respondent 170803_005	17
Relax/Rest	*"I just really like being out on the canoe. It's really nice and really relaxing and serine"* – Respondent 170824_004	16
Quiet	*"You know we like to get more into the hikes and maybe get away from the people and experience just the wildlife, the trees, that kind of thing-- the quietness"* – Respondent 170721_004	15
Setting Temperature	*"The lake is gorgeous. It's very clear. The water is warm compared to Colorado lakes"* – Respondent 170805_006	14
Family/Friends Togetherness	*"Just being together as a family mostly"* – Respondent 170803_005	11
Safety	*"Because we like how accessible the lake is and it's shallow. You can see the kids and the water's clear"* - 170803_003	10
Nostalgia	*"My husband and I worked here like 25 years ago and so we really wanted to come back and show our kids. I mean. It was either the beach or here and we're glad they chose here"* – Respondent 170803_002	5
Introspection	*"Lots of staring at the campfire and hiking"* – Respondent 170725_002	5
Teaching/ Exposing Others	*"Expose our kids to backcountry camping"* – Respondent 170809_002	5
Risk/Adventure	*"I guess I've always day hiked. But, I've always wanted to go backpacking, so I just decided to try it."* – Respondent 170729_003	4
Learning	*"Everyone was personable, we learned, had great conversations with a couple of them"* – Respondent 170726_002	3
Achievement	*"I am not as capable as I once was to get all the way in the back in the backcountry. To be able to do it in a canoe and go back into Moraine area and feel like you're in the wilderness I mean you're not but you feel like it. It was big"* – Respondent 170726_005	3
Meet New People	*"Well, meeting these new friends. It's amazing just to be in the foothill with the lake. Everything looks beautiful"* – Respondent 170809_004	1
Creativity		0
Physical Fitness		0
Leadership		0

Crowding

Thirty respondents reported some level of crowding in the SLL area. The impact of crowding had varying results on visitor behavior, often coinciding with the perceived severity of crowding.

Respondents noted that the entire park was crowded, limiting the amount of destinations they could visit, perhaps funneling them into the SLL area:

"No, the Grand Teton Park is victim of its success. Campgrounds are full. Parking are full. The infrastructures are not enough, but not enough to accept certain amount of visitors. Probably for the environment it's okay." – Respondent 170731_002

A backpacker found an unsettlingly difference in the number of other hikers on the trail the closer they got to the frontcountry:

"The only disappointing thing I would say is, but I can't get angry. As soon as I got from the fork from the North and South Cascade all the way to this trail head the trail is just packed. I mean it's good people who are using it, I'm glad. But I enjoy it when we are the only ones on the trail." – Respondent 170729_003

Others noted that the crowding was expected and changed their behavior as a result, moving to Leigh Lake in an attempt to find more solitude:

"With the research we did it was exactly as we thought. There was a lot of people here, we knew if we paddled and portaged, we would be able to get away from everybody and we were able to do just that." - Respondent 170729_005

Still, some respondents noted that the crowding was forcing them to leave the SLL area altogether.

"We're fixing to get going because it's crowding out, so that's our behavior I guess." – Respondent 170811_002

Displacement

Due to the amount visitors who reported crowding or conflict reasons they changed behavior, we decided to examine the level of displacement that occurred within or to the SLL area. We coded interviews for both spatial and temporal displacement. Instances of coping were identified in the coding process, however it was determined that the interview questions did not sufficiently, absolutely recognize instances of coping. Spatial displacement was subdivided into intersite (from or to another area in GRTE) and intrasite (within the SLL area). The most common intersite displacement occurred between Jenny Lake and String Lake:

"We tried Jenny Lake first but they were full, this was the next spot." – Respondent 170729_006

The most common intrasite displacement was from String Lake to Leigh Lake, for example:

"I would say, we kept continuing past String Lake cause there was a lot of activity. And so that's when we got to Leigh Lake, it was nice to see there was only one to two people that were participating – Participant 170721_004

Temporal displacement most commonly consisted of respondents getting to the SLL area earlier than they would otherwise, in an attempt to "beat the crowd", however others left the area earlier than they otherwise would:

"We're only going to stay here for a little while cause we know it gets crazy later. Then go else where. But today we're just hanging out for a while. We've done times when we've portaged through over to Leigh Lake, which is really cool. I like that better than hanging right here cause it gets too congested. So, here for most of the day. Then else where in the park." – Respondent 170722_08

Water-based users tended to be more displaced than land-based users, with the largest exception being picnickers who, of the 8 respondents interviewed, reported 6 instances of displacement (Table 37).

Additionally, we were unable to gain a sufficient understanding of how displacement was affecting visitors' achievement of the benefits they were seeking through their motivations of visitation. Based on the interviews, however, it might be hypothesized that these factors vary according to user group.

Table 37. Distribution of Respondent Temporal, Intrasite, and Intersite Displacement by User Group

Primary Activity	**Temporal** Occurrences	**Intrasite** Occurrences	**Intersite** Occurrences	**Total** Occurrences
Picnic (n=8)	3	0	3	6
Canoe/Kayak (n=8)	3	2	1	6
Stand-up Paddleboard (n=8)	5	1	1	7
Day Hike (n=16)	5	1	3	9
Backpack (n=8)	2	1	1	4
Beach User (n=12)	5	1	3	9
Other (n=2)	0	0	0	0
Total	**23**	**6**	**12**	**41**

Summary of Key Findings

Overall Use

Vehicles Use

- Across the entire sampling season, North Jenny Lake Road sees approximately 2,000 – 3,000 vehicles per day. Of those vehicles, approximately 1,000 - 1,300 use String Lake Road and approximately 1,300 use the Jenny Lake One-Way Road.

- For vehicles driving westbound, towards String Lake, peak vehicle use ranges between 10:00am and 12:00pm on North Jenny Lake Road and String Lake Road. Peak use for vehicles driving eastbound, or away from String Lake, ranges between 3:00pm and 5:00pm. On the Jenny Lake Road one-way, peak vehicle use remains consistent between 1:00pm and 2:00pm across the entire sampling period.

Parking Lot Use

- The three designated parking lots along String Lake Road experience peak use between the hours of 11:00am and 4:00pm across both sampling periods.

- On average, between 132 and 166 vehicles park in designated spaces throughout all parking lots along String Lake Road.

- The North Lot has the greatest capacity for designated parking and the least capacity for undesignated parking.

- The North Lot and Boat Launch offer more variability in the maximum number of vehicles able to legally park in a designated space. This is due to the large trailer parking spaces that non-trailer vehicles often park in. These spaces can hold up to 3 vehicles at a time.

- On average, between 11 – 17 vehicles park in undesignated spaces among all parking lots throughout the sampling period. The Boat Launch has the greatest capacity for vehicles to park in undesignated spaces, with the ability to hold as many as 26 extra vehicles.

- In general, most vehicles do not park in illegal spaces. Jenny Lake Roadside parking experiences rapid jumps in vehicle parking, with spikes in parking at 12:00pm during the Summer sampling period. The maximum number of vehicles recorded on the Jenny Lake Roadside is 89 vehicles.

Pedestrian Use

- The NE shore of String Lake has the highest level of use of the six counter locations installed in the SLL area with 851 visits per day at this location.

- After the NE shore counter location, the next busiest locations are the Leigh Lake Portage, Jenny Lake Junction, SE shore of String Lake, South shore of String Lake, and Paintbrush Canyon.

- Weekend use is slightly higher than weekday use for all counters, but use levels are very similar across sampling periods.

- Average *hourly* use levels varies by day across the entire sampling period. However, *daily* use levels experiences consistent peaks in use between 11am and 2pm daily.

Visitor Use and Impact Patterns

Vehicle Parking and Use Patterns

- A total of 167 GPS tracks were collected from vehicles of visitors to the SLL with a response rate of 96%.

- Of the visitors given GPS units in their vehicles, 76% of the vehicles were non-locals and average group size was 3 people per vehicle.

- The majority of vehicles tracked did not drive around searching for parking; 82% of visitors parked in the first parking lot they drove to.

- The North Lot was the most popular, as well as the largest, parking lot with 62% of visitors driving to this parking lot first and parking there.

- On average visitors spend between 3 and 4 hours in the SLL area. Individuals who parked at the South Lot, spent the most time in the SLL area.

Pedestrian Use Patterns

- A total of 652 GPS tracks were collected from visitors to the SLL with a response rate of 89%.

- The SLL area provides access to a wide variety of hiking and recreational destinations and the variety of behaviors collected via the GPS tracks reflect these opportunities.

- The behavior of visitors varied based on their starting location; with high densities of visitors tending to stay close to their starting point.

- An exception to this pattern was observed for visitors who started their trip at the South Lot, where we saw the greatest variety of hiking behaviors exhibited.

Resource Impacts

- Impacts to ecological resources because of visitor use are concentrated on the Eastern shore of String Lake. Very few resource impacts were found along the String Lake Loop trail overall.

- The parking lot impacts consist mostly of long, low impacted informal trails.

- The picnic areas are highly impact with large visitor-created sites that have significant soil impacts.
- A total of 128 visitor-created sites and 285 informal trails were located along the String Lake Loop trail with the overwhelming majority of these occurring along the String Lake Loop Trail between the North Lot and South Lot.

- The resource impacts found along the Eastern edge of String Lake are small in terms of total extent but highlight impacted in terms of vegetation loss and soil impacts.
- Damaged trees are widespread across a relatively small area on the Eastern shore of String Lake.

Visitor Observations

People at One Time

- Across the sampling period, peak use for visitors recreating along the String Lake observation study area is at 1:00pm with an average range of 103 to 163 people counted.
- In general, weekend use is higher than weekday use, particularly during the latter part of the sampling season (August 16 – September 8.)

Activity Types

- The most common activities for people recreating along the String Lake observation area are hiking, picnicking, and sitting, or 'beaching'.
- Combined, these activity types account for approximately 70% -80% of activity types in the String Lake observation area.
- For users engaging in water-based activities, the most common activity types are kayaking and stand-up paddleboarding, accounting for approximately 60% - 70% of water-based activity types.

Behaviors of Interest

- During the summer sampling period, the commonly observed behaviors of interest are improper food storage, lacking a visible PFD on watercraft, loud human caused noise, and visitors hiking off the designated trail.
- Each of these observed behaviors account for approximately 20% of BOI.
- The frequency of improper food storage drops significantly into the shoulder sampling period, accounting for only 7% of behavior.
- The frequency of loud human-caused noise increases in the shoulder sampling period, accounting for 35% of behavior.

- To note, of the visitors observed along the String Lake observation area, 81% of people do not carry visible bear spray.

Qualitative Interviews

Sixty-two semi-structured interviews were compiled using a random-sampling technique in SLL during the summer of 2017. Results suggest that conflict, crowding, and displacement are three key indicators of quality that were identified for future research and monitoring efforts in the SLL area.

To summarize the key findings of the qualitative portion of the study:

- Respondents visit SLL to satisfy a variety of motivations through a diverse array of activities such as day hiking, picnicking, wildlife viewing, swimming, paddleboarding, or canoeing and kayaking. The most salient motivations include enjoying nature, escape and solitude, relaxation, quiet, and the appealing temperature found in the area.

- Within the larger SLL area, String Lake is the most popular destination.

- Respondents note the lack of detailed information (kiosks, signage, maps, etc.) available about the SLL area.

- Respondents most often use hardcopies of NPS publications received at entrance booths and visitor centers after arriving at GRTE to plan their visits to SLL.

- The majority of respondents report being drawn, at least partially, to the SLL area for its wilderness characteristics, yet perceptions of wilderness varied widely.

- Respondents understand and notice that use is increasing in the SLL area.

- Respondents' behavior in GRTE is generally influenced by parking availability, either at Jenny Lake or the SLL area.

- A substantial number of respondents reference resource impacts and some element of the trails, parking lot infrastructure, or other facilities in the SLL area that can be improved.

- A substantial number of respondents describe experiencing conflict such as conflict with park management or policies, human/wildlife conflict, and conflict with other visitors.

- Water users report experiencing conflict more often land-based users.

- Nearly half (30 of 62) of the respondents report being crowded in the SLL area.

- Over one-third of respondents are temporally displaced.

- Visitors are being displaced from Jenny Lake to String Lake, and from String Lake to Leigh Lake.

- Water users are more likely to be displaced than land-based users.

Next Steps

Data collected during the 2017 data sampling effort and presented in this report will inform year two of the Leigh and String Lakes Visitor Use Study. A second field season will occur between June and August of 2018. The same visitor use estimation techniques and counter locations that were used in 2017 will be repeated in 2018. Recreation ecology measures for the 2018 field season will focus on resource impacts located between the Leigh Lake Portage trail and up to Bearpaw and Trapper Lake. These locations were chosen because the qualitative survey results indicate visitors may be displaced to the Leigh Lake area. Therefore, it was deemed important to gather baseline resource condition data for the Leigh Lake trail system and shoreline areas. Observational techniques conducted in the 2017 field season were exploratory in nature. Their primary outcome was to inform survey methodology and sampling protocol for the 2018 field season. Unless deemed useful and necessary to GRTE, observational methods will be used in a limited capacity in the 2018 field season (if at all). Parking lot counts will be repeated in the 2018 field season, but the frequency may be dropped to one count per hour due to logistical considerations.

GPS-based tracking data will be collected in 2018. However, the focus of the data collection effort will shift slightly. Water-based recreationists were not GPS tracked during the 2017 data collection period. However, due to the prevalence of water-based recreation observed at SLL in 2017, one focus of the spatial data collection in the 2018 field season will be to collect GPS tracks from more water-based recreationists. All other spatial data collected from visitors and vehicles will be paired with quantitative survey techniques.

In next field season's quantitative study (which will be paired with GPS-based tracking spatial data), we propose measuring the indicators identified in the interviews: crowding, displacement, and conflict. We also propose measuring displacement's effect on benefit achievement and visitor willingness to travel within the SLL area. In doing so, we favor administering three individual surveys to three broad user groups:

Drivers/vehicles:

- A survey focused on displacement from the SLL area
- Conducted on the Jenny Lake Roadside
- Questions concerning:
- Displacement and coping
- Activities anticipated when arriving to intended location
- Anticipated destination after displacement
- 14 days of surveying and GPS tracking
- 7 treatment, 7 control (with and without the "Parking Lot Full" sign in place)

- Survey data paired to be paired with spatial data

Hikers/picnickers/beach:

- A paired pre/post-survey focused of survey on experience and expectations
- Questions concerning:
- Indicators of quality derived from interviews (perceived crowding, temporal and spatial displacement, willingness to travel, etc.)
- Reactions to ecological resources
- Management actions/presence
- Paired with spatial data

Water users:

- A pre/post survey focused on conflict and experience
- Questions concerning:
- Indicators of quality derived from interviews (perceived crowding, temporal and spatial displacement, perceived user conflict, etc.)
- Conflict questions derived from literature and interviews
- Paired with spatial data

Logistical Considerations: OMB submission for the 2018 survey(s) will be completed by early winter 2018. Housing requests to the UW-Research Station will be completed by early winter 2018. IRB revisions and submissions to both Oregon State and Penn State will be completed by early spring 2018. The research permit request for the 2018 field season will be completed by spring 2018.

Integration: The 2017 (and the forthcoming 2018) data collection methodology were designed to allow for integration between the various data collection techniques (social, ecological, spatial, etc.). Thus far, both universities have focused their efforts on data analysis and summaries of individual data types for this report and will be exploring integrative analyses in the coming months. Any new results which may integrate the findings presented in this report will be presented and delivered to the park upon their completion.

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Appendices

See attached document for the follow appendices:

Appendix A: Sampling Schedule

Appendix B: OMB Approval and Interview Questions

Appendix C: Qualitative Study Literature Review

Appendix D: Daily total vehicle counts

Appendix E: Hourly directional vehicle counts

Appendix F: Hourly summaries of trail counters

Appendix G: Hourly averages of trail counters by date (graphs)

Appendix H: Parking lot use by hour of day

Appendix I: Additional maps of GPS-based tracking of pedestrians

Appendix J: Activity type frequencies by zone

Appendix K: Water-based activities by zone

Appendix L: People at one time count averages by zone

Appendix M: Non-compliant behaviors by zone

Appendix N: Additional Resource Impact Map

Appendix O: Interview Transcript