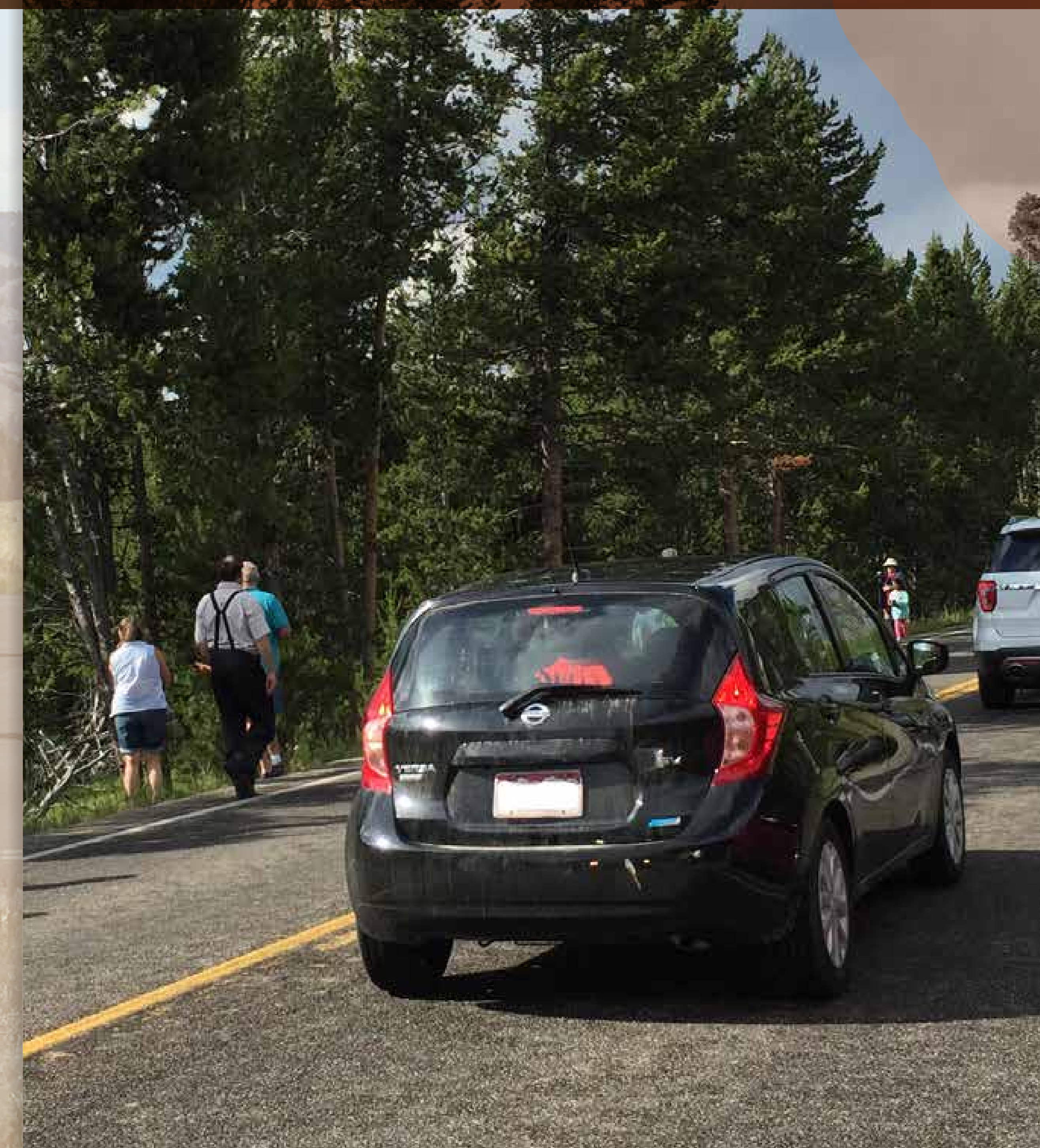
National Park Service
U.S. Department of the Interior

Yellowstone National Park

TRANSPORTATION AND VEHICLE MOBILITY STUDY

FINAL
JUNE 2017

DATA COLLECTION AND ANALYSIS



ACKNOWLEDGEMENTS

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INTRODUCTION

PURPOSE

The purpose of this study was to collect and analyze data related to traffic and parking conditions at Yellowstone National Park in order to provide a foundation for future visitor use management and transportation planning. The study team analyzed and evaluated existing conditions at key intersections, roadways, and key parking areas and site locations in the most congested areas of the park. The study assessed traffic volumes, visitor trip patterns, parking utilization, lodging in gateway communities, and other information. The visitor volume data collected in August 2016 was scaled to represent peak July operating volumes.

BACKGROUND

The National Park Service (NPS) completed data collection and analysis of existing conditions at Yellowstone National Park to quantify existing vehicle conditions and visitor flow patterns, document areas of problematic traffic flow and congestion, calculate current vehicle capacity, and evaluate the current efficiency of park transportation systems.

Figure 01 on page 1 shows the context of the study as well as data collection methods.

In 2015, Yellowstone experienced a 17 percent increase in visitation over 2014, surpassing four million visits for the first time ever. Although the park had not seen an annual increase in visitation of over 10 percent in more than 25 years, this dramatic spike occurred after 15 years of steady growth. Increasing and changing visitation in the park is creating many interrelated challenges to visitor safety, visitor experience, and resource protection. Fundamental to all of these challenges were limitations in the current efficiency and capacity of the park's transportation and visitor management systems.

The demographics of visitors and the way that people visit the park are also changing. For instance, employees and stakeholders in gateway communities have observed large increases in the number of international visitors accessing the park, particularly through the West Gate. The number of tour buses visiting the park has doubled since 2010, and rates of visitation are increasing dramatically during shoulder seasons when the park has limited staff and services available. The West Gate, already the park's busiest by more than double the volume of any other gate, saw a 21 percent increase in visitation over 2014. From early June through late September, traffic backups at this entrance led to gridlock on four or more days a week in the town of West Yellowstone. Once through this entrance, stop-and-go traffic often continued inside the park for 11 miles to the Madison Junction, with driving times through this corridor consistently reported at two hours.

Throughout the rest of Yellowstone, parking lots were regularly closed and overflowed onto road edges, vegetation, and thermal areas. Wildlife jams commonly resulted in 30-minute to two-hour waits. Staff and visitors frequently commented on pulses of severe crowding at popular park locations, partially attributed to increasing tour bus numbers (up 23 percent over 2014, and nearly double 2010 counts).

This study is one of several planning and analysis activities underway as Yellowstone National Park proceeds through a pre-planning effort to gather data to inform initial options and strategies that could address these challenges over the long term. This study aggregates existing and new data to analyze current park transportation and visitor mobility systems and will be integrated with other ongoing efforts to understand impacts to resources and visitor experience and to inform future park planning efforts.

STUDY CONTEXT AND SCOPE

Yellowstone National Park sits on a high volcanic plateau encompassing over 2.2 million acres of land in the states of Idaho, Montana, and Wyoming surrounded by mountainous terrain. The park's 310 miles of major roadways include a figure eight 'Grand Loop Road' with a middle road connecting Norris Junction and Canyon Village. Five roads connect the park's entrance stations with the Grand Loop. The park contains five major developed areas: Canyon Village, Grant Village, Lake Village, Mammoth Hot Springs, and Old Faithful. The roadway also connects several other important junctions and developed areas, including: Bridge Bay, Fishing Bridge, Madison, Norris, Tower-Roosevelt, and West Thumb. The roadways system connects visitors to these areas, as well as other attractions such as campgrounds, geyser basins, trailheads, scenic viewpoints, wildlife watching sites, and pullouts scattered throughout the park.

The analysis of traffic and parking conditions was performed at multiple scales. At a park-wide scale, the study evaluated the capacity, flow, and efficiency of:

1. the park's entrance stations,
2. each of the five road segments connecting entrance stations with the Grand Loop Road,
3. the nine road segments connecting major junctions and developed areas on the Grand Loop and the connector from Norris to Canyon Village,
4. locations where unique events (such as wildlife jams or slow traveling visitors observing scenery) cause adverse effects to transportation performance.

At a corridor-level scale, the West Gate and connections to the major developed areas of Old Faithful and Canyon Village were studied more in depth. This focal area included analyses of the flow of traffic (both level of service and daily/hourly vehicle volumes) through the park's West Gate, at Old Faithful and Canyon Village, at the geyser basins, canyon rims, and at other attractions between or bordering the West Gate, Old Faithful, and Canyon Village, including Madison and Norris Junctions.

Less congested areas were also studied to further understand and evaluate the park's transportation system. These areas included the following junctions and attractions:

1. Boiling River
2. Mammoth Hot Springs
3. Tower-Roosevelt junction
4. Mud Volcano and Fishing Bridge
5. West Thumb Junction and Geyser Basin
6. the south entrance road including the Lewis Lake and Lewis Falls areas
7. Grant Village
8. Lake Village

Weekend and weekday vehicle use levels and circulation were examined during peak periods to provide snapshots of key times throughout the April through October season when park roads are open. Existing Level of Service (LOS) for key intersections and road segments within the park also were documented. Parking conditions were examined for designated and user-created parking areas in major lots and along roads (pullouts). Parking areas were categorized as visitor day-use parking, visitor overnight parking, and administrative/employee parking. Special parking spaces were noted where they occur (large vehicle, commercial vehicle, tour bus, ABAAS, etc). These areas include Old Faithful, Canyon Village, the Canyon Rim drives, Midway Geyser Basin, and Norris Geyser Basin. Parking lot turnover rates were analyzed for these locations as well.

Conditions related to traffic flow and queuing at each of the five park entrance gates were documented and analyzed by time of day and by day of the week. Rates of gate processing were analyzed with respect to traffic congestion levels outside of the park. Comparative information was gathered across gates to inform analyses and future gate operations.

Vehicular capacity was determined for existing roadways, parking areas, and entrance infrastructure and systems for the entire park, as well as for the study intersections, roadways, and parking lots. Figure 01 on page 1 shows the study context and locations of data collection devices for this study.

HOW THIS STUDY IS ORGANIZED

This first introductory section of the study provides an overview of the purpose, background, context, and scope of the transportation and parking data collection and analysis assignment at Yellowstone National Park. Data collection methods, the seasonal adjustment factor, and the approach to analysis also are described in this section. The next sections of the study include the following information:

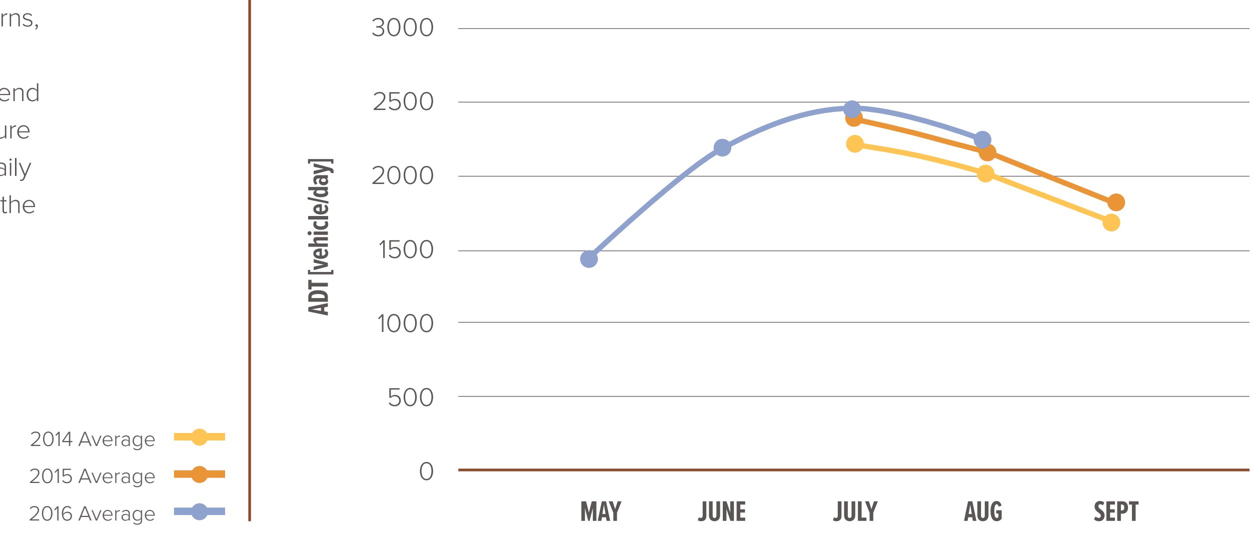
- **Traffic Conditions—**overall observations along with specific roadway and intersection analyses
- **Parking Conditions—**capacity and turn-over analysis at key locations, along with parking utilization observations
- **Vehicular Capacity—**observations related to projected vehicular capacity at the park
- **Visitor Flow Patterns—**entrance gate processing, origin-destination splits, visitor travel patterns in the park, visitor lodging patterns, and international visitor trends
- **Location-Specific Observations—**traffic and parking observations at several key sites throughout the park

While not included in this initial draft of the study, the team intends to add a "Recommendations" section to the final draft of the report based on further discussions and coordination with park staff at an upcoming workshop in March 2017.

SEASONAL ADJUSTMENT FACTOR

In order to analyze the park's peak conditions, historical volumes from Automatic Traffic Recorders (ATR) were used to calculate an adjustment factor to scale the volume data collected in August to July conditions, the peak season at the park. The seasonal adjustment factor provides a more accurate representation of the level of traffic that the park experiences during its peak visitation time. Using ATR data from May to August in 2016, adjustment factors were calculated for the weekend and weekday daily traffic. The only available complete data sets were from the ATRs in East Mammoth and at the South Gate. Based on the data from those sites, July weekend days experienced on average 13.4 percent more traffic than August weekend days. Similarly, July weekdays experienced 13.1 percent more traffic than August weekdays. As such, based on volumes from July and August 2016, adjustment factors of 1.131 and 1.134 were used to scale weekday and weekend day volumes, respectively. These adjustment factors were applied to the traffic analyses because they are volume dependent. However, the adjustment factors were not used in analyzing visitor patterns, parking, entrance processing or vehicular speed, since those depend on factors other than volume. Figure 02 shows a plot of the average daily traffic recorded used to calculate the seasonal adjustment factors.

FIGURE 02. 2014 - 2016 TRAFFIC DATA FROM ATRS



DATA COLLECTION METHODS

Data was collected over a three-day period in the park, from Sunday, August 14 through Tuesday, August 16, 2016. Pneumatic tubes were placed throughout the park to collect 24-hour traffic volume, class, and speed data to establish a baseline of existing conditions and operations for the area. Each gate had a set of tubes placed inside and outside the park, and each of the major roadways had a set of tubes across both lanes of traffic. A sample of Wi-Fi data also was collected at the locations of each set of tubes to analyze trip patterns. Travel monitor video was also recorded to capture intersection turning movements at Madison Junction, Norris Junction, Canyon Junction, North Rim Junction, and South Rim Junction during peak traffic times. Refer to Figure 01 on page 1 for the locations where these data collection devices were placed in the park.

In addition to these data collection methods, members of the study team observed and documented traffic and parking conditions and patterns at key locations throughout the park.

ANALYSIS APPROACH

TRAFFIC AND ROADWAY CONDITIONS

Circulation patterns were found by reviewing the Wi-Fi data gathered from all three days, especially from peak morning and afternoon periods. Raw data was used to find the most common routes that visitors would use from each gate and the travel time from each individual Wi-Fi station to each adjacent station. The study applied a typical approach in the transportation analysis field that evaluates the level of service (LOS) of roadway segments and intersections according to key factors such as delay (in seconds) and the flow through of traffic. LOS categories for roadways and intersections are presented in Tables 01 and 02.

For roadways, LOS is a qualitative measure used to understand and compare the quality of traffic service. LOS is used to analyze highways by categorizing traffic flow and assigning quality levels of traffic based on performance measures like speed, density, etc. The grades range from A to F, with LOS A representing free flowing traffic, and LOS F representing excessive delay or a breakdown in flow.

The roads in Yellowstone National Park serve as scenic and recreational routes and are considered class II two-lane highways according to the Highway Capacity Manual (HCM) 2010.

LOS on class II two-lane highways is defined in terms of percent time spent following (PTSF) another vehicle. PTSF on a two-lane highway is dependent on the following:

- Peak hour factor
- Percent of heavy vehicles (e.g., buses, RVs, etc.)
- Level vs rolling terrain
- Grade of the roadway
- Percent of no passing zones along the roadway
- Demand flow rates in each direction of the roadway

The LOS standards described in Tables 01 and 02 and the thresholds for rural and urban/suburban conditions are adopted standards used by jurisdictions and transportation professionals throughout the United States. The NPS currently does not have adopted standards or thresholds to assess traffic conditions on roadways or at intersections. In addition to applying these standards typically used in the transportation industry, the NPS applies a variety of factors for decision-making about transportation systems and visitor facilities inside park boundaries. Along with visitor safety and transportation functions, the NPS considers other factors such as visitor experience, resource protection, wildlife corridors, scenic qualities, minimizing noise, and a variety of other conditions. Each park may adopt a specific approach based on site specific context and resources, For purposes of this study, since the park exhibits rural conditions on its roadways, but urban/ suburban conditions at its intersections, LOS C was considered the threshold for roadways, and LOS D was considered the threshold for intersections. Highway Capacity Software (HCS) 2010 was used to analyze PTSF and LOS for the two-lane roads, and Synchro 7 using the HCM 2010 method was used to analyze delay and LOS at the park's intersections. All roadway and intersection volumes were adjusted by a heavy vehicle factor to account for RVs and buses and the seasonal adjustment factor to account for increased volumes seen during the peak visitation season in July. All volume measurements were scaled accordingly.

Based on the same ATR data, the average yearly growth was found to be around 5 percent during the three-year period from 2014-2016. In past years, the average annual growth rate was 3.7 percent. We recommend that the park assume an average annual growth range of 3.7 to 5 percent moving forward to proactively plan for potential future conditions.

PARKING AREA CONDITIONS

Capacities of each parking lot studied were provided by the NPS at the start of the study process. The study team counted vehicles in each lot during the three-day study period, from the beginning to end of each day from 6:00 am to 7:00 pm. The number of vehicles that entered and exited each lot was recorded and counted to track occupancy and vehicle dwell times. Turnover rates were calculated as cars per stall per hour and were dependent on the occupancy and dwell times in each lot. Parking studies do not use level of service as a metric to determine how they are operating, but instead use the parking lot occupancy compared to the supply. Target occupancies generally range from 85 percent to 90 percent to define the "effective" capacity of a parking supply on a typical peak day. For Yellowstone, a target occupancy of 90 percent was used to define the parking capacity. Parking lots with occupancy percentages at 90 percent and above are considered over capacity for the respective study time periods.

GATE CONDITIONS

To calculate the delay at each gate, a free-flow travel time was approximated from the Wi-Fi units inside and outside each gate. Subtracting that free-flow travel time from the travel times actually experienced during the peak hours provided an approximate delay time experienced at each gate. Average queue length was calculated by dividing the total number of vehicles counted by the pneumatic tubes by the delay time.

TABLE 01. ROADWAY LEVEL OF SERVICE STANDARDS

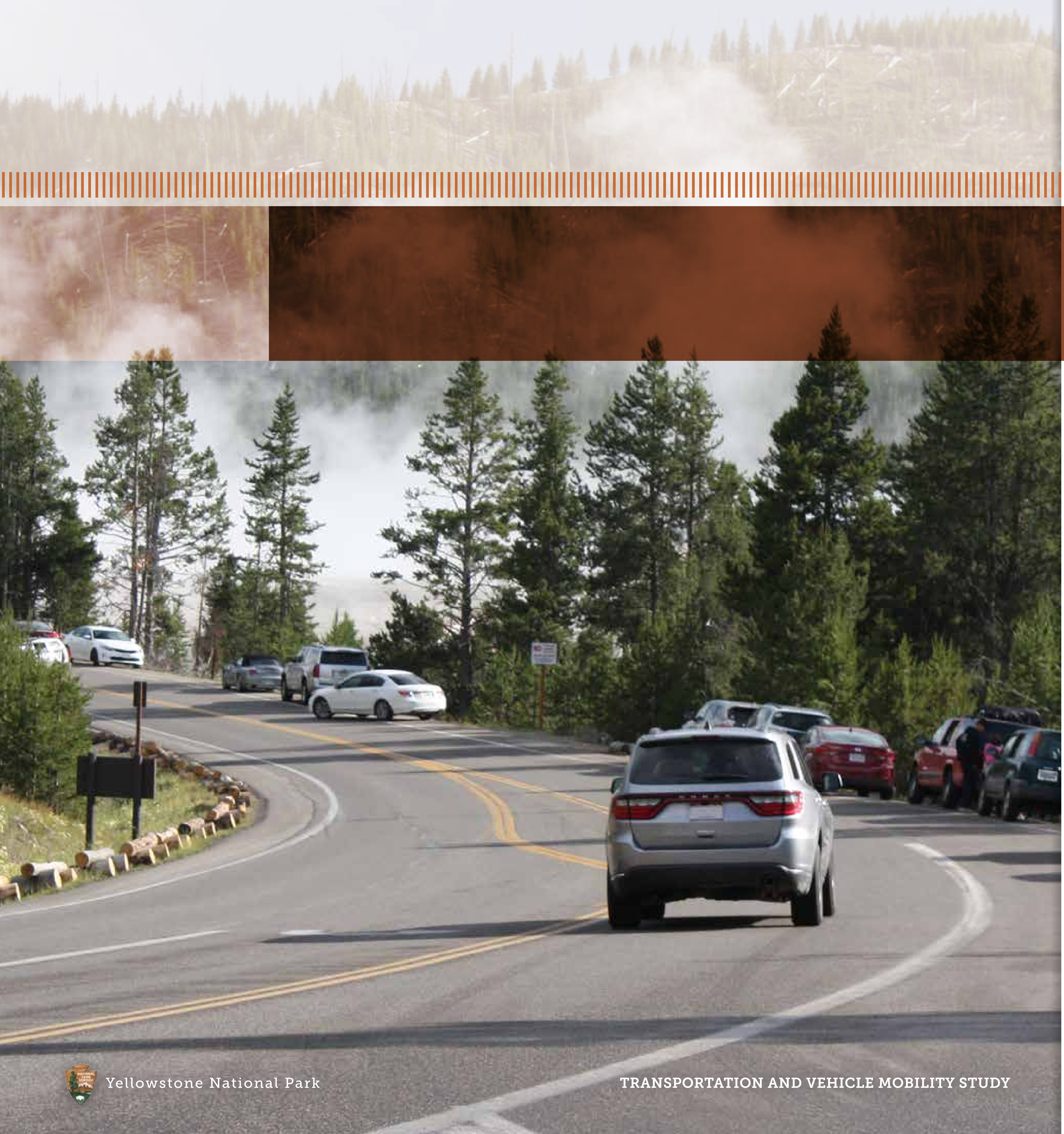
LEVEL OF SERVICE	DESCRIPTION	PERCENT TIME SPENT FOLLOWING
A	Speed would be controlled primarily by roadway conditions. A small amount of platooning would be expected.	< 40.0
B	The degree of platooning becomes noticeable. Some speed reductions are present.	> 40.0 to 55.0
C	Most vehicles are traveling in platoons. Speeds are noticeably curtailed.	> 55.0 to 70.0
D	Platooning increases significantly. Passing demand is high, but passing capacity approaches zero. A high percentage of vehicles are now traveling in platoons.	> 70.0 to 85.0
E	Demand is approaching capacity. Passing is virtually impossible. Speeds are seriously curtailed. The lower limit of this LOS represents capacity.	> 85.0
F	Whenever demand flow in one or both directions exceeds the capacity of the segment. Operating conditions are unstable, and heavy congestion exists.	-

Source: 2010 Highway Capacity Manual.

TABLE 02. UNSIGNALIZED INTERSECTION LOS CRITERIA

LEVEL OF SERVICE	DESCRIPTION	DELAY IN SECONDS
A	***Free Flow / Insignificant Delay*** Extremely favorable progression. Individual users are virtually unaffected by others in the traffic stream.	< 10.0
B	***Stable Operations / Minimum Delays*** Good progression. The presence of other users in the traffic stream becomes noticeable.	> 10.0 to 15.0
C	***Stable Operations / Acceptable Delays*** Fair progression. The operation of individual users is affected by interactions with others in the traffic stream.	> 15.0 to 25.0
D	***Approaching Unstable Flows / Tolerable Delays*** Marginal progression. Operating conditions are noticeably more constrained.	> 25.0 to 35.0
E	***Unstable Operations / Significant Delays Can Occur*** Poor progression. Operating conditions are at or near capacity.	> 35.0 to 50.0
F	***Forced, Unpredictable Flows / Excessive Delays*** Unacceptable progression with forced or breakdown of operating conditions.	> 50.0

Source: 2010 Highway Capacity Manual.



TRAFFIC CONDITIONS

OVERVIEW

This section of the study presents findings related to data collection and analysis of major roadway segments and intersections in the park, along with information about trip distribution and vehicle speeds. Evaluations of roadway and intersection LOS also are provided. Additional observations related to traffic and parking pertaining to specific locations are presented in the "Location-Specific Observations" section of this study.

ROADWAY NETWORK

The figure eight configuration of the Grand Loop Road in the park connects gateway communities and gates with the major developed areas of Mammoth Hot Springs, Canyon Village, Old Faithful, Lake Village, and Grant Village, as well many other attractions throughout the park. The following roadway segments were analyzed based on volumes and LOS evaluation:

- West Gate to Madison
- Madison to Old Faithful
- Old Faithful to West Thumb
- South Gate to West Thumb
- West Thumb to Fishing Bridge
- Fishing Bridge to East Gate
- Canyon to Fishing Bridge
- Norris to Canyon
- Madison to Norris
- North Gate to Mammoth
- Mammoth to Roosevelt
- Canyon to Roosevelt
- Northeast Gate to Roosevelt

TRIP DISTRIBUTION

The pneumatic tube counters were used to record how many vehicles entered and exited the park at each gate. Table 03 shows the number of vehicles that entered and exited the park each day (adjusted to July conditions), as well as the number of vehicles that stayed in the park overnight.

TABLE 03.
PARK-WIDE ENTERING AND EXITING VEHICLES

	SUNDAY	MONDAY	TUESDAY
Entered Park	13,054	13,703	13,415
Exited Park	9,512	13,444	12,981
Stayed in Park	3,542 (27%)	259 (2%)	434 (3%)

Three-day average number of vehicles entering at each of the five respective gates are listed to the right on this page. In review of the data collected, the most popular gate is West Gate, followed by North Gate, South Gate, East Gate, and Northeast Gate. This order is fairly consistent between the three days – the only change is on Sunday when the South and North Gates swap positioning for second most popular.

The gates in numerical order of the highest to lowest amount of total daily traffic (entering and exiting) are:

1. **West Gate:** 10,190
2. **North Gate:** 6,100
3. **South Gate:** 5,730
4. **East Gate:** 3,170
5. **Northeast Gate:** 2,030

The gates in numerical order of the highest to lowest amount of daily bus traffic are:

1. **West Gate:** 410
2. **South Gate:** 230
3. **North Gate:** 180
4. **East Gate:** 160
5. **Northeast Gate:** 40

The gates in numerical order of the highest to lowest amount of daily RV traffic are:

1. **West Gate:** 920
2. **North Gate:** 550
3. **South Gate:** 460
4. **East Gate:** 290
5. **Northeast Gate:** 200

This analysis shows that the West Gate is almost 40% busier than the next busiest gates (North and South Gates). The West Gate also has nearly double the amount of bus and recreational vehicle traffic than the next two busiest gates.

VEHICLE SPEEDS

Pneumatic tubes were used to collect vehicle speed data at one location along each of the roadway segments in the park. The 85th percentile speed ranged between two to eight miles per hour above the posted speed limit. In general, wider roads tend to induce higher speeds. Higher speeds do not directly result in an increase in crashes but could increase the severity of crashes. However, side friction from horizontal curvature, wildlife viewing, pullouts, driveways, and dense foliage is likely a higher factor in affecting the travel speed on the roadways in the park than the width of the roadways. The graphs that show the 85th percentile speed at each study location are included in the appendix.

ROADWAY VOLUMES

Average daily traffic (ADT) volumes were collected for the major roadways in the park. Figure 03 shows total ADT per segment and the percentage of bus and recreational vehicle (RV) traffic within the total daily traffic volume. The ADT shown is the highest ADT from the three days observed – adjusted up to July conditions. The ADT numbers are rounded to the nearest 10 vehicles.

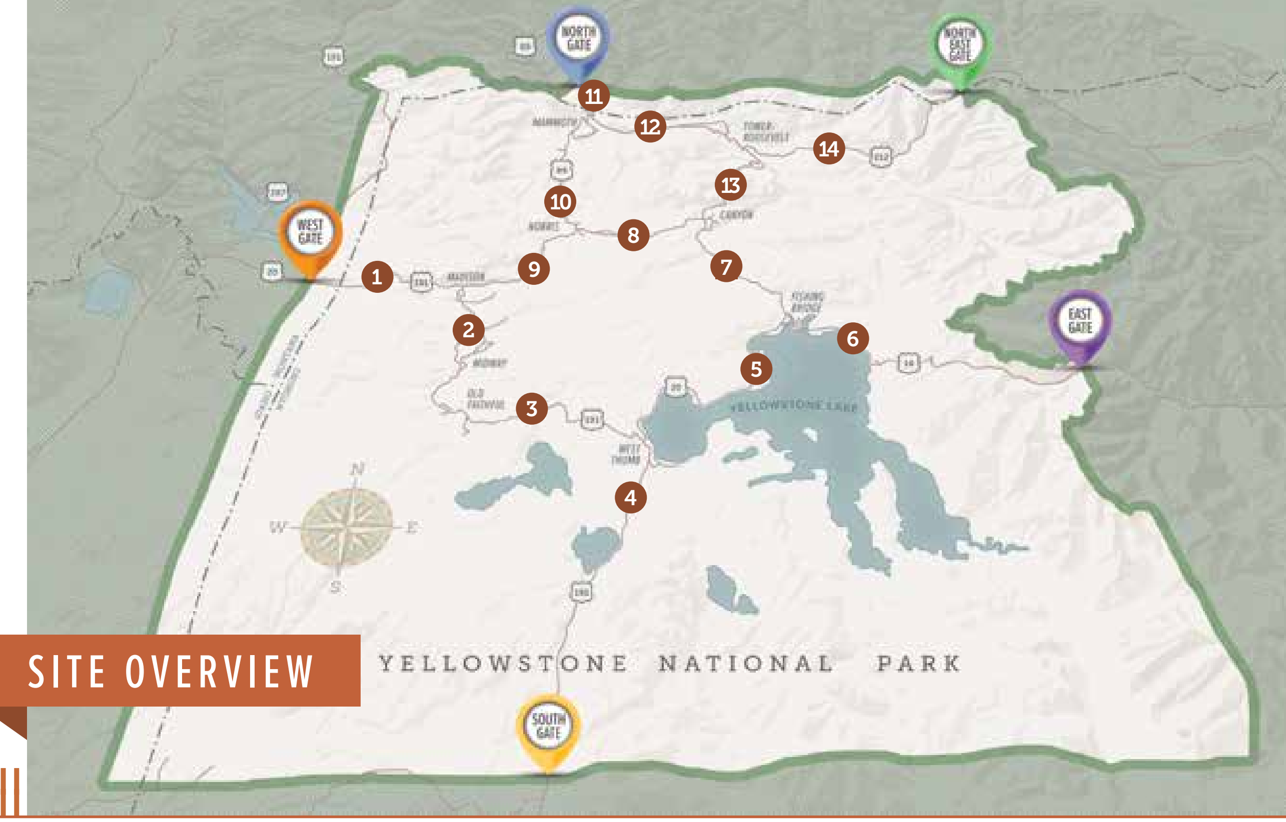
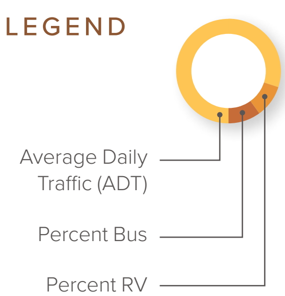


FIGURE 03.

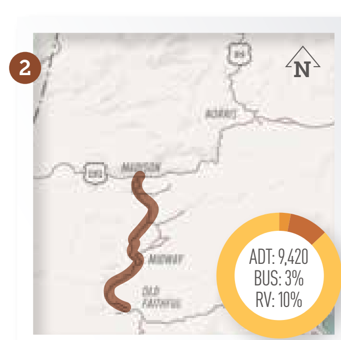
AVERAGE DAILY WEEKDAY ROADWAY VOLUMES

ADJUSTED TO AVERAGE WEEKDAY IN JULY

LEGEND

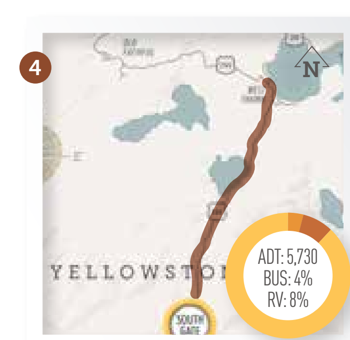


ROAD SEGMENT
WEST GATE TO MADISON

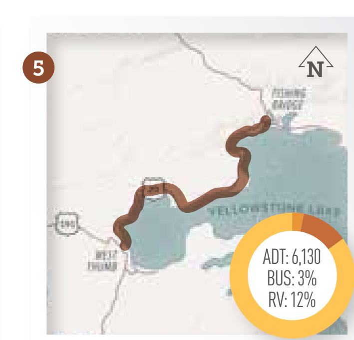


ROAD SEGMENT
MADISON TO OLD FAITHFUL

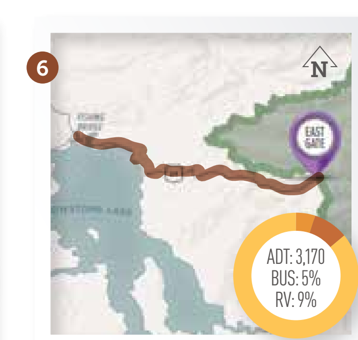
ROAD SEGMENT
OLD FAITHFUL TO WEST THUMB



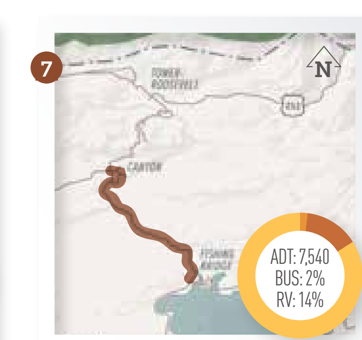
ROAD SEGMENT
SOUTH GATE TO WEST THUMB



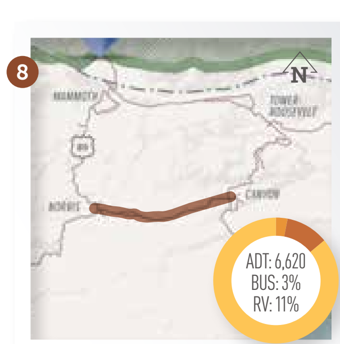
ROAD SEGMENT
FISHING BRIDGE TO WEST THUMB



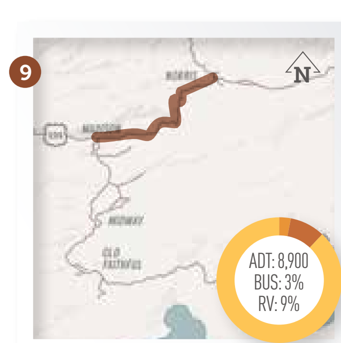
ROAD SEGMENT
EAST GATE TO FISHING BRIDGE



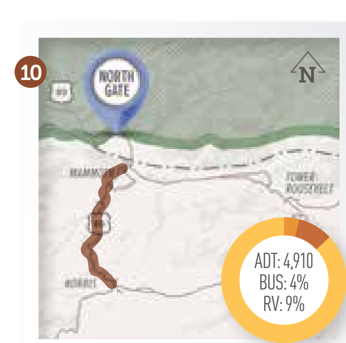
ROAD SEGMENT
CANYON TO FISHING BRIDGE



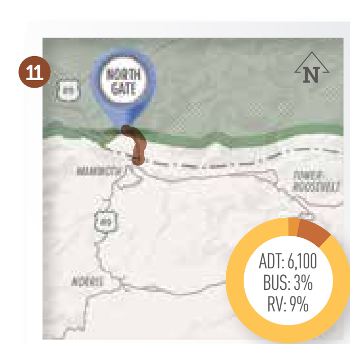
ROAD SEGMENT
NORRIS TO CANYON



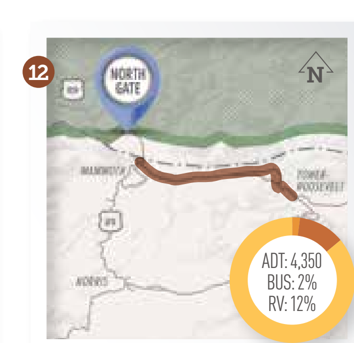
ROAD SEGMENT
MADISON TO NORRIS



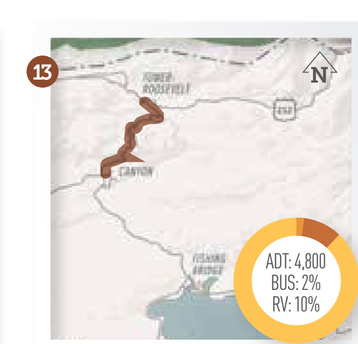
ROAD SEGMENT
MAMMOTH TO NORRIS



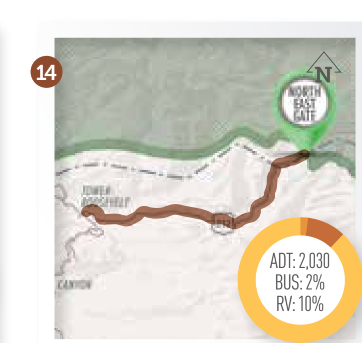
ROAD SEGMENT
NORTH GATE TO MAMMOTH



ROAD SEGMENT
MAMMOTH TO ROOSEVELT



ROAD SEGMENT
CANYON TO ROOSEVELT



ROAD SEGMENT
NORTHEAST GATE TO ROOSEVELT

ROADWAY LEVEL OF SERVICE ANALYSIS

ROADWAY LOS SUMMARY

Seven of the roadways in the park operate at LOS C or better while the other seven operate at LOS D with regards to percent time spent following another car (PTSF). The segments that operate worse than the threshold of LOS C include the following: 1) Canyon – Lake, 2) Canyon – Norris, 3) Madison – Norris, 4) Madison – Old Faithful, 5) North Gate – Mammoth, 6) Old Faithful – West Thumb, 7) West Gate – Madison. Table 04 reports LOS and PTSF at all of the study roadways. Detailed descriptions of the roadway operations are provided later in this report.

Using HCS 2010 and the HCM 2010 thresholds defined on page 4, the existing weekday peak hour LOS was computed for each study roadway. The results of this analysis for the weekday peak hours are reported in Figure 04 (see Appendix for the detailed LOS reports). See page 4 for the LOS descriptions. This analysis assumes the roadway widths as of August 2016.

TABLE 04.
PEAK SEASON ROADWAY LEVEL OF SERVICE SUMMARY

	ROADWAY	EXISTING LOS	PTSF
1	West Gate to Madison	D	82%
3	Old Faithful to West Thumb	D	79%
2	Madison to Old Faithful	D	78%
11	North Gate to Mammoth	D	73%
9	Madison to Norris	D	73%
8	Norris to Canyon	D	72%
7	Canyon to Fishing Bridge	D	71%
6	East Gate to Fishing Bridge	C	68%
10	Mammoth to Norris	C	66%
4	South Gate to West Thumb	C	66%
13	Canyon to Roosevelt	C	64%
5	Fishing Bridge to West Thumb	C	64%
12	Mammoth to Roosevelt	C	61%
14	Northeast Gate to Roosevelt	B	51%

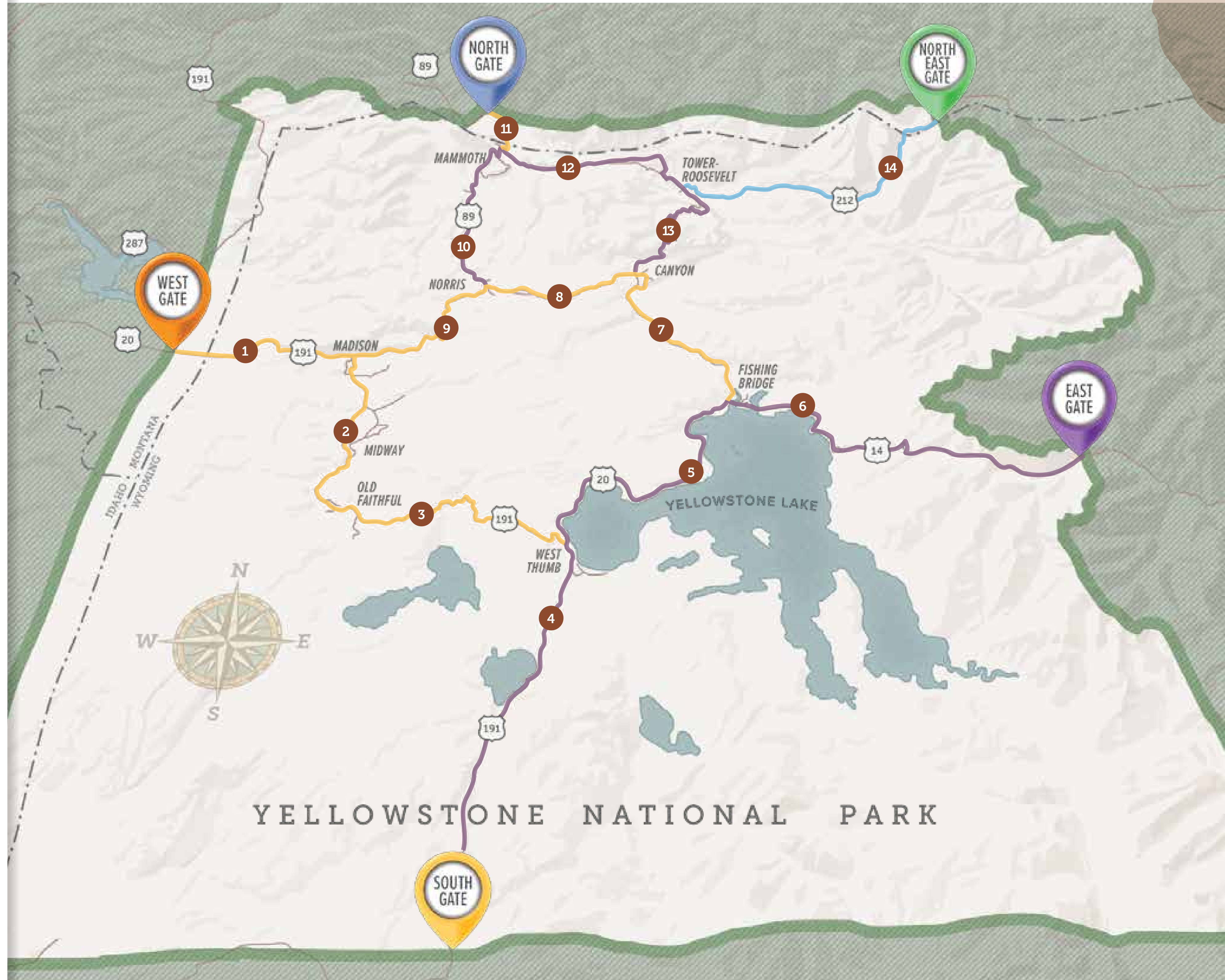
Note: analysis assumes roadway widths as of August 2016.

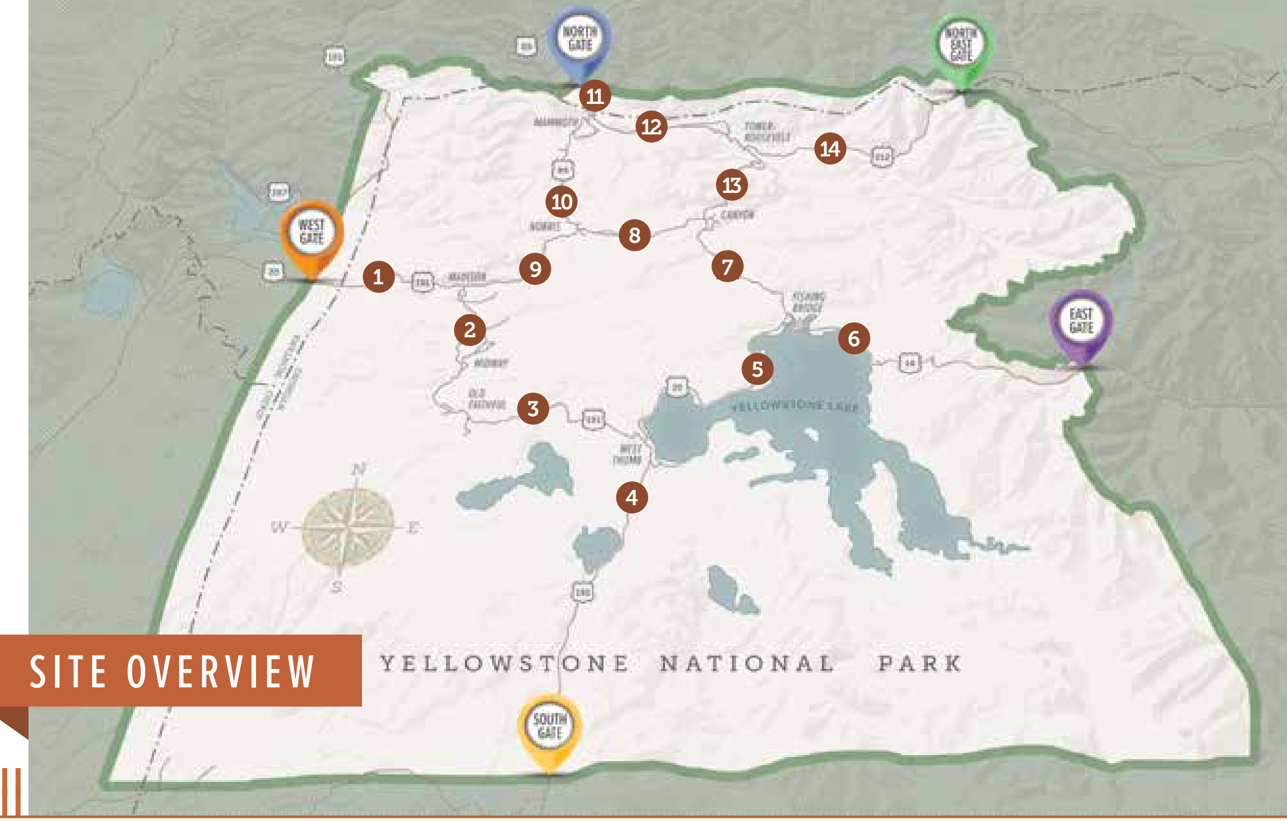
FIGURE 04. ROADWAY LEVEL OF SERVICE

LEGEND

A B C D E F

Level of Service (LOS)





SITE OVERVIEW

YELLOWSTONE NATIONAL PARK

FIGURE 05.

PEAK HOUR WEEKDAY ROADWAY LEVEL OF SERVICE

ADJUSTED TO AVERAGE WEEKDAY IN JULY

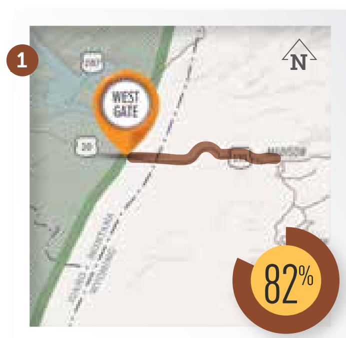
LEGEND

XX%

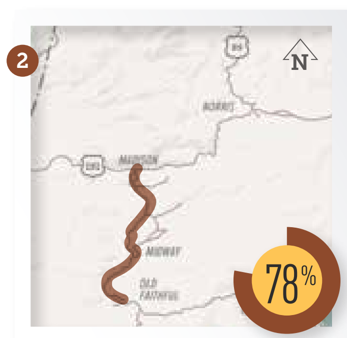
Level of Service (LOS)

A B C D E F

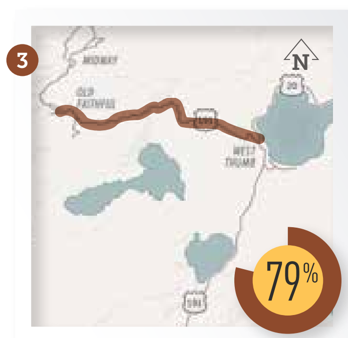
Percent Time Spent Following Another Vehicle (PTSF)



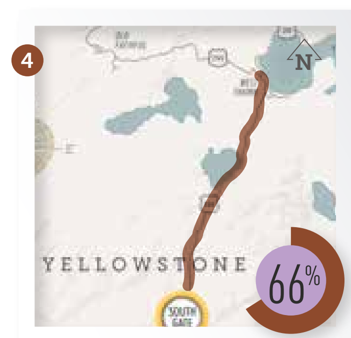
ROAD SEGMENT
WEST GATE TO MADISON



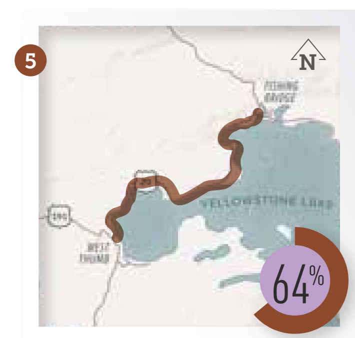
ROAD SEGMENT
MADISON TO OLD FAITHFUL



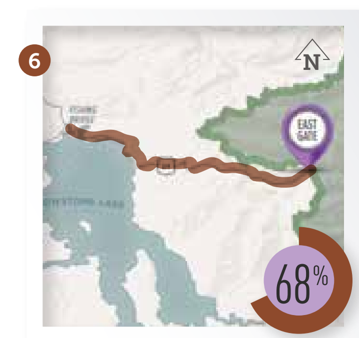
ROAD SEGMENT
OLD FAITHFUL TO WEST THUMB



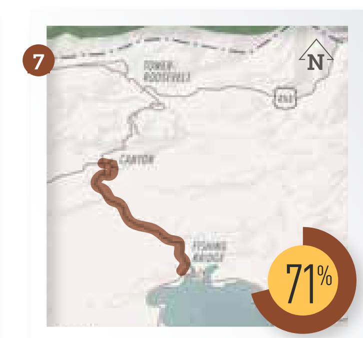
ROAD SEGMENT
SOUTH GATE TO WEST THUMB



ROAD SEGMENT
FISHING BRIDGE TO WEST THUMB

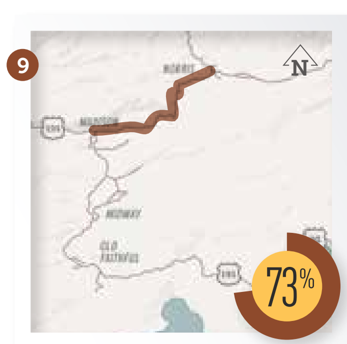


ROAD SEGMENT
EAST GATE TO FISHING BRIDGE

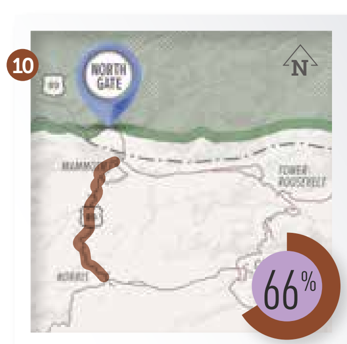


ROAD SEGMENT
CANYON TO FISHING BRIDGE

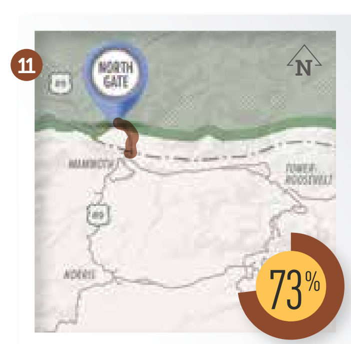
ROAD SEGMENT
NORRIS TO CANYON



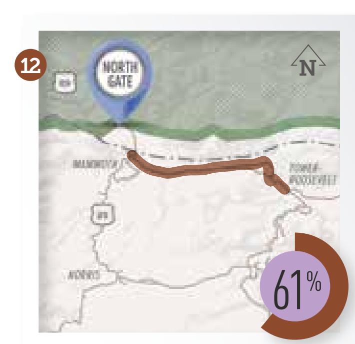
ROAD SEGMENT
MADISON TO NORRIS



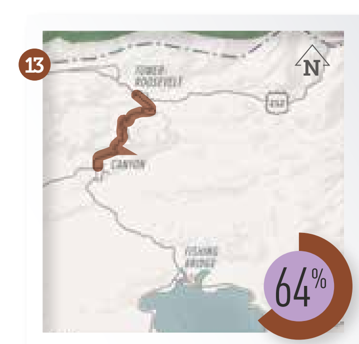
ROAD SEGMENT
MAMMOTH TO NORRIS



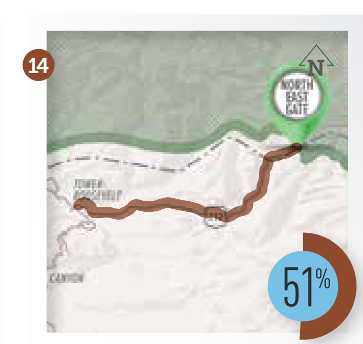
ROAD SEGMENT
NORTH GATE TO MAMMOTH



ROAD SEGMENT
MAMMOTH TO ROOSEVELT



ROAD SEGMENT
CANYON TO ROOSEVELT



ROAD SEGMENT
NORTHEAST GATE TO ROOSEVELT

INTERSECTION LEVEL OF SERVICE ANALYSIS

INTERSECTION LOS SUMMARY

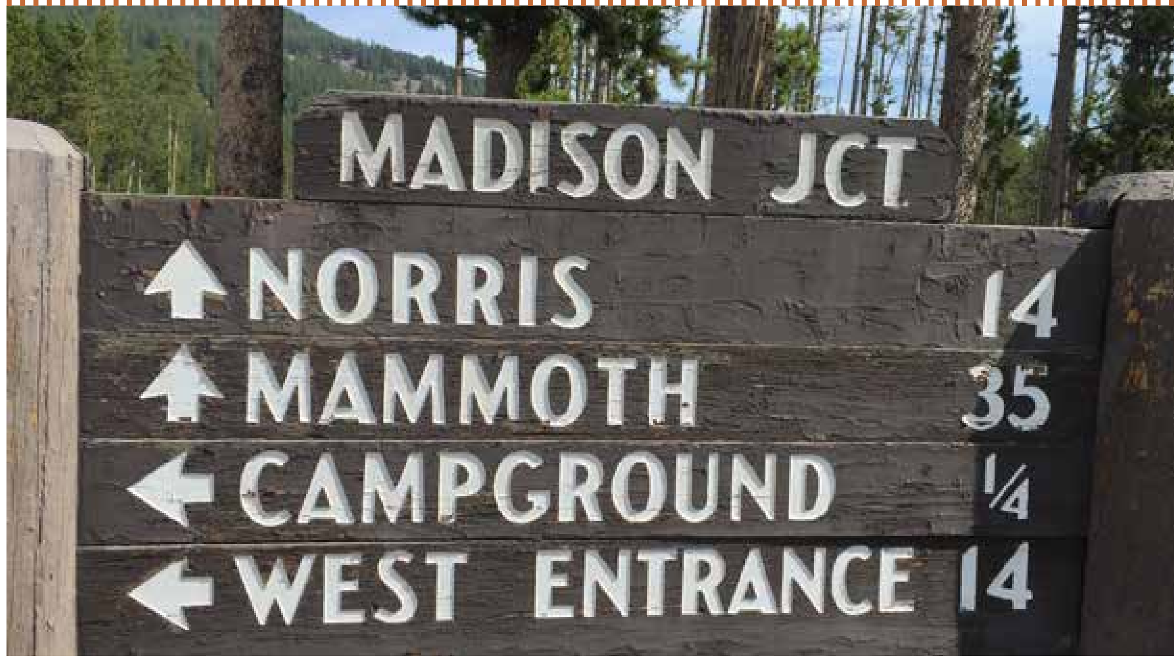
The capacity of an intersection is dependent on the number of vehicles that can use the intersection before it reaches a LOS D.For purposes of this study, LOS D is considered the intersection capacity threshold. Since all of the intersections are unsignalized in the park, all of the LOS calculations at the intersections were based on the worst movement at each intersection. Table 05 reports the LOS at the five study intersections (Roosevelt Junction is not included because it was only studied for a single hour on a single day). The intersection analysis shows that Madison and Canyon Junctions have operational issues during at least one peak hour of the day – the remaining intersections operate at a LOS D or better for the peak hours.

Based on intersection analysis, Madison and Canyon junctions operate worse than the established LOS D threshold during at least one peak part of the day. Table 01 reports LOS at five of the study intersections. For unsignalized intersections, the worst movement delay and LOS are reported. Using Synchro software and the HCM 2010 thresholds, the existing weekday AM and PM peak hour LOS were computed for each intersection studied, as shown in Table 05. The results of this analysis for the weekday and weekend AM and PM peak hours are reported in Figures 06-08 on the following pages (see Appendix for the detailed LOS report). See page 4 for LOS descriptions.

TABLE 05.
AM AND PM PEAK HOUR LEVEL OF SERVICE SUMMARY

INTERSECTION LOCATION	INTERSECTION PERIOD	EXISTING BACKGROUND LOS & SEC/VEH [1]
Madison Junction	Weekend AM	D / 31
Madison Junction	Weekend PM	E / 42
Madison Junction	Weekday AM	E / 45
Madison Junction	Weekday PM	E / 43
Norris Junction	Weekend AM	C / 24
Norris Junction	Weekend PM	C / 26
Norris Junction	Weekday AM	C / 18
Norris Junction	Weekday PM	D / 43
Canyon Junction	Weekend AM	D / 33
Canyon Junction	Weekend PM	C / 21
Canyon Junction	Weekday AM	D / 36
Canyon Junction	Weekday PM	E / 46
North Rim Junction	Weekend AM	A / 3
North Rim Junction	Weekend PM	A / 2
North Rim Junction	Weekday AM	A / 3
North Rim Junction	Weekday PM	A / 3
South Rim Junction	Weekend AM	B / 14
South Rim Junction	Weekend PM	B / 14
South Rim Junction	Weekday AM	C / 18
South Rim Junction	Weekday PM	C / 15

[1] Worst movement LOS and delay for unsignalized intersections.
SEC/VEH = seconds per vehicle



The worst LOS is likely to occur in July during the busiest time of the year. Since weekdays tend to be the busier in the park than weekends, weekdays would likely produce worse LOS than weekends. Most intersections have a peak period in the morning and afternoon, but Roosevelt Junction only has one daily peak due to the relatively lower total volumes. The peak morning and afternoon traffic time at each intersection will vary by day as shown on the right. Roosevelt, Lake, and West Thumb Junction peaks were based on pneumatic tube counts while the peak of the remaining Junctions were based on intersection counts.

WEEKEND (SUNDAY)

- **Madison Junction:** morning peak hour—**11:00 AM**, afternoon peak hour—**4:30 PM**
- **Norris Junction:** morning peak hour—**11:00 AM**, afternoon peak hour—**3:30 PM**
- **Canyon Junction:** morning peak hour—**12:00 PM**, afternoon peak hour—**3:30 PM**
- **Roosevelt Junction:** peak hour—**2:30 PM**
- **Lake Junction:** morning peak hour—**11:30 AM**, afternoon peak hour—**3:30 PM**
- **West Thumb Junction:** morning peak hour—**11:00 AM**, afternoon peak hour—**3:00 PM**

WEEKDAY (MONDAY & TUESDAY)

- **Madison Junction:** morning peak hour—**11:00 AM**, afternoon peak hour—**5:30 PM**
- **Norris Junction:** morning peak hour—**11:00 AM**, afternoon peak hour—**4:30 PM**
- **Canyon Junction:** morning peak hour—**12:00 PM**, afternoon peak hour—**3:30 PM**
- **Roosevelt Junction:** peak hour—**2:30 PM**
- **Lake Junction:** morning peak hour—**12:00 PM**, afternoon peak hour—**3:30 PM**
- **West Thumb Junction:** morning peak hour—**11:00 AM**, afternoon peak hour- —**2:30 PM**

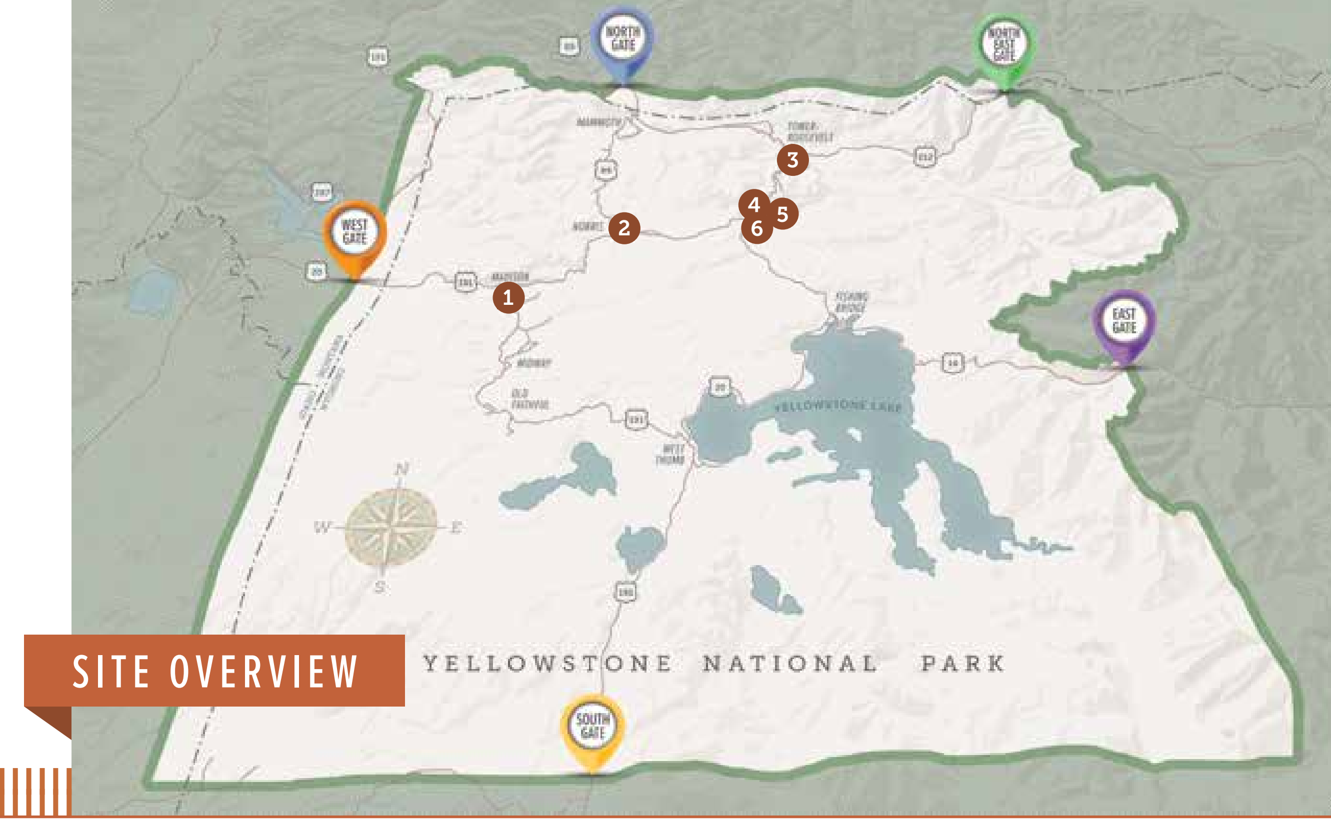


FIGURE 06.

HIGHEST PEAK HOUR INTERSECTION LEVEL OF SERVICE

ADJUSTED TO AVERAGE WEEKDAY IN JULY

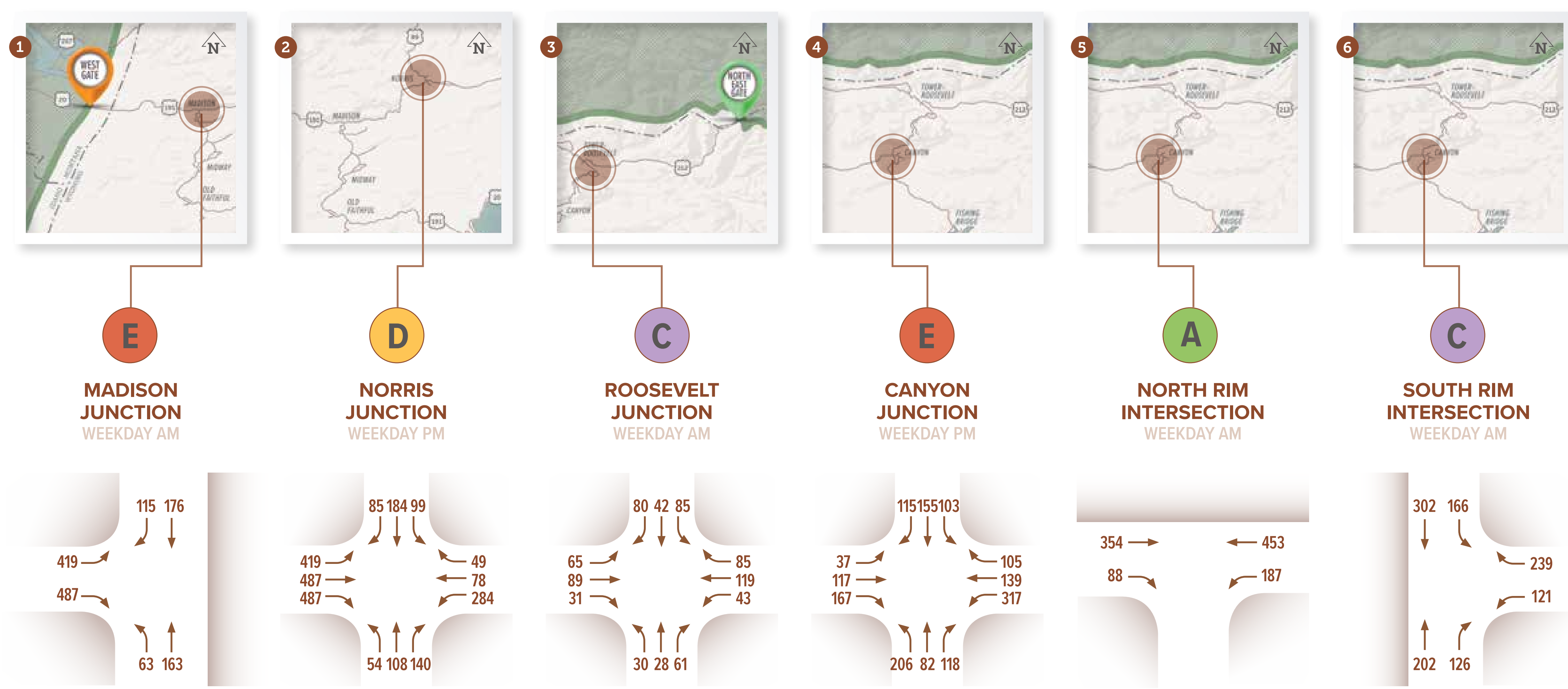
LEGEND

Level of Service (LOS)

A B C D E F

Intersection Analysis Locations

Peak Hour Turning Movement Traffic Volumes —Vehicles Per Hour (VPH)



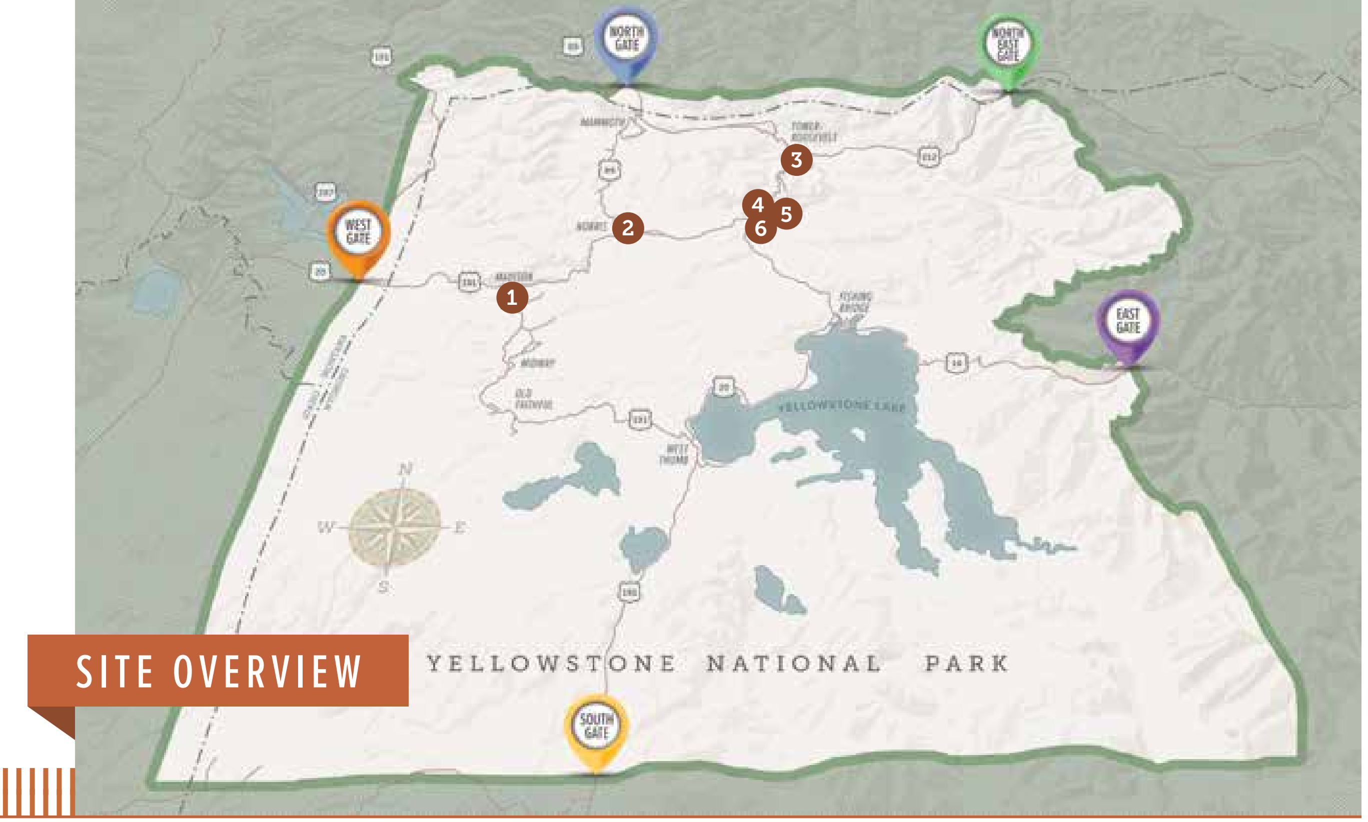


FIGURE 07.

PEAK HOUR INTERSECTION LEVEL OF SERVICE - WEEKDAY AM (PM)

ADJUSTED TO AVERAGE WEEKDAY IN JULY

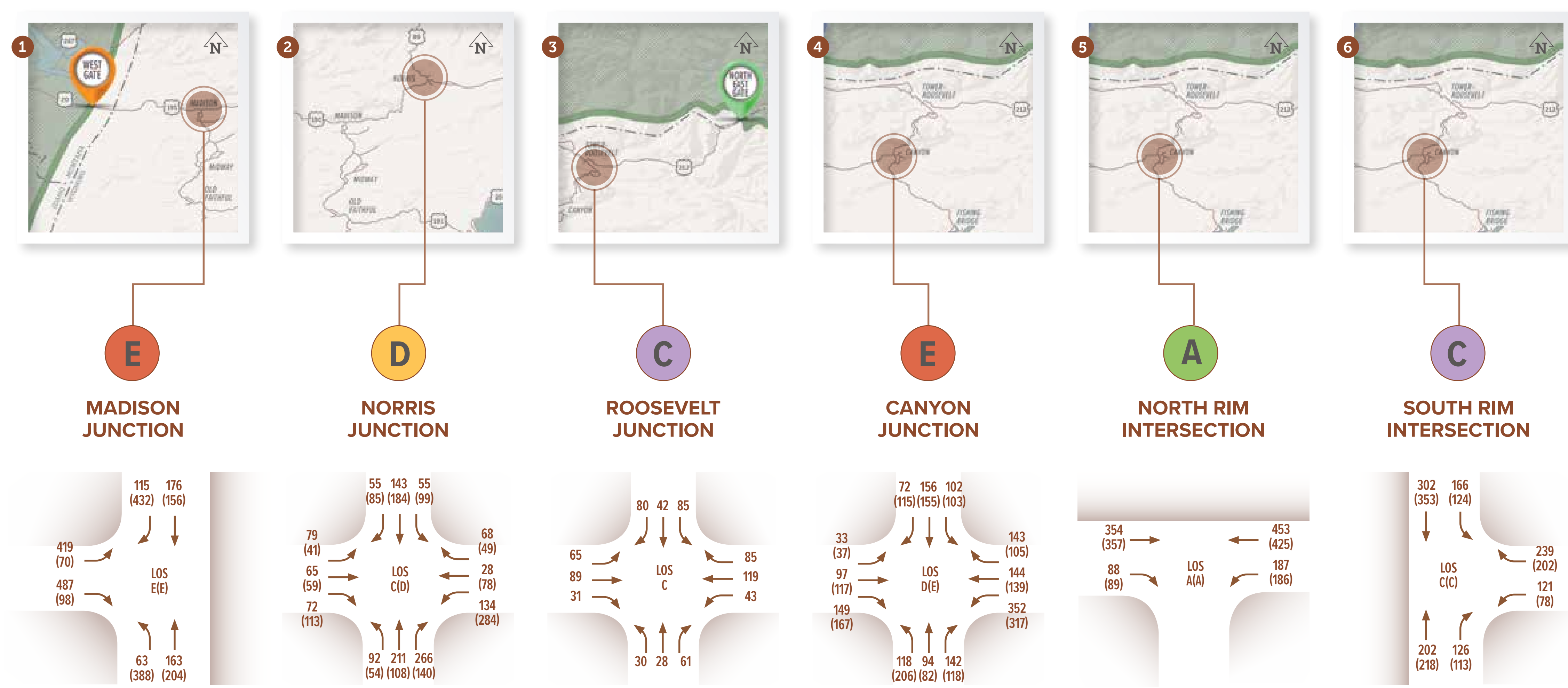
LEGEND

Level of Service (LOS)

A B C D E F

Intersection Analysis Locations

Peak Hour Turning Movement Traffic Volumes —Vehicles Per Hour (VPH)



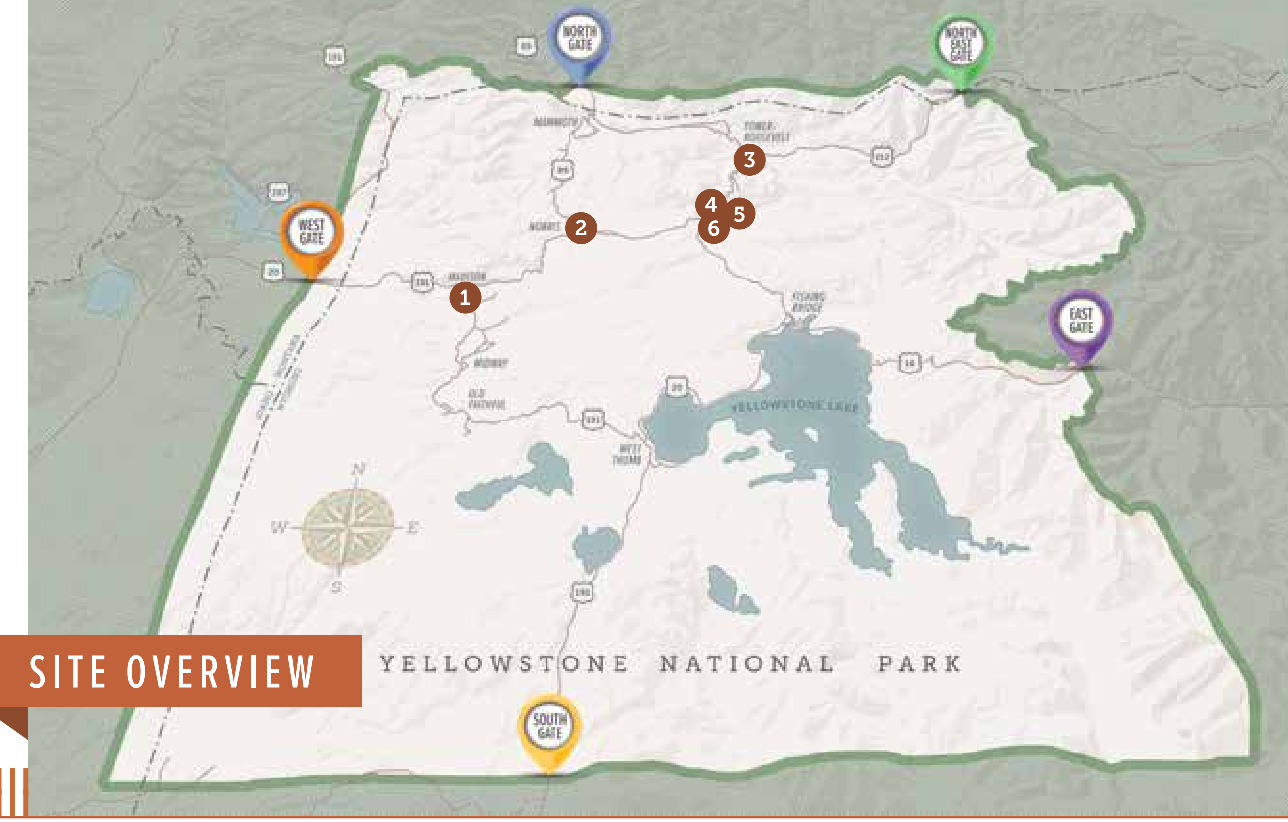


FIGURE 08.

PEAK HOUR INTERSECTION LEVEL OF SERVICE - WEEKEND AM (PM)

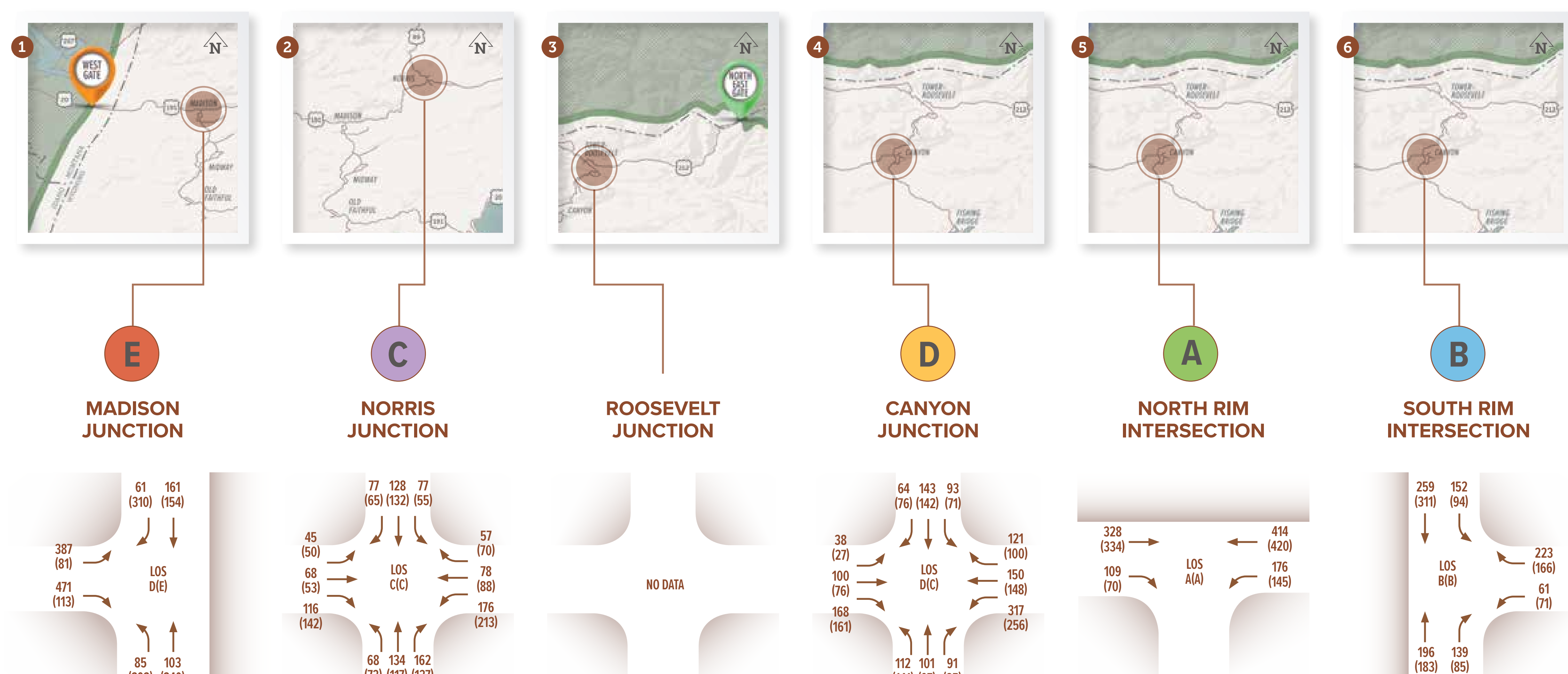
ADJUSTED TO AVERAGE WEEKDAY IN JULY

LEGEND

Level of Service (LOS)
A B C D E F

Intersection Analysis Locations

Peak Hour Turning Movement Traffic Volumes —Vehicles Per Hour (VPH)



TWO-WAY VS ALL-WAY STOPS

As part of the study, three intersections were analyzed to see if they were good candidates to switch from two-way stop controlled to all-way stop controlled to improve safety. Using volumes collected at the intersections, Synchro analyses were performed at Madison junction, Roosevelt Junction, and South Rim Junction.

MADISON JUNCTION

At Madison Junction, converting to an all-way stop controlled intersection increased the total delay in all scenarios (AM and PM peak hours for weekend and weekday) by an average of 43%. In the morning scenarios, the worst movement (eastbound left-turn) delay remained about the same and improved in the afternoon scenarios. However, due to the large increase in total delay, converting Madison Junction to an all-way stop controlled intersection is not recommended at this time.

ROOSEVELT JUNCTION

At Roosevelt Junction, converting to an all-way stop controlled intersection did not significantly affect the total delay in any scenario. However, the worst movement delay improved in the afternoon scenarios changing from LOS C with 17 seconds of delay to LOS B with 11 seconds of delay. Due to the large volume of horse traffic and the favorable impact to delay, converting Roosevelt Junction to an all-way stop controlled intersection could actually prove to be beneficial.

SOUTH RIM JUNCTION

At South Rim Junction, converting to an all-way stop controlled intersection increased the total delay in all scenarios by an average of 161%. In the weekday afternoon scenario, the worst movement delay improved, but it worsened in all other scenarios. Due to the increase in total delay and worst movement delay in most scenarios, converting South Rim Junction to an all-way stop controlled intersection is not recommended at this time.

PARKING CONDITIONS

OVERVIEW

This section of the study provides data collection results and analysis of several key parking areas in the park. General observations are described, followed by parking capacity and turn-over, along with parking utilization analysis at some of the more consistently congested locations. Additional observations related to traffic and parking pertaining to specific locations are presented in the "Location-Specific Observations" section of this study.

GENERAL OBSERVATIONS

During the study, all parking areas that were examined reached capacity for several hours each day. Larger attractions like Old Faithful and Canyon Village that had more available parking only reached or exceeded capacity during the peak hours of the day. However, other parking areas like Norris Geyser, Midway Geyser Basin, North Rim and South Rim reached or exceeded capacity for 6-8 hours each day. The parking along North Rim road was particularly susceptible to overflowing.

Of the five park entrances, the north and south gates experience the highest delays and longest queues and would benefit the most from significant improvements.

PARKING CAPACITY & TURNOVER

OVERVIEW

According to a GIS database maintained by the park, there are roughly 16,680 parking stalls in 254 parking lots and pullouts throughout the entire park. 4,470 of those parking stalls are typical striped passenger car stalls, 254 are striped accessible parking stalls, 261 are striped oversized stalls (for RV's and buses), and 210 are striped administrative stalls. The rest of the stalls are all non-striped stalls.

Of the parking lots and pullouts throughout the park, the following eleven were chosen as the key study areas: Old Faithful-East, Old Faithful-Central, Old Faithful-Inn, Midway Geyser, Norris Geyser, Canyon Village, Upper Falls, Wapiti Lake, Uncle Tom, Artist Point, and North Rim. It should be noted that parking occupancy data is not available for the other parking lots and pullouts that were not evaluated in this study.

Table 06 shows the percentage of parking stalls occupied throughout the third day of the study (Tuesday, August 16). This singular day was used because it represents the highest parking utilization numbers from the three days observed. Understanding that there would be more parking congestion in July, the August parking utilization numbers were not adjusted to July conditions due to the lack of July season parking data to accurately seasonally adjust (without historical data it is difficult to assume the seasonal affects as was possible on roadway traffic).

Parking studies do not use level of service to determine how they are operating, but instead use the parking lot occupancy versus the supply. For Yellowstone National Park, a target occupancy of 90% was used to define the "effective" capacity of a parking supply on a typical peak day. Therefore, any parking lot with occupancies over 90% are considered "over-capacity" for those respective time periods.

All parking areas that were examined during this study reached capacity for several hours each day.

TABLE 06.
PARKING OCCUPANCY (%)

	OLD F INN	OLD F CENTRAL	OLD F EAST	OLD F TOTAL	MIDWAY GEYSER	NORRIS GEYSER	CANYON VILLAGE	UPPER FALLS	WAPITI LAKE	UNCLE TOM	ARTIST POINT	SOUTH RIM TOTAL	NORTH RIM
6:00 AM	**114%**	32%	1%	25%	4%	1%	4%	1%	9%	2%	7%	6%	-
7:00 AM	**108%**	35%	4%	27%	24%	4%	14%	1%	11%	7%	12%	10%	-
8:00 AM	**91%**	41%	12%	31%	60%	17%	27%	8%	16%	11%	14%	13%	-
9:00 AM	87%	46%	35%	45%	**153%**	51%	41%	12%	29%	47%	25%	34%	-
10:00 AM	79%	50%	63%	62%	**162%**	**113%**	45%	25%	47%	**111%**	67%	80%	-
11:00 AM	64%	58%	86%	75%	**176%**	**148%**	54%	32%	62%	**140%**	**94%**	**105%**	**114%**
12:00 PM	67%	75%	**118%**	**99%**	**180%**	**131%**	81%	36%	**104%**	**160%**	**113%**	**129%**	**156%**
1:00 PM	71%	80%	**127%**	**106%**	**180%**	**128%**	**97%**	38%	**109%**	**151%**	**119%**	**129%**	**168%**
2:00 PM	79%	82%	**123%**	**106%**	**178%**	**133%**	**91%**	43%	**98%**	**137%**	**120%**	**122%**	**167%**
3:00 PM	87%	71%	**120%**	**101%**	**169%**	**126%**	82%	43%	67%	**123%**	**112%**	**108%**	**152%**
4:00 PM	**95%**	55%	**91%**	81%	**173%**	**122%**	72%	30%	42%	**127%**	83%	**92%**	-
5:00 PM	**104%**	52%	76%	73%	**156%**	**107%**	62%	18%	13%	**99%**	72%	71%	-
6:00 PM	88%	33%	42%	46%	**176%**	73%	66%	10%	7%	49%	61%	47%	-

TABLE 07.
PARKING AVERAGE DWELL TIMES

LOCATION	SUNDAY DWELL [H:MM:SS]	MONDAY DWELL [H:MM:SS]	TUESDAY DWELL [H:MM:SS]	3-DAY AVERAGE DWELL [H:MM:SS]
Old F Inn	1:35:31	1:17:10	1:29:53	1:27:31
Old F Central	0:49:32	1:08:27	1:01:59	0:59:59
Old F East	1:00:48	1:04:54	1:12:23	1:06:02
Midway Geyser	0:41:40	0:54:13	0:35:50	0:43:54
Norris Geyser	1:00:00	0:53:43	0:55:42	0:56:28
Canyon Village	0:42:42	0:36:05	0:45:11	0:41:19
Upper Falls	0:25:34	0:24:23	0:20:58	0:23:38
Wapiti Lake	1:00:40	0:46:26	0:55:01	0:54:02
Uncle Tom	0:41:54	0:38:44	0:44:59	0:41:52
Artist Point	0:33:52	0:35:52	0:38:37	0:36:07
North Rim	0:31:58	0:36:17	0:38:53	0:35:43

TABLE 08.
PARKING CAPACITY AND TURNOVER RATES (VEHICLES/STALL/HOUR)

LOCATION	CAPACITY	SUNDAY TURNOVER	MONDAY TURNOVER	TUESDAY TURNOVER	3-DAY AVERAGE TURNOVER
Old F Inn	150	0.58	0.53	0.53	0.55
Old F Central	313	0.26	0.29	0.28	0.28
Old F East	640	0.64	0.70	0.73	0.69
Midway Geyser	55	2.32	2.49	2.79	2.53
Norris Geyser	143	1.19	1.18	1.21	1.19
Canyon Village	349	0.86	0.92	0.91	0.90
Upper Falls	101	0.52	0.53	0.54	0.53
Wapiti Lake	45	0.52	0.69	0.61	0.61
Uncle Tom	90	1.30	1.44	1.51	1.42
Artist Point	109	1.22	1.31	1.34	1.29
North Rim	108	2.36	2.38	2.37	2.37

Parking turnover rate is dependent on occupancy and dwell time.

Occupancies that exceed 100% indicate that vehicles were circulating around the lot in search for a spot to park or were parking in areas not designated for parking (e.g., landscaped areas, along the side of the road, etc.). Vehicles parked on the street outside of the parking lots were not included as part of the parking lot counts, they were only used as anecdotal information. It should be noted that while the Old Faithful East lot was regularly full, the other two lots were rarely full. In other words, the Old Faithful Central and Old Faithful Inn lots could absorb some, but not all, of the East lots extra vehicle demand. Additional wayfinding in the Old Faithful lots could help distribute visitors to the Central and Inn lots and relieve some of the congestion in the East lot. Similarly, the North Rim lots were constantly full while the Canyon Village lot usually had spots left.

Table 07 shows the average dwell time for each parking lot studied for each day and as a three-day average dwell time. Table 08 shows the capacity (existing parking supply) for each lot, the turnover rate, calculated as vehicles/stall/hour, at each lot for each of the three study days and as a three-day average. The turnover rate of each lot is dependent on the both occupancy, and the dwell times. Midway and North Rim have high turnover rates because visitors tend to move on from those attractions quickly and because those lots are constantly over capacity, while the Old Faithful lots have low turnover because visitors tend to spend more time there. The lots at the Upper Falls and Wapiti Lake have an atypically low turnover despite the quick visitor dwell times, which is likely due to lower visitation rates.

The parking capacity at major attractions in the park provides a static number of vehicles that can park at a time. The eleven parking lots studied allow for 2,103 parked vehicles at any given time. This does not include any of the campgrounds or pullouts.

FIGURE 09. PARKING UTILIZATION NEAR CANYON VILLAGE AND CANYON RIM ROADS

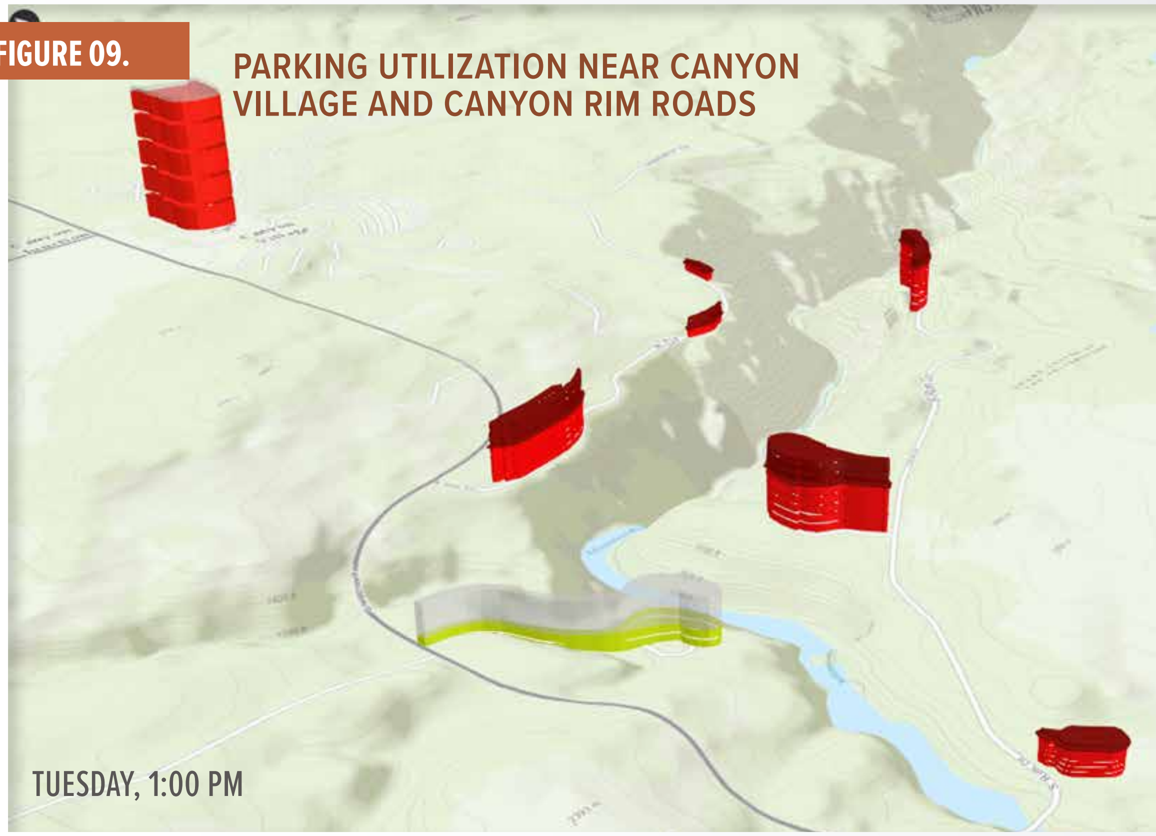


FIGURE 10. PARKING UTILIZATION NEAR OLD FAITHFUL

PARKING UTILIZATION STUDY FIGURES

Figures 09, 10, 11, and 12 illustrate a 3D representation of parking utilization developed by Fehr & Peers. A program available at *https://goo.gl/m2TUUm* was used to show parking utilization during peak periods at the studied locations. As shown, the utilization of these lots far exceeds available capacity at peak times.

Each of the parking lots in the figures are represented by layers that show 20% of the various parking lots' capacities; five full layers of 20% represent a fully occupied (100%) parking lot. The lighter color represents parked cars that are within capacity. The darker colors show how far over capacity an intersection is during its peak time. For example, Figure 11 shows that the Midway Geyser Basin parking lot far exceeded its capacity around noon during the study; the figure shows four layers of dark color because the lot overflowed by 80%.

Figure 09 shows that during the peak visitation period at the Canyon area, all lots along the north and south rim roads exceed capacity. While the Visitor Center parking lot approached capacity, the lot never actually filled to 100% during the study. The Upper Falls parking lot also never even reached half capacity during the study.

Figure 10 shows that the east parking lot in Old Faithful far exceeded capacity during peak visitation times. The west and center parking lots, on the other hand still had over 20% of their parking stalls available during that same time.

During the study, the Norris Geyser parking lot filled passed capacity from 10 AM to 5 PM. Figure 12 shows the Norris Geyser Basin parking lot far exceeding its capacity during the peak visitation time at 11 AM.

FIGURE 11. PARKING UTILIZATION NEAR MIDWAY

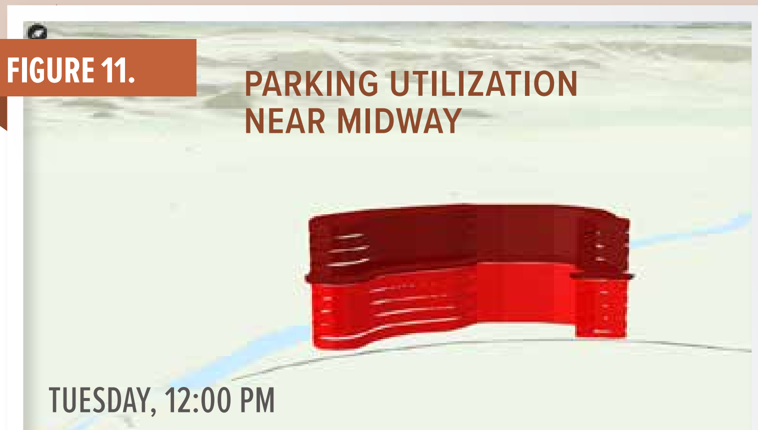
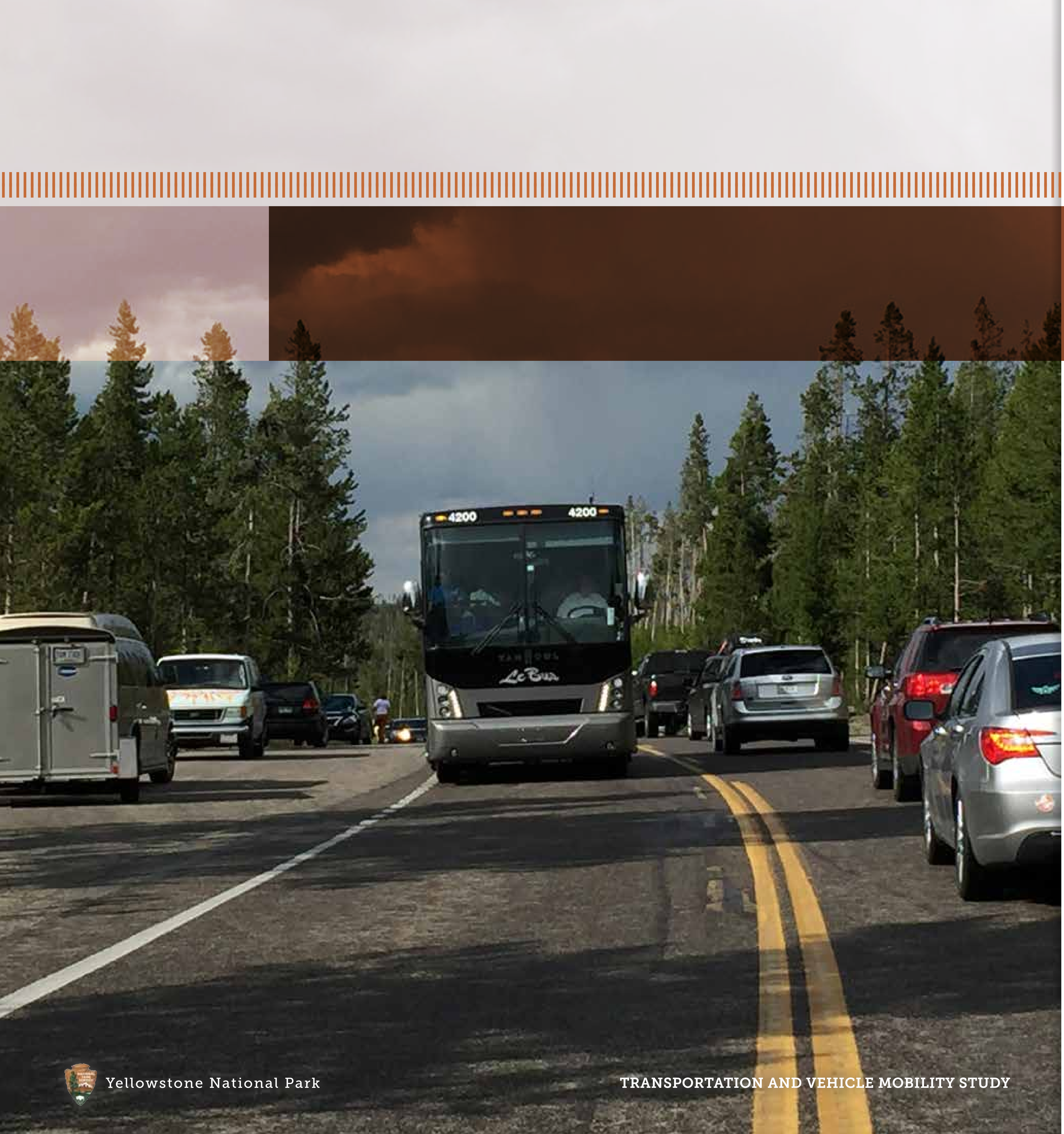


FIGURE 12. PARKING UTILIZATION NEAR NORRIS GEYSER



VEHICULAR CAPACITY

OVERVIEW

Considerations related to the vehicular capacity of the park are provided in this section of the study. Existing peak vehicle capacity based on roadway and parking capacities are presented, along with projected time frames that the park could reach full capacity in the future.

VEHICULAR CAPACITY

The total vehicular capacity of the park is dependent on the roadway directional capacity and the parking capacity. Park capacity was identified as the conditions at which the roadways exceeded the designated LOS threshold and parking lots exceeded the available parking supply.

PARK-WIDE ROADWAY CAPACITY

The capacity threshold is the peak number of vehicles the park can handle before roadway congestion occurs and user experience degrades. For purposes of this study, LOS C is considered the roadway capacity threshold. LOS C means that the percent time spent following (PTSF) along roadways is at 70% or lower. Assuming an even distribution of vehicles throughout the park, peak season capacity is as follows:

- The current (July 2016) peak roadway volume on the roadways in the park at any given time = **9,000** vehicles.
- LOS C conditions roadway capacity = **11,400** vehicles.
- In other words, if traffic distributed equally throughout the entire park, the park could theoretically absorb 27% more traffic on its roadways during peak season conditions. However, traffic does not distribute equally throughout the park. There is more traffic in popular areas of the park, placing a higher demand on roadways and parking capacity in these areas. The more popular areas of the park are already over capacity under current conditions during peak season. See "Congested Area" discussion, next page.

Roadway capacity is based on the percent time each car spends following another car. This was a planning-level analysis of the roadway capacity and therefore, variations in roadway cross-sections on a single segment were not adjusted. The average speed was taken from the pneumatic tube counts located in one location on each roadway segment. Lane widths and shoulder widths would affect travel speeds and therefore roadway capacity; however, these would have to be major variations of more than five feet to have a large impact on roadway operations and capacity. Using the results from this planning-level analysis, it is recommended to take the roadway segments that are approaching a PTSF of 70% or more and perform a more detailed data collection study (i.e. cross-sectional variations, speed studies at more locations, etc.) and subsequent traffic analysis.

Vehicular capacity should not be equated to the visitor carrying capacity of the park. Visitor carrying capacity is influenced by many other factors, such as resource protection, visitor experience, and the park's staffing/ operation levels to serve visitors.

The latest National Park Service statistics abstract states that the park volume is expected to increase by 3.7% annually. Based on a linear growth rate derived from the ATR data from 2014-2016, the park volume is expected to increase by 5.3% annually. Assuming a 3.7-5.3% growth rate per year, the park should expect to exceed its overall vehicular capacity by 2021-2023 based on LOS C threshold. The park should continue to proactively plan and prepare for these conditions from now onward.

PARKING CAPACITY

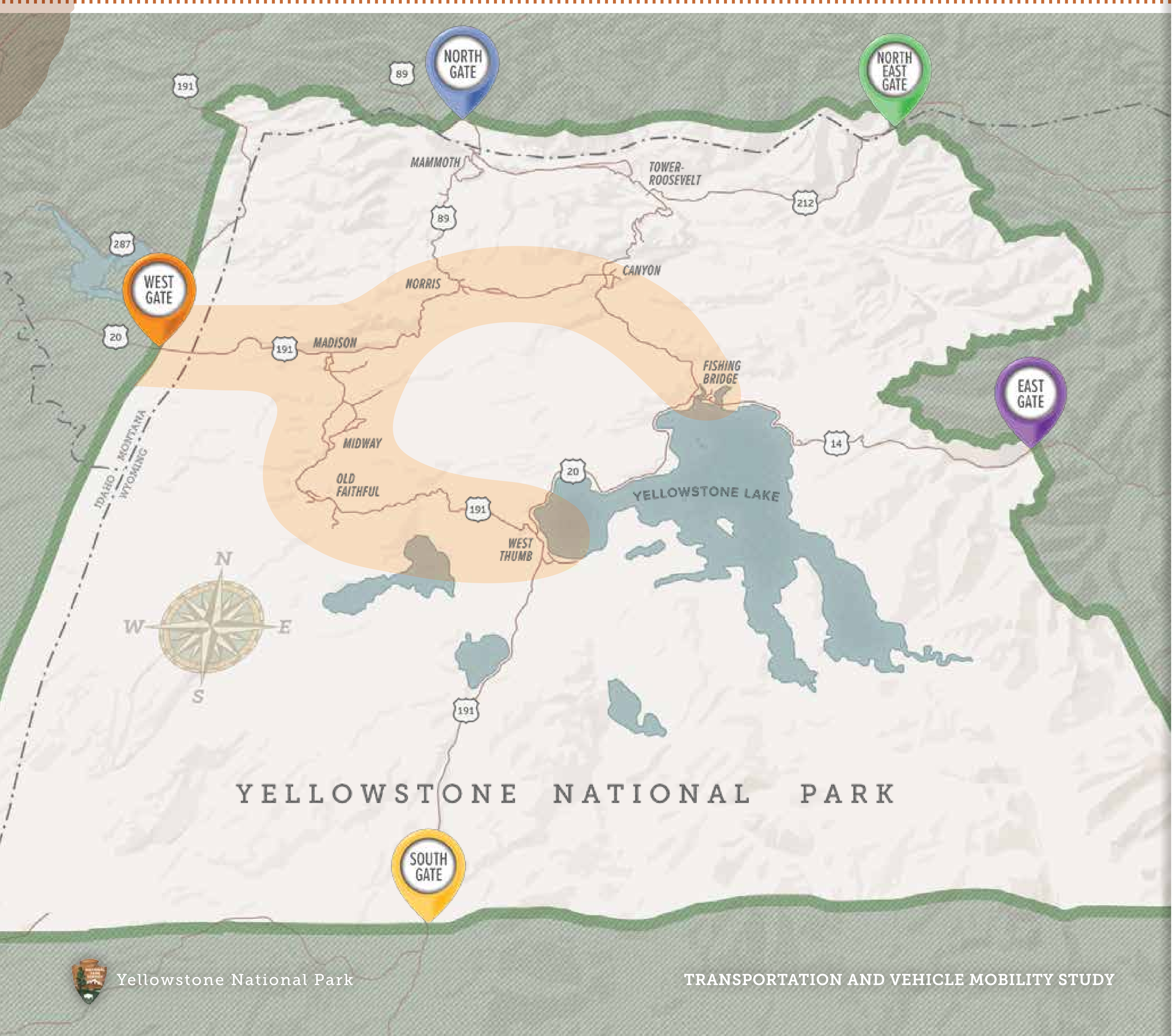
The capacity threshold is the peak number of vehicles that can park at the key areas studied before excessive circulation, parking in undesignated locations, and on-street parking occurs. This assumes that the parking lots are 90 percent or more. For purposes of this study, a target occupancy of 90 percent was used to define the "effective" capacity of a parking supply on a typical peak day. Therefore, any parking lot with occupancies over 90 percent are considered "over-capacity" for those respective time periods. Based on the parking capacity analysis, the park (the studied key areas) currently reaches it parking capacity from 12 PM to approximately 4 PM.

CONGESTED AREA CAPACITY

FIGURE 13.

LEGEND

Most Congested Areas in Park



CONGESTED AREA CAPACITY

The "Congested Area" refers to the key roadway corridors and parking areas that are currently nearing or over capacity according the thresholds previously discussed in the report. Figure 13 depicts this congested area. The congested area falls within the area of the park that tends to have the highest number of daily visitors – the roadway corridors of West Gate to Madison Junction, Madison Junction to Old Faithful, Old Faithful to West Thumb, Madison Junction to Norris Junction, and Norris Junction to Canyon Village – and the parking areas of Old Faithful, Midway Geyser Basin, Norris Geyser, Canyon Village, North Rim, and South Rim.

ROADWAY CAPACITY

Given the criteria previously explained in the Park-Wide Roadway Capacity section, peak season roadway capacity in the congested area is a follows:

- The current (July 2016) peak vehicle volume on the roadways in the congested area at any given time = **4,950** vehicles.
- LOS C conditions roadway capacity = **3,850** vehicles.
- In other words, the roadways are **over-capacity** in the congested area by **29%** during the current peak season (July) conditions.

PARKING CAPACITY

Given the criteria previously explained in the Parking Capacity section, peak season parking capacity in the congested area is a follows:

- The current (August 2016) number of vehicles parked in the peak hour in the congested area = **2,450** vehicles.
- Parking capacity in the congested area = **1,900** vehicles.
- In other words, the parking areas are **over-capacity** in the congested area by **29%** during the current peak season (August) conditions.

TOTAL CAPACITY

- The current traffic volume on the roadways and within the parking lots = **7,400** vehicles.
- Roadway and parking capacity in the congested area = **5,750** vehicles.
- The park is **over-capacity** in the congested area by **29%** during the peak season (July and August) conditions.

VISITOR FLOW PATTERNS

OVERVIEW

This section of the study presents data and analysis related to the way visitor traffic flows to, from, and within the park. Analyses of gate processing, origin-destination and direction splits, and other travel patterns are presented. In addition, information gathered about regional visitor lodging patterns and international visitor trends is also provided.

GATE PROCESSING

The maximum rate of processing varied from gate to gate during the study period as follows:

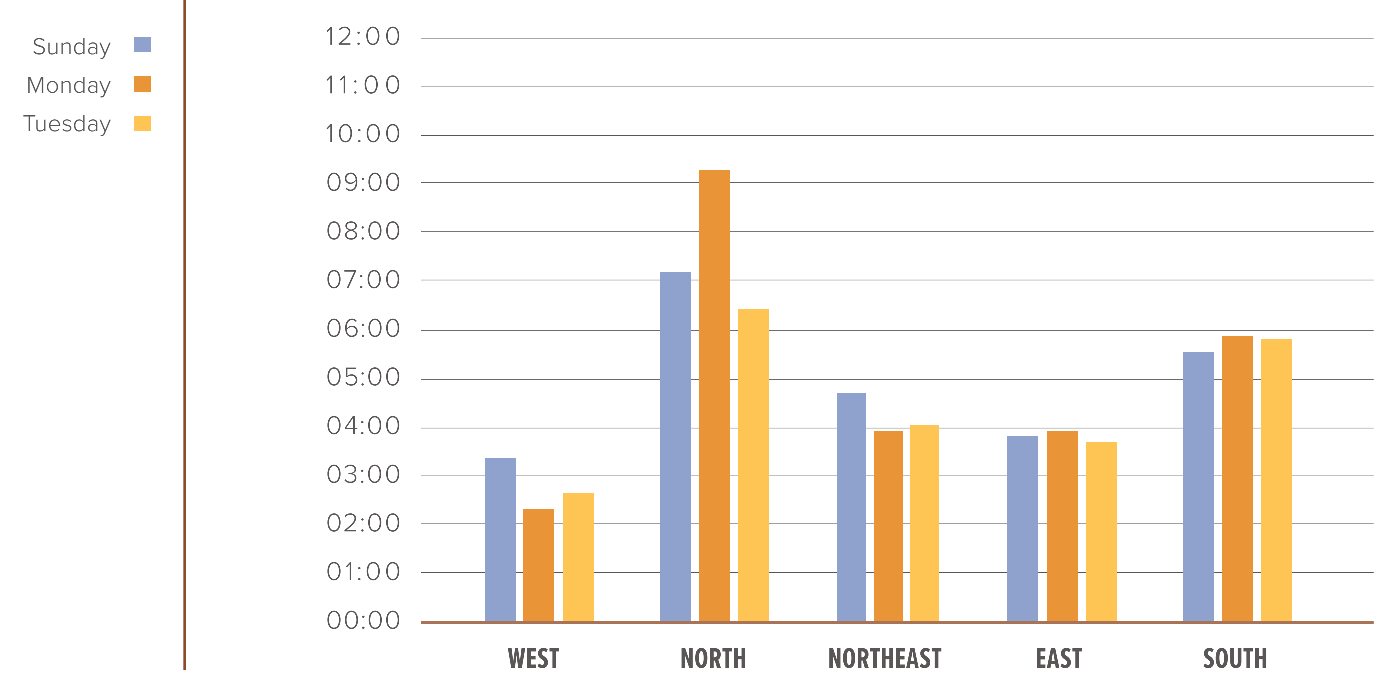
- West Gate processed about 189 cars per lane on Tuesday from 9-10 AM.
- North Gate processed about 144 cars per lane on Monday from 9-10 AM.
- Northeast Gate processed about 65 cars per lane on Monday from 2-3 PM.
- East Gate processed about 130 cars per lane on Monday from 10-11 AM.
- South Gate processed about 157 cars per lane on Tuesday from 10-11 AM.

While these are the maximum numbers of cars processed per hour per lane, it is reasonable to assume that each lane could put through 140-150 vehicles per hour if each lane had a constant queue of ready to process vehicles. The West Gate processed an exceptionally large number of vehicles due to having extra park staff ready to answer questions to customers waiting in the queue. Figure 14, below, shows the peak delay time experienced at each gate during each day of the three-day study period.

The observed maximum queue length during peak processing time varied from gate to gate as follows:

- The West Gate was observed to have a maximum of 28 queued vehicles in the “express” lane during peak processing times. The queue extended about 1,100 feet back from the gate.
- The North Gate was observed to have a maximum of 28 queued vehicles in any one lane during peak processing times. The queue extended about 850 feet back from the gate.
- The Northeast Gate was observed to have a maximum of 9 queued vehicles in any one lane during peak processing times. The queue extended about 385 feet before opening the second lane.

FIGURE 14. PEAK DELAY TIME (MINUTES:SECONDS/MM:SS)



- The East Gate was observed to have a maximum of 9 queued vehicles in any one lane during peak processing times. The queue extended about 360 feet back from the gate.
- The South Gate was observed to exceed 35 vehicles in the queue during peak processing times. The queue extended about 1,435 feet back from the gate.

During the study, approximately 760 vehicles per hour arrived at the West Entrance. After adjusting for July visitation volumes, it would be reasonable to expect 860 vehicles per hour to arrive at the West Entrance. While traffic does increase in West Yellowstone, the queue from the west gate never backed up into the town. Even after multiplying the queue length by the adjustment factor to replicate peak July volumes, the queue would extend back 31 cars in the express lane. Theoretically, that queue could extend back another 130 feet (roughly 3 cars) before it reached Sky Rim Loop and another 600 feet (roughly 15 cars per lane) beyond that before it reached West Yellowstone. Altogether, 50 cars could theoretically fit in one lane before the queue would reach back to West Yellowstone and present queue lengths reach about 60% of that.

To prevent increased queuing and delay time in the future, gate operations should improve with the increased yearly visitation. However, improving the effective processing of vehicles at the entry gates could create more congestion on the corridors between the gates and their corresponding junctions. This possibility should be considered and addressed as the transportation system is furthered analyzed and improved over time in the future. For example, increasing processing of vehicles at the West Gate would likely increase congestion between the West Gate and Madison Junction. For roadways where the LOS is C or better, the increased number of cars on the road would still be within acceptable levels. While it is also possible that the increased processing rate would also increase congestion at the intersections themselves, it is likely that the congestion will lessen as the traffic spreads out away from the gates. Improving intersection operations would also mitigate any added congestion from improved processing times at the gates.

Currently, the gates with the longest delay times are the North and South Gates. Figure 15 shows the peak number of vehicles processed per hour at each gate on each day of the study. Figure 16 shows a three-day average peak delay time at each gate.

FIGURE 15. PEAK VEHICLES PROCESSED PER HOUR

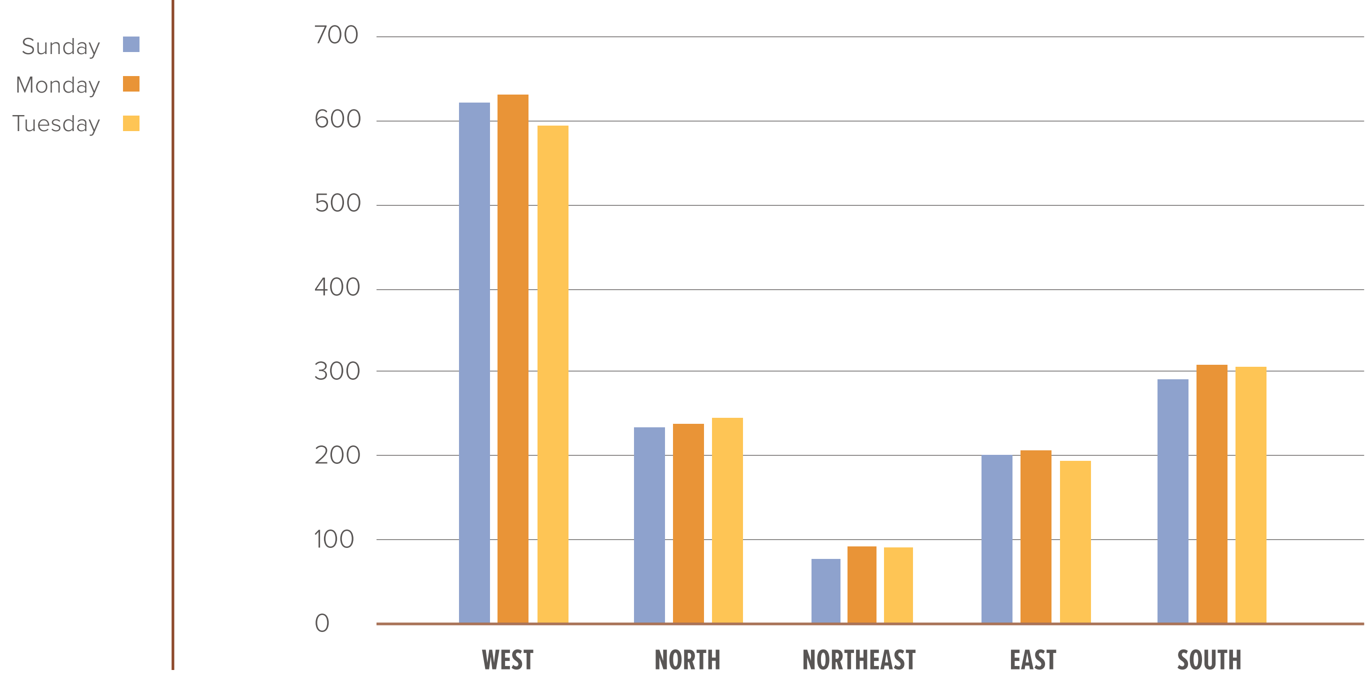
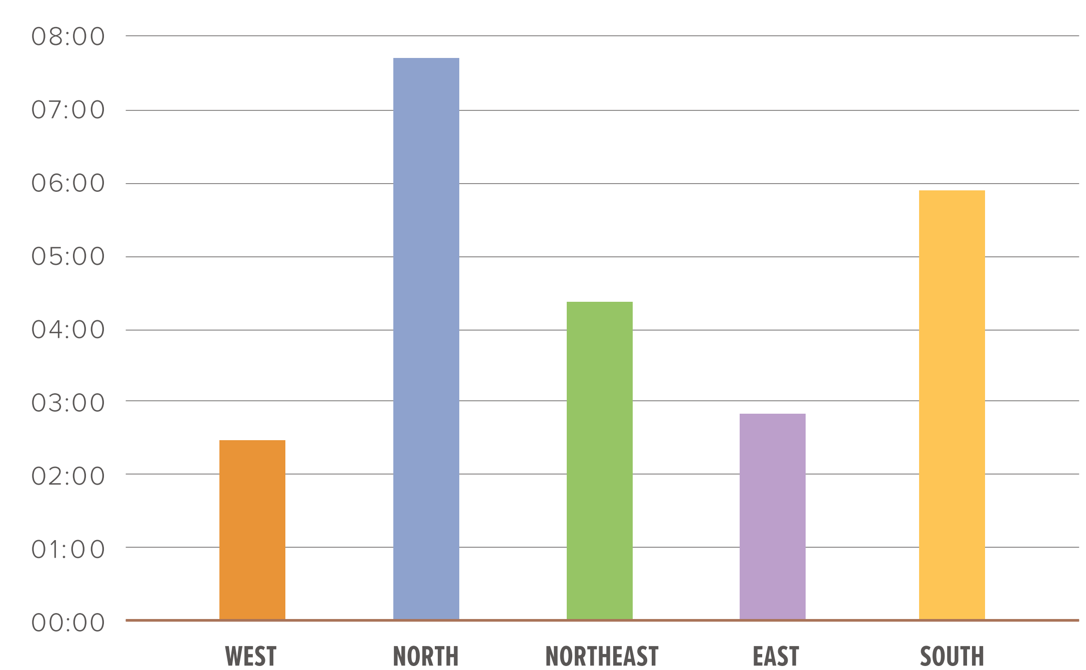


FIGURE 16. AVERAGE DELAY TIME (MINUTES:SECONDS/MM:SS)



ORIGIN-DESTINATION SPLIT

Wi-Fi units placed near the five gates were used to analyze the gates that the park visitors used to enter and exit the park. Figure 17 shows the percentage of visitors that would exit through each gate after entering the park through the West, North, Northeast, East, and South gates, respectively (based on a three-day average over the study period).

The percentage of visitors that enter and exit the park through any particular gate varies slightly between single day visitors (i.e., visitors that enter and leave the park in a single day) and overnight visitors (i.e., visitors that stay within the park boundaries for more than one day). Figure 18 shows the percentage of single day visitors that would exit through each gate after entering the park through the West, North, Northeast, East, and South gates, respectively. Figure 19 shows the same dataset for overnight visitors. The data in Figures 18 and 19 show that there is not a large difference between one-day and overnight visitors in the percentage distribution to and from the respective gates when compared to the three-day average shown in Figure 17. The Northeast and East Gates are the only exceptions where the gate distribution for overnight visitors varies more substantially from the three-day average or one-day visitors.

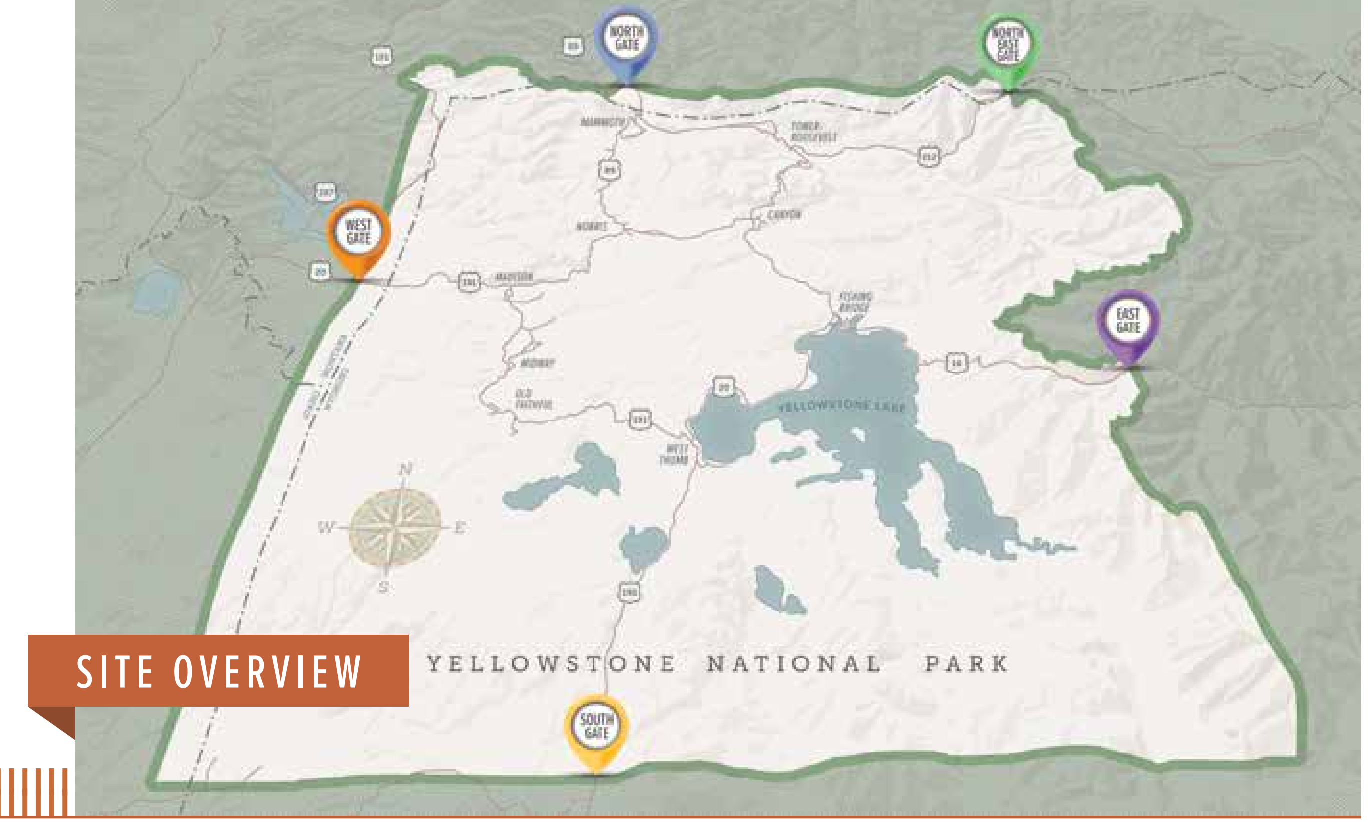


FIGURE 17.

GATE ORIGIN-DESTINATION SPLIT

GATE EXITED PARK \ GATE ENTERED PARK	WEST GATE	NORTH GATE	NORTHEAST GATE	EAST GATE	SOUTH GATE
WEST GATE	54%	31%	29%	33%	44%
NORTH GATE	8%	26%	29%	9%	14%
NORTHEAST GATE	4%	11%	9%	5%	6%
EAST GATE	8%	5%	11%	29%	11%
SOUTH GATE	26%	27%	22%	24%	25%

SITE OVERVIEW

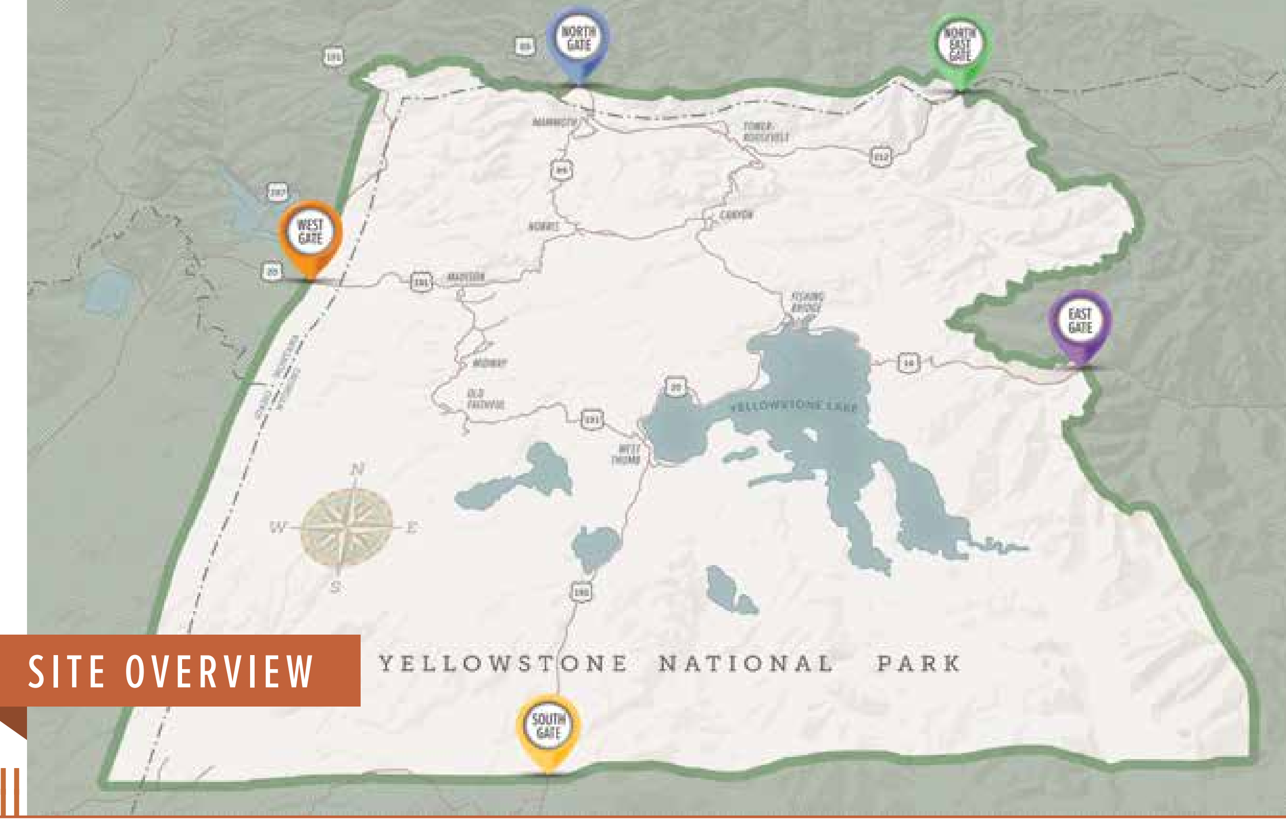


FIGURE 18.

ONE-DAY GATE ORIGIN-DESTINATION SPLIT

GATE EXITED PARK \ GATE ENTERED PARK	WEST GATE	NORTH GATE	NORTHEAST GATE	EAST GATE	SOUTH GATE
WEST GATE	55%	32%	30%	35%	45%
NORTH GATE	8%	25%	29%	8%	14%
NORTHEAST GATE	4%	12%	8%	5%	6%
EAST GATE	8%	6%	12%	28%	11%
SOUTH GATE	24%	25%	20%	23%	25%

SITE OVERVIEW

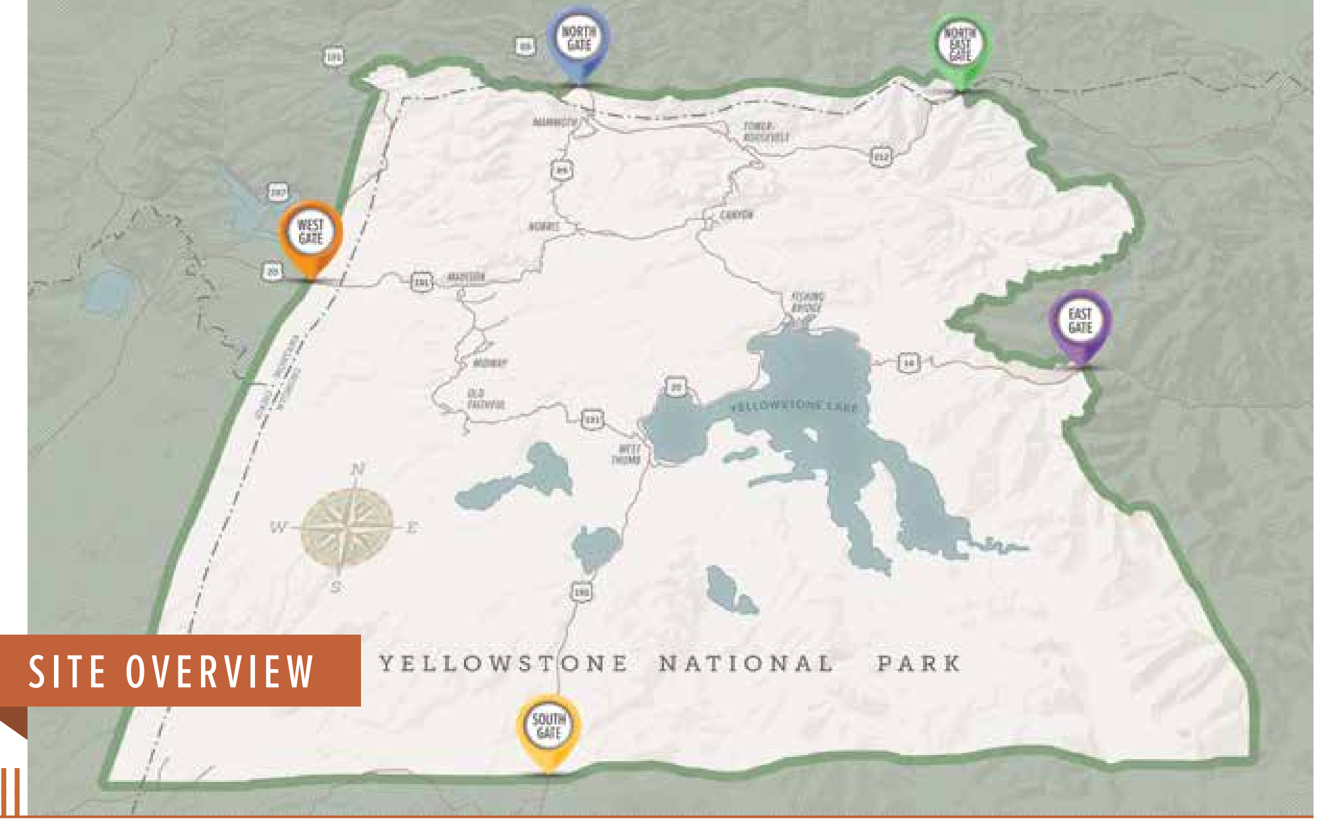


FIGURE 19.

OVERNIGHT GATE ORIGIN-DESTINATION SPLIT

GATE EXITED PARK \ GATE ENTERED PARK	WEST GATE	NORTH GATE	NORTHEAST GATE	EAST GATE	SOUTH GATE
WEST GATE	49%	28%	19%	14%	41%
NORTH GATE	8%	31%	26%	14%	16%
NORTHEAST GATE	4%	5%	15%	6%	11%
EAST GATE	6%	0%	4%	33%	11%
SOUTH GATE	33%	36%	37%	33%	25%

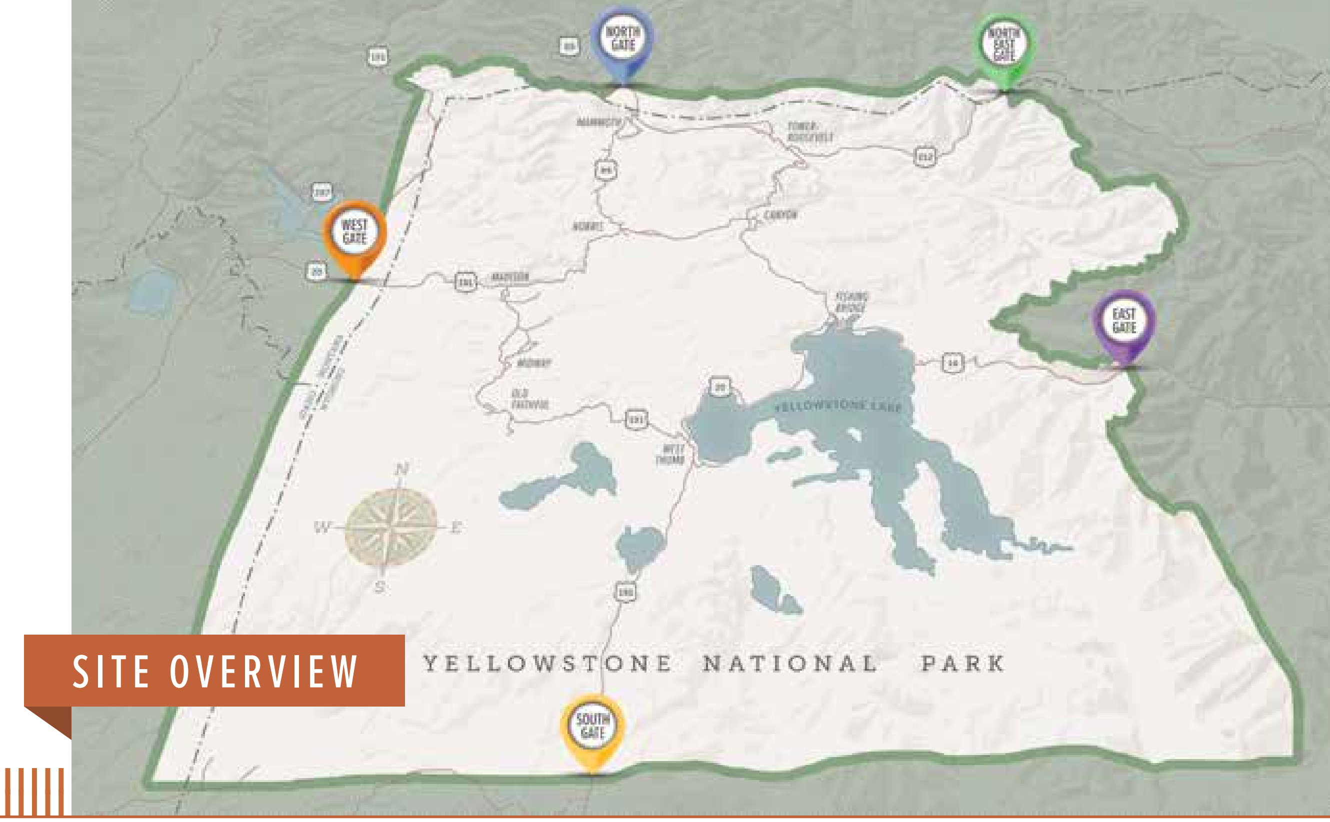


Figure 20 shows the ratio of single day to overnight visitors that enter and exit through each gate. For example, of all of the visitors that enter through the West Gate and leave through the North Gate, 87% of those leave on the same day that they entered, while 13% of those visitors stay overnight.

FIGURE 20.

ONE DAY VS. (OVERNIGHT) SPLIT

Gate Exited Park \ Gate Entered Park	West Gate	North Gate	Northeast Gate	East Gate	South Gate
West Gate	88% (12%)	85% (15%)	93% (7%)	96% (4%)	92% (8%)
North Gate	87% (13%)	80% (20%)	90% (10%)	86% (14%)	90% (10%)
Northeast Gate	86% (14%)	91% (9%)	82% (18%)	90% (10%)	84% (16%)
East Gate	89% (11%)	100% (0%)	96% (4%)	90% (10%)	91% (9%)
South Gate	82% (18%)	77% (23%)	82% (18%)	88% (13%)	92% (8%)

Wi-Fi traffic data was also used to record a sample of visitor trips and analyze the most commonly used routes throughout the park. Wi-Fi units placed near the five busiest junctions were used to analyze the immediate routes that visitors tend to take upon entering the park. Figure 21 shows the percentage of traffic split among visitors entering the park near the Madison, Mammoth, Roosevelt, Fishing Bridge and West Thumb Junctions. To further define the distribution and patterns at Roosevelt Junction – an estimated 54% of visitors traveling to the Lamar Valley from the Roosevelt Junction, turn-around and return towards Roosevelt Junction instead of exiting at North Gate.

SITE OVERVIEW

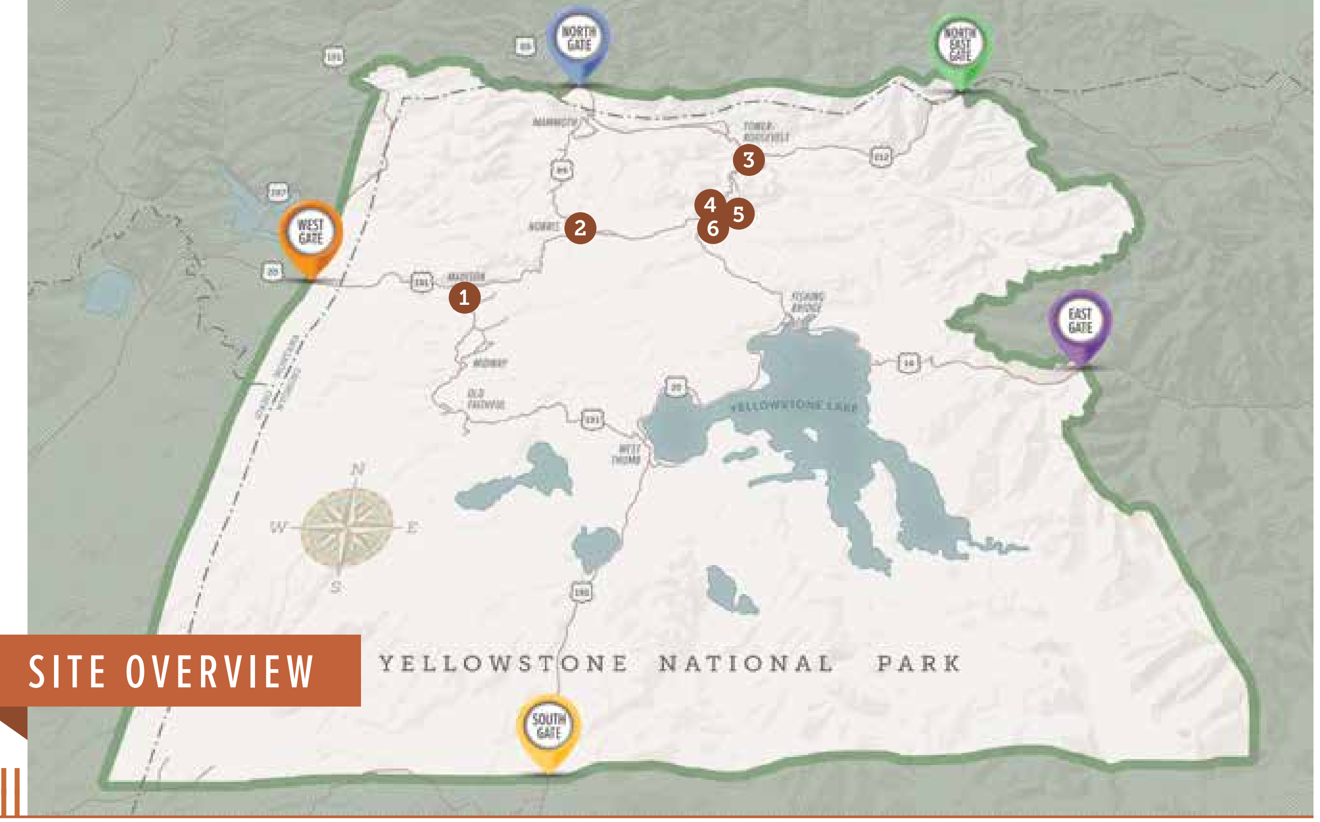
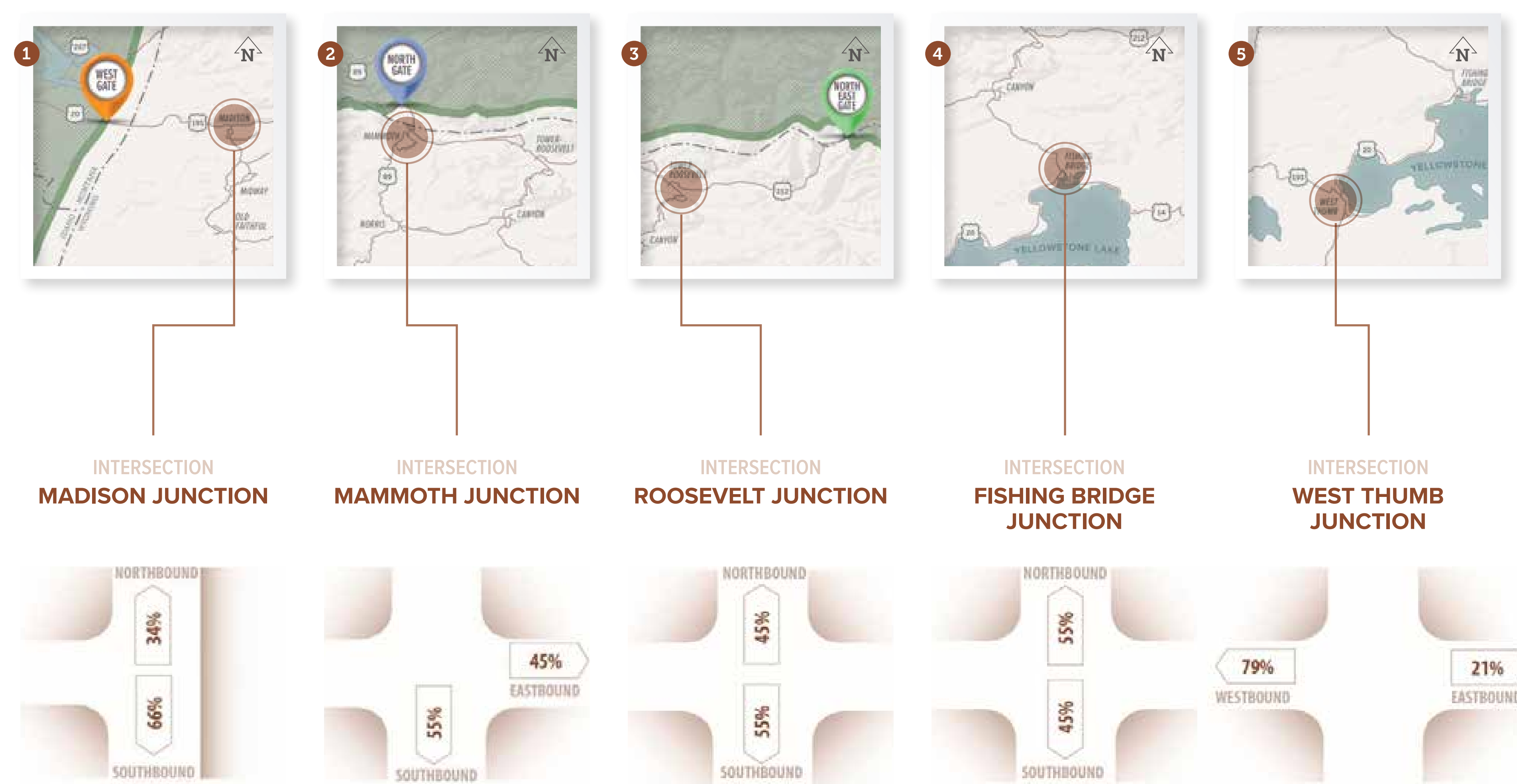
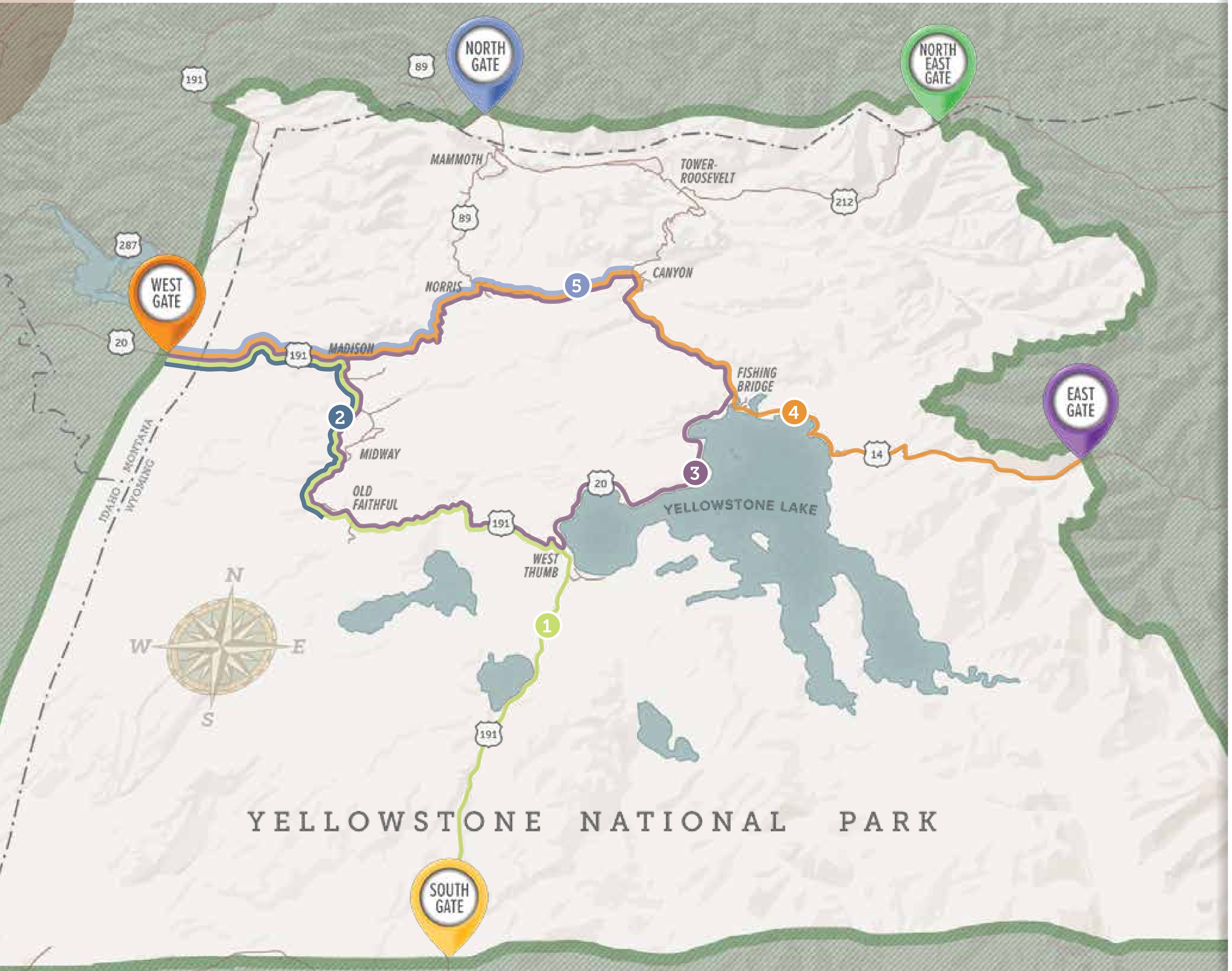


FIGURE 21.

DIRECTIONAL SPLIT AMONG VISITORS ENTERING THE PARK





VISITOR TRAVEL PATTERNS IN THE PARK

The same Wi-Fi data was analyzed to determine which routes were most commonly driven in the park. Figure 22 shows the five most common routes that visitors would take through the park after they would enter through the West gate as well as the percentage of visitors that would take each route. Figure 22 through 26 show the same data for visitors that enter through the North, Northeast, East, and South gates, respectively.

FIGURE 22.

TOP FIVE ROUTES FROM WEST GATE

29% — **ROUTE 1**
Madison—Old Faithful—West Thumb—South Gate

20% — **ROUTE 2**
Madison—Old Faithful—Madison—West Gate

6% — **ROUTE 3**
Madison—Old Faithful—West Thumb—Fishing Bridge—Canyon—Norris—Madison—West Gate

5% — **ROUTE 4**
Madison—Norris—Canyon—East Gate

4% — **ROUTE 5**
Madison—Norris—Canyon—Norris—Madison—West Gate

36% Of visitors took other routes through the park

FIGURE 23.

TOP FIVE ROUTES FROM NORTH GATE

25% **ROUTE 1**
Mammoth—Norris—Madison—West Gate

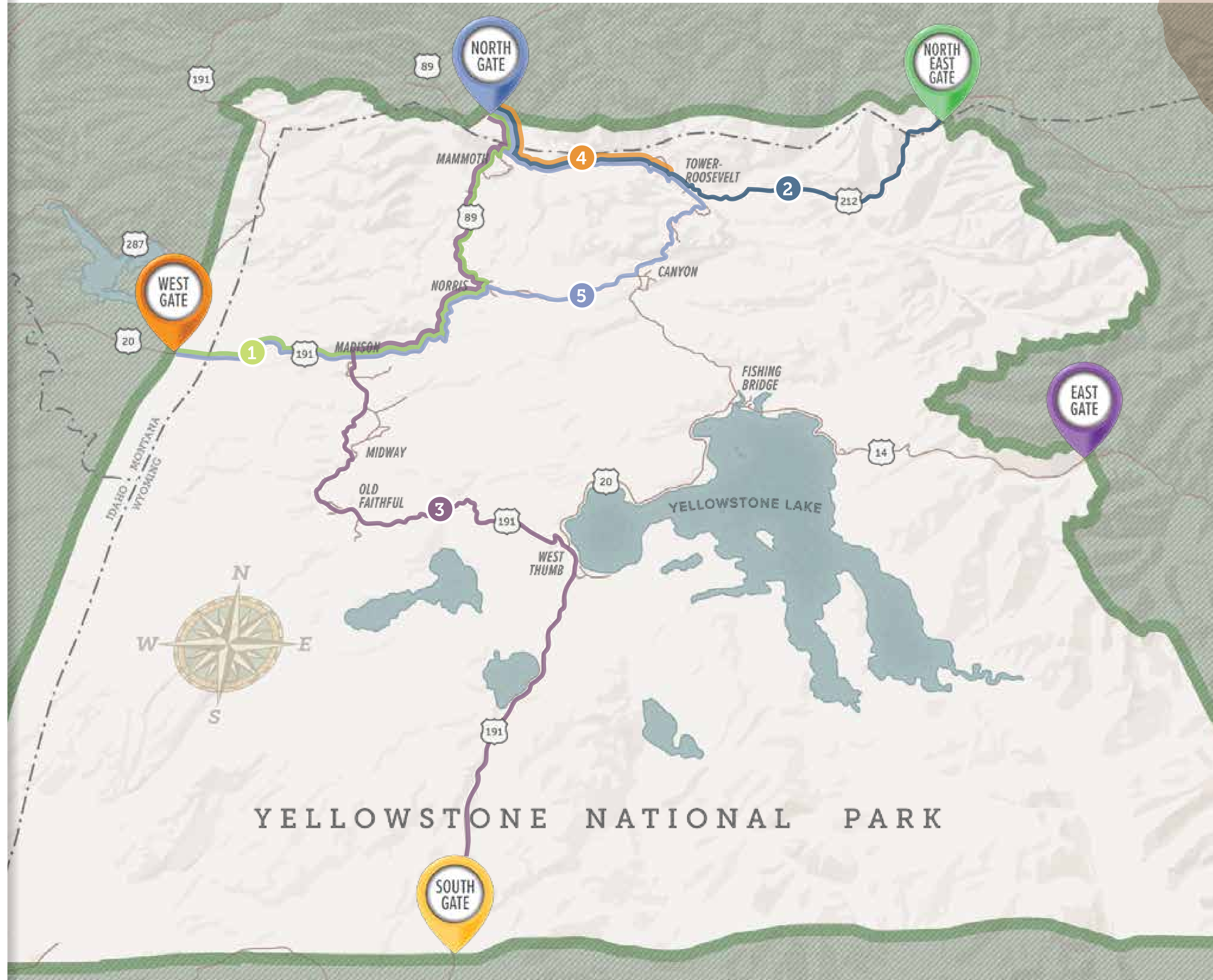
18% **ROUTE 2**
Mammoth—Roosevelt—Northeast Gate

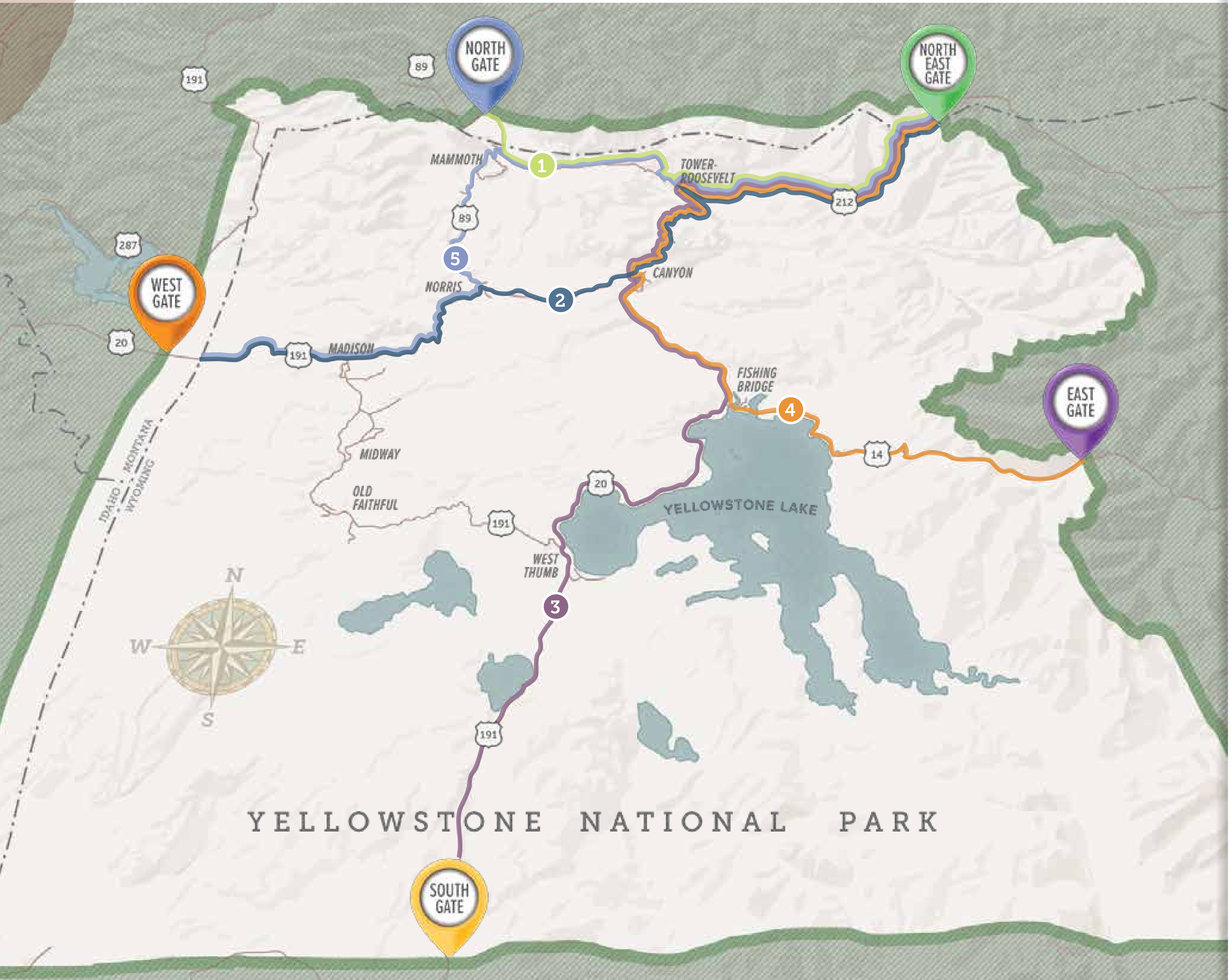
15% **ROUTE 3**
Mammoth—Norris—Madison—Old Faithful—West Thumb—South Gate

12% **ROUTE 4**
Mammoth—Roosevelt—Mammoth—North Gate

7% **ROUTE 5**
Mammoth—Tower-Roosevelt—Canyon—Norris—Madison—West Gate

21% Of visitors took other routes through the park





What are the travel patterns most prevalent in Yellowstone?

FIGURE 24.

TOP FIVE ROUTES FROM NORTHEAST GATE

48% — **ROUTE 1**
Tower-Roosevelt—Mammoth—North Gate

21% — **ROUTE 2**
Tower-Roosevelt—Canyon—Norris—Madison—West Gate

15% — **ROUTE 3**
Tower-Roosevelt—Canyon—Fishing Bridge—West Thumb—South Gate

8% — **ROUTE 4**
Tower-Roosevelt—Canyon—Fishing Bridge—East Gate

7% — **ROUTE 5**
Tower-Roosevelt—Mammoth—Norris—Madison—West Gate

1% Of visitors took other routes through the park

FIGURE 25.

TOP FIVE ROUTES FROM EAST GATE

29% ROUTE 1
Fishing Bridge—Canyon—Norris—Madison—West Gate

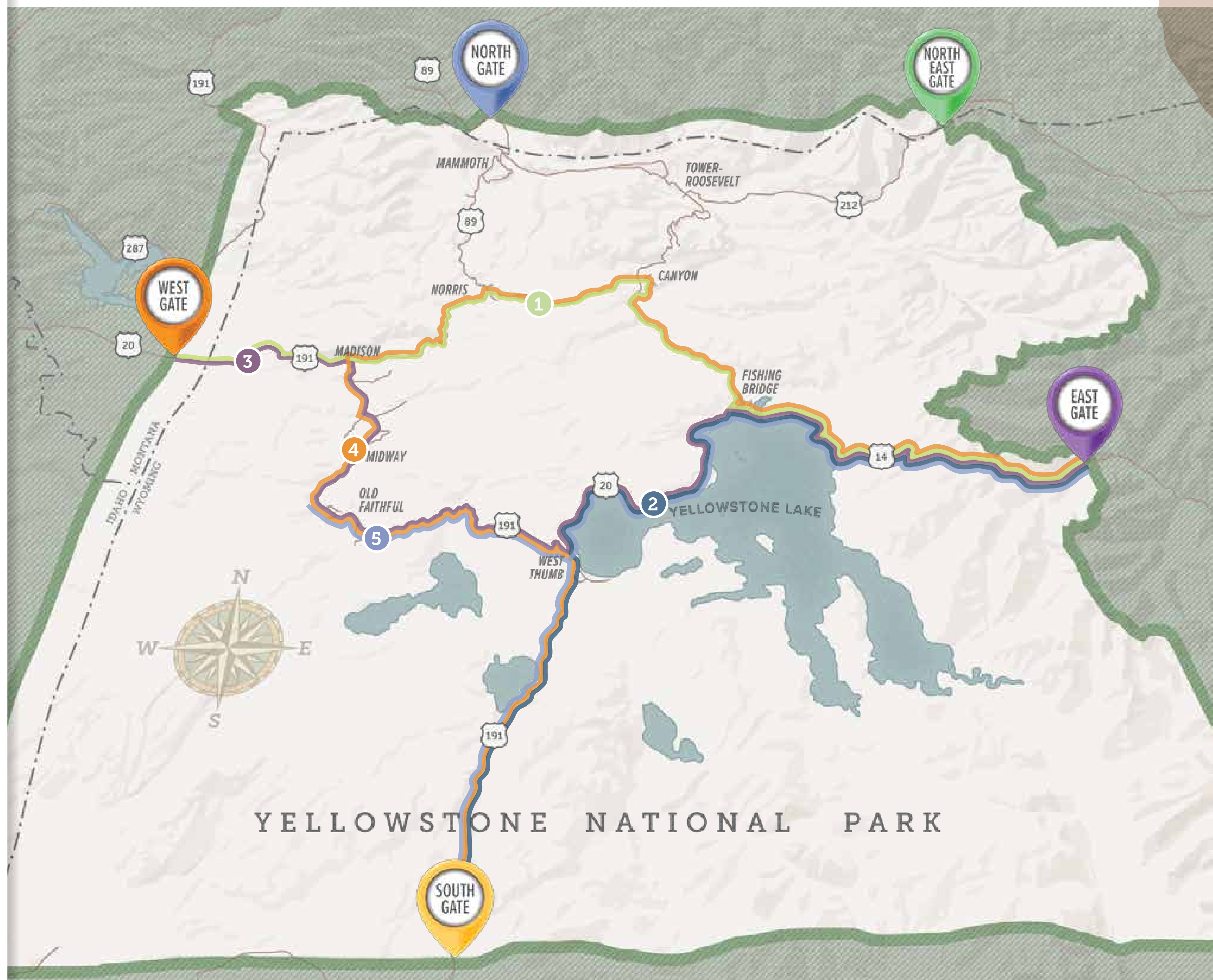
23% ROUTE 2
Fishing Bridge—West Thumb—South Gate

11% ROUTE 3
Fishing Bridge—West Thumb—Old Faithful—Madison—West Gate

8% ROUTE 4
Fishing Bridge—Canyon—Norris—Madison—Old Faithful—West Thumb—South Gate

7% ROUTE 5
Fishing Bridge—West Thumb—Old Faithful—West Thumb—South Gate

22% Of visitors took other routes through the park



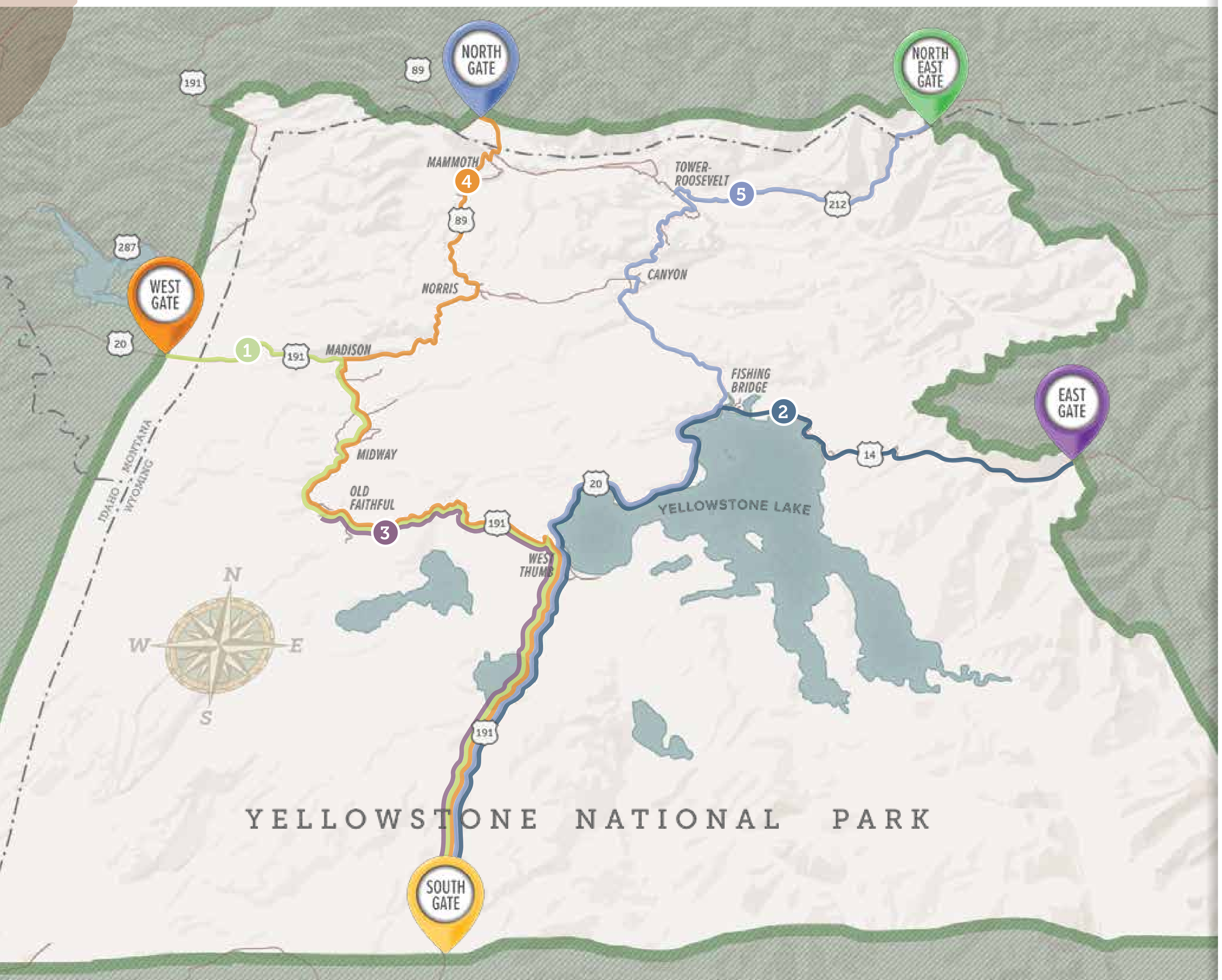


FIGURE 26.

TOP FIVE ROUTES FROM SOUTH GATE

56% **ROUTE 1**
West Thumb—Old Faithful—Madison—West Gate

10% **ROUTE 2**
West Thumb—Fishing Bridge—East Gate

8% **ROUTE 3**
West Thumb—Old Faithful—
West Thumb—South Gate

8% **ROUTE 4**
West Thumb—Old Faithful—Madison—
Norris—Mammoth—North Gate

3% **ROUTE 5**
West Thumb—Fishing Bridge—Canyon—
Tower-Roosevelt—Northeast Gate

13% Of visitors took other routes through the park

THREE-DAY PASS BY VOLUMES

Wi-Fi receivers were used to track which locations were most commonly visited by patrons who entered the park through each gate. The figures on this page and the next indicate how popular each area of the park was depending on which gate the visitors entered through. The data includes visitors that stayed in the park overnight, and single-day visitors, but no distinction between the two could be made in this data set. For example, Figure 27 below shows that of all the people to enter the West Gate, far more of them passed by the Old Faithful area than the Mammoth Hot Springs area.

FIGURE 28.

FIGURE 27.

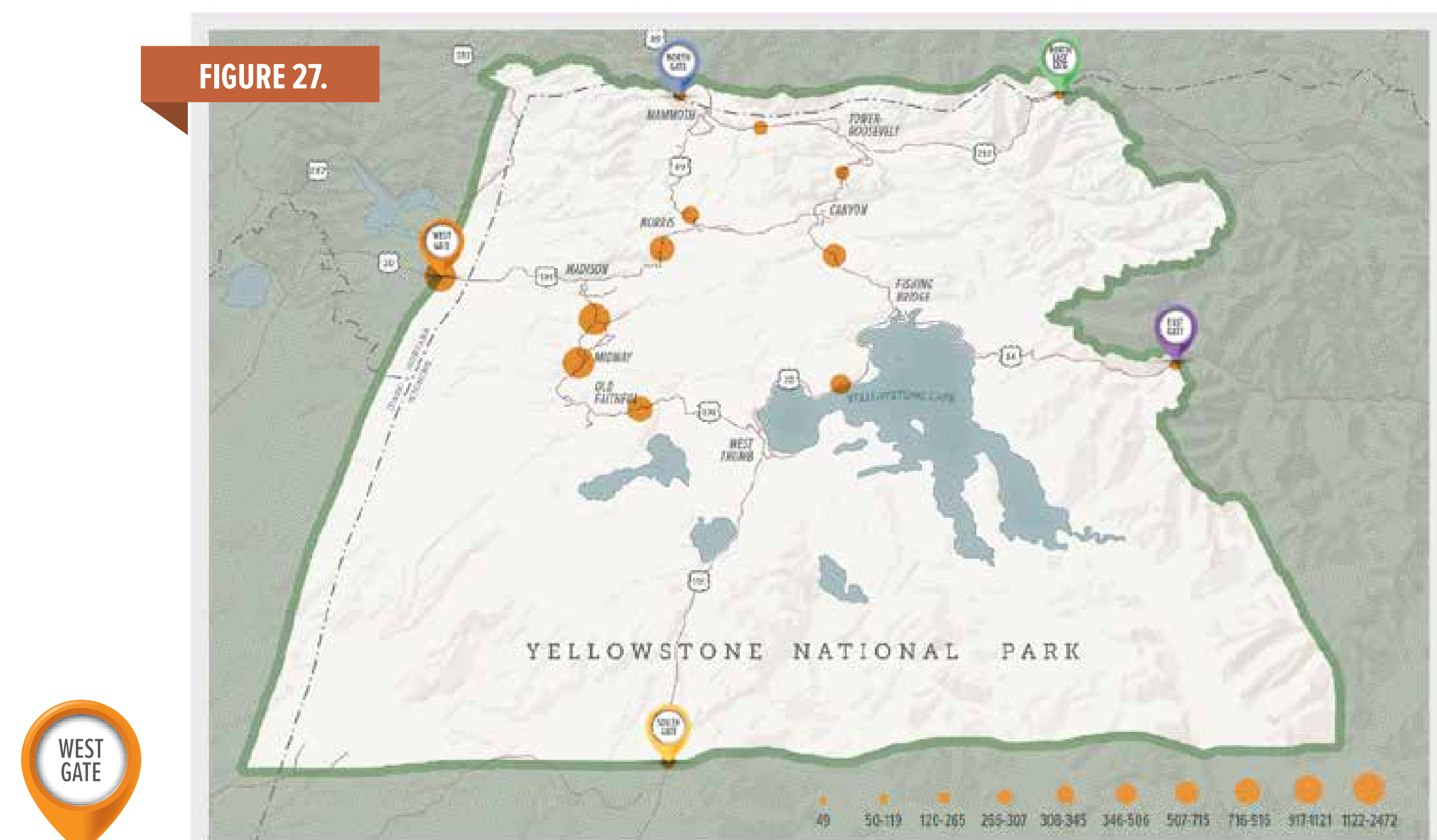


FIGURE 29.

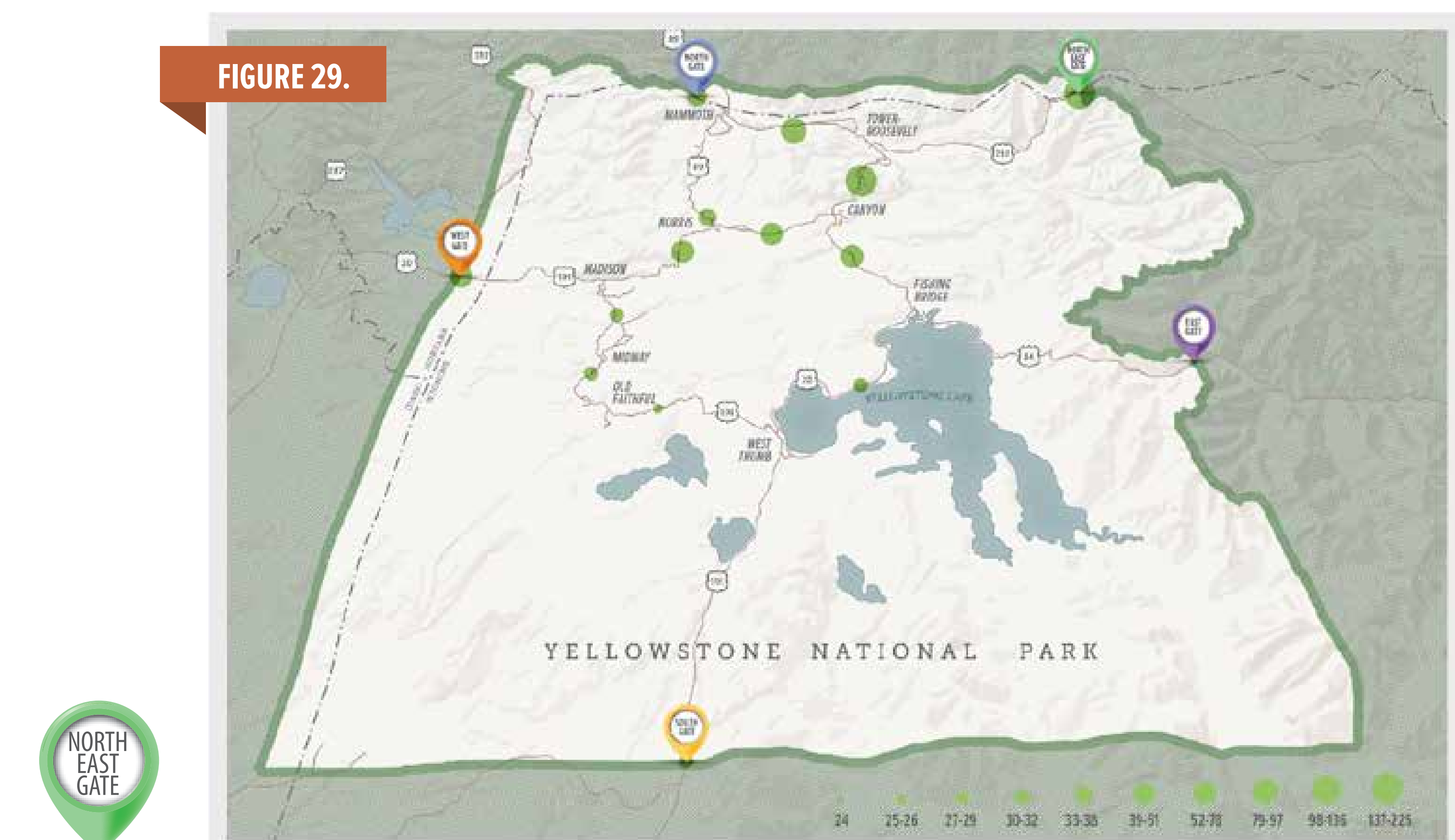


FIGURE 30.

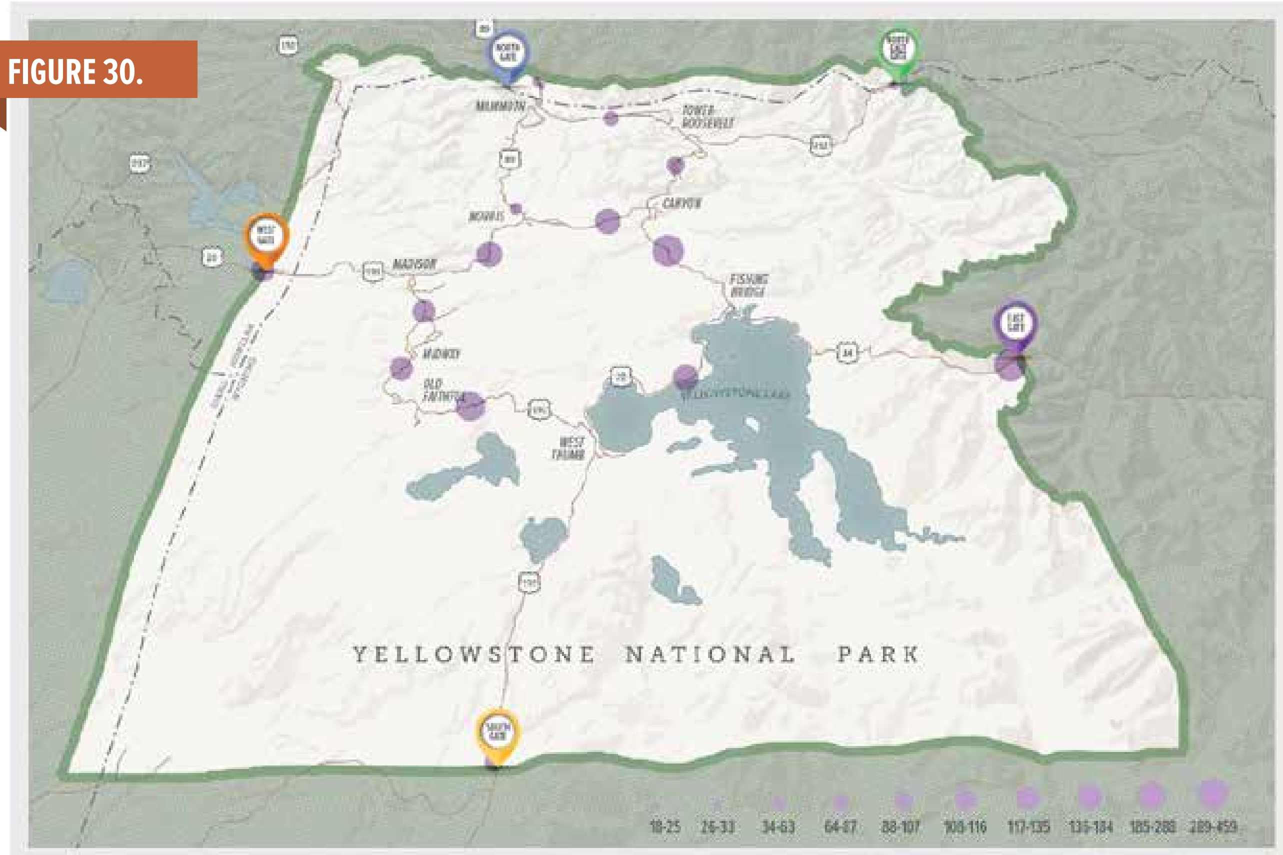
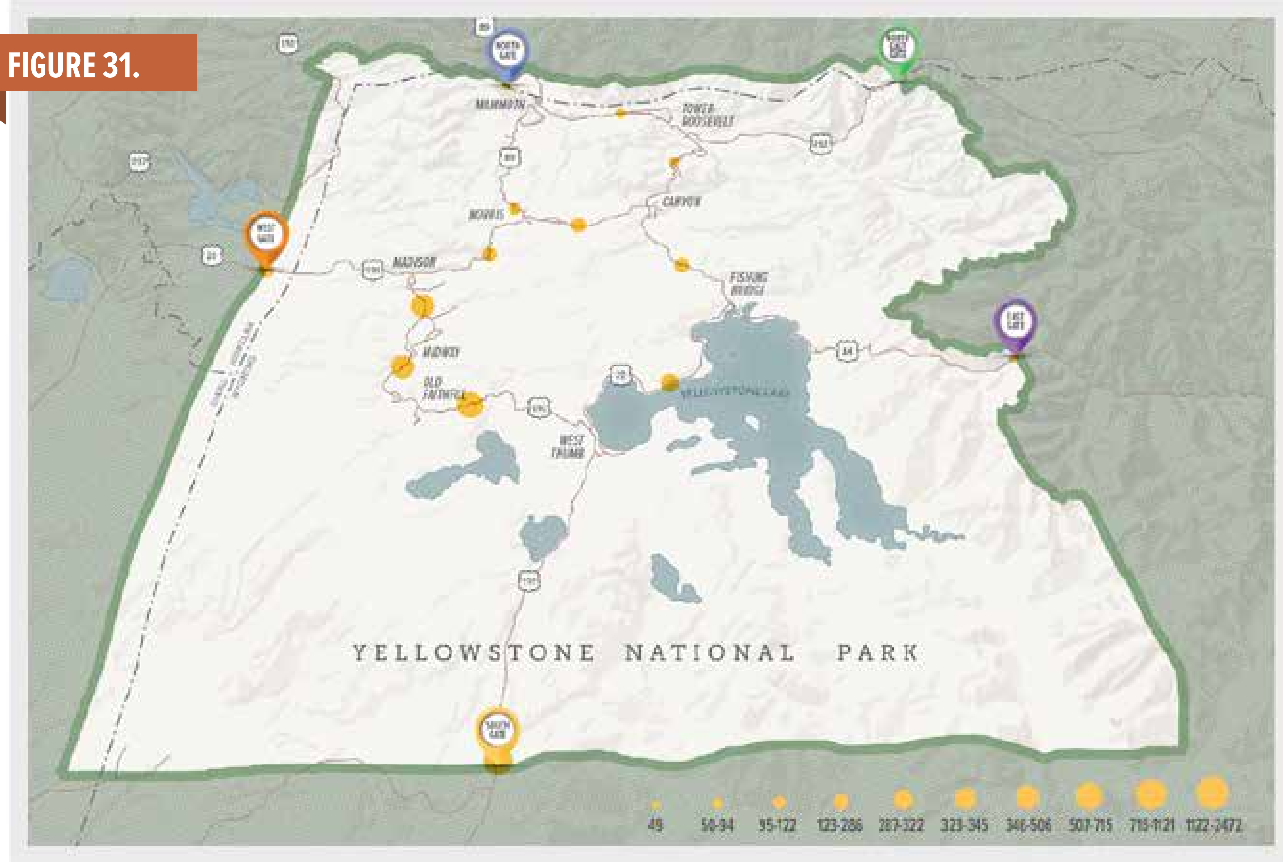


FIGURE 31.



VISITOR LODGING PATTERNS

Locations of visitor lodging influence travel patterns to, from, and within Yellowstone National Park. To better understand the quantity of lodging facilities and how this may affect visitor travel patterns, a database of lodging facilities located in key gateway communities surrounding the park, as well as lodging facilities inside the park, was assembled as part of this study.

LODGING OUTSIDE THE PARK

Lodging facility types inventoried include hotels, motels, bed and breakfasts, vacation rentals including vacation rental by owner (VRBO) properties, cabins, and RV and camping sites. The main gateway communities researched were Idaho Falls and Rexburg in Idaho, Big Sky, Bozeman, Cooke City, and Gardiner in Montana, and Cody, Jackson, and Wapiti in Wyoming. Smaller communities in between these locations were also researched and included in the database.

As shown in Table 10, the total number of rooms available in the main gateway communities surrounding Yellowstone is approximately 26,281. (This does not include lodging facilities inside the park.) Hotels and motels make up 70% of the total amount of rooms available for visitors, while bed & breakfasts comprise about 1%. On average, hotels and motels typically have 58 rooms per site/establishment, while bed & breakfasts typically have 5 rooms per location on average.

Thousands of lodging accommodations are available for overnight visitor stays within a one to three hour drive from Yellowstone National Park entrances. Figure 32 depicts the locations and amount of lodging surrounding the park, as well as lodging in the park. Table 9 lists the number of lodging facilities in surrounding gateway communities as of 2016. It should be noted that more lodging is added in the region on a regular basis, particularly in the communities nearest to the park, including Bozeman, West Yellowstone, Idaho Falls, and Jackson. Of all locations, Jackson has the most rooms available, including lodging at Teton Village. West Yellowstone has the most rooms in closest proximity to the park. Very small towns such as Rigby, Saint Anthony, Ashton, Wapiti, Emigrant, Pray, Livingston, and others have smaller amounts of lodging available.

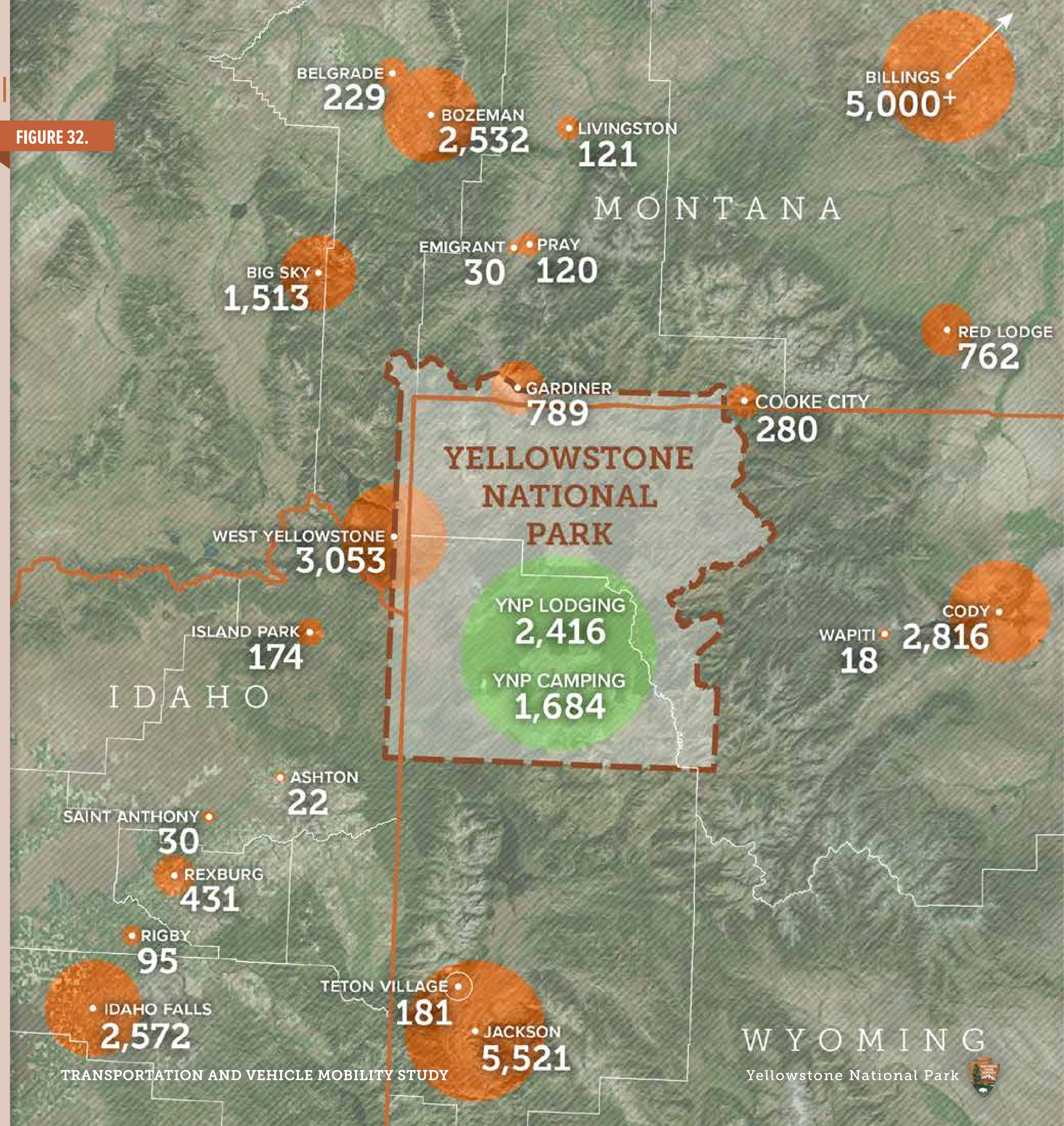
TABLE 09.
LODGING IN THE VICINITY OF THE PARK
(LISTED FROM NORTH TO SOUTH)

LOCATION	NUMBER OF UNITS
Belgrade	229
Bozeman	2,532
Livingston	121
Billings	5,000+
Big Sky	1,513
Emigrant	30
Pray	120
Red Lodge	762
Gardiner	789
Cooke City	280
West Yellowstone	3,053
Island Park	174
Wapiti	18
Cody	2,816
Ashton	22
Saint Anthony	30
Rexburg	431
Rigby	95
Idaho Falls	2,572
Teton Village	181
Jackson	5,521
	26,289

Note: camping facilities are not included. This study did not research quantities and locations of camping facilities outside the park.

INSIDE THE PARK	
YNP Lodging	2,416
YNP Camping	1,684
	4,100

FIGURE 32.



NUMBER OF AVAILABLE ROOMS

TABLE 10.
LODGING TYPES OUTSIDE THE PARK IN GATEWAY COMMUNITIES

TYPE OF LODGING	NUMBER OF UNITS
Hotel/Motel	20,031
Bed & Breakfast	158
Cabin	900
Commercial Vacation Rental	709
Vacation Rental by Owner (VRBO)	1,432
RV & Campsite	3,059
	26,289

Note: As of 2017—Commercial and private lodging facilities are being added on an ongoing basis in surrounding areas.

Table 10 shows how the lodging facilities in gateway communities and nearby locations outside the park (listed in Table 9) breakdown into different types of accommodations. While this inventory is thorough, some nuances of the data need to be considered when estimating the numbers of rooms and how these may influence Yellowstone visitation. For example, dude ranches may have cabins and camping sites, and in confirming lodging numbers with an employee at Cross Sabres Ranch in Cody, the ranch experience was described as a week-long getaway that includes a one-day trip for all guests to Yellowstone National Park. For the remainder of the week, guests stay at the ranch, enjoying a full program of activities. Therefore, while visitors in other lodging types typically have a higher turnover rate and potentially visit the park for the longest duration of their stay, dude ranches have a set number of visitors every seven days and will visit the park only once during their visit. Another nuance includes visitors passing through the area visiting multiple parks at one time, so Yellowstone may not be their primary destination or only destination.

It is also important to consider seasonal influences. Many RV sites/campgrounds, cabins, and smaller motels close down during the off season (November through March) because there is an inadequate amount of business to keep the location up and running all year long. Many of the lodging facilities inside the park are closed during the winter as well. Therefore, the number of rooms shown on this page is more representative of capacity during peak summer months.

Table 11 shows lodging facilities inside the park. According to the National Park Service website, lodging facilities and campgrounds within the park can accommodate about 14,300 overnight visitors during the summer months (www.yellowstonenationalparklodges.com).

TABLE 11.
LODGING FACILITIES INSIDE THE PARK

LODGING FACILITIES	
Canyon Lodge and Cabins	590
Grant Village	300
Lake Lodge Cabins	186
Lake Yellowstone Hotel and Cabins	299
Mammoth Hot Springs Hotel and Cabins	200
Old Faithful Inn	332
Old Faithful Lodge	161
Old Faithful Snow Lodge and Cabins	134
Roosevelt Lodge and Cabins	80
TOTAL	**2,416**

CAMPGROUNDS	
Bridge Bay Campground	404
Canyon Campground	270
Grant Campground	408
Madison Campground	270
Fishing Bridge RV Park	340
TOTAL	**1,684**

Source: Yellowstone National Park, 2017

The inventoried locations do not encompass all potential locations where Yellowstone National Park guests could be staying. For example, hotels in Pocatello, ID have started reporting increasing numbers of Yellowstone tour groups staying the night because there has been no room left at closer lodging locations in Idaho or Wyoming. Many hotel managers have started to put a cap on the number of tour groups that can stay in their facility to leave room for families and smaller parties. From discussions with many lodging representatives and research of trends, it is clear that the increasing visitation to Yellowstone including the pulse of international tour groups, is creating an overflow to towns and cities beyond the typical gateway communities surrounding the park. Visitor groups are starting to stay farther away from the park and traveling farther for their visits.

In addition to the quantity of lodging, it is important to consider year-round travel patterns and activities surrounding the park and how these influence lodging patterns in the communities as well as travel to and from Yellowstone. For example, one of the reasons Jackson has such a large capacity for lodging is due to its status as a ski resort town and year-round well-known tourism destination.

This increase in regional tourism puts pressure on Yellowstone in the summer, but not in the winter when southern roads in the park are closed.

Information about facilities and associated room counts was collected through numerous websites including tripadvisor.com, mapquest. com, lodging locations' direct website, and state tourism marketing websites. If the numbers of rooms, cabins, or sites were not listed, a phone call was made to the facility to collect and confirm counts. Refer to the sources of information listed at the end of this section of the report.

A more in-depth analysis with a combined evaluation of visitor lodging patterns, gate entrance data, roadway travel volumes, data collected from the 2016 visitor study, and other information could further reveal influences in visitor travel patterns to, from, and within the park. This analysis could include not only evaluation of existing lodging capacity, but also potential future capacity through forecasts based on building permit trends for lodging facilities in the region.

VISITATION INCREASES & INTERNATIONAL TRENDS

Visitation to Yellowstone National Park has been increasing at higher rates over the last few years, compared to years before that. Table 12 below shows the change in annual recreation visits by all visitors to the park since 2000.

TABLE 12.
CHANGE IN ANNUAL RECREATION VISITS

YEAR	NUMBER OF VISITS
2000	2,838,233
2001	2,758,526
2002	2,973,677
2003	3,019,375
2004	2,868,317
2005	2,835,651
2006	2,870,295
2007	3,151,343
2008	3,066,580
2009	3,295,187
2010	3,640,185
2011	3,394,326
2012	3,447,729
2013	3,188,030
2014	3,513,484
2015	4,097,710
2016	4,257,177

Source: https://irma.nps.gov/Stats/

From 2000 to 2006, annual visitation was consistently below 3,000,000 visitors. Then in 2007, visitation jumped by 281,048 to 3,151,343 annual visitors, and through 2014, annual visitation fluctuated up and down from 3,066,580 at the lowest to 3,640,185 at the highest. 2015 saw another big increase, breaking the 4,000,000 level to 4,097,710, and then another substantial increase occurred in 2016, up to 4,257,177.

There are many contributing factors, but one of the largest contributors to tourism in Yellowstone over the past few years has been the influx of international tourists to the United States, and in particular to Western national parks. According to the International Trade Administration, National Travel and Tourism Office, between 2009 and 2015 the number of international tourists visiting the United States (US) grew 41%. The International Trade Administration predicts that this trend should continue in the coming years and international interest in travel in the US continues to grow. Other contributing factors to increased national park visitation among American travelers include the more stable economy in the US, lower gasoline prices, and concerns about travel to abroad destinations.

The top five origin countries for international visitors to the US are Canada, Mexico, United Kingdom, Japan, and China. Of those, the number of annual visitors from Canada decreased from 2013 to 2015, while the number of visitors from the other countries increased. Refer to Table 13 for international visitation to the US from 2011 through 2015.

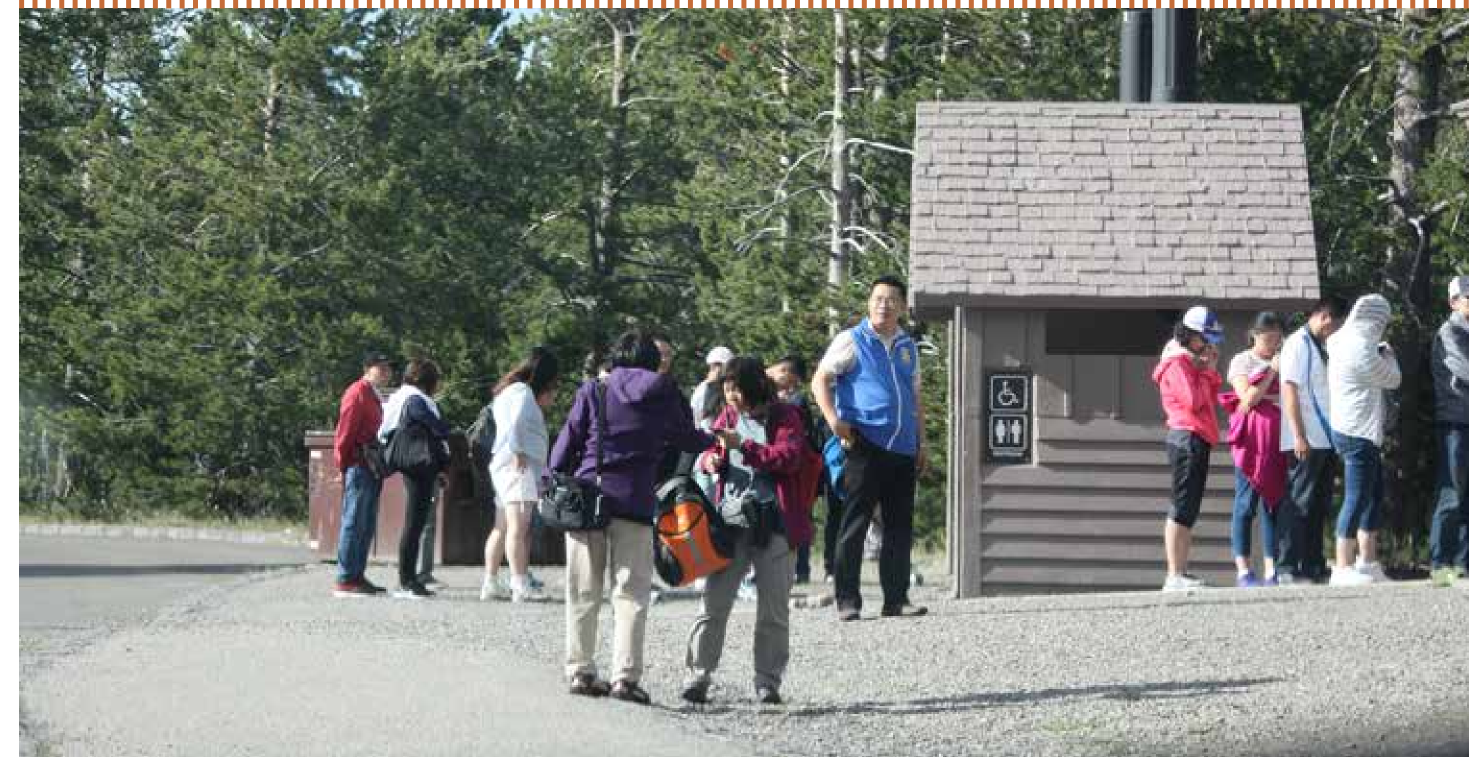


TABLE 13.
TOP FIVE ORIGIN COUNTRIES FOR INTERNATIONAL VISITORS TO THE UNITED STATES

	2011	2012	2013	2014	2015
Canada	21,337,000	22,697,345	23,387,275	23,013,691	20,704,701
Mexico	13,491,000	14,198,645	14,342,722	17,069,818	18,413,649
United Kingdom	3,835,000	3,763,000	3,835,000	4,149,129	4,900,823
Japan	3,250,000	3,698,000	3,730,000	3,620,224	3,758,297
China	1,089,000	1,474,000	1,807,000	2,189,781	2,591,333

Source: International Trade Administration, National Travel and Tourism Office

The number of visitors from China increased substantially between 2014 and 2015 (18%), which is of particular interest to Yellowstone because the park has seen a correlating substantial increase in visitors from China over the past few years—including substantially more organized tour groups than in previous years, and much more so than from other international origins. Starting in 2012, the US streamlined the travel visa application process for Chinese travelers, and in November 2014 began offering multi-entry business and tourist visas valid for up to ten years. In addition to easing the process to visit the US, there has been a significant growth in Chinese middle class salaries and rise in China's millionaire class. The combination of these conditions and a pent up eagerness to see other parts of the world has resulted in Chinese visitation in the United States, as a whole, to increase by 426% between 2007 and 2016, according to statistics provided by the US Department of Commerce. In 2015 alone, a total of 2.59 million Chinese visitors came to the United States. On average, during these trips Chinese visitors spend $6,000 - $7,200 per person, according to estimates by Brand USA in January 2015.

As recorded by numerous travel agencies that Chinese visitors use to book their trips including Ctrip, Expedia.com, and Booking.com, popular destinations within America are Los Angeles, Las Vegas, Yellowstone National Park, and other national parks in the West. Many of the organized trips for Chinese tourists involve group tours that organize visits to these destinations into a 7-day tour. Many of the tours to Yellowstone are grouped with San Francisco, Salt Lake City, Las Vegas, and/or Los Angeles attract large volumes of tourists.

In 2015, an estimated 500,000 visitors to the park were Chinese, equivalent to 12% of the total annual visitors to Yellowstone National Park and 19% of the total annual Chinese travelers visiting the US (Idaho Statesman; Spokesman Review). In 2015, Chinese President Xi Jinping proclaimed 2016 as "China- US Tourism Year", vowing to continue encouraging travel to grow between the two countries. The National Travel and Tourism Office forecasts a 121% increase of Chinese tourists over the next five years (from 2017 forward), bringing the total annual number to 5.7 million Chinese visitors.

This recent surge in organized international travel groups has caused some unintended consequences in the park and surrounding gateway communities. Tour companies reserve lodging for their customers months in advance, rapidly taking up available accommodations with no vacancy during peak months. This means that other travelers in small groups, families and individuals now have difficulties finding lodging compared to past years. Some businesses in gateway communities are experiencing economic benefits. For example, the Yellowstone Big Gun Fun indoor shooting range in West Yellowstone, MT has reported that it attracts 20 to 30 buses per day with about 30 Chinese tourists per bus during the peak season. As one of the hit attractions for tourists and not far outside the park, this shooting range and others only demonstrate a fraction of the amount of tour buses seen within the park each day. Some small businesses in Yellowstone gateway communities have hired mandarin-speaking employees to accommodate and cater to the arrival of Chinese tourists.

Considering how increasing tourism (international and national), including organized tour groups, will continue to affect travel to, from, and within Yellowstone is important to inform planning and actions to accommodate these increases in visitation—both within surrounding gateway communities and within the park. Being able to forecast, plan for, and apply adaptive management practices to serve growing visitation will be crucial in continuing to achieve the park's mission of providing a positive visitor experience and protecting the natural resources that attract visitors.

Sources of Information Referenced for Visitor Lodging Patterns and International Visitor Trends

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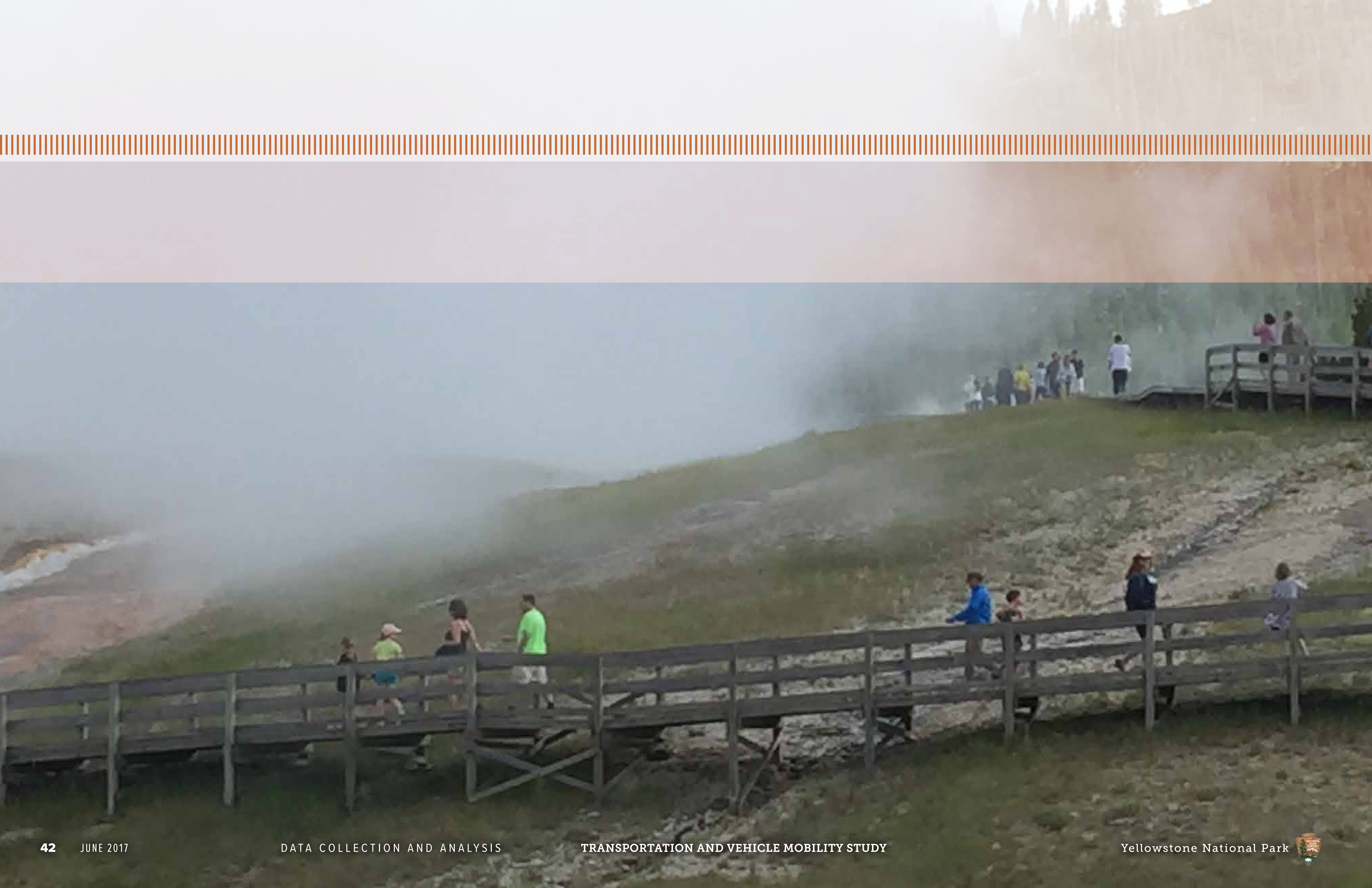


LOCATION-SPECIFIC OBSERVATIONS

OVERVIEW

The study team analyzed several key locations in the park currently experiencing congestion problems, particularly during peak visitation. Observations related to the following locations are presented in this section of the study:

- *Old Faithful (traffic patterns, travel times, and parking conditions)*
- *Midway Geyser Basin*
- *Norris Geyser Basin*
- *Canyon (travel times and parking conditions)*
- *Tower Fall*
- *Mammoth*
- *Boiling River*
- *North Gate/Gardiner*

These were locations of focused analysis requested during scoping of the study. Data collection and analysis of other locations may be needed in the future as planning efforts proceed.

OLD FAITHFUL TRAFFIC FLOWS

The traffic heading toward Old Faithful from Madison junction peaked between 12 PM – 2 PM and the traffic from West Thumb peaked between 11 AM – 1 PM. The overlapping time between 12 PM – 1 PM is likely to be the most congested time throughout the Old Faithful corridor. Figure 39 shows the most common routes to Old Faithful from the West, North and South gates (the entrances with the most visitors driving directly to Old Faithful). Figures 33-38 show the volume of traffic in the Old Faithful corridor throughout the study. Figures 33-35 show the traffic just Northwest of Old Faithful, and Figures 36-38 show the traffic just Southeast of Old Faithful. The dashed green lines in the graphs indicate the eruption times at Old Faithful.

The high volumes of traffic in this area is likely to be related to the influx of visitors in the morning, especially from the West and South gates. As was shown in the previous section, 55% of West gate's traffic and 72% of the South gate's traffic travels directly past Old Faithful. Since the West entrance reached peak admittance between 9 AM – 11 AM and the South entrance peaked between 10 AM – 12 PM it is likely that these two entrances played the largest role in the spike of traffic at Old Faithful between 11 AM – 1 PM.

Based on observations during the study, the Old Faithful parking lots do experience increased congestion shortly after Old Faithful eruptions. However, once the platoons of cars reach Grand Loop Road, the platoons begin to disperse. By the time the cars leaving from Old Faithful reached Madison or West Thumb Junctions, the platoons had dispersed so much that they had little impact on the operations of Madison and West Thumb Junctions. Also, as is shown in Figures 33-38, not all of the eruptions resulted in a surge of traffic heading away from Old Faithful.

FIGURE 33. OLD FAITHFUL NORTH TRAFFIC (SUNDAY)

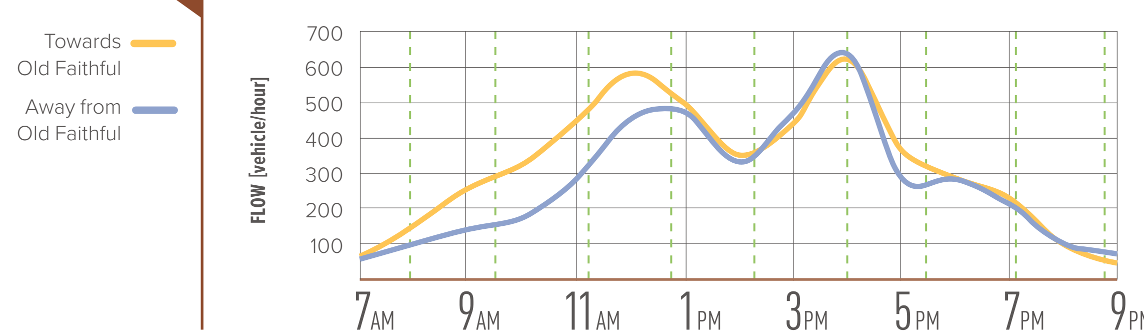


FIGURE 34. OLD FAITHFUL NORTH TRAFFIC (MONDAY)

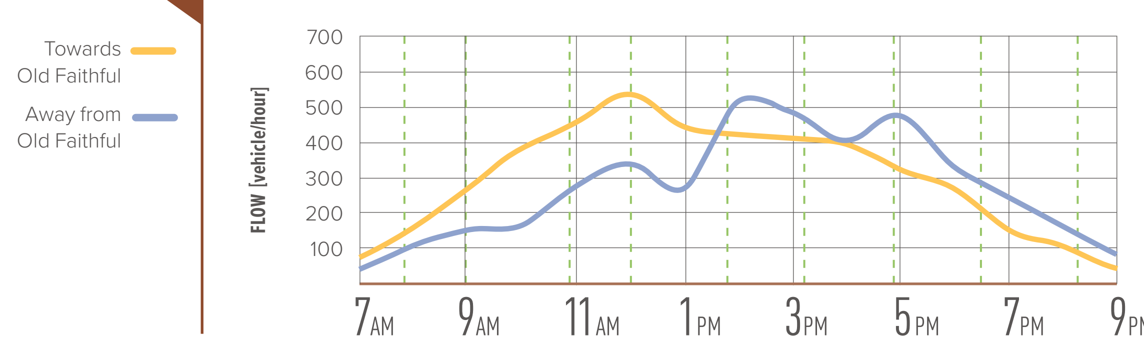


FIGURE 35. OLD FAITHFUL NORTH TRAFFIC (TUESDAY)

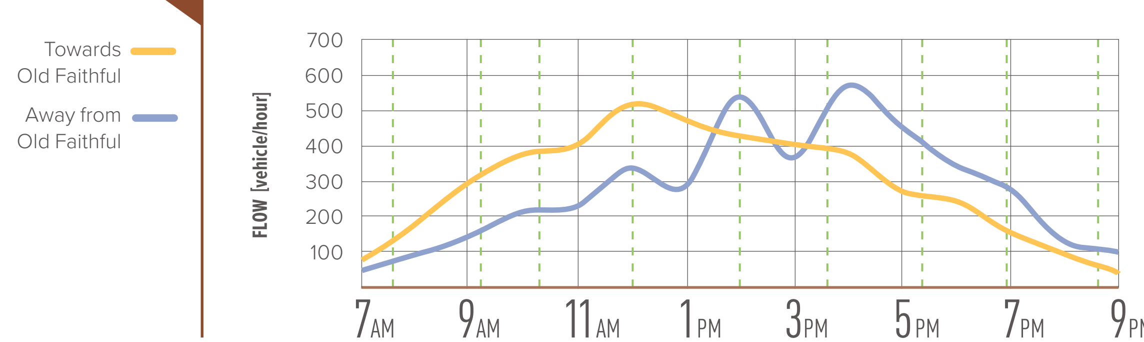


FIGURE 36. OLD FAITHFUL SOUTH TRAFFIC (SUNDAY)

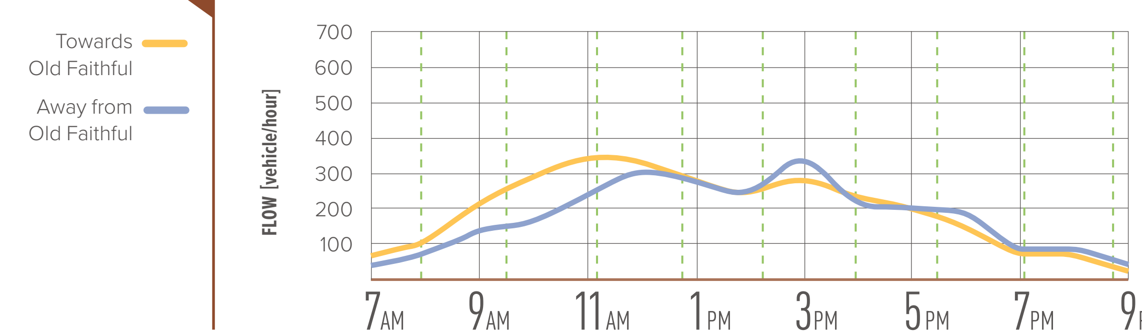


FIGURE 37. OLD FAITHFUL SOUTH TRAFFIC (MONDAY)

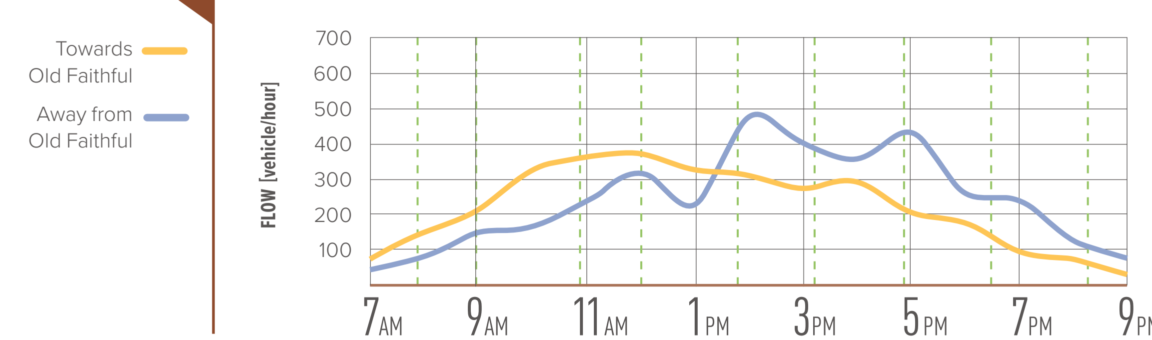
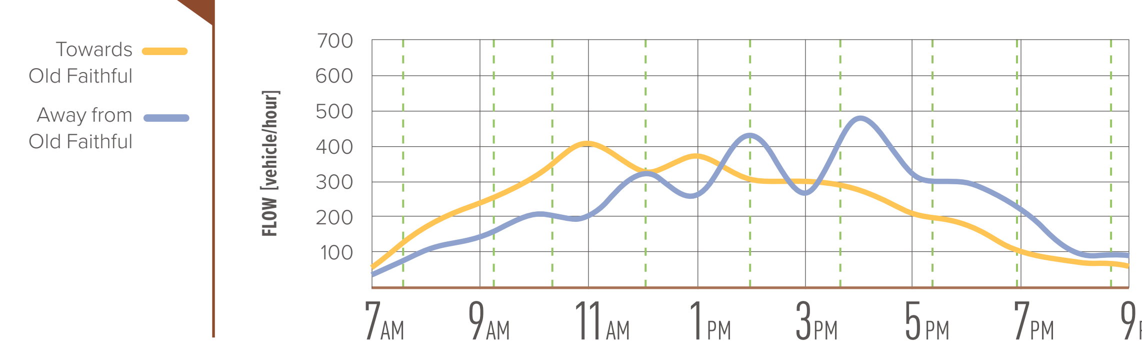


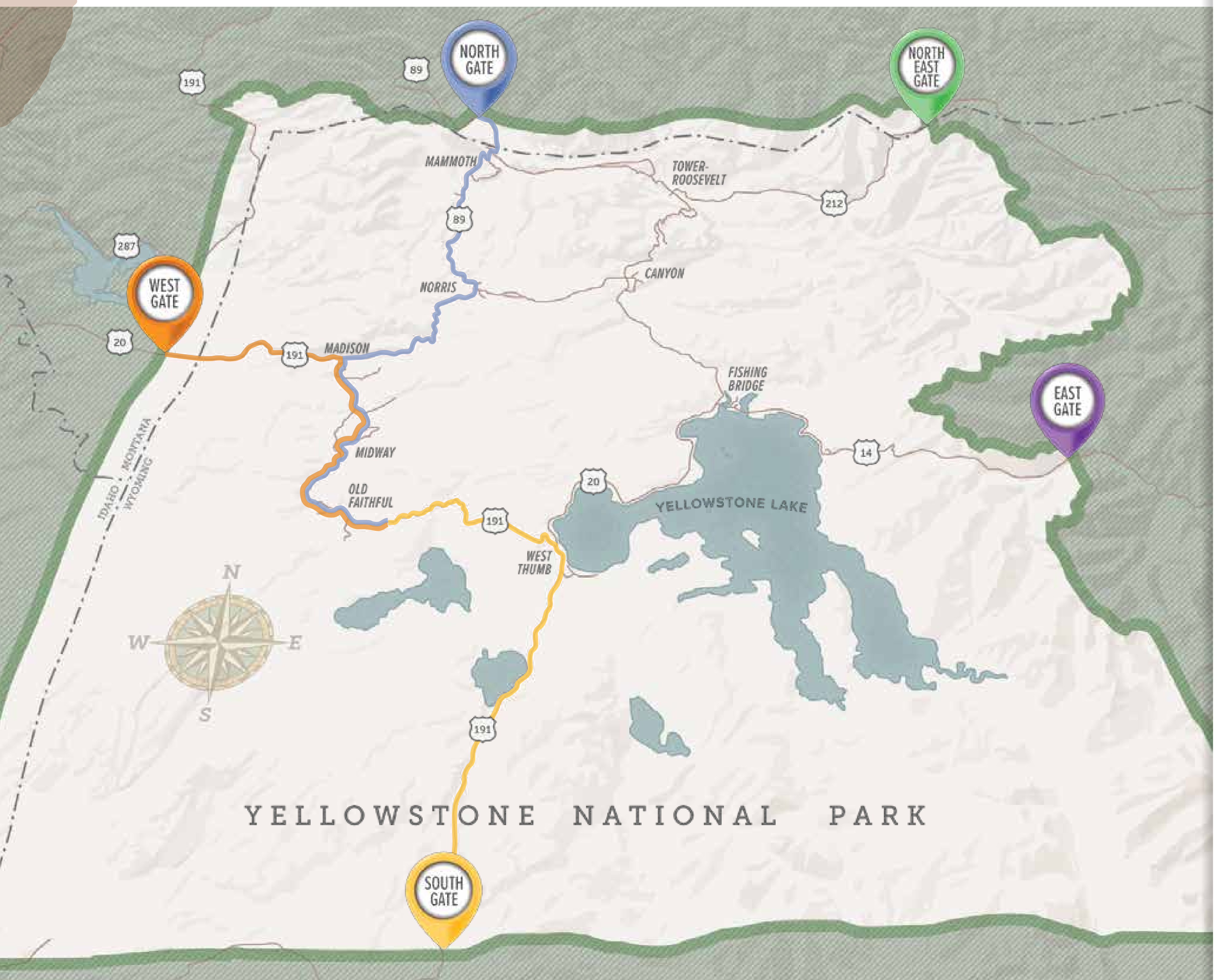
FIGURE 38. OLD FAITHFUL SOUTH TRAFFIC (TUESDAY)



MOST COMMON ROUTES TO OLD FAITHFUL FROM BUSIEST GATES

FIGURE 39.

LEGEND

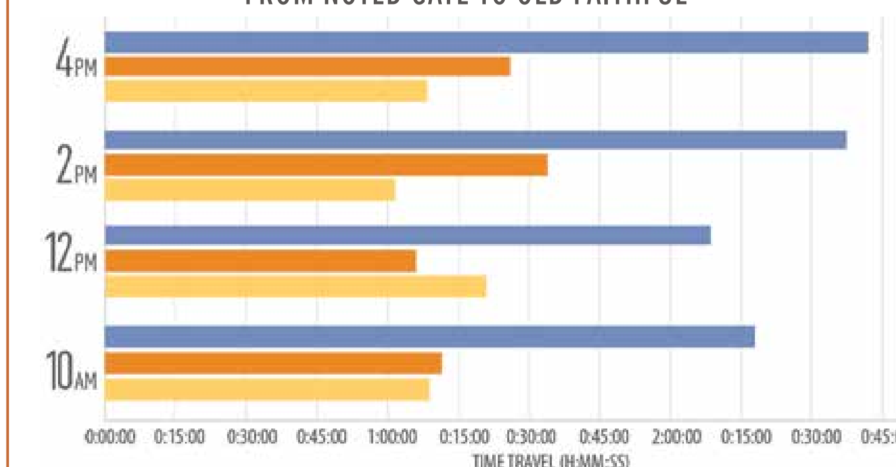


OLD FAITHFUL TRAVEL TIMES

Since a large percentage of visitors that enter through the West, North and South gates travel directly to Old Faithful after entering the park, travel times from those gates to Old Faithful in both directions are shown below and keyed to the map on the left. The travel times were calculated from Wi-Fi data to show the different travel time from each gate throughout different parts of the day.

FIGURE 40. OLD FAITHFUL TRAVEL TIMES

FROM NOTED GATE TO OLD FAITHFUL



FROM OLD FAITHFUL TO NOTED GATE

OLD FAITHFUL PARKING OBSERVATIONS

Old Faithful's parking capacity is affected by how and where people park including undesirable parking patterns. The area has three main parking lots, all of which allow pedestrian access to the geyser's viewing areas. The East lot regularly filled to or above capacity during the afternoons, but the Center and Inn lots rarely filled to capacity. When the lots start to fill towards the middle of the day, visitors tend to park in places that are not actual parking stalls. Figure 41 below (taken 8/16/16, 1:47 PM) shows two sets of visitors parked in a landscaped area rather than an actual parking spot in the center lot in Old Faithful. According to Table 06, which shows parking occupancy at that time, the Central lot was only at 80% capacity. It is likely that these visitors chose to use illegal parking spots as Old Faithful eruption time nears. Figure 42 (taken 8/16/16, 1:12 PM) also shows visitors in the Center lot parking incorrectly on the same day at 1:12 PM.

FIGURE 41.

VISITORS PARKING IN LANDSCAPED AREAS AT OLD FAITHFUL

FIGURE 42.

VISITORS PARKING INCORRECTLY AT OLD FAITHFUL

FIGURE 43.

BUSES AT MIDWAY GEYSER PARKING LOT

MIDWAY GEYSER BASIN

Midway Geyser Basin provides access to the Grand Prismatic Spring, Excelsior Geyser, and the Turquoise Pool. During the third day of the study, the parking lot filled past capacity by 9 AM and was still over capacity at 6 PM that evening. During the peak parking period, there were nearly twice as many visitors attempting to park as there were spots available.

The majority of extra cars parked along shoulders creating safety concerns. Tour buses also create concerns at this area; buses that unload large groups of passengers create a "pulse" of visitors as shown in Figure 43 (taken 7/1/16, 4:13 PM) and Figure 44 (taken 7/1/16, 3:53 PM). Sudden influxes of visitors like this can create management challenges.

Circulation should be analyzed to find options to allow vehicle flow through and review bus parking capacity and configuration. It is also recommended that pedestrian counts be performed to understand current levels of pedestrian density on the walkways near the geysers.

FIGURE 44.

CROWDED BOARDWALK DUE TO PEDESTRIAN "BUS PULSE"

NORRIS GEYSER BASIN

As was shown in Table 06, during the study, Norris Geyser Basin parking filled over capacity by 10 AM and stayed full until about 6 PM. Several cars parked illegally once lot was full. When the parking is completely full, staff members place a road closed sign near the entrance of the lot which creates confusion for visitors as is shown in Figure 45 (taken 8/14/16, 12:25 PM). Some visitors were deterred by the sign, but others just drove around it to the full parking lot anyway as is shown in Figure 46 (taken 8/14/16, 12:24 PM). Another issue seen in the Norris Geyser lot was the tendency for passenger vehicles to park in RV/Bus spaces as is shown below in Figure 47 (taken 8/14/16, 12:04 PM). Similar to Midway Geyser Basin "bus pulses" can create management challenges with large groups of visitors accessing facilities and trails at one time.

While added parking stalls would temporarily relieve the capacity issue, it is likely that the lot would fill to capacity soon after. It is recommended that circulation is analyzed to find options to allow flow through and review bus parking capacity/configuration.

FIGURE 45.

ROAD CLOSED SIGN USED WHEN NORRIS LOT IS FULL

FIGURE 46.

VISITORS BYPASSING ROAD CLOSED SIGN

FIGURE 47.

VISITORS PARKING PASSENGER VEHICLES IN RV PARKING SPOTS

CANYON VILLAGE TRAFFIC TIMES

Since a large percentage of visitors that enter the park travel directly to the Canyon Village area after entering the park, the average travel times from the five gates to Canyon Village in both directions are shown below. Traffic heading to and from Canyon Village was also monitored during the study and is reflected in the charts below. The travel times were calculated from Wi-Fi data to show the different travel time from each gate throughout different parts of the day.

FIGURE 48. WEST GATE TRAVEL TIME

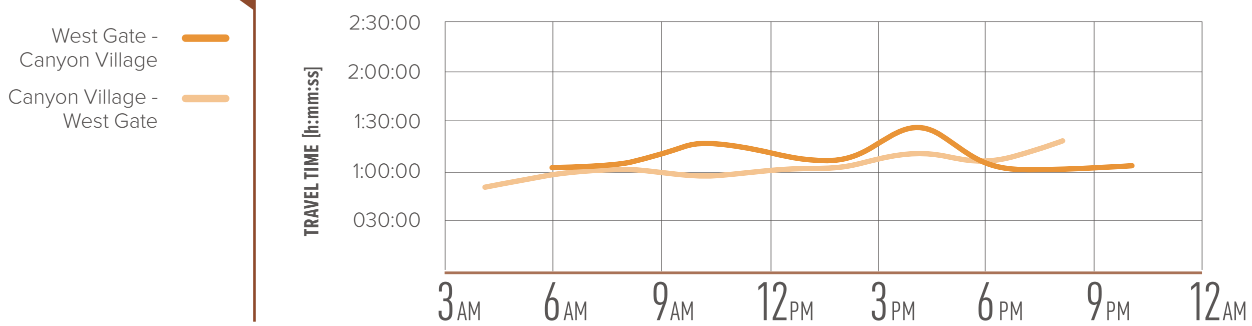


FIGURE 49. NORTH GATE TRAVEL TIME

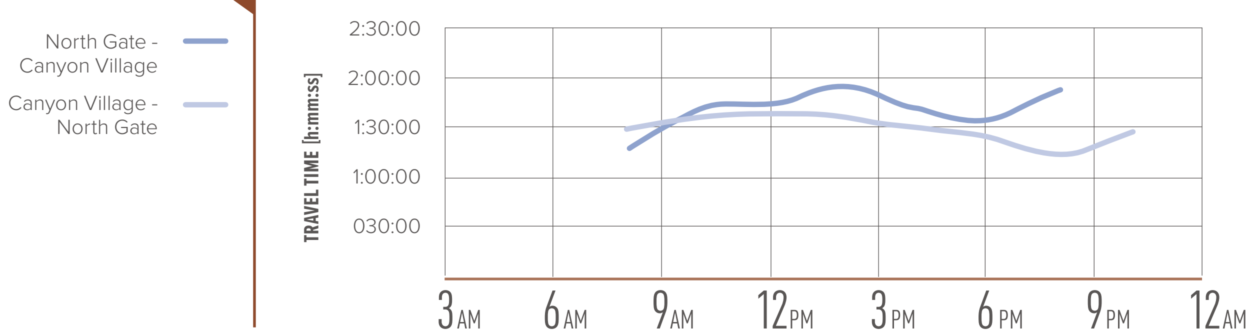


FIGURE 50. SOUTH GATE TRAVEL TIME

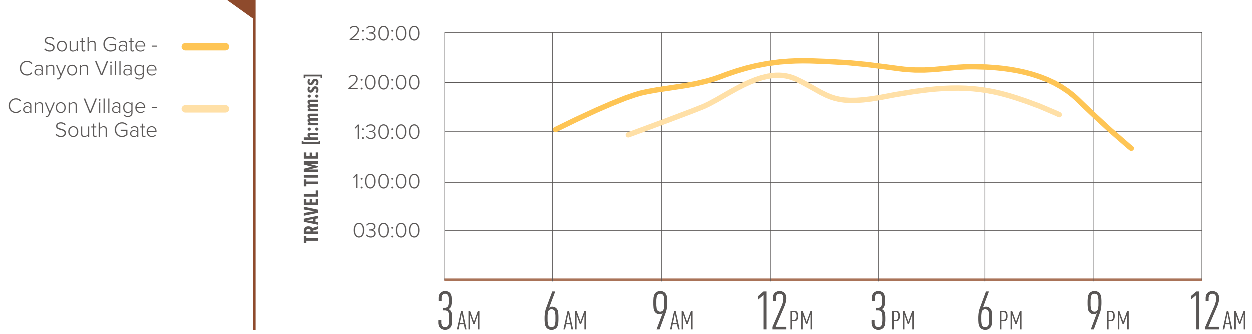


FIGURE 51. NORTHEAST GATE TRAVEL TIME

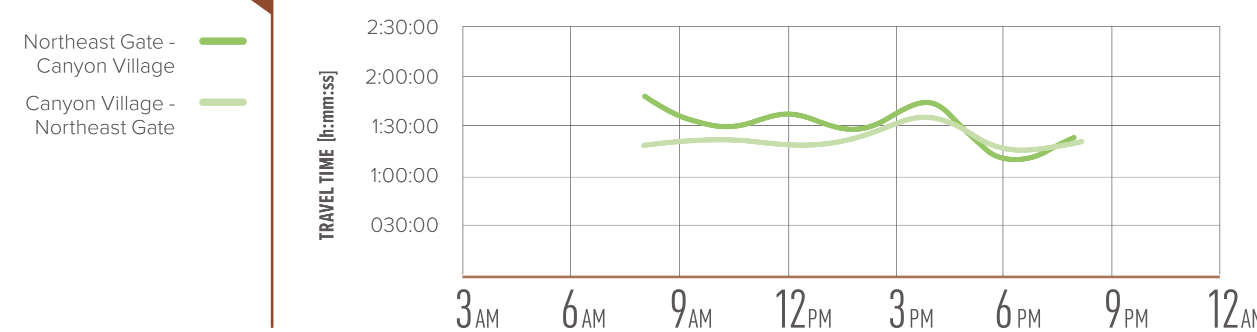
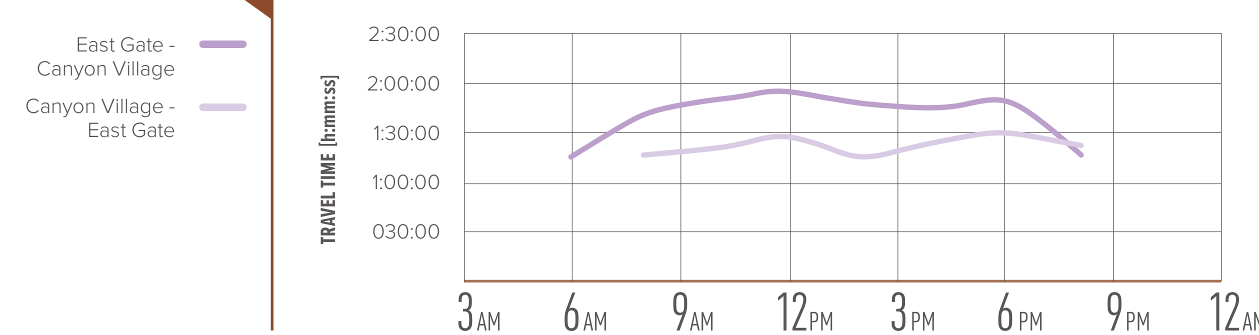


FIGURE 52. EAST GATE TRAVEL TIME



TOWER FALL

The Tower Fall store is a popular wayside stop between the Canyon Village area and the Roosevelt lodge. Parking is often filled beyond capacity mid-day as is shown in Figure 53 (taken 7/16/15, 2:10 PM) and Figure 54 (taken 8/16/16, 2:10 PM). When the lot fills to capacity, visitors proceed to park in unmarked areas and along shoulders creating safety and sight-distance issues. Furthermore, visitors who drop passengers off at the store and then circle the lot to find parking inhibit traffic flow. Directional arrows and a specific drop off area could help the flow of traffic. Plans are currently underway to expand parking in this area. Expanded parking may help for a few years and additional analysis/modeling could help to determine a projected duration of capacity.

Based on tube counts adjusted to reflect July traffic, approximately 4,800 vehicles per day drove through the Dunraven Pass just south of Tower Fall. Approximately 11% of those vehicles are RVs and another 9% consist of buses.

FIGURE 53.

PARKING CONGESTION AT TOWER FALL STORE

MAMMOTH

The Mammoth area of the park tends to peak in congestion during the mid-day and early afternoon time period when visitors are arriving for lunch and ice cream. This is also a popular area to view the elk that reside around the town. The elk viewing causes, at times, congestion on the roadways and unsafe conditions with pedestrians that are crossing at many locations along the road, often times not looking for traffic. The Mammoth Junction intersection generally seems to operate without major issues. However, there were peak times when queues at the intersection exceed 250 feet (approximately 10 vehicles) on the northbound approach (traffic travelling from Roosevelt to turn westbound towards Norris). During the three-day study period, this queue occurred several times, but would quickly subside. The section of roadway between the Yellowstone General Stores and the Mammoth Hot Springs Hotel was frequently congested with traffic and pedestrian activity. The 90 degree on-street parking in front of the Terrace Grill, the pedestrian crossings, and queues from the Mammoth Junction are all contributing factors the roadway congestion. Segregation of the on-street parking from the travel lanes of the roadway in this area could alleviate some of the current issues. Because the developed area of Mammoth provides multitude of lodging and visitor facilities, the hot springs attraction, and park headquarters offices, it is a busy hub in the park and that could benefit from some additional analysis of circulation, parking efficiency, and wayfinding improvements to help orient visitors from this hub toward other areas of the park more efficiently.

FIGURE 54.

PARKING CONGESTION AT TOWER FALL STORE

FIGURE 55.

PARKING AT MAMMOTH

FIGURE 56.

BOILING RIVER VISITORS PARKING ALONG ROAD SHOULDER

FIGURE 57.

QUEUES OUTSIDE NORTH ENTRANCE

BOILING RIVER

The Boiling River has recently become a very popular attraction as social media and word-of-mouth have continued to promote location. The hot springs attract the most visitors late in the day and early evening with fewer visitors in the early morning. The parking area quickly fills to capacity so vehicles park on shoulders across the street, creating safety concerns as shown above in Figure 56 (taken 8/14/16, 3:10 PM). While parking expansion with monitoring of patterns and resources is an option, the relief to the congestion may only be temporary. Once the parking lots reach capacity again, other management options would need to be considered.

NORTH GATE

The North Gate experiences some of the longest queue lengths of the five park entrances even late into the afternoon as shown in Figure 57 (taken 8/15/16, 2:12 PM). To relieve the long queue lengths and wait times, it is recommended that the park explore similar approaches to improve the North Gate as adapted for the West Gate in 2016. Some additional analysis and micro-simulation modeling would inform the design of improvements for entrance area.

RECOMMENDATIONS

OVERVIEW

This Transportation and Vehicle Mobility Study for Yellowstone National Park was largely focused on data collection and a general level of analysis related to interpreting the results of data collection and observations at the park during the 2016 study period. Based on trends over the last few years, it is anticipated that visitation to the park will continue to increase annually and that problems pertaining to visitation patterns at key destinations in the park, influxes of large tour groups, and pressures on certain roadway segments and parking areas will continue to intensify. As such, we recommend that the park proceed to take increasing levels of action in an adaptive management approach to proactively address these issues.

As noted earlier in this study, it is estimated that increasing visitation to the park could lead to unacceptable conditions by 2020. When developing solutions to address this future foreseeable challenge, the park will need consider a variety of factors:

- The quality of the visitor experience and providing an ongoing enjoyable experience;
- The level of services and facilities that can realistically be made available to visitors with ongoing increases in demand;
- The health of the environment and effects on natural resources;
- Potential effects on cultural and historical resources;
- The need for more staffing to serve more visitors and manage more traffic;
- The level of infrastructure expansion and improvements (parking areas, roadways, etc.) that can be made given the factors above and constraints on funding; and
- Other management policies and decisions.

Some areas of the park may already be at the visitor capacity for those locations at peak periods, and expanding transportation and parking would only further congest these areas and create additional management challenges.

Making large scale improvements in national parks requires careful study and analysis, given that increasing transportation and parking capacity could have other implications on resources and values important to the park, as mentioned above. In cities, we often say, "you can't build your way out of congestion." The same can be said within national parks. We can continue to widen roads and expand parking areas up to the limits of resource and experiential constraints; but this expansion will only attract more traffic and congestion, and ultimately may not be enough to serve increasing visitation over time.

As the park considers its next century as a world destination and cherished American landscape, there is an opportunity to carefully evaluate changing trends and increases in visitation and to take steps to manage and address these changes through a variety of solutions that may increase in intensity over time. Some may be temporary piloted solutions; some may be permanent physical improvements; and others may be transportation demand and visitor management solutions that do not involve physical changes in the park or construction, but rather changes in management approaches (such as reservation systems for key destinations).

HIGHEST PRIORITY RECOMMENDATIONS

Based on discussions with park staff, the following actions should be implemented in the near term (next one to three years) as possible.

SEASONAL PARKING UTILIZATION AND ROADWAY TRAFFIC VOLUME STUDY

The park is interested in determining more specifically the typical week, month, and duration of when key parking areas tend to reach capacity. This will require some additional data collection in the summer of 2017 to supplement the results and analysis that were the focus of this study.

Park staff members are currently in the process of collecting additional parking utilization data, which can be used to correlate when parking reaches capacity with the average daily traffic levels on key roadways. This analysis will help to inform park staff of when certain plans/measures need to be implemented during peak visitation to alleviate congested parking and roadway conditions.

CORRIDOR STUDY – WEST GATE TO OLD FAITHFUL

This study confirmed that the West Gate to Old Faithful is the most congested area in the park, followed by the Madison to Norris to Canyon to Fishing Bridge corridor, and together these areas form a “C” zone of congestion in the park, as shown in Figure 13. In order to gain a better understanding of how this key corridor functions and to more accurately assess impacts to the elements listed below, a more focused corridor study with modeling is recommended. With regard to the West Gate, improvements made in 2016 addressed some of the extreme congestion that was experienced earlier in the spring. However, pulses of congestion may continue at peak periods and as visitation increases in the coming years, which may need to be addressed with additional improvements and management actions, as analyzed by this study. The analysis also could help to inform incremental actions that could be implemented at other gates in the future.

This study would model traffic and potential visitor flow pattern scenarios and the potential effects on gate operations, pull-outs, wildlife viewing, geyser eruptions, and side friction (from congested areas such as geyser basins). This study also would evaluate and model potential solutions through micro-simulation. Specifically, the analysis could evaluate:

- Travel times in the corridor;
- West Gate performance and potential modifications (adding a lane, switching a lane to an express lane, changing the processing time, etc.); and
- Madison Junction intersection analysis and potential modifications (roundabout, Hi-T, storage lengths, etc.);
- Midway turning counts/turning movements;
- Old Faithful traffic flow patterns;
- Effects of adding more pull-out areas or other improvements/modifications.

Understanding the operational benefits related to these potential solutions will help the park prioritize recommended improvements.

Whether part of the corridor study, or future phases of work, the following high congestion areas may need a special level of focus, analysis, and treatment as visitation continues to increase:

Old Faithful area circulation and parking—more detailed analysis of alternatives should be completed to determine specific improvement recommendations to address issues related to pedestrian platoons crossing busy exit routes, undesirable parking patterns and behaviors, the need for wayfinding, improvements for better traffic flow to and from parking areas, and other opportunities. Additional signing and wayfinding could help distribute visitors to the Central and West lots and relieve some of the congestion in the East lot.

Geyser Basins (Midway and Norris) circulation and parking—evaluate existing parking capacity and circulation and analyze alternatives to improve flow of traffic, and reduce back up and congestion. This may include evaluating potential expansion of parking areas and review of bus parking capacity and configuration in these areas. In conjunction with this analysis, consider more permanent roadway shoulder hardening improvements to control/eliminate overflow parking on the roadways approaching these areas. Additionally, in-depth analysis of the trails/boardwalk systems is recommended to evaluate pedestrian use and people at one time present in the resource area. Pedestrian densities are reaching extreme levels in the geyser basin areas during peak periods. This intensity of use is causing a variety of problems including overcrowding on the trails and boardwalks, lines outside of restrooms with limited ability to maintain service, litter and trampling in the resource areas, and other concerns.

While parking expansion with monitoring of patterns and resources is an option, the relief to congestion may be only temporary and may cause the pedestrian densities to increase exacerbating the problems described above. And ultimately even if expanded, the parking lots would reach capacity again in the future. Other management options need to be considered. Determine if there is a resource/visitor carrying capacity for this area of the park (how many visitors can be accommodated) and with that known, consider managing use during peak periods through reservation systems. This could be needed due to increasing use and extreme levels of congestion causing damage to resources or effects on visitor experience, but if implemented would require additional park management and enforcement resources.

GREATER YELLOWSTONE ECOSYSTEM REGIONAL VISITATION AND TRANSPORTATION STUDY

A study of the broader region will help the park better understand how visitors travel to/from the park and how these visitor patterns may affect the greater Yellowstone ecosystem (GYE). The fundamental purpose of this regional study would be to gain a better understanding of how visitors travel to/from Yellowstone and to/from other origins and destinations in the region and how this impacts the GYE resources and communities.

The current park-focused analysis is helping to answer the question, “Are there patterns in the ways visitors move throughout Yellowstone National Park?” A broader, regional study will help to answer the questions: “Are there patterns in the ways visitors move throughout the region, including access to and from Yellowstone and other regional origins and destinations?” “How do these patterns affect the GYE?” and “How can these patterns be managed or addressed to protect the ecosystem while also supporting gateway communities to the park?”

The regional study could be completed in collaboration with other agency and organization partners in the GYE and would leverage information already collected through this study and the 2016 visitor use survey work along with new data sources. The use of a ‘Big Data’ (GPS and cell phone data) source is recommended to determine **When**, **Where**, **Why**, and **How** people move around the region. Information obtained from ‘Big Data’ sources can be organized and analyzed by day types, day parts (hourly, customizable), and data periods (monthly, back to 2014).

Through the use of ‘Big Data’ and other tools, this regional study could include:

- Identification of regional portals, roadway volumes, and gateway community congestion issues;
- Gaining a better understanding of what the 7 day experience is in the region;
- Patterns in visitation, traveler attributes (trip purpose, census information, demographics of visitors, and other characteristics);
- Origin-destination analysis;
- Trip attributes (average trip time, length, speed, and circuity); and
- Determining if there are correlations between regional travel patterns and resource conditions (wildlife migration routes for example).
- Assessing trends in tourism throughout the region, including volumes of tour buses as well as how potential lodging capacity increases that may happen in the future may affect visitation patterns to, from, and within Yellowstone.

Other specific questions that could be answered as a result of completing a broader regional study, include:

- What are the traffic patterns around the GYE and how does traffic flow into and out of the GYE? In other words, how is the park influencing regional traffic patterns?
- What is the demographic breakdown related to park and GYE visitation and how does this relate to providing an equitable experience for all visitors?
- Do the patterns indicate specific areas of focus or need across the region?
- Are certain areas in the region receiving more visitation with increases in park visitation over the last few years?
- How will increases in park visitation continue to affect regional travel patterns and resources and communities of the GYE?
- What are the Greenhouse Gas (GHG) emissions caused by the park visitor traffic and regional traffic patterns? (Note: this also could be looked at in the recommended corridor study for inside the park boundaries and could look at GHG based on modifications in gate operations and other improvements to the roadway that could change travel time or the time spent idling in the queue.)
- How are travel patterns affecting wildlife migration routes, sensitive natural resources, and other conditions within the GYE?
- What is happening in gateway communities? What are the projections of surrounding areas related to population growth, trends in lodging construction, and how are communities planning to manage tourism and traffic increases?
- Are there Transportation Demand Management (TDM) strategies to help mitigate the regional traffic congestion?
- Are there opportunities to partner on solutions with the NPS, GYE communities, various organizations, and others joining together to address needs related to increased tourism in the coming years?

The regional study will establish a baseline understanding of visitor and traffic patterns throughout the region; define areas of needs across the region; and help partners prioritize, align, and leverage financial and management resources to address these needs. The study will provide a starting framework for the partners to implement and monitor cooperative and collaborative management actions across jurisdictional boundaries and throughout the GYE.

OTHER RECOMMENDATIONS

In addition to the highest priority recommendations discussed above, additional general recommendations applicable to the parkwide context and to specific locations within the park are summarized below.

GENERAL/PARKWIDE

The park should continue to evaluate visitation patterns in association with effects on impacts to wildlife, ecosystems, and the environment, as well as in consideration of effects on visitor experience.

Through an integrated approach that combines analysis of visitation, resource conditions, staffing and operations, and the transportation and parking systems in the park, move forward with developing a visitation congestion management plan that evaluates and defines visitor capacities for key locations in the park. Once the visitation congestion management plan is completed, the park can move forward to:

- Develop improvement plans and management strategies to manage to identified visitor capacities and in accordance with an integrated visitation congestion management plan. An integrated, coordinated staff team should continue to be assigned to this effort on an ongoing basis, including management staff from each park district.
- Consider options to promote other areas in the park that are underutilized (such as the Lake district). Improvements to underutilized areas, along with marketing and promotion of these areas to visitors could help alleviate congestion in other areas of the park, and also could help expand visitor experience options particularly if implemented concurrently with reservation systems in highly congested areas.
- Develop a prioritization program for hardening along roadway edges/shoulders where overflow parking problems continue to persist and/or require constant management and enforcement. While the current program of temporarily placing signs, traffic cones, timber pole “saw horse” barriers, and other treatments is proving to be effective in some locations, a permanent

and consistent parkwide treatment may be preferable as a long term management solution (i.e. could reduce staff time spent managing traffic and with enforcement allowing more time to be devoted to visitor interpretation/education; also could reduce visual effects of varied treatments along the roadside). Permanent solutions would have a higher capital cost upfront, but should reduce operational costs over time. Such solutions may include rock walls, high curbs, rocks, or other permanent elements along the roadside along with some minimal signing, designed in accordance with traffic safety standards.

- Consider potential Intelligent Transportation System (ITS) strategies and improvements that could be implemented at key locations (such as entrances, visitor centers, gateway communities, etc.) to help with congestion management (e.g., variable message signs, travel time information, real-time parking utilization).
- Prepare a comprehensive signing and wayfinding program for the park that is in sync with NPS design standards, but that applies an overlay of new techniques (web-based wayfinding, branding, supplemental wayfinding signs, etc.) to help visitors travel more efficiently and effectively throughout the park. These actions could complement and support marketing and promotions of underutilized areas of the park discussed above.
- Monitor and document changes in transportation and vehicle patterns in the park and correlate to visitation patterns on an ongoing basis and prepare an annual report summarizing improvements and management actions made to address congestion problems in certain areas and the effectiveness of these, including how these actions may be applied to other areas of the park over time.

As actions are taken, the park should continue to work closely and collaboratively with representatives from gateway communities and other surrounding jurisdictions on congestion management, syncing park management objectives and actions together with policies and initiatives of the local communities. Share data and information collected across jurisdictions to continue to understand and proactively plan for visitation patterns throughout the region.

KEY LOCATIONS

In addition to the highest priority areas described above, several other key locations could be further evaluated for potential actions and improvements based on existing conditions and problems, as summarized below.

- **MAMMOTH:** Conduct an in-depth study of circulation and parking in and around Mammoth Hot Springs/park headquarters facilities and develop a specific wayfinding and signing program, as well as recommendations to improve circulation and parking to address congestion in this area.
- **CANYON:** Continue to analyze and make improvements to the Canyon area circulation and parking areas that are already in planning and design. The North Rim lots are often congested while the Canyon Village lot typically has some capacity. Analyze, design, and implement other improvements (such as separating traffic flow from parking circulation where possible) to keep traffic flowing through the North Rim lots and to encourage visitors entering from the main road to continue on rather than overflow park in that vicinity with the perception that all parking areas are full.

  Take initial steps to evaluate the potential for shuttling visitors in the Canyon area as a future congestion management strategy. Potential implementation of shuttle service would be well-suited to the Canyon area of the park given the distance between potential stops and the loop configuration of the road system. As a first step, complete a feasibility study for potential implementation of a looping shuttling system focused at providing service between the Canyon Village and North Rim locations. At a minimum, the study should consider the system routing, stop locations, numbers of vehicles needed, service timeframes, maintenance and operations requirements, and costs and financial strategies to support the system.
- **TOWER FALL:** Proceed to finalize design and implement planned parking and circulation improvements at Tower Fall, but first analyze the proposed design and determine refinements to further improve traffic calming, pedestrian access, and other elements prior to finalizing the plan for construction. Also, as with other locations, while expanded parking may help for a few years and additional analysis and modeling could help to determine projected duration of the new capacity, with increasing visitation this area may continue to be a congestion hot spot in the future.
- **BOILING RIVER:** Continue to monitor and evaluate conditions at the Boiling River, including overflow parking along the road and pedestrian crossing patterns to the parking area across the road. Consider options (perhaps through piloted approaches) to harden edges in vicinity to control overflow parking along roadway. Evaluate and explore options to enhance parking efficiency and effectiveness, with some minimal expansion opportunity if feasible. While parking expansion with monitoring of patterns and resources is an option, the relief to congestion may be only temporary. Once the parking lots reach capacity again, other management options would need to be considered. Determine if there is a resource/visitor carrying capacity for this area of the park (how many visitors can be accommodated) and with that known, consider managing use during peak periods through a reservation system.
- **NORTH AND SOUTH ENTRANCE AREAS:** Given that the West Gate to Old Faithful corridor study would provide a more focused analysis of potential solutions for that entrance, the park could use this analysis as a model for solutions at other gates. In the near term, the park could adapt similar congestion management methods as were implemented at the West Gate operations in 2016 (i.e., short processing times, fast pass lane, etc.) at other entrances as congestion increases during peak periods (such as the North and South Gates). This may also include evaluation of configuration and quantity of entrance booths, circulation to and from the booths, signing, and other physical improvements that may be needed in these areas based on further analysis and design. Some additional micro-simulation modeling would help to inform specific design of improvements for Gardiner roadways and the North Gate area.
- **TOWER/ROOSEVELT JUNCTION:** As discussed earlier in this study, consider converting the Tower/Roosevelt Junction intersection to an all way stop to improve the level of service at this intersection (from LOS C with 17 seconds of delay to LOS B with 11 seconds of delay). Due to the large volume of horse traffic and favorable impact to delay, converting this intersection to an all-way stop could prove to be beneficial for traffic flow.