



Current Condition of Standards from the Denali Park Road Vehicle Management Plan

2018 Summary Report

Natural Resource Report NPS/DENA/NRR—2019/1934



ON THE COVER

A tour bus stops to view a caribou on a summer day on the Denali Park Road.

NPS Photo (A. Kirk)

Current Condition of Standards from the Denali Park Road Vehicle Management Plan

2018 Summary Report

Natural Resource Report NPS/DENA/NRR—2019/1934

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Executive Summary

Conditions of six Vehicle Management Plan (VMP) indicators, the probability of a visitor observing one of the “big five” wildlife species (caribou, grizzly bear, moose, sheep, and wolf), and statistics related to the number of vehicle entrances on the permit-controlled section of the Denali Park Road were documented and analyzed for the 2018 regulatory year (May 26 – September 13, 2018). The six tier-1 indicators are: (1) Number of vehicles stopped at wildlife in the same place at one time (wildlife stops); (2) number of vehicles parked at rest stops at one time; (3) number of vehicles visible in specific viewsapes at one time; (4) hourly 10-minute gaps in traffic at sheep crossing locations (sheep gaps); (5) nighttime (2200–0600) traffic rates; and (6) amount of time a hiker waits for a bus (hiker wait time). The method for monitoring standards for a seventh indicator, large vehicle traffic (> 80,000 pounds gross vehicle weight rating), has not been implemented.

Here we (1) compare current conditions of the VMP indicators to the 1-year VMP standards; (2) use 2014–2018 data to assess 5-year VMP standards; (3) recommend monitoring method improvements; and (4) provide recommendations for meeting the desired conditions of the resource as described by the VMP and measured by the indicators.

Collectively, sample size increased 16% from 2017. Eighty-eight percent (36 of 41¹ metrics) of all VMP standards were met in 2018, an 8% improvement from 2017.

Assessment of the 1-year VMP standards:

- 1) Wildlife stop standards were met in all three Wildlife Viewing Subzones (WVS).
- 2) Rest stop standards for number of total vehicles were met at all sites. However, rest stop standards for total number of buses failed on three instances. Twice at Toklat (>11 buses) and once at Eielson (>10 buses).
- 3) Viewscape standards were met at all four sites. However, the total percentage of time meeting standard has been decreasing for two years running. Additionally, data show that vehicle spacing has been decreasing since 2016.
- 4) Sheep gap standards were met at two of five sites (Tattler Creek and Grassy Pass).
- 5) Nighttime traffic standards were met at all monitoring locations.
- 6) Hiker wait time standards were met. However, incidents of buses unable to pick up hikers due to capacity increased.

¹ Beginning in 2016 data collected at the traffic counter located at mile 28.7 (Tek) is not being considered to measure the nighttime traffic standard because it is only 1.6 miles from the next counter, TekGate. While the two counters' proximity is necessary for determining traffic patterns (i.e. how many vehicles turn into Teklanika campground), it is redundant information for traffic disturbance. Each traffic counter location measures two nighttime traffic metrics: percentage of nights with <3 vehicle passes per hour and percentage of nights where no one hour had >6 vehicle passes. Thus, the number of metrics measured henceforth is 41 not 43.

Assessment of the 5-year VMP standards:

- 1) Eight of nine wildlife stop 5-year standards were met. The only failure was in WVS 3, which failed the percent time one or fewer vehicles were present at wildlife stops.
- 2) All 5-year viewscape standards were met.
- 3) Sheep gap standards were met at one site and failed at four sites (mile 21.6, 37.6, 52.8, and 60.6). The Tattler Creek sheep gap (mile 37.6) highlights how 1-year metrics can be met every year, while failing the stricter 5-year metric over the same period.
- 4) All hiker wait time 5-year standards were met. However, the VTS driver dataset is an outlier of other hiker wait time datasets and its quality is questioned.

Total vehicles entrances on the controlled section of roadway was 12,890, a 1.6% increase over 2017. This value includes a 6% and 18% increase in entrances by long tour and short tours, respectively, and a 9% and 4% reduction in government- and personal-operated vehicles entrances, respectively. The maximum number of vehicles observed in a single day was 151, which occurred July 19. The average number of vehicle entrances per day in 2018 was 116.

Sheep gap success rate continues to be the biggest management challenge and should be first addressed by collecting 24-hour data at sheep gap sites (planned for 2019). A sustained effort to inform all road users of the unique management strategies of the road is imperative to avoid complacency. Continued integration of VMP-related Terms and Conditions into commercial use agreements, contracts, operating plans, and road use permits, in addition to careful traffic scheduling (particularly nighttime projects), establishing park-authorized parking places, and continued internal and external education and outreach are imperative for meeting the desired conditions outlined in the VMP.

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Introduction

Annual monitoring related to the Vehicle Management Plan (VMP) will be reported in the format herein. Meaning, results will be reported in this stand-alone document and background literature related the VMP including definition of standards is available in another document at <https://irma.nps.gov/DataStore/Reference/Profile/2258362>. Additionally, methods and analysis protocols are available at <https://irma.nps.gov/DataStore/Reference/Profile/2258367> and <https://irma.nps.gov/DataStore/Reference/Profile/2258369>, respectively. Any changes to methods or analysis protocols will be documented solely in their respective documents.

Park staff and volunteers collected data to assess the current state of VMP indicators. The primary objective of this report is to compare the current conditions of the indicators to their defined standards (i.e. desired conditions). The results will help inform adaptive management strategies to affect the transportation system to achieve desired conditions. This report summarizes data for six of seven Denali Park Road VMP tier-1 indicators: (1) Number of vehicles stopped at wildlife at one time (i.e. wildlife stops), (2) number of vehicles at rest stops, (3) number of vehicles visible in viewscapes, (4) hourly 10-minute gaps in traffic at sheep crossing locations (i.e. sheep gap spacing), (5) average hourly nighttime vehicle traffic, and (6) hiker wait time. The methodology used to monitor the seventh standard, large vehicle traffic, has not been implemented.

Results

Data Collection Effort

We sampled 330 VTS and five Tour trips using the Ride Observe and Record (ROAR) protocol spanning 110 regulatory days and 72 regulatory days using the National Park Service Observation (NPSO) protocol, respectively. We completed 1,126 VMP condition observations in 2018 (Table 1). Observations closely matched the schedule for the Peak and Late subseasons and were further from target values in the Early subseason (Table B-1).

Table 1. VMP indicator observations were made throughout the Early, Peak, and Late subseasons of the summer on the Denali Park Road (Denali National Park and Preserve, Denali Park, Alaska USA). The rate of observation is lowest during the Early subseason due to training days and other commitments.

Samples	Early (19 days)	Peak (49 days)	Late (42 days)	Total
ROAR	50	115	165	330
NPSO	93	422	281	796
Observations per day	7.5	11.0	10.6	–
Observations per VMP site	2.6	7.0	4.7	–
Total	143	537	446	1,126

Number of Vehicles at Wildlife Stops

ROAR observers recorded 4,157 wildlife stops. Seventy-nine percent of wildlife stops occurred in Wildlife Viewing Subzone (WVS) 2, 13.5% occurred in WVS 1, and 7.2% occurred in WVS 3. WVS 2 was the most animal-rich road segment (Table 2).

Table 2. The number of ROAR observations recorded in three subzones during the 2018 regulatory year on the Denali Park Road. The number of stops was normalized to Subzone lengths (miles) to report stops per mile. WVS 2 is the most animal-rich subzone in the park by this measure.

Stop Type	WVS 1	WVS 2	WVS 3
Number of wildlife stops	562	3,293	302
Stops per mile	26.8	86.4	16.2

All wildlife stop measures met VMP 1-year standards in all subzones (Table 3). Wildlife stops in 2018 were slightly more crowded in WVS 1, less crowded in WVS 2, and the same level of crowding in WVS 3 when compared to 2017. A maximum of 12 vehicles was observed once for a bear near Toklat (WVS 2). Ten vehicles were observed at a sow and cub near mile 57 (WVS 2). These are the only wildlife stop observations with more than eight vehicles present. The 5-year (2014–2018) standard for wildlife stops was met in two of the three wildlife viewing subzones (eight of nine metrics met;

Table 4). The percentage of instances when less than one vehicle was observed in WVS 3 failed by 0.29%.

Table 3. Traffic volume conditions as a percentage of time x or fewer ($\leq$) vehicles were observed at a wildlife stop on the Denali Park Road. All wildlife stop 1–year standards were met in 2018.

Method	Wildlife Subzone 1			Wildlife Subzone 2			Wildlife Subzone 3		
	% $\leq$ 3 vehicles	% $\leq$ 4 vehicles	% $\leq$ 5 vehicles	% $\leq$ 2 vehicles	% $\leq$ 3 vehicles	% $\leq$ 4 vehicles	% $\leq$ 1 vehicles	% $\leq$ 2 vehicles	% $\leq$ 3 vehicles
Standard	70	85	90	70	85	90	70	85	90
ROAR result	92.3	96.6	98.9	82.4	93.3	97.5	76.8	94.4	98.7

Table 4. The 5–year VMP standards for number of vehicles at a wildlife stop was met for eight out of nine criteria on the Denali Park Road. One criteria, the most strict, failed in wildlife viewing Subzone 3 by 0.29%.

Method	Wildlife Subzone 1			Wildlife Subzone 2			Wildlife Subzone 3		
	% $\leq$ 3 vehicles	% $\leq$ 4 vehicles	% $\leq$ 5 vehicles	% $\leq$ 2 vehicles	% $\leq$ 3 vehicles	% $\leq$ 4 vehicles	% $\leq$ 1 vehicles	% $\leq$ 2 vehicles	% $\leq$ 3 vehicles
Standard	75	90	95	75	90	95	75	90	95
ROAR result	94.3	97.8	99.3	82.2	93.1	97.3	74.7*	94.4	99

* Failed VMP standard, also shown in red.

Number of Vehicles at Rest Stops

We collected 3,197 traffic volume samples using the ROAR protocol, and 209 20–minutes samples using the NPSO protocol at Teklanika, Toklat, and EVC rest stops. Rest stops exceeded standards three times in 2018, twice at Toklat and once at EVC (Table 5, Figure 1, Figure 2, Figure 3). The EVC continued to have the highest average number of buses and total vehicles observed (* Failed VMP standard, also shown in red.

Table 6,

Table 7). There is a systematic increase from the NPSO to the ROAR protocol in the observed maximum number of buses, maximum total vehicles, and their averages at each rest stop. However, each rest stop has bus and vehicle capacity on Sundays (Figure A-1. Traffic volumes in 2018 at the Teklanika (a), Toklat (b), and EVC (c) rest stops on the Denali Park Road.

).

Table 5. Maximum number of buses and vehicles parked at one time at the Teklanika and Toklat rest stops and Eielson Visitor Center (EVC) during the 2018 regulatory year on the Denali Park Road. Bus maximums at Toklat and the EVC exceeded standards.

Method	Teklanika			Toklat			EVC		
	bus max	vehicle max	<i>n</i>	bus max	vehicle max	<i>n</i>	bus max	vehicle max	<i>n</i>
Standard	12	16	–	11	16	–	10	19	–
NPSO result	7	8	690	9	10	710	9	12	690
ROAR result	10	10	1,273	12*	12	1,148	11*	14	771

* Failed VMP standard, also shown in red.

Table 6. Mean (and standard deviation, σ) number of total buses parked at one time at the Teklanika and Toklat rest stops and Eielson Visitor Center during the Denali Park Road. ROAR data were consistently greater than NPSO data; the most buses were observed at EVC.

Method	Teklanika		Toklat		Eielson Visitor Center	
	mean (σ)	<i>n</i>	mean (σ)	<i>n</i>	mean (σ)	<i>n</i>
NPSO result	2.1 (± 1.6)	690	2.1 (± 2.0)	710	2.3 (± 2.0)	690
ROAR result	2.7 (± 1.5)	1273	3.6 (± 1.9)	1148	4.1 (± 1.8)	771

Table 7. Mean (and standard deviation, σ) number of total vehicles parked at one time at the Teklanika and Toklat rest stops and Eielson Visitor Center during the 2018 regulatory year on the Denali Park Road. The margin of difference between EVC and Toklat grows considerably when we considered mean total vehicles compared to mean total buses. The EVC frequently has non–bus traffic because it is the duty station for several park employees. The standards for the number of total vehicles parked at rest stops were met in 2018.

Method	Teklanika		Toklat		Eielson Visitor Center	
	mean (σ)	<i>n</i>	mean (σ)	<i>n</i>	mean (σ)	<i>n</i>
NPSO result	2.4 (± 1.7)	690	2.5 (± 2.1)	710	3.7 (± 2.5)	690
ROAR result	2.9 (± 1.6)	1273	3.9 (± 2.0)	1148	5.9 (± 2.3)	771

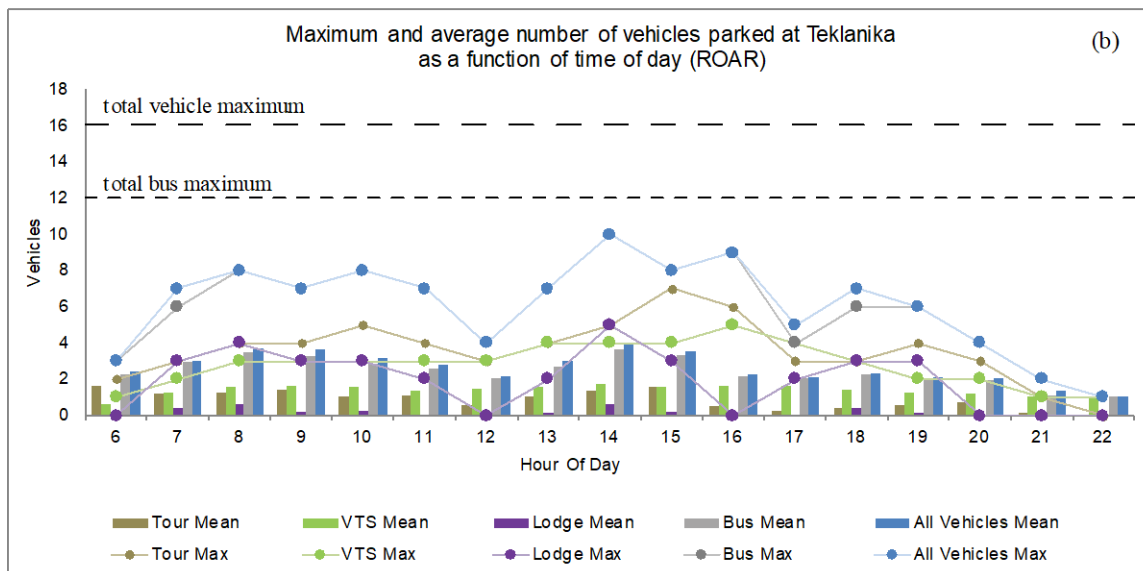
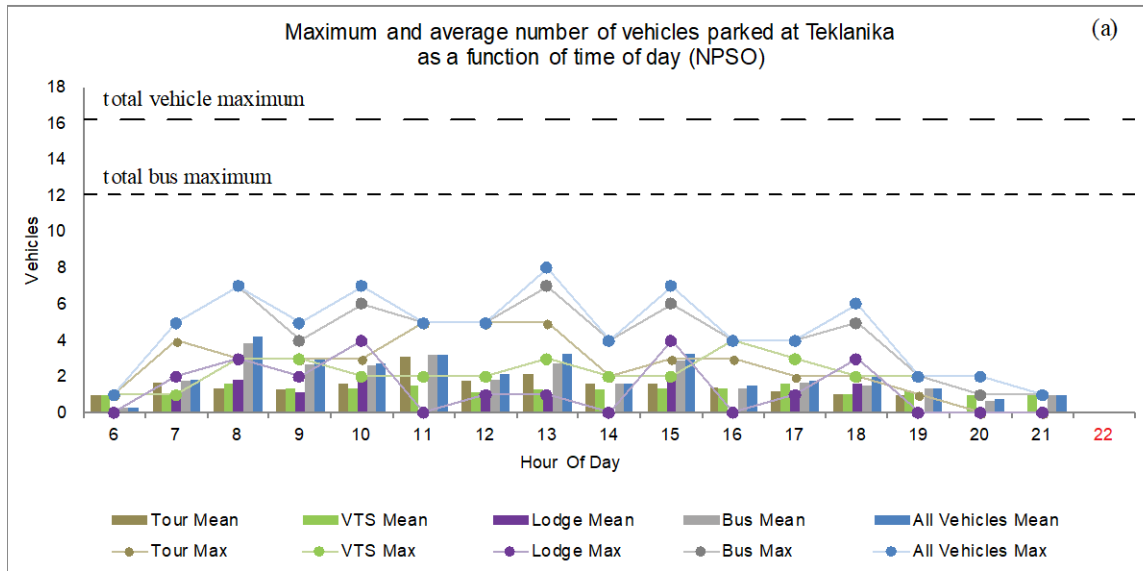


Figure 1. Maximum and average number of vehicles parked at the Teklanika rest stop based on the NPSO (a) and ROAR (b) protocols used on the Denali Park Road. Both total bus and total vehicle maximums at the Teklanika rest stop met VMP standards for 2018. Red hour blocks on the x-axis indicate the time was not observed (i.e. no data available).

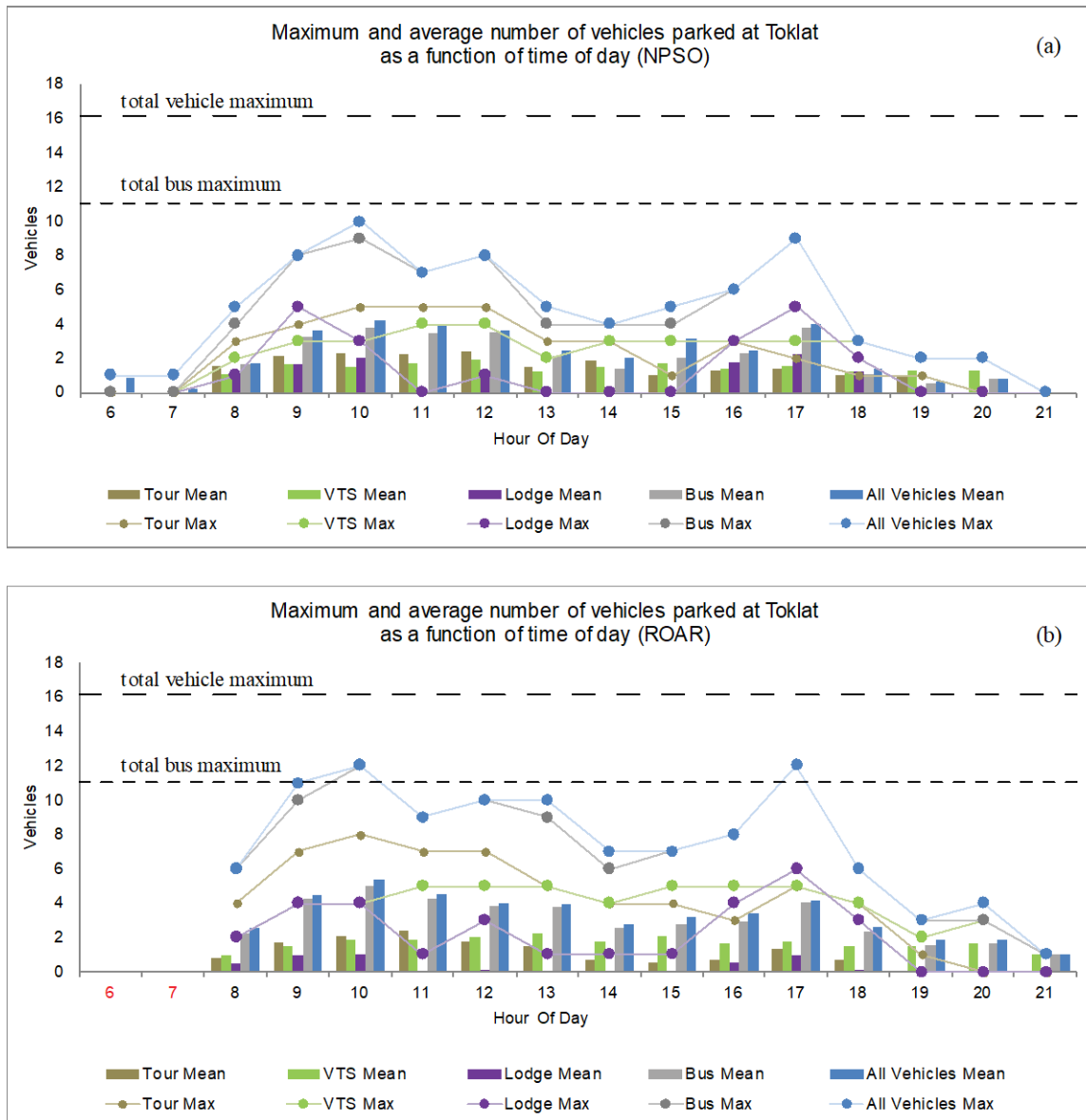


Figure 2. Maximum and average number of vehicles parked at the Toklat rest stop based on the NPSO (a) and ROAR (b) protocols used on the Denali Park Road. Total bus maximum at Toklat did not meet VMP standard twice in 2018. Total vehicle maximum met VMP standards in 2018. Red hour blocks on the x-axis indicate the time was not observed (i.e. no data available).

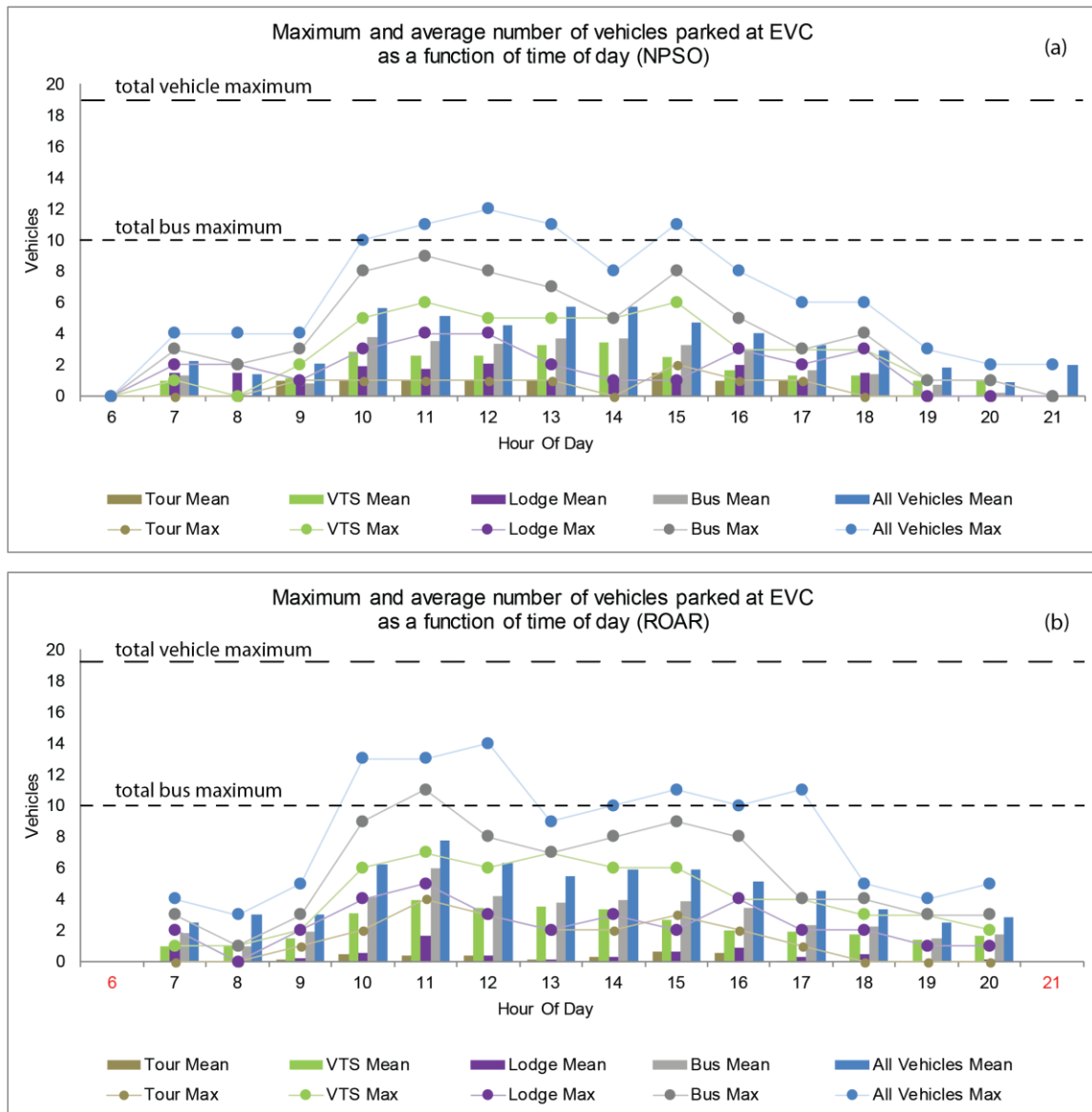


Figure 3. Maximum and average number of vehicles parked at Eielson Visitor Center (EVC) based on the NPSO (a) and ROAR (b) protocols used on the Denali Park Road. The total bus maximum did not meet VMP standard once in 2018. Total vehicle maximums met VMP standards. Red hour blocks on the x-axis indicate the time was not observed (i.e. no data available).

Number of Vehicles in Viewscapes

We collected 257 20-minute viewscape observations at mile 26 ($n = 67$), mile 55 ($n = 65$), mile 62 ($n = 65$), and mile 68 ($n = 60$). Both the 1-yr and 5-yr VMP standards for vehicle visibility in each of the four viewscapes were met at all sites (Table 8,

Table 9). The highest maximum number of vehicles observed (nine vehicles) occurred at mile 26 during the 1200-hour block, an increase from the 2017 maximum of five vehicles. The highest average maximum (1.6) for the season also occurred at mile 26 during the 1200-hour block (Figure 4).

Table 8. Traffic conditions measured as a percent of time x or fewer ($\leq$) vehicles were observed within a viewscape on the Denali Park Road. All of the VMP viewscape standards were met in 2018.

Method	Mile 26		Mile 55		Mile 62		Mile 68	
	% ≤ 3 vehicles	% ≤ 4 vehicles	% ≤ 2 vehicles	% ≤ 3 vehicles	% ≤ 2 vehicles	% ≤ 3 vehicles	% ≤ 1 vehicles	% ≤ 2 vehicles
Standard	80	90	80	90	80	90	80	90
2018 result	96.1	99	94.2	98.6	93.9	98.5	88.7	96.2

Table 9. The 5-year VMP standard at four defined viewscales along the Denali Park Road met standards in 2018.

Method	Mile 26		Mile 55		Mile 62		Mile 68	
	% ≤ 3 vehicles	% ≤ 4 vehicles	% ≤ 2 vehicles	% ≤ 3 vehicles	% ≤ 2 vehicles	% ≤ 3 vehicles	% ≤ 1 vehicles	% ≤ 2 vehicles
Standard	85	95	85	95	85	95	85	95
2018 result	97.9	99.5	95.1	98.0	94.8	98.9	92.5	98.2

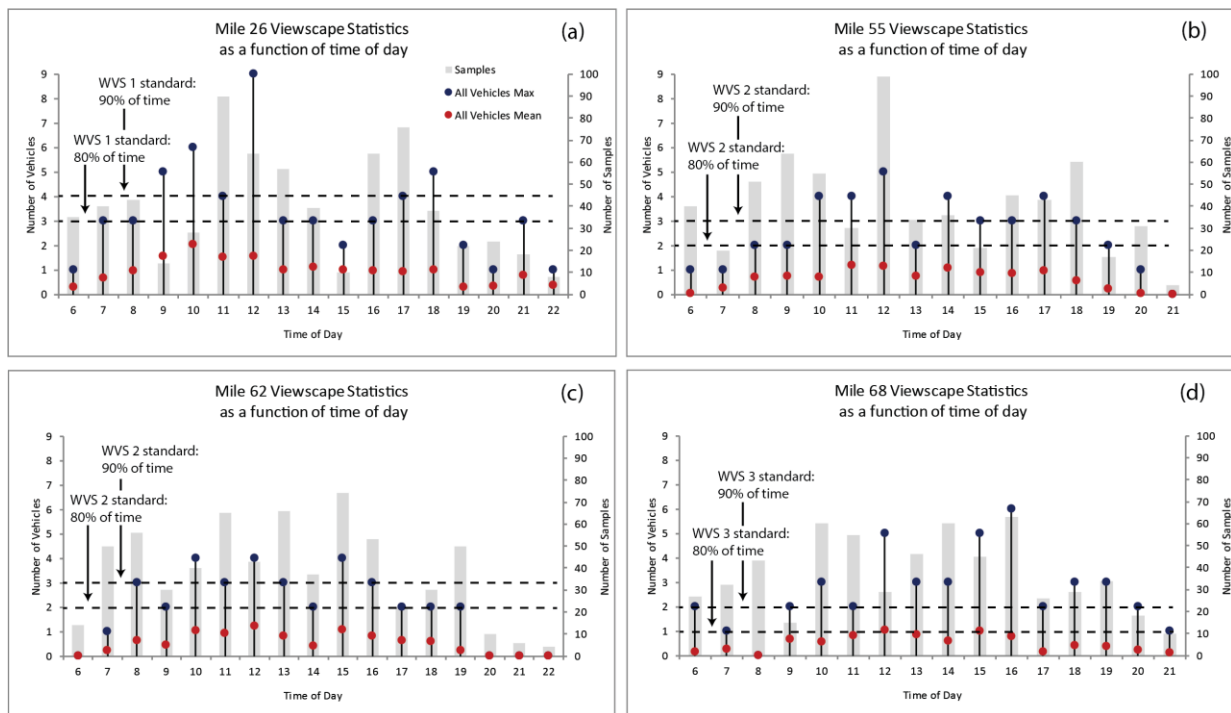


Figure 4. The maximum and mean ($+1 \sigma$) number of vehicles visible at one time at the mile 26 (a), 55 (b), 62 (c), and 68 (d) viewscales on the Denali Park Road. Bars show the number of observations for that site and hour block.

The total percentage of time meeting VMP viewscape standards has decreased each year since 2016 (Figure 5). While at the same time, the percentage of time that a vehicle was visible in a viewscape

has continued to decrease (Table 10). When vehicles are present in viewscales, they tend to be more clumped together than in 2016 and 2017 and increasingly out of VMP standards.

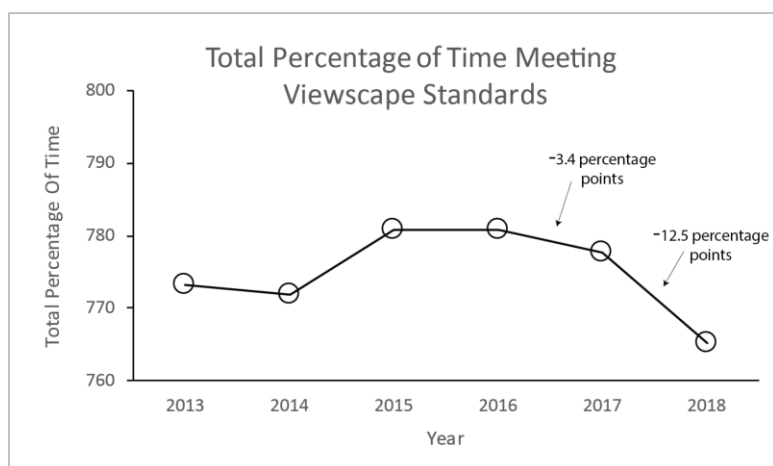


Figure 5. The total percentage of time that viewscape standards were met has fallen for the past two years on the Denali Park Road.

Table 10. Over the last two years, the amount of time that vehicles are visible in Denali Park Road viewscales has decreased.

Year	Minutes Sampled	Minutes with Vehicles
2016	4,420	59%
2017	4,200	57%
2018	5,140	52%

Sheep Gap Spacing

Staff recorded 330 sheep gap observations in 2018. Additionally, we recorded 2,615 hours of sheep gap observations at mile 68.5 using the Grassy Pass traffic counter. VMP standards for the percentage of hours with at least one 10-minute gap in traffic were met at mile 37.6 (Tattler) and mile 68.5 (Grassy Pass, as measured by both NPSO and traffic counter). The VMP standard was not met at mile 21.6 (Hogan Creek), 52.8 (Sheep Hill), nor 60.6 (Stony Hill, Table 11). The observed success rate improved at Hogan and decreased at Tattler, Sheep Hill, and Stony. The success rate at Grassy did not change.

Over the five-year period from 2014–2018, we have collected 1,251 sheep gap samples. Four of the five sheep gap sites have failed the 5-year standard for the second year in a row (* Failed VMP standard, also shown in red.

Table 12). The Stony Hill site is the most frequent to fail, never having met the 1-year or 5-year standard, while the Tattler Creek site has succeeded at the 1-year standard every year but has failed to meet the 5-year standard two years in a row.

Table 11. The percentage of hours with at least one 10-minute gap in traffic at each of the five sheep gaps established along the Denali Park Road. Two of five sheep gaps met the standard during the 2018 regulatory season.

Protocol	Mile 21.6 % hours	Mile 37.6 % hours	Mile 52.8 % hours	Mile 60.6 % hours	Mile 68.5 % hours
Standard	90	90	90	90	90
NPSO	84.4* (n = 64)	90.4 (n = 73)	83.8* (n = 68)	84.8* (n = 66)	100 (n = 59)
Traffic Counter	–	–	–	–	99.9 (n = 2,720)

* Failed VMP standard, also shown in red.

Table 12. The 5-year sheep gap standards were not achieved at four of five sites along the Denali Park Road.

Protocol	Mile 21.6 % hours	Mile 37.6 % hours	Mile 52.8 % hours	Mile 60.6 % hours	Mile 68.5 % hours
Standard	95	95	95	95	95
NPSO	85.8* (n = 238)	93.0* (n = 259)	88.8* (n = 259)	85.9* (n = 256)	99.1 (n = 239)

* Failed VMP standard, also shown in red.

More failures were observed on Saturdays than other days of the week (not statistically significant) but Tuesdays had the greatest percentage of failure relative to sample size by day of week.

Nighttime Traffic

The park road was open for 110 nights from the Savage Check Station to the Toklat rest stop and 101 nights to points west of Toklat. Data are collected along the controlled section of road for the whole regulatory period. The traffic counters only experienced short interruptions in data collection (Figure 6, Table 13).

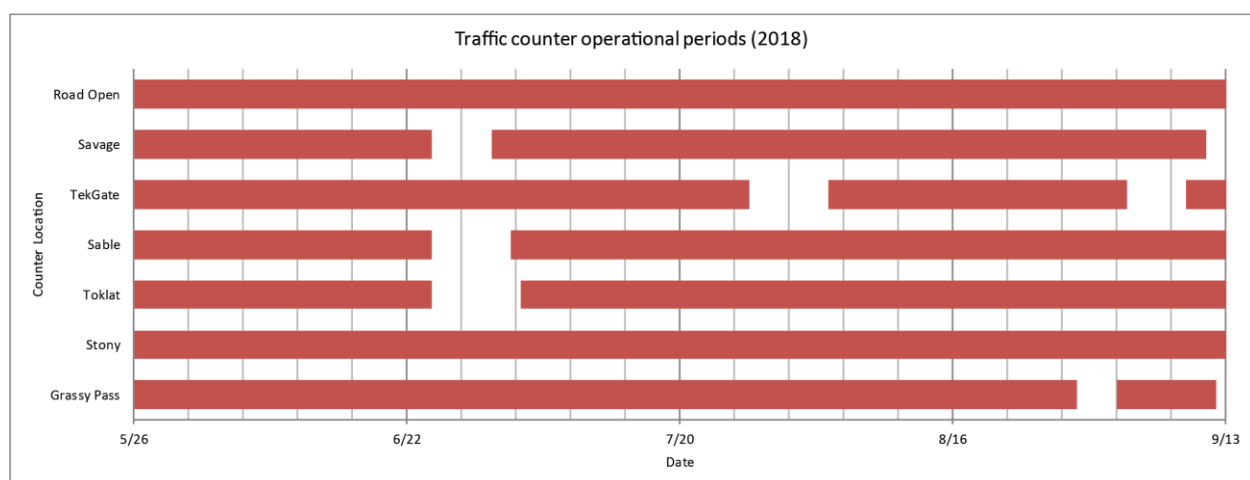


Figure 6. Gantt chart of traffic counter operation periods compared to the Denali Park Road regulatory year for 2018.

All counter locations met the VMP standards for both percentage of nights that averaged three or fewer vehicles per hour, and the percentage of nights with six or fewer vehicles passing in any one hour.

Table 13. Summary of nighttime (10pm – 6am) traffic rates on the Denali Park Road. All counter locations passed fine-scale (≤ 6 vehicles in any hour) and coarse-scale (≤ 3 vehicles/hour over the night time period) VMP standards in 2018.

Location	Number of nights sampled	% nights ≤ 3 vehicle per hour	Number of nights with >3 vehicles per hour	% nights ≤ 6 vehicles per any nighttime hour	Number of nights with >6 vehicles in any hour
Standard	–	95%	–	95%	–
TekGate	94	100%	0	96.8%	3
Sable	101	100%	0	99%	1
Toklat	100	100%	0	96%	4
Stony	110	100%	0	97.3%	3
Grassy	103	100%	0	96.1%	4

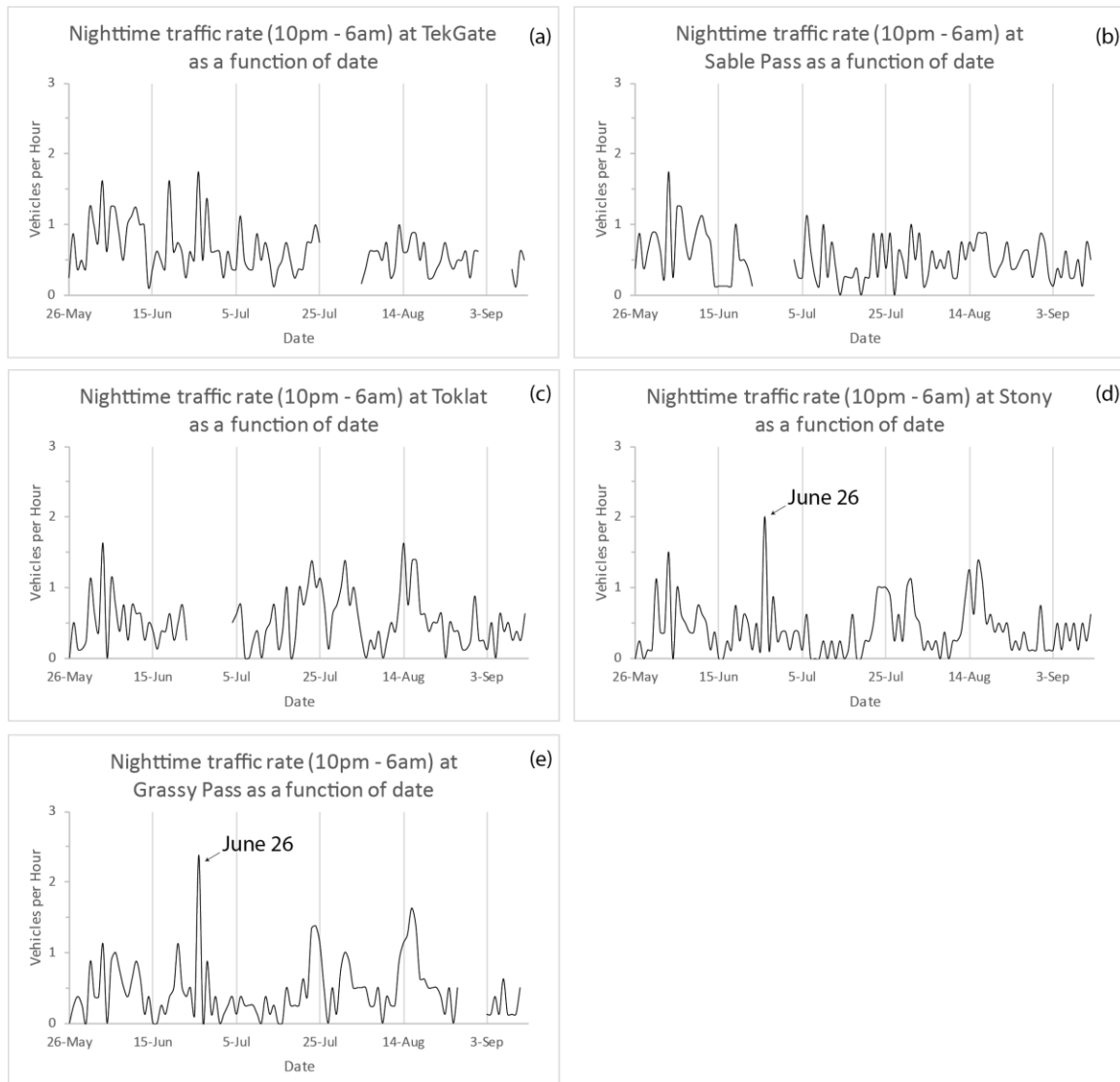


Figure 7. Average nighttime (2200–0600) traffic rates (west and eastbound combined) for (a) TekGate, Sable Pass, (b) Toklat, (c) Stony, and (d) Grassy Pass on the Denali Park Road.

Hiker Wait Time

We collected wait time data on 884 day and overnight hikers (346 pickup events) using the ROAR protocol. (We collected related data on an additional 610 hikers – 219 events.) Both the 1-year and 5-year standards for hiker wait time were met during the 2018 regulatory season (Table 14,

Table 15). Data collected using the ROAR protocol had the lowest percentage of hikers waiting less than 30 minutes for a bus. Additionally, we recorded 189 hikers (75 events; 13% of potential hiker pick-ups) who were not picked up because the bus was too full, a 15% increase over 2017 – however their wait times are unknown and may still be short.

Table 14. Hiker wait times as reported by concessioner dispatch at the Eielson Visitor Center (EVC), concessioner VTS drivers, and ROAR observers on the Denali Park Road. Sample size is consistent with data of previous years. All hiker wait time VMP standards were met in 2018.

Method	% Time <30 min	<i>n</i>	% Time <60 min	<i>n</i>	% Time <90 min	<i>n</i>
Standard	70%	—	93%	—	98%	—
EVC Dispatch	88.2	11,546	99.2	12,994	99	13,093
VTS Driver	99.1	18,966	99.1	18,966	99.2	18,976
ROAR	79.5	703	96.7	855	97.8	865

Table 15. The 5-year standard for hiker wait time was met for all categories between 2014–2018 on the Denali Park Road.

Five-year	% Time <30 min	% Time <60 min	% Time <90 min	<i>n</i>
Standard	75%	95%	99%	—
2014–2018 result	92.5	98.7	99.2	201,696

We plotted 2014–2018 hiker wait time results based on collection method (Figure 8). Sample size is dependent on sampling method and independent of meeting VMP standards. However, the rate of meeting the < 30 minute wait time indicator appears to be affected by sample method.

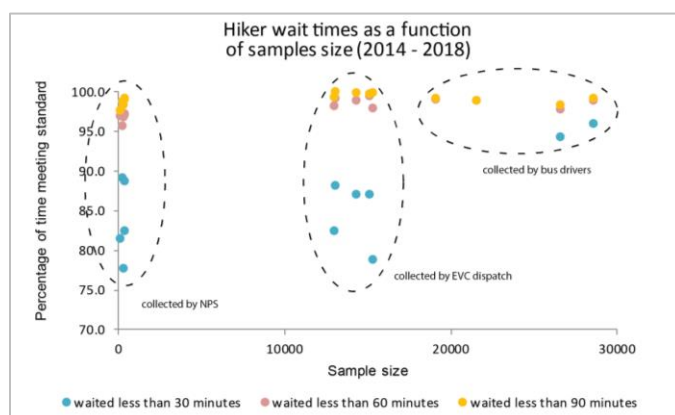


Figure 8. Percentage of time that hiker wait time standards were met as a function of sample size for the three methods used to collect hiker wait time data, 2014–2018, on the Denali Park Road. Sample size does not affect the percentage of time that hiker wait time standards are met. However, the dataset suggests VTS driver-collected data are outliers.

Vehicle Statistics

In 2018, 12,890 vehicle entrances were counted on the controlled section of roadway. The maximum number of vehicle entrances was 151 (July 19) and the mean was 116 (Figure 9). Over the last five years, vehicle entrances peaked in 2015 (Figure 10). Since 2015, overall entrances fell 10% in 2016 and increased 2.9% and 1.6% since (Figure 10). Long and short tour entrances have increased and GOV and POV entrances have decreased compared to 2017 (Table 16).

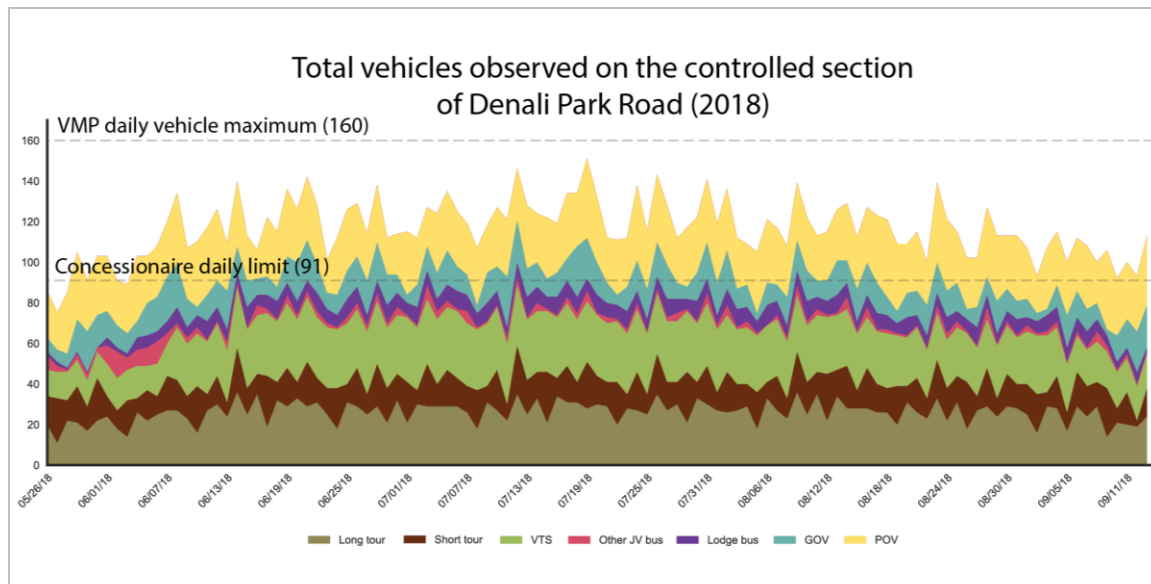


Figure 9. The VMP daily capacity limit was never exceeded in 2018 – the most number of vehicles on the Denali Park road was 151 (July 19). Concessionaire buses are consistently fewer on Saturdays and Sundays.

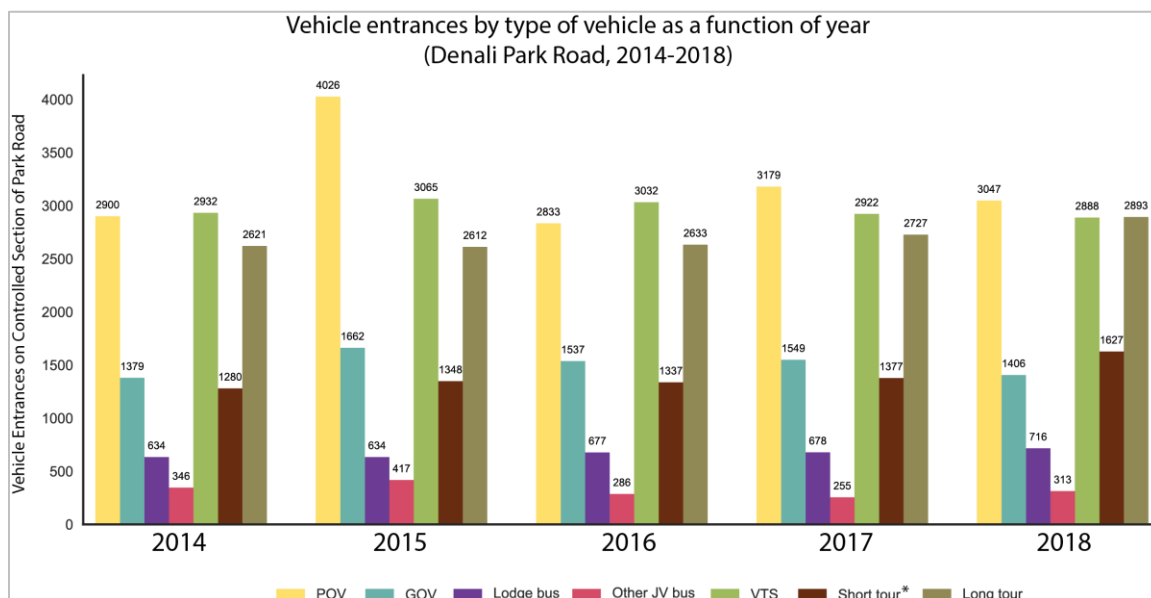


Figure 10. Vehicle entrances by vehicle type on the Denali Park Road (2014-2018). (*) denotes that beginning in 2017, Short Tours terminated at mile 28 (Teklanika Flats). Prior to this time, they terminated at mile 17 (Primrose). All contractor vehicle permits are included in the POV category.

Table 16. Vehicle entrance statistics for the Denali Park Road in 2018.

Vehicle Type	Total 2018 Entrances	% Share	% Change from 2017	% Change from 2010
Long tour	2,893	23	6	37
Short tour	1,627	13	18	6
VTs	2,888	23	-1	-2
Other JV bus	313	3	23	165
Lodge bus	716	6	6	22
GOV	1,406	11	-9	-22
POV	3,047	24	-4	-9

Wildlife Sighting Probability

The probability of seeing one of the “big five” from a VTS bus increased in 2018 compared to 2017 (Figure 11). In fact, the probability of seeing the big five are each at a five-year high and the probability of seeing caribou and grizzly bear are the highest since at least 2010.

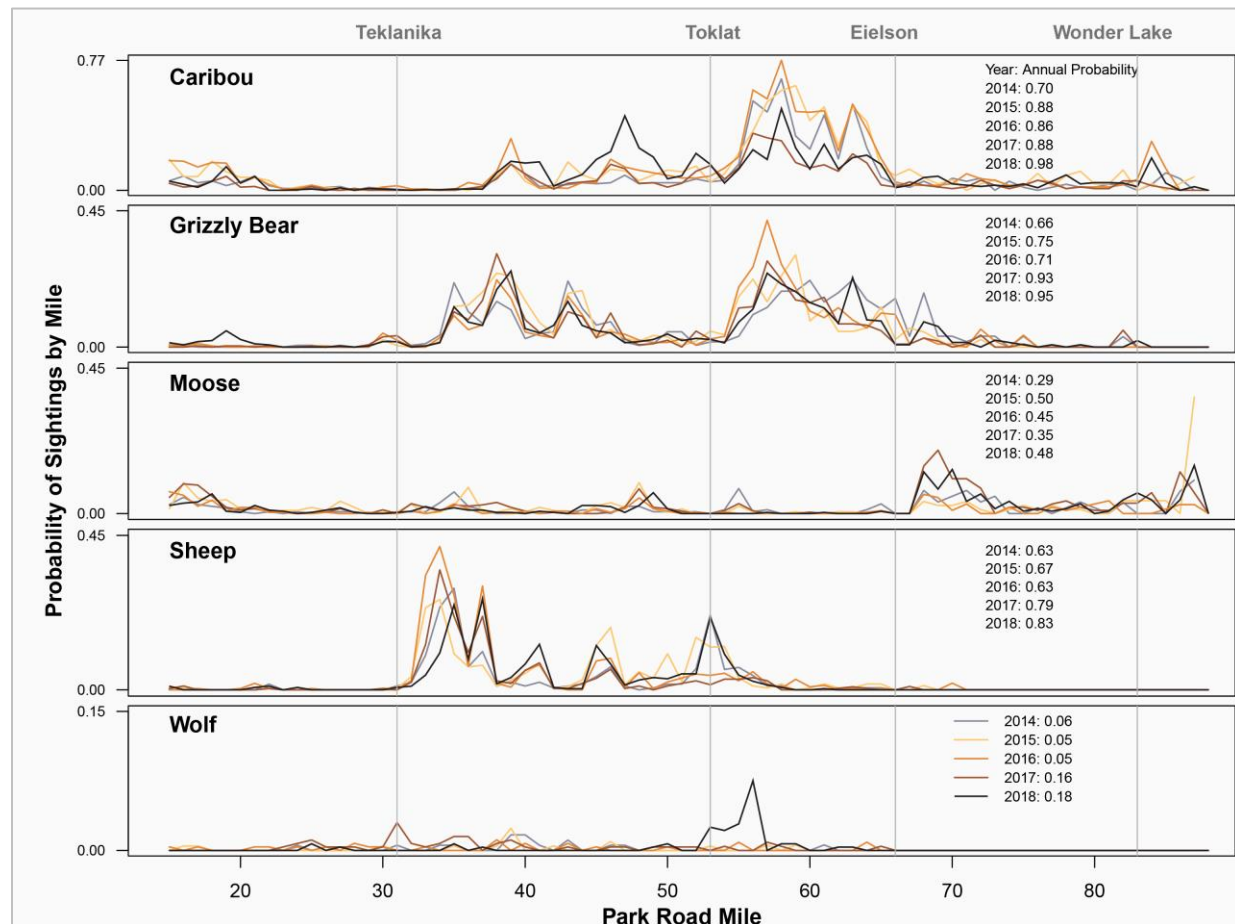


Figure 11. The probability of seeing one of the “big five” wildlife species (caribou, grizzly bear, moose, Dall sheep, and wolf) on the Denali Park Road. The probability of seeing each of the big five species is at a five-year high (2014-2018).

Discussion

The Road Ecology Program (REP) measured 41 metrics related to the Vehicle Management Plan (VMP) indicators in 2018 and 36 (88%) met standard. Collection effort increased 16% from 2017.

Number of Vehicles at Wildlife Stops

The number of vehicles at wildlife stops is the only VMP indicator that directly measures conditions related to both park natural resources and visitor experience. Thus, the number of vehicles at a wildlife stop is a particularly important indicator of park socio-bio dynamics.

In 2018, the transportation system met all 1-year and eight of nine 5-year wildlife stop standards, while serving approximately 12,890 vehicle entrances. The majority (83%) of all observed wildlife stops were occupied by either one or two buses. Only 2.4% of all wildlife stops had greater than four buses present at one time. Moreover, most (five of nine) wildlife metrics show that crowding trends are decreasing over the last five years – including all three metrics in WVS 3. This could be an indication that NPS outreach efforts and driver behavior are positively impacting these metrics.

Despite this, the 5-year standard for the percent time of ≤ 1 vehicles at wildlife stops in WVS 3 was not met (2014-2018). No more than one bus can be stopped at a wildlife stop in three of every four wildlife stops. This is the most strict wildlife-related criterion in the VMP and was only met 74.7% of the time.

Number of Vehicles at Rest Stops

Rest stop standards were exceeded on three occasions – all by the maximum number of buses parked at one time – twice at Toklat and once at EVC. Two of these instances occurred during the 10 o'clock and 11 o'clock hour blocks, which continues a trend from 2017 when both failures occurred during the 10 o'clock hour. In fact, of instances where the maximum allowable number of vehicles or buses was equaled or exceeded, nine of 10 instances occur during the 10 and 11 o'clock hour blocks.

Despite exceeding standard at two rest stops on three total occasions, the data show that during morning and early afternoon hours at Teklanika, early afternoon at Toklat, and early morning and mid-to-late afternoon hours at EVC have further capacity within VMP standards. This highlights how critical strategic scheduling is to meeting desired conditions. For example, for an "even" schedule we expect about 14% of all traffic to occur each day of the week. In 2018, total bus traffic was more evenly distributed than in past years. However, Thursdays consumed 16% of total bus traffic, "stealing" some share from Wednesdays (13%) and Fridays (13.4%). Because each 1% is about 0.8 buses per day, evening the bus schedule may reduce the instances of exceeding rest stop standards. Sheep gap and viewscape standards could also benefit from an even bus schedule throughout the week.

Maximum number of vehicles at rest stops observed using the ROAR protocol is consistently greater than that observed using the NPSO maximum (McKenny et al. 2015, McKenny et al. 2014, Clark 2016, Clark 2018(a), Clark 2018(b)). This may be caused by the difference in sampling behavior between the two protocols. The ROAR protocol is inherently tied to the bus network because the

observer is travelling within the network. Network behavior is imposed on the ROAR observer's sampling schedule. The NPSO observer travels both west and eastbound sampling sites in a nonlinear fashion – the NPSO observer imposes *their* behavior on the sampling schedule. We believe the ROAR protocol better captures visitor experience at rest stops.

Number of Vehicles within Viewscapes

The viewscape standard was met at all four sites for the sixth year in a row – the only VMP indicator to do so. Every viewscape site also met the 5-year VMP standard for the second year in a row. However, the data show a trend toward increased vehicle clumping and a decrease in the percentage of time VMP standards are met.

Viewscapes remain particularly vulnerable because by their nature they are locations that tempt drivers to temporarily stop or linger to obtain views unique to Denali. Temporary stops within a viewscape for extended periods would have outsized negative effects on the standard when observed. Moreover, the 5-year wildlife stop metric that failed in WVS 3 is less strict than the 5-yr viewscape standard that has not been observed to fail – while the viewscape standard in WVS 3 is being met where it is being measured, it may be failing standards in areas that go unobserved.

Sheep Gap Spacing

The 1-year sheep gap standard was met at two of the five sheep gap sites. The mile 37.6 sheep gap passed the standard by 0.4%. For the second year in a row, the 5-year standard was only met at mile 68.5. The mile 60.6 sheep gap site has never achieved 10-minute gaps in 90% of observed hours in the six years since monitoring began.

We believe that the mile 60.6 site's proximity to a popular scenic view, Stony Overlook, makes it difficult to meet VMP standards. The mile 60.6 sheep gap is located at the base of a hill 1.4 miles east of Stony, where an iconic view of Denali awaits. The Stony overlook is also the turn-around point for the majority of the popular Tundra Wilderness Tours (TWT). TWT buses stop at Stony for approximately 10–15 minutes. The proximity of this turn-around to the mile 60.6 sheep gap increases traffic return rates. Combined with other traffic, achieving a 10-minute gap in this location is difficult.

The 5-year sheep gap standards failed at four sites; miles 21.6, 37.6, 52.8, and 60.6. The sheep gap at mile 68.5 has passed the 1-year standard every year and passed the 5-year standard again in 2018. A larger sample size of high-success results will help increase overall averages for future years because the 5-year standard is a moving window.

The sheep gap indicator is defined as a 24-hour standard. Currently, it is only sampled by staff during bus operating hours. However, as the mile 68.5 Grassy Pass site highlights, we have the ability to automate sheep gap data collection and achieve a continuous dataset with traffic counters. At the mile 68.5 sheep gap, all nighttime hours achieved a 10-minute gap in traffic. To replicate this data collection technique, four additional traffic counters will need to be installed under the road surface in close proximity to the other sheep gap sites; Hogan Creek, Tattler Creek, Toklat River, and Stony Creek. It is our hypothesis that the vast majority of nighttime hours achieve a 10-minute gap

in traffic at each of these locations. Sheep gap sites would still require dedicated time to ground-truth and validate results. Additionally, as we have seen in the last several years, traffic counters do occasionally experience temporary failures. However, the amount of data lost is insignificant when compared to the amount of data missed by not employing this methodology.

An in-depth analysis of sheep gap data is needed to determine the appropriate adaptive management track. That analysis is underway.

Nighttime Traffic

Data collection for nighttime traffic was more successful in 2018 than 2017. The effect of nighttime traffic on next-day wildlife sightings is still under analysis. The park plans to continue working with researchers to better describe and categorize these effects on wildlife, wildlife sightings, and visitor experience.

Hiker Wait Time

The hiker wait time indicator is the most direct performance measure of the transportation system's primary purpose as a transit service. All hiker wait time measures were within VMP standard. While the overall data suggest park management is meeting its goals, the number of instances of a full bus not able to pick up hikers has steadily increased since collecting those data began (2017).

Bus driver datasets recorded no hikers waiting between 30 and 60 minutes. Bus driver-collected hiker wait times appear to be outliers compare to other collection methods. We argue that bus driver-collected wait time data are not well collected and recorded and do not capture the true nature of hiker wait times.

Large Vehicle Traffic

The VMP defines large vehicles as vehicles > 80,000 pounds gross vehicle weight rating (a concessionaire bus is 36,000 pounds). To assess weight, park management could employ Weigh-In-Motion (WIM) technology, which does not require a vehicle to stop to be measured. However, the technology is expensive to purchase (~ \$45,000) and maintain (yearly calibrations) and research suggests it is finicky. Additionally, many WIM solutions would require infrastructure counter to the historic and rustic character of the park road. Park management determined that WIM technology was inappropriate for Denali and has decided to monitor large vehicle traffic using remote, motion-triggered cameras co-located with traffic counters. This solution is analysis-heavy and more subjective than WIM technology since weight will not be directly measured. Thus, this standard will continue to be refined.

Vehicle Statistics

With 12,890 vehicle entrances, VMP limits were not exceeded. However, increases in Tour buses have driven the 1.6% increase from 2017, while VTS, GOV, and POV entrances have decreased.

Wildlife Sighting Probability

An explicit desired condition of the VMP is to maintain the opportunity for “world class wildlife viewing”. For 2018 Denali met that goal – the probability of sighting each of the big five is at a five-year high.

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Appendix A. Temporal Analysis Graphs of Denali Park Road Vehicle Management Plan Indicators

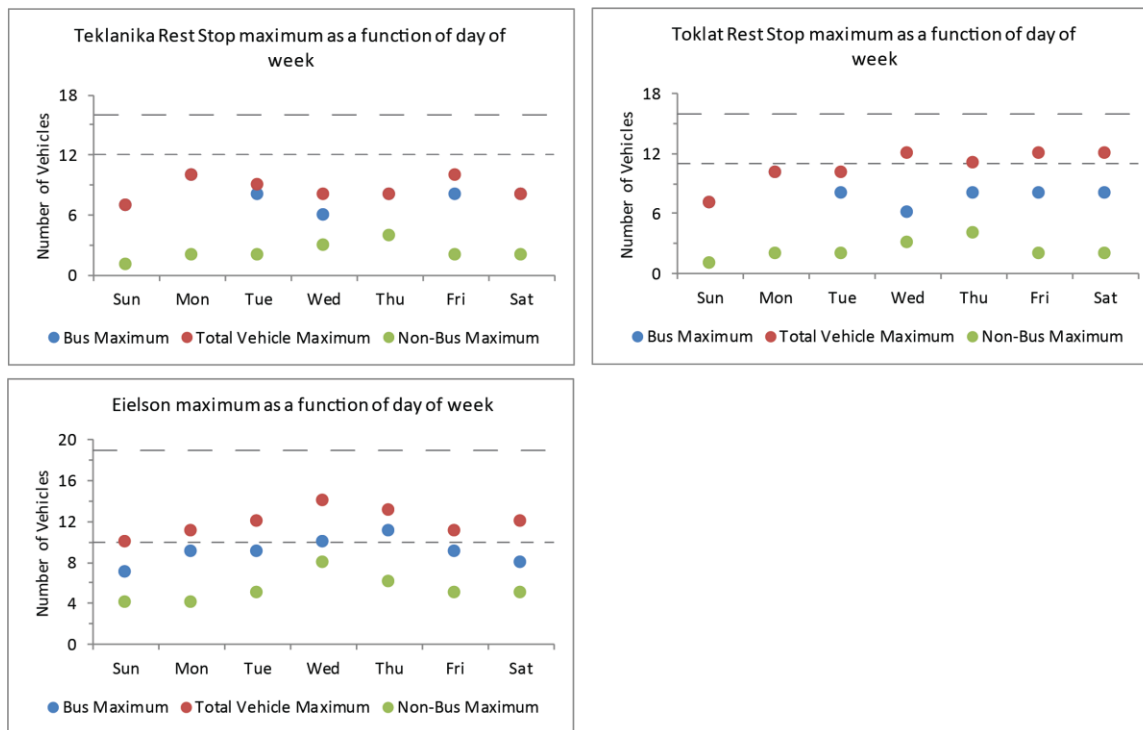


Figure A-1. Traffic volumes in 2018 at the Teklanika (a), Toklat (b), and EVC (c) rest stops on the Denali Park Road.

Appendix B. 2018 Sampling

Table B-1. The distribution of VTS ROAR observations compared to the 2018 VTS schedule on the Denali Park Road. The target proportion of observations was close in Peak and Late subseasons; variance was greater in the Early subseason.

Subseason	Location	Proportion of Trips		<i>n</i>
		VTS schedule (target)	ROAR observations (actual)	
Early	Toklat	35.2	39.6	21
	EVC	44.4	37.5	18
	Wonder Lake	13.0	16.7	8
	Kantishna	7.4	6.3	3
Peak	Toklat	13.8	13.0	21
	EVC	44.8	44.1	70
	Wonder Lake	24.1	26.1	42
	Kantishna	17.2	16.8	27
Late	Toklat	11.9	12.2	13
	EVC	43.3	46.3	50
	Wonder Lake	23.9	23.2	25
	Kantishna	20.9	18.5	20

Table B-2. The 2018 sampling was stratified through times of day and season on the Denali Park Road.

Mile	Indicator	Time Block					Total
		6–9	9–12	12–15	15–18	18–22	
21.6	Sheep Gap	12	14	15	13	10	64
26	Viewscape	12	14	15	15	11	67
30	Tek Rest	12	14	17	16	10	69
37.6	Sheep Gap	13	17	16	17	10	73
53.5	Toklat Rest	13	16	15	15	12	71
52.8	Sheep Gap	12	15	17	13	11	68
55	Viewscape	11	15	16	12	11	65
60.6	Sheep Gap	13	15	16	13	9	66
62	Viewscape	12	15	15	13	10	65
66	Eielson Rest	13	16	17	14	9	69
68	Viewscape	11	13	14	13	9	60
68.5	Sheep Gap	11	13	13	13	9	59

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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