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Assessment of Vehicle Use and Wildlife Sightings in Denali National Park and Preserve

Summary report 2006-2009

Natural Resource Technical Report NPS/DENA/NRTR—2012/600

ON THE COVER
A bus stops to view a caribou in Denali National Park and Preserve.
Photograph by: John Hourdos/National Park Service

Assessment of Vehicle Use and Wildlife Sightings in Denali National Park and Preserve

Summary Report 2006 - 2009

Natural Resource Technical Report NPS/DENA/NRTR—2012/600

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Abstract

Managers at Denali National Park and Preserve (Denali) initiated a series of concurrent studies in 2006 to develop greater understanding of the impacts of traffic volume and traffic patterns on the physical, biological and social environment of the Denali Park Road. This report summarizes information collected on traffic volume and wildlife viewing on the park road in 2006 – 2009 as part of these studies. Key results include:

- Daily peak traffic volume on the road occurred from 0600 to 2100, with a small dip in traffic volumes between 1100 and 1300.
- Bus drivers recorded the highest number of bear, sheep, and caribou sightings between mile 32 and mile 45 in both 2007 and 2008.
- Most moose sightings occurred between mile zero and mile 20 in 2007 and 2008.
- Wolf sightings occurred in low numbers along the road with more sightings in 2008 near the Toklat River (miles 47 to 61).
- From 2007 to 2009, the mean number of animal groups recorded per trip ranged from 1.5 to 1.9 for grizzly bears, 1.6 groups per trip each year for caribou, 1.0 groups per trip each year for sheep, 0.4 to 0.6 groups per trip for moose (0.6 ± 0.8), and 0.2 groups per trip each year for wolves.
- The probability of sighting large mammals along the park road was highest (probability of 0.25 to 0.65) from miles 35-36, miles 38-41, and miles 56-58, based on data collected by bus drivers from 2007 to 2009.
- No significant impact of once-weekly quiet nights was found on morning wildlife sightings
- In 2007 and 2009, it was found that periods of high night-time traffic have lower morning wildlife sightings compared to periods of low night-time traffic

Denali is proposing standards for the following indicators: numbers of vehicles at wildlife stops, rest stops and in viewscapes. We compared observed values to the results of a social norm curve created from visitor surveys for wildlife stops and viewsheds. The possible range of values for the standards are based on a study of visitor experience that portrayed a range of numbers (low, medium and high) of vehicles for each stop/view type. From Savage to Wonder Lake, only 3% of observations exceeded the high value for vehicles at a wildlife stop, while 22% exceeded the low value. If one assumes that the results of the social norm curve did not take into account the bus the visitor was riding (i.e. add one bus to each of the standards), no observations exceeded the high value for vehicles at a wildlife stop and 10% of observations exceeded the low value. No observations exceeded the high value for vehicles in a viewscape and under 20% exceeded the low value for viewscape, under 10% if one vehicle is added to the standard to account for the observer vehicle. The high variation in wildlife sighting data underscores the need for a long term data set to more accurately represent status and trends. We will continue to collaborate with bus drivers or to develop protocols for increased staff observations to increase data collection accuracy and efficiency for the future.

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Introduction

Overview

Denali National Park and Preserve (Denali) is one of the most visited subarctic national parks. Most visitation occurs from late-May through mid-September and is concentrated along the 90-mile Denali Park Road. Since 1972, traffic on the park road has been limited to mostly buses, and in 1986 the park‘s General Management Plan (GMP) instituted a limit of 10,512 vehicle trips during the late-May to mid-September visitor season. Shuttle and tour buses have been operating at or near this GMP established level for several years. Faced with increasing visitation and pressure to defend or change limits to road traffic, Denali managers initiated a series of concurrent studies in 2006 to develop greater understanding of the impacts of traffic volume and traffic patterns on the physical, biological and social environment of the park. This report summarizes information collected on traffic volume and wildlife viewing on the park road in 2006 – 2009 as part of these studies. Information collected from these studies will be used to inform the Vehicle Management Plan (VMP) for the Denali Park Road.

Background

Traffic

Before 1972, visitors were few and arrived by train or on the unimproved Denali Highway. Completion of State Highway 3 between Fairbanks and Anchorage in 1971 provided the first direct paved-road access to the Denali Park Road. In 1972, park visitation increased 100% in direct response to the opening of State Highway 3. Anticipating the increase in visitation, park management implemented a mandatory public transportation system in 1972 to minimize disturbances to wildlife and scenery, minimize road hazards, and maximize wildlife and scenery viewing with the least resource impact and energy consumption. In 1986, a General Management Plan (GMP; U.S. Department of Interior 1986) for Denali was developed through public hearings and other public input. The GMP authorized a motor vehicle use level of 10,512 vehicle round trips on the unpaved portion (past the Savage Check Station at mile 15) of the Denali Park Road during the core visitor season starting the Saturday before Memorial Day until the second Thursday after Labor Day. The 10,512 vehicle level was established using 1984 use levels as a base and allowing a maximum 20 percent increase in shuttle and tour bus traffic. This increase in bus traffic was to be offset by a 45% reduction in non-bus traffic and considered such factors as road wear and maintenance, natural resource protection (including maintaining the opportunity for unparalleled wildlife watching), environmental impacts, and traffic safety.

The GMP detailed an allocation of the 10,512 vehicle trips authorized on the road each season to different user groups. Tour and shuttle bus trips to transport visitors into the park are allocated 5,094 trips per season. Tour bus offerings on the park road include a long trip called the Tundra Wilderness Tour (TWT), primarily billed as a wildlife viewing opportunity, that travels to mile 53 or mile 62 depending on weather conditions and time, and the Denali Natural History Tour (DNHT) which focuses on cultural history and does not count against the annual allocation of buses because it only travels to mile 17 on the park road. The shuttle bus system (VTS) is designed to replace private vehicles and transport hikers and backpackers into the park, as well as providing low-cost transportation to visitors who do not want a guided tour experience. This

bus system runs on a regular schedule to all major destinations along the park road. The Entrance Area and Road Corridor Development Concept Plan for Denali (U.S. Department of Interior 1997) retained annual limits and established daily limits for each bus type on the road. Currently, up to 30 TWT, 23 DNHT, and 36 shuttle buses are allowed to travel the road each day.

Other road user groups include National Park Service (NPS) staff and NPS approved partners, Kantishna inholders (Kantishna property owners, guests and employees of Kantishna businesses), professional photographers, researchers, Teklanika campground users, and private contractors. NPS staff and Kantishna inholders have the largest allocation of vehicle trips per season, with 1,754 and 1,360 vehicles respectively.

Wildlife

Observing large mammals in their natural habitat is one of the primary recreational experiences in the park, and managers have been concerned about the impacts of traffic and visitor behavior on wildlife viewability from the opening of the Parks Highway in late 1971. In response to increased visitation, the park supported several observational studies of wildlife abundance and behavior along the park road (reviewed in Appendix A). Data from these studies indicated possible negative effects of traffic on movements and behavior of Dall‘s sheep (*Ovis dalli dalli*), grizzly bears (*Ursus arctos horribilis*), and moose (*Alces alces*).

Many of these studies also evaluated the probability of seeing large mammals on bus trips into the park and methods to monitor for changes in the number of wildlife sightings over time. Tracy (1977), Singer and Beattie (1986), Looney (1992), Taylor et al. (1997), and Burson et al. (2000) quantified sightings of moose, grizzly bear, caribou (*Rangifer tarandus*), Dall‘s sheep and in some cases wolves (*Canis lupus*) from the park road. Singer and Beattie (1986) and Burson et al. (2000) compared their results to previous studies to look for trends in the number of sightings over time, but no comprehensive monitoring of wildlife sightings was implemented for the park road. Data on wildlife sightings collected as part of this study will be compared to past data and will act as a baseline for long-term monitoring of wildlife sightings on the park road as part of the adaptive management strategy for the VMP.

Concurrent Studies

The results presented here represent information collected as part of a larger group of studies evaluating the impacts of traffic patterns on the physical, biological and social environment of the park (Phillips et al. 2010a). Three major studies were implemented beginning in 2006 examining visitor experience, wildlife movements, and traffic patterns. The visitor experience study surveyed visitors to determine important indicators and associated standards of a quality experience on the park road. From these results, researchers identified indicators and quantified crowding standards in terms of vehicle numbers. These standards will be used in park planning to outline desired future conditions for visitor experience on the park road (Manning and Hallo 2010).

Studies examining the movements of Dall‘s sheep and grizzly bears found little to suggest direct impacts of traffic on their behavior. Bears and sheep both tended to move more quickly while crossing the park road than when making general movements away from the road. Results also

suggested that sheep may move away from the road or be less likely to cross the road at higher traffic volumes (Phillips et al. 2010b).

Traffic studies collected data about vehicle movements and traffic patterns to create a traffic model that simulates the behavior of vehicles on the park road. Schedules and numbers of vehicles can be manipulated within the model to test alternative strategies for transportation systems on the road (Morris et al. 2010). The model combines standards identified from the visitor experience and wildlife studies with modeling scenarios to predict how well alternative transportation systems may maintain those standards. This information is being used to create a Vehicle Management Plan (VMP) and Environmental Impact Statement (EIS) to determine the best transportation strategy for the park road.

The VMP is proposing to shift from the single seasonal allocation of 10,512 to an approach that combines indicators and associated standards along with an adaptive management strategy to ensure that any changes to vehicle numbers or patterns do not impact natural resources or the visitor experience. Six of the indicators and associated standards to be used to limit traffic on the park road. Indicators that will limit the numbers of concessioner buses and other daytime use of the park road are numbers of vehicles at wildlife stops and rest stops; numbers of vehicles visible in certain viewsheds at one time; and the occurrence of gaps in traffic at critical sheep crossing locations. Additional indicators include limits to large vehicle traffic and night-time traffic levels. For the wildlife stop, rest stop and viewshed indicators, a series of visitor surveys were conducted to determine a range of standards for these indicators, and in this report this range is placed in context with the observed current condition for these indicators.

Study Area

Denali is located in interior Alaska between Anchorage and Fairbanks (Fig. 1). Most visitors to Denali access the park‘s 2.4 million hectares via the 90-mile road that connects Alaska Highway 3 to the former mining community of Kantishna. The road is narrow and winding, unpaved for all but the first 15 miles. It follows a 1 to 10 km wide valley between the Alaska Range to the south and the foothills to the north commonly referred to as the Outer Range. Habitat along the road includes boreal forests dominated by spruce (Picea spp.), scrub shrub dominated by birch (*Betula* spp.) and willow (*Salix* spp.), and high-elevation tundra characterized by *Dryas* (spp.) or graminoid *Carex* and *Eriophorum* spp.

The climate in Denali is subarctic, with short cool summers ranging on average from 0º to 24º C (Western Regional Climate Center 2007). Annual precipitation averages 38 cm with over half occurring during the summer months. Snow cover is generally present from October through early May. Daylight varies during the year from more than 20 hours in June to four hours in December.

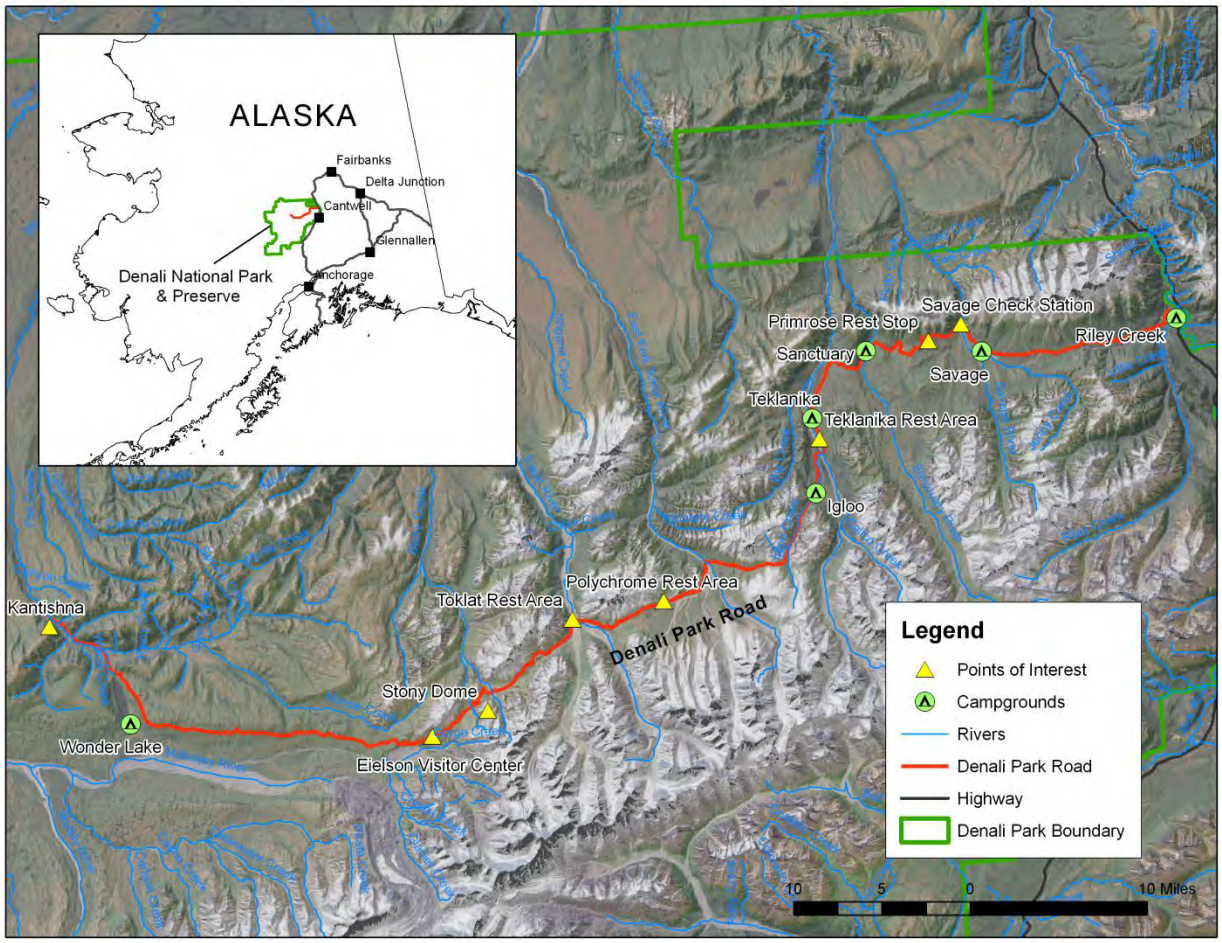


Figure 1. Denali National Park and Preserve encompasses over 6 million acres in the center of the state of Alaska. Denali has one main road that provides access to the interior of the park.

Methods

Traffic Monitoring

General vehicle schedules and numbers

We compiled general daily schedules reflecting vehicle traffic on the park road for each month using VTS schedules, daily dispatch records from the bus system operator and the Savage check station database. We defined hourly average number of vehicles as the number of vehicles past the Savage check station for each hour of the day. We calculated the hourly average number of VTS and tour buses from daily dispatch records. We calculated the hourly average number of lodge buses and nonbus vehicles from Savage Check Station records for each month.

Traffic Counters

Traffic interval counters (Sprite™ ,Diamond Traffic, Oakridge, Oregon) installed in the roadbed of the park road at six locations collected information on the number and direction of travel of vehicles every hour of the day during the summer season (generally early May to mid-September). The savage traffic counter was located at mile 15, Tek28 counter was at mile 28, TekGate counter was past the Teklanika rest stop at mile 30, the Toklat counter was west of the junction of the Toklat camp road at mile 53.5, the Stony counter was at the base of Stony Hill at mile 62, and the Grassy counter was three miles past the Eielson Visitor Center at mile 69 (Fig. 2). At each traffic counter location, electrical wire was embedded in the road surface, creating an inductive loop with a magnetic field that was disturbed by large metal objects passing through the field. Inductive loops were installed originally in 2000, and the Stony loops were replaced in 2008. The Sprite™ traffic counter measured disruptions in the electrical field as vehicles passed over the loops. The counter provided basic vehicle counts and direction of travel, but no classification data.

The Sprite™ counters were housed in steel boxes along the road bed and installed in the spring as the road opened and removed in fall after the park‘s annual road lottery, when a limited number of private vehicles are allowed to drive the road. The counters were equipped with an eight pack of D cell batteries designed to last most, if not all, of the summer season. We conducted weekly or bi-monthly checks on the counters to download data, check performance, and monitor battery voltage. We collected data from the counters using a Dell Latitude D180 laptop with the software Trafman, Centurion Parks, or Centurion CC (Diamond Traffic, Oakridge, OR, USA). We exported data into Microsoft (MS) Excel files for analysis, graphics, and statistical tests. For the purpose of summary, we present traffic volume data from 2008 in this report. Data from 2008 provides an example of a more typical year due to slightly abnormal traffic patterns in 2007 when Eielson Visitor Center was closed and there was a large amount of contractor traffic for the Eielson Visitor Center replacement and Igloo Canyon road reconstruction.

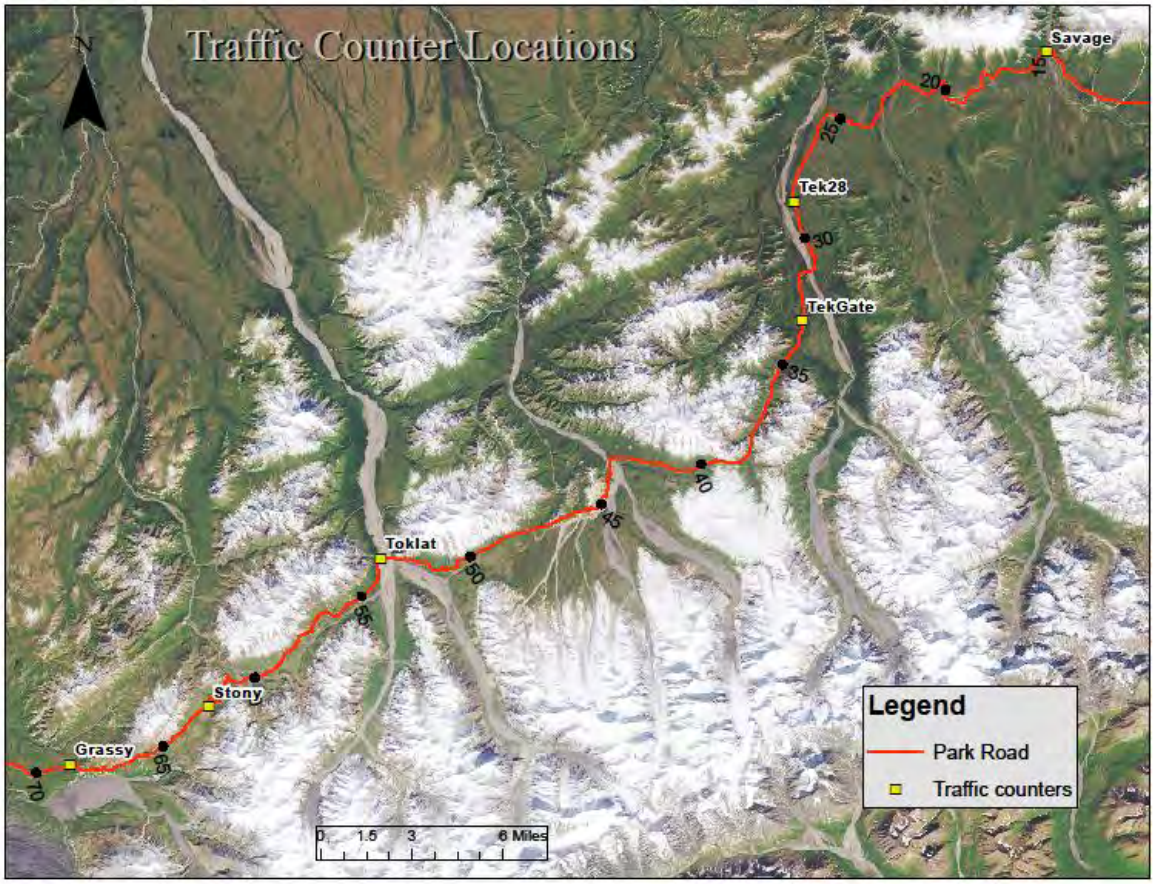


Figure 2. Six traffic counters were deployed along the length of the Denali Park Road to monitor traffic volume, 2006 - 2009.

Savage Check Station Data

Staff at the Savage Check Station recorded traffic data during dates and hours of operation of the station (0600 to 2300 hours, May 20 to September 19-20). Staff recorded every vehicle passing the station and the following information for buses: date, time, bus number, bus type (shuttle, tour, etc), training run, destination, and total count of passengers. Data collected for vehicles other than buses included: date, time, entry type (i.e. type of permit), number of passengers, destination, name of permit holder, and name of researcher. Both types of entries include comments and the name of the data collector. Staff entered check station data in a Microsoft (MS) Access database. We exported data to MS Excel files for ease of organization and graphical representation.

Bus Schedules

Bus system operator for Denali, Doyon/Aramark Joint Venture (JV), recorded daily dispatch information listing the actual departure time and bus number for each bus operating that day. We entered daily dispatch data into an MS Excel file for use in creating daily schedules and comparing traffic counter and check station data.

The NPS Concessions Management Division at Denali created and distributed visitor transportation system (VTS) schedules by operating period. VTS schedules from 2008 are included in Appendix B.

NPS Staff Observations

Road study biologists collected information about vehicles traveling the park road from 2007 to 2009. Data recorded included number and type of vehicles at rest stops, number and type of vehicles in a viewscape, number and type of vehicles at a wildlife stop, location of stops due to road construction, location and type of parked vehicles, and location of buses stopped to pick up or drop off of passengers. In 2009, we recorded the number of vehicles in viewscapes at mile 55 and 62 as the maximum number of vehicles observed in those sections of road during a two minute period for consecutive periods. We recorded the types of vehicles at the point in time when the maximum number of vehicles was observed. Each two minute observation is recorded separately. Each viewscape observation was conducted for a total of 16 to 46 minutes (collecting 8 to 23 two-minute observations during that time).

In addition to recording the number and type of vehicles at a rest stop when we first arrive during the course of a routine monitoring trip in the park, in 2009 we began collecting concentrated rest stop observations. Similar to viewscape observations, we recorded the number and type of vehicles in a rest stop as the maximum number of vehicles in the rest stop during the two minute period. We recorded the types of vehicles at the point in time when the maximum number of vehicles was observed. Each two minute observation is recorded separately.

We compared observed numbers of vehicles for the rest area, viewscape, and at wildlife stops indicators to the range of potential standards established by visitor surveys. When calculating the proportion of observations that exceed the different potential standards, we used only observations at wildlife stops, rest stops and viewscapes with one or more vehicle present. We did not include records of zero vehicles at a rest stop to reflect visitor experience standards and mimic the methods for evaluating standards used by the traffic model. In addition, we presented the average number of vehicles at a rest stop, wildlife stop, or viewscape omitting zero counts (counts when no vehicles other than the researchers‘ were present).

Professional Photographer Stops

From 2007 to 2009, staff distributed Global Positioning System (GPS) units to permit holders driving the park road past Savage Check Station. The GPS units collected positional information recorded as a track of the driver‘s travel. We downloaded the units and used linear referencing tools in ArcMap™ (ERSI ® ArcMap™ 9.3.1, Redlands, CA, USA) to extrapolate mileage of track points. We processed data in MS Excel to determine driver destination, stop location, and stop duration. We used data from 2007 and 2008 to calculate the proportion of stops by management section and average stop duration by section. Stops occurring at a campground, rest stop, or Kantishna lodges were not used in the analysis of stop proportion and stop duration.

Statistical analyses were performed in Microsoft Excel and the R statistic package (http://www.r-project.org). P-values (*P)* of 0.05 or less are considered significant for this report. Means are presented with standard deviation (mean ± SD) unless otherwise noted.

Wildlife Sightings

NPS Staff Observations

During the summer seasons of 2007 to 2009, road study technicians collected information about wildlife observed along the park road west of Savage Check Station. We focused on five large mammal species, grizzly bear (bear), caribou, Dall‘s sheep (sheep), moose, and wolves. Data were recorded for additional species observed if vehicles were stopped along the road to view the animal. Data recorded included: date, time, event type, species, number of adults and young, sex, behavior, any disturbance reactions, distance from the road, direction (north or south of the park road), and number and type of vehicles present. We entered observation data and conducted analyses in MS Excel spreadsheets.

Bus Driver Observations

Touch Screen Panels: In 2006, JV radio technicians installed 20 touch screen liquid crystal display (LCD) panels (5.7” Prime View Enclosed Unit, Reach Technology, Fremont, CA, USA) in buses that travel the park road to Toklat or farther. Panels were programmed with software that allowed bus drivers to classify the reason for a stop along the park road. Stop categories encoded included: wildlife, rest stop, road construction, passenger stop, traffic, or other. Wildlife stop entries were further categorized by species (grizzly bear, caribou, Dall‘s sheep, moose, wolf, or other) and a final screen allowed drivers to locate the animal relative to their location on a bull eye. The passenger stop option also encoded counts of boarding and exiting counts passengers.

Panel entries were linked to GPS locations of the vehicle by a mobile GPS unit mounted in each bus (Validator V2000, Universal Tracking, Valencia, CA, USA). GPS location data and associated panel data downloaded to a base station located near the nightly parking area of the buses. We regularly exported GPS and panel data from the base station software to Microsoft Access files.

Bus drivers collected touch screen data round trip (westbound and eastbound). To compare the touch screen data to the results of previous studies and to eliminate the risk of double-counting groups of wildlife, we restricted the touch screen data to the westbound portion of the trip. The westbound leg of the trips tend to be more complete records of wildlife sighing potential, as stops are often not made for frequently-seen wildlife on the return, eastbound, leg of the trips. For all wildlife sighting calculations, we only used trips with more than one panel entry per trip to reduce counting test entries made by JV staff. Overall mean numbers of wildlife sightings by touch screen panel includes sightings from the eastern end of the park where traffic is not restricted (East of Savage River).

Written Observations: Bus drivers collected information about wildlife viewed along the park road following protocols outlined in Burson and Fortier (1997) from 1995 to 2007. During westbound trips from Savage to Eielson, bus drivers recorded location, time, species, number, age, sex and animal‘s distance from the road for each animal sighting. NPS staff entered the data into MS Access databases each year.

We calculated ―probability of sighting" of wildlife as the number of sightings in a mile section of road, divided by the number of trips traveling through the mile collecting data. We defined ―likelihood of viewing" as the probability of seeing one or more of a given species on a trip to a given destination. We used data from multiple trips per day for probability of sighting, likelihood of viewing, and overall number of groups and individuals seen.

Temporal Trends in Wildlife Sightings

We calculated the mean number of groups seen per trip for each species using data collected by bus drivers using written observations (1996-2006) and touch screen panels (2007-2009) and tested for temporal trends in wildlife sightings using simple linear regression techniques. Burson et al. (2000) tested for temporal trends in wildlife sightings using the mean number of individuals seen per trip; we used the mean number of groups of wildlife seen because touch screen data from 2007 to 2009 does not include number of individuals. To analyze temporal trends, we used data from one randomly selected trip on the park road per day for both written observations and touch screen data. To avoid a bias, we repeated the random selection of one trip per day 10 times and report the mean of these repeated samples. For touch screen data, we included data from trips to Eielson and beyond that collected at least three panel entries for rest stops (to verify that the driver was using the panel) and westbound wildlife sighting records between Savage and Eielson only. Written observations include westbound sightings between Savage and Eielson by procedure (Burson and Fortier 1997) and thus are comparable to the subset of touch screen panel data selected.

Comparison of Data Collection Methods

We evaluated the difference in the number of groups observed for three collection methods, bus driver written observations, touch screen panels and park service road observations using analysis of variance and Tukey‘s test for multiple comparisons of means. We used data from 2007, using one randomly selected trip per day per method, trips to Fish Creek or beyond, and records between Savage and Fish Creek only for this analysis. Fish Creek is at mile 63 of the park road and was the replacement bus stop for the Eielson Visitor Center during construction in 2007.

Night-time Traffic and Potential Impacts on Wildlife Sightings

A ―quiet night" of minimal or no traffic was implemented during the summer season from 2006 to 2008 (June 9 to September 10 in 2006, May 9 to September 9 in 2007, and May 25 to September 7 in 2008). Traffic west of Savage Check Station was limited to urgent or emergency travel from 2000 hours on Sundays until 0600 hours on Mondays. Quiet night compliance was evaluated using traffic counter data and a Digital Video Recorder (DVR model EDSR400M, EverFocus, Taipei, Taiwan) installed at the Savage Check Station.

Touch screen LCD panels provided wildlife sighting data from the morning after quiet nights (6:00 am to 12:00 pm) from 2007 to 2009. Since a different number of LCD panel equipped buses traveled the road each day, the number of wildlife sightings per day were sampled first as an average of the number of recorded sightings per morning, second as the highest number of recorded sightings and the third option used observations from a randomly selected trip each day.

A secondary analysis was conducted using the Tek28 traffic counter data for 2007, 2008 and 2009. The purpose of this analysis was to test for a relationship between night-time traffic volumes on the park road and wildlife sightings the subsequent morning. We conducted statistical analyses to detect significant differences between traffic levels and wildlife sighting data within and between years using single-factor ANOVA and Tukey‘s test.

Current Conditions of Social Indicators

Potential indicators and standards for visitor experience on the park road were identified using two visitor surveys conducted in 2006 and 2007. Details about the methods used and results of these studies can be found in Manning and Hallo (2010). The park is proposing to carry three crowding indicators from these studies forward to the VMP that would serve in part to define the numbers of vehicles on the park road. These are numbers of vehicles stopped at one time to view wildlife, numbers of vehicles visible at one time in viewsheds, and numbers of vehicles parked at rest stops. We collected data on these parameters to better understand the current condition.

When the data were collected to create the social normative curves for visitor response to different levels of vehicles, visitors were shown photos of the same scene with different numbers of buses visible. For wildlife stops and viewsheds, the photos were taken from the perspective of being on a bus, i.e. what a visitor would see from their bus window. Therefore, in applying the results of this study to the development of standards for the park, it may be more realistic to increase the reported values by one vehicle to account for the bus in which the visitor is riding. We present the results of our comparison using both the values from Manning and Hallo (2010) and those same values plus one.

To collect data on numbers of vehicles at wildlife stops, road study staff stopped along the road when wildlife were observed, with or without other vehicles present. Data were collected on species, number, age classes, sex, distance from the road and behavior. In addition, if other vehicles were present, the maximum number and types of vehicles stopped were recorded. For rest stops, road study staff parked in rest stops and recorded the maximum number of vehicles observed in two minute intervals. Similarly, for viewsheds, observers parked or were stationed at the east end of the viewshed, facing west, and recorded the maximum number of vehicles observed in two minute intervals.

Results

Traffic Monitoring

General Vehicle Schedules and Numbers

Savage Check Station data and VTS and Tour bus schedules showed mean daily number of vehicles westbound past Savage ranging from 84 to 133, with maximum traffic flow occurring at 0700 and 1400 (Appendix C). Hourly average westbound traffic trend from the general schedule appeared similar to traffic trends from the Savage traffic counter in 2008 (Table 1). There was no significant difference between the calculated hourly average produced by the general schedule and traffic counter hourly averages ($p>0.05$ for all months). Traffic counter data from Savage counter is not significantly different from Savage Check Station data for the same day and time ($p > 0.05$). Bus schedule data provided by JV showed that approximately eight out of every 10 TWT buses in 2007 and 2008 went to Stony overlook versus ending their tour at Toklat.

Table 1. A comparison of daily average number of vehicles westbound past Savage Check Station based on the general schedule (G.S.) created by Savage Check Station records and bus schedules; and traffic counter (T.C.) data from 2008.

	May		June		July		Aug		Sept	
Hour	G. S.	T.C.	G. S.	T.C.	G. S.	T.C.	G. S.	T.C.	G. S.	T.C.
0	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.0	0.1
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	2.2	0.0	4.4	1.0	5.2	1.0	3.7	0.0	1.4	1.0
6	6.3	4.0	13.8	10.0	14.7	9.0	12.2	5.0	9.4	2.0
7	7.5	8.0	14.3	15.0	17.0	18.0	16.2	16.0	15.1	11.0
8	5.8	10.0	12.0	16.0	13.5	16.0	13.1	19.0	13.7	17.0
9	4.6	8.8	8.2	11.0	8.1	11.0	8.2	11.0	10.0	11.0
10	5.1	7.0	7.2	12.0	8.4	11.0	7.4	9.8	8.9	11.0
11	3.6	4.0	6.7	7.2	8.1	9.8	7.4	9.4	5.2	6.0
12	2.7	5.0	3.7	5.4	4.1	6.1	3.6	6.0	4.0	5.0
13	5.1	3.0	7.5	5.1	7.4	5.6	8.1	6.0	9.1	5.0
14	9.2	6.0	14.8	10.0	16.0	11.0	13.6	11.0	10.0	11.0
15	3.2	5.0	4.0	7.8	5.1	7.5	5.1	6.6	3.8	6.0
16	2.1	4.0	1.6	6.2	3.5	6.7	3.2	6.0	1.8	5.0
17	3.1	3.0	3.9	5.4	4.9	6.0	4.2	4.0	3.5	4.0
18	1.6	1.0	2.0	1.0	2.7	3.0	3.1	7.4	2.1	2.0
19	1.0	3.0	2.8	3.0	3.3	3.0	4.4	3.0	3.8	3.0
20	0.5	1.0	2.8	2.0	4.2	2.0	4.7	3.0	4.5	1.0
21	0.4	1.0	2.3	1.0	4.7	1.0	4.2	1.0	4.3	1.0
22	0.3	0.0	0.9	1.0	1.5	2.0	0.9	1.0	0.6	0.0
23	0.0	1.0	0.4	1.0	0.3	0.0	0.1	1.0	0.0	0.0
TOTAL	64.3	74.9	113.7	121.3	132.9	129.9	123.5	126.3	111.4	102.1

Traffic Counters

In 2008, highest average hourly (0600-2300 hours) traffic volumes recorded by traffic counters occurred at Savage, followed by Tek28, Toklat, Stony, Tek Gate, and Grassy (Savage, 13.5 ± 4.71; Tek28, 9.9 ± 2.08; Toklat, 8.4 ± 2.30; TekGate, 5.6 ± 2.08; Grassy, 4.1 ± 0.63). Peak traffic volume occurred from 0600 to 2100 at all counters, with a small dip in traffic volumes between 1100 and 1300 for most counters (Figures 3-7).

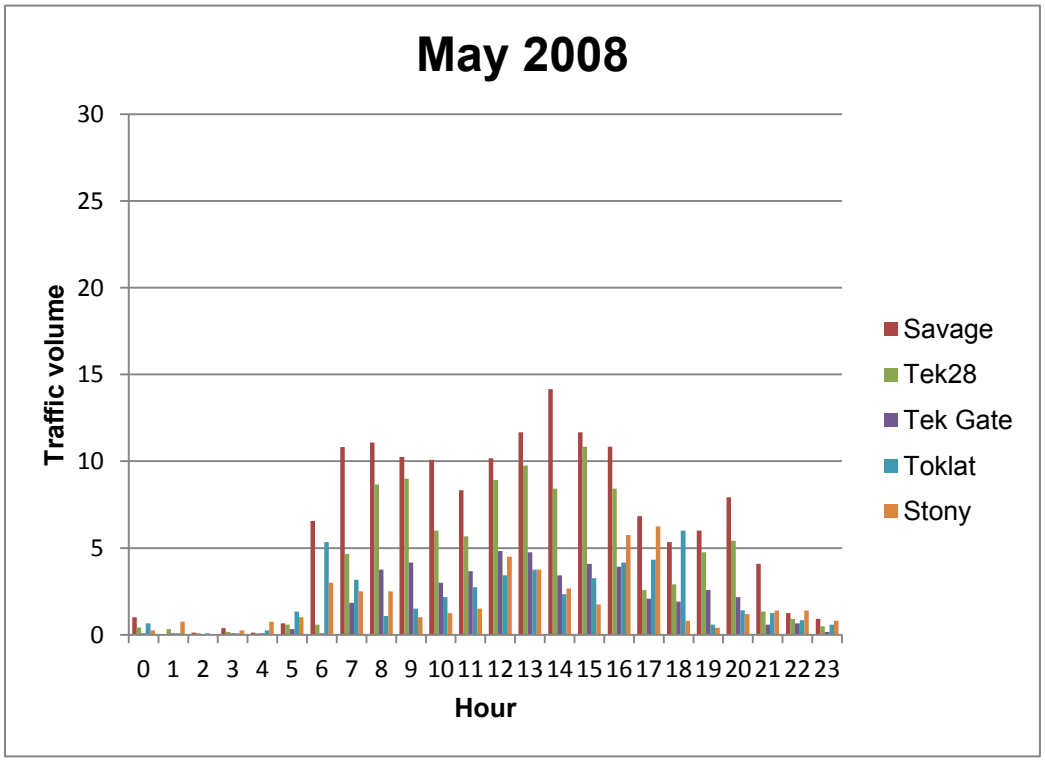


Figure 3. Average hourly traffic volume on the Denali Park Road (both lanes) in May 2008.

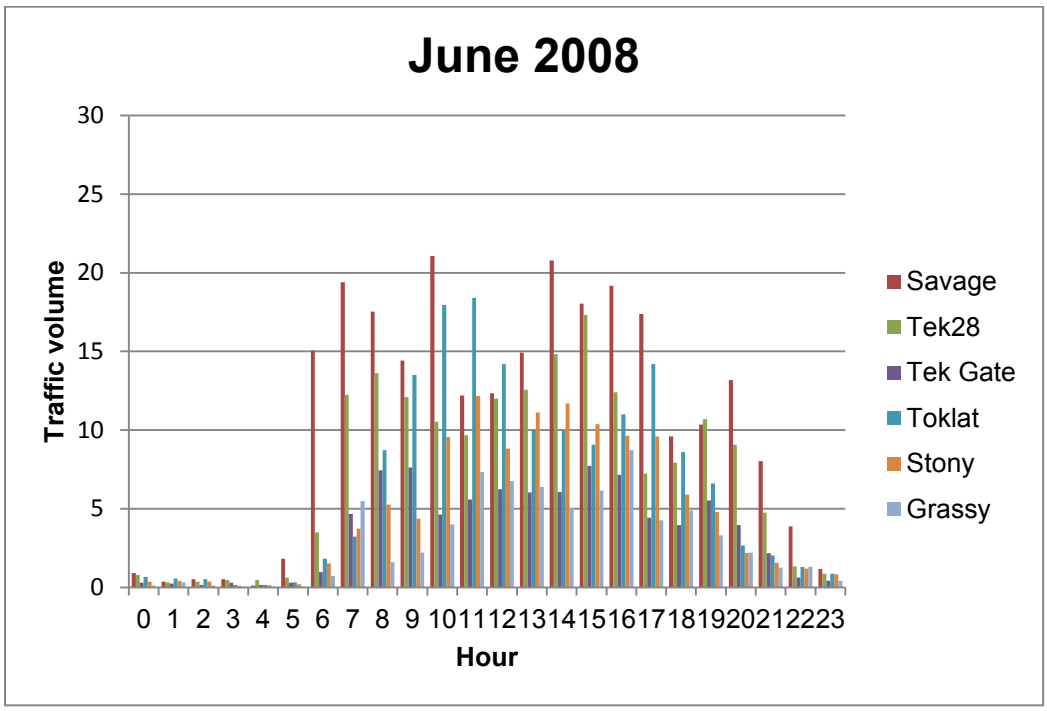


Figure 4. Average hourly traffic volume on the Denali Park Road (both lanes) in June 2008.

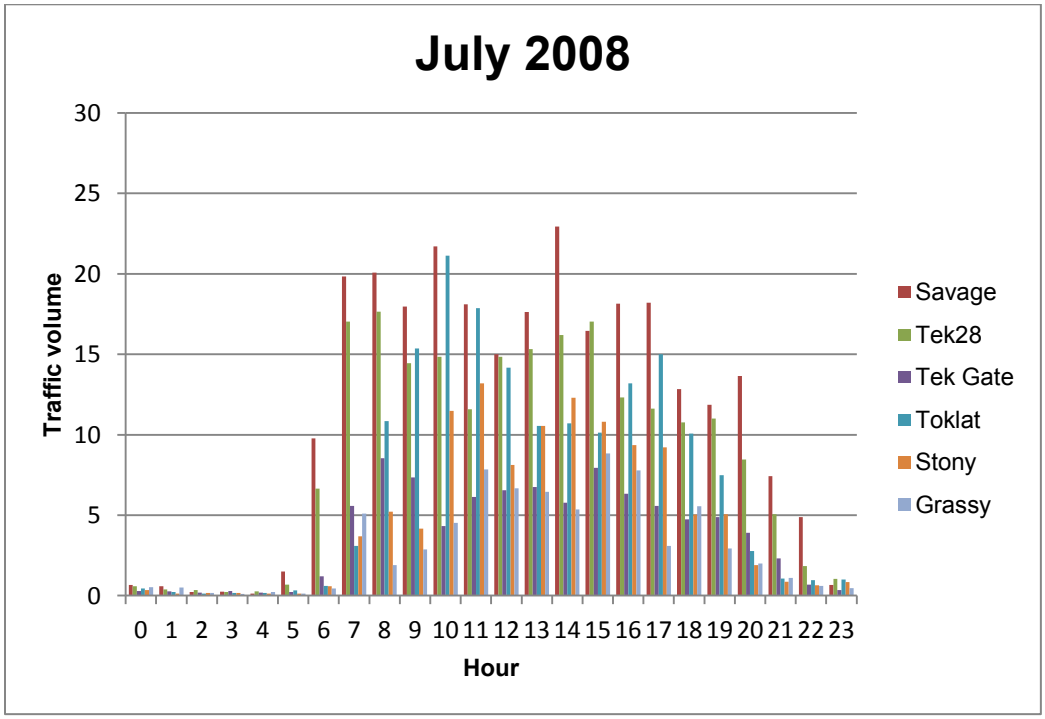


Figure 5. Average hourly traffic volume on the Denali Park Road (both lanes) in July 2008.

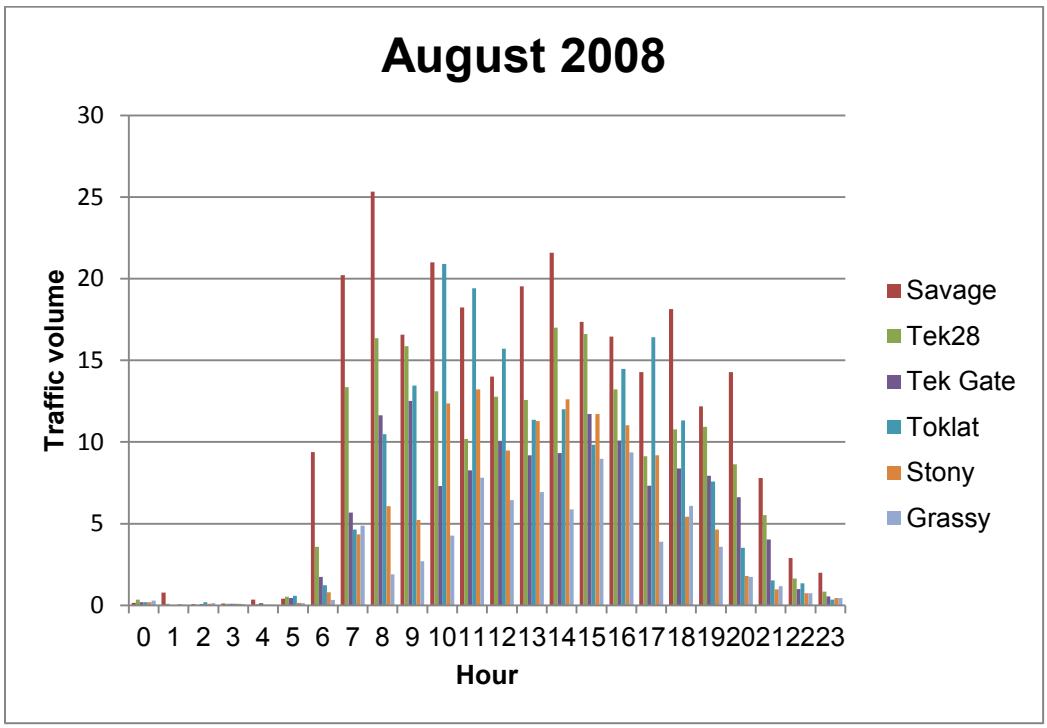


Figure 6. Average hourly traffic volume on the Denali Park Road (both lanes) in August 2008.

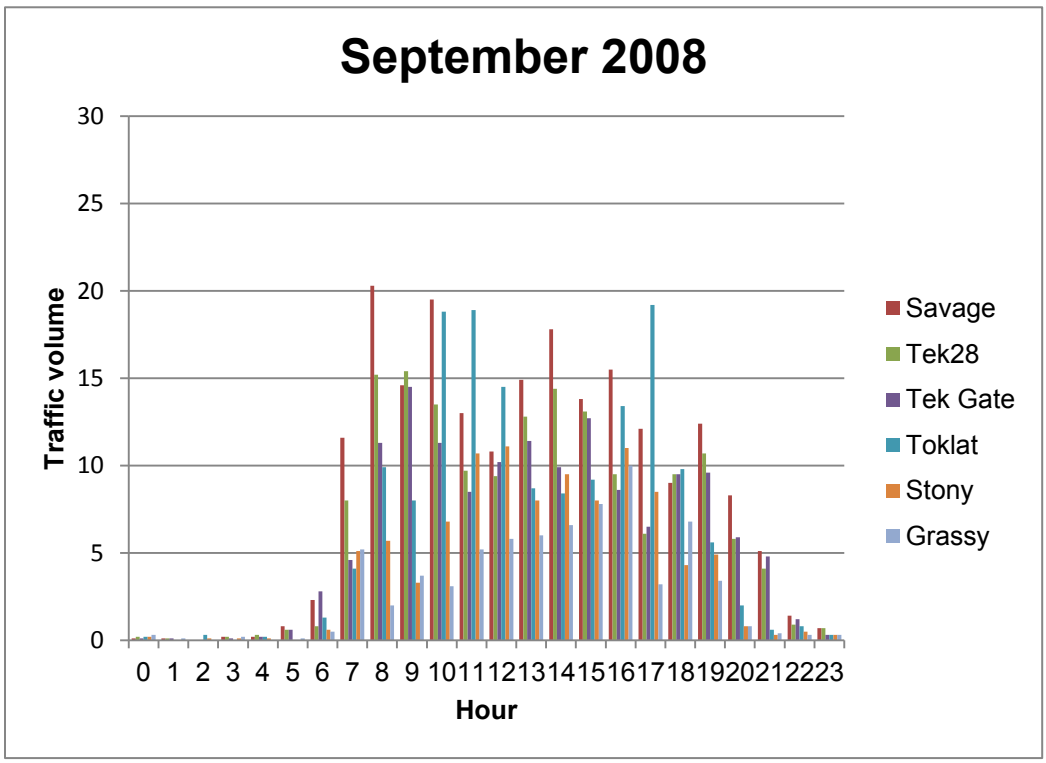


Figure 7. Average hourly traffic volume on the Denali Park Road (both lanes) in September 2008.

Professional Photographer Stops

Using hand-held GPS units, we recorded 116 stops made by professional photographers along the park road from Savage to Kantishna in 2007 and 2008. The largest proportion of stops (0.66) occurred in the Teklanika to Eielson section, followed by the Eielson to Wonder Lake section (0.18), Savage to Teklanika section (0.12), and the Wonder Lake to Kantishna section (0.04). The average duration of stops was longest in the Eielson to Wonder Lake section (17 minutes ± 15, max = 56 min), followed by Teklanika to Eielson (12 ± 13, max = 82 min), Wonder Lake to Kantishna (14 ± 19, max = 49 min), and Savage to Teklanika (9 ± 8, max = 39 min).

Wildlife Sightings

NPS Staff Observations

On nine trips made from Savage to Eielson or beyond in 2007, we recorded 30 bears, 51 caribou, 278 sheep, and three moose. Mean number of individuals observed per trip were 3.3 ± 2.7 bears, 5.7 ± 5.5 caribou, 30.9 ± 32.6 sheep, 0.3 ± 0.7 moose, and 0.1 ± 0.3 wolves. On average, we observed 1.7 ± 1.1 groups of bears, 2.1 ± 1.4 groups of caribou, 4.1 ± 2.6 groups of sheep, 0.3 ± 0.5 groups of moose, and 0.1 ± 0.3 groups of wolves per trip (Table 2).

In 2008, we made 10 trips to Eielson or beyond and recorded 37 bears, 39 caribou, 143 sheep, five moose, and one wolf. Mean number of individuals observed per trip were 3.7 ± 2.0 bears, 3.9 ± 5.0 caribou, 14.3 ± 18.0 sheep, 0.5 ± 0.5 moose, and 0.1 ± 0.3 wolves. On average, we observed 2.6±1.5 groups of bear, 1.6±1.6 groups of caribou, 2.2 ± 1.9 groups of sheep, 0.4 ± 0.5 groups of moose, and 0.1 ± 0.3 groups of wolves per trip (Table 2).

In 2009, we made 9 trips to Eielson or beyond and recorded 25 bears, 206 caribou, 200 sheep, three moose, and one wolf. Mean number of individuals observed per trip were 2.8 ± 1.7 bears, 22.9 ± 18.0 caribou, 22.2 ± 20.2 sheep, 0.3 ± 0.7 moose, and 0.1 ± 0.3 wolves. On average, we observed 1.4±1.0 groups of bear, 4.1±2.4 groups of caribou, 3.3 ± 2.5 groups of sheep, 0.4 ± 0.7 groups of moose, and 0.2 ± 0.7 groups of wolves per trip (Table 2).

Table 2. Mean (with standard deviation) number of groups and individuals of large mammals seen per trip based on NPS staff observation data (Savage to Eielson).

	2007		2008		2009	
Species	Groups	Individuals	Groups	Individuals	Groups	Individuals
Bear	1.7 (1.1)	3.3 (2.7)	2.6 (1.5)	3.7 (2.0)	1.4 (1.0)	2.8 (1.7)
Caribou	2.1 (1.4)	5.7 (5.5)	1.6 (1.6)	3.9 (5.0)	4.1 (2.4)	22.9 (18.0)
Sheep	4.1 (2.6)	30.9 (32.6)	2.2 (1.9)	14.3 (18.0)	3.3 (2.5)	22.2 (20.2)
Moose	0.3 (0.5)	0.3 (0.7)	0.4 (0.5)	0.5 (0.5)	0.3 (0.7)	0.4 (0.7)
Wolf	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.2 (0.7)

Bus Driver Observations

Bus drivers collected written data on wildlife sightings during 55 trips in 2007 going at least as far as Eielson/Fish Creek. In 2007, drivers observed more groups of caribou on average per trip (2.2± 1.5) than groups of bears (1.7 ± 1.2), sheep (1.8 ± 1.2), moose (0.3 ± 0.5), or wolves (0.2 ± 0.5). The likelihood of viewing a bear, sheep or caribou on a trip to Eielson was 0.82, 0.86 and 0.91, respectively, while the likelihood of viewing the other two species of interest was lower (moose, 0.28; wolves, 0.18).

In 2007, bus drivers collected panel data that included three or more panel entries for rest stops on 148 bus trips to Fish Creek at mile 63 (Eielson Visitor Center was closed in 2007) or further west. The mean number of groups seen per trip was highest for caribou (1.6 ± 1.3), followed by bears (1.5 ± 1.3), sheep (1.0 ± 0.9), moose (0.4 ± 0.7), and wolves (0.2 ± 0.6, Table 3).

In 2008, bus drivers collected panel data that included three or more panel entries for rest stops on 124 trips to Fish Creek or Eielson. The mean number of groups seen per trip was highest for bears (1.7 ± 1.5) followed by caribou (1.6 ± 1.6), sheep (1.0 ± 1.0), moose (0.5 ± 0.8), and wolves (0.2 ± 0.5, Table 3).

In 2009, bus drivers recorded three or more panel entries for rest stops on 47 trips to Eielson. The mean number of groups seen per trip was highest for caribou (1.9 ± 1.3) followed by bear (1.6 ± 1.2), sheep (1.0 ± 0.9), moose (0.6 ± 0.8), and wolves (0.2 ± 0.4, Table 3).

Table 3. Mean (with standard deviation) number of groups of large mammals seen per trip by bus drivers. Data summarized from observations entered into touch screen panels on bus trips going at least as far as Eielson Visitor Center/ Fish Creek.

	2007	2008	2009
Species	Groups	Groups	Groups
Bear	1.5 (1.3)	1.7 (1.5)	1.9 (1.2)
Caribou	1.6 (1.3)	1.6 (1.6)	1.6 (1.2)
Sheep	1.0 (0.9)	1.0 (1.0)	1.0 (0.9)
Moose	0.4 (0.7)	0.5 (0.8)	0.6 (0.8)
Wolf	0.2 (0.6)	0.2 (0.5)	0.2 (0.4)

Probability of Wildlife Sightings

Bus drivers collected data on wildlife sightings from 2007 to 2009 using touch screen panels. Using all touch screen panel records, the highest number of bear, sheep and caribou sightings recorded by bus drivers occurred between mile 32 and mile 45 in both 2007 and 2008 (Figures 8, 9). Most moose sightings occurred between mile zero and mile 20 in 2007 and 2008. Wolf sightings occurred in low numbers along the road with more sightings in 2008 near the Toklat River (miles 47 to 61).

The probability of sighting wildlife along the park road was highest (probability of 0.25 to 0.65) from miles 35-36, miles 38-41, and miles 56-58, based on touch screen data from 2007 and 2008 (Figure 11). Wildlife sighting probability was above 0.12 from Igloo Canyon (mile 33) to Sable Pass (mile 42). Wildlife sighting probabilities were low (0.00-0.06) in the Teklanika flats and Igloo forest area (mile 27 to mile 33) and past Eielson (mile 66).

The likelihood of viewing a caribou was higher than the likelihood of viewing for any other species for trips to Teklanika (0.42) and Toklat (0.74). Likelihood of viewing for bears was higher than the likelihood of viewing for any other species for trips to Eielson and Wonder Lake (0.86, 0.89, Table 4).

Table 4. Likelihood of sighting large mammal species on the Denali Park Road by trip destination. Data summarized from touch screen panel entries, 2007 and 2008.

Destination	Bear	Caribou	Sheep	Moose	Wolf
Teklanika	0.14	0.42	0.06	0.35	0.06
Toklat	0.68	0.74	0.71	0.43	0.12
Eielson	0.86	0.83	0.74	0.44	0.20
Wonder Lake	0.89	0.85	0.74	0.58	0.21

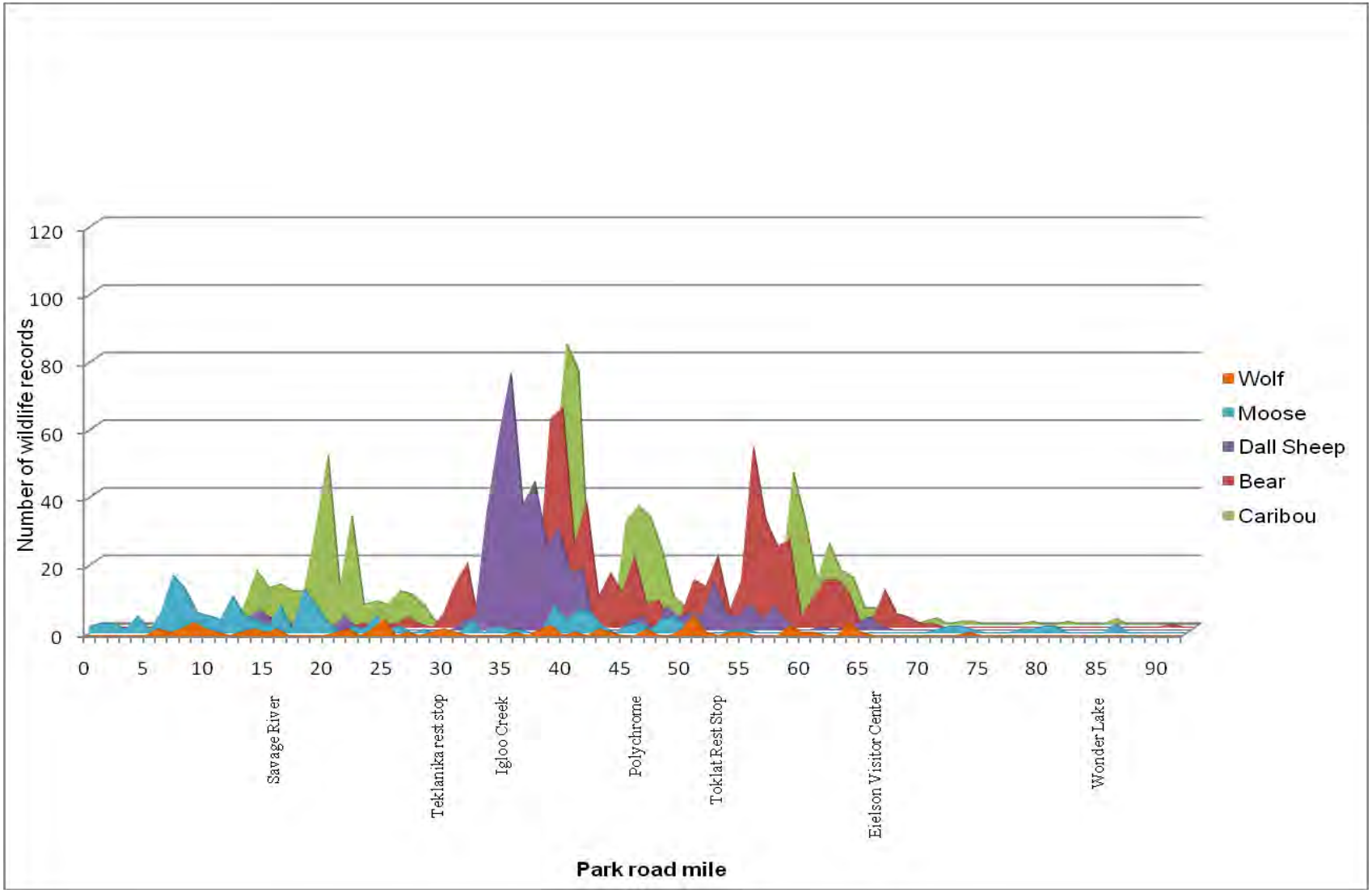


Figure 8. Wildlife sightings on the Denali Park Road entered in touch screen panels by bus drivers in 2007.

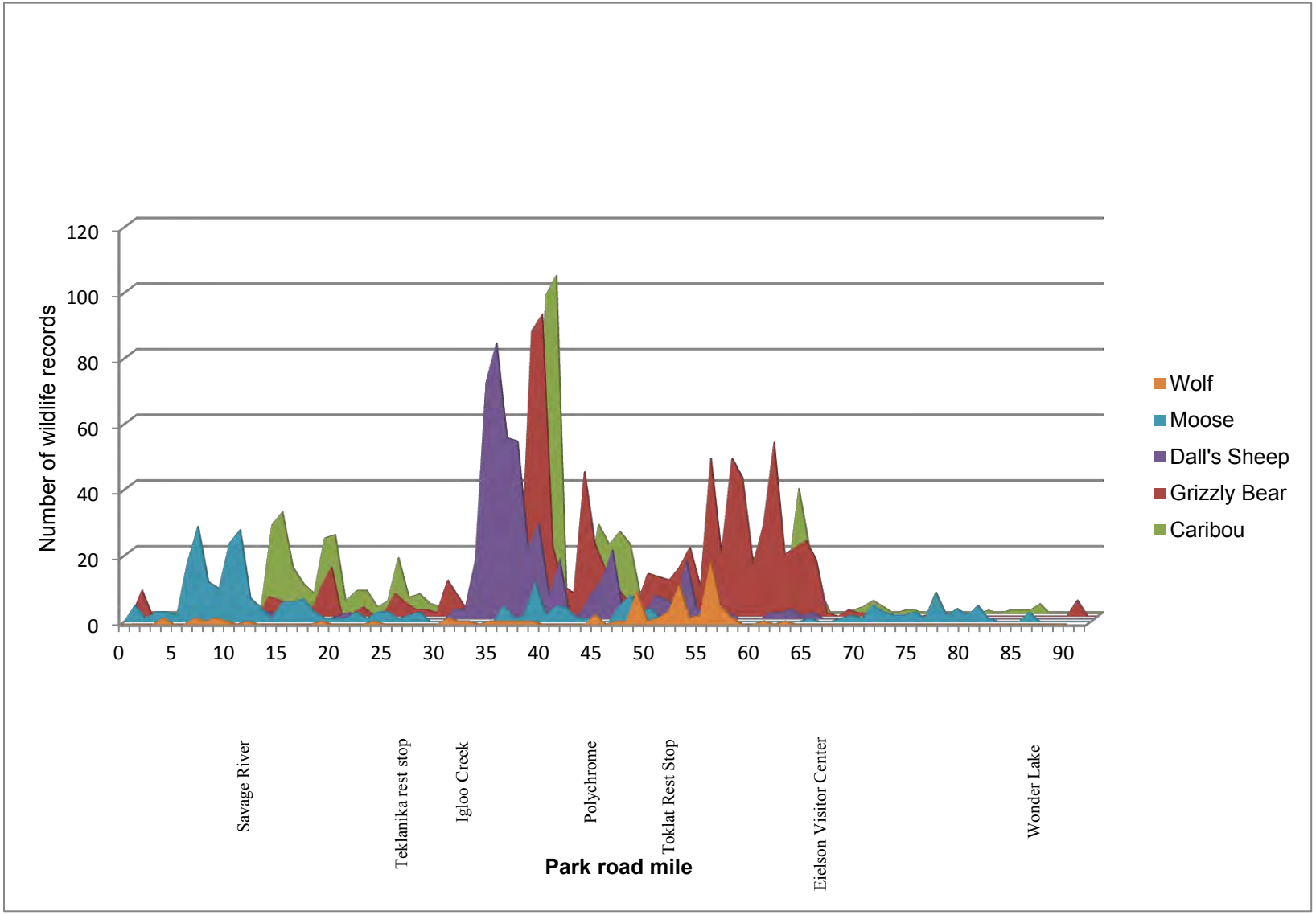


Figure 9. Wildlife sightings on the Denali Park Road entered in touch screen panels by bus drivers in 2008.

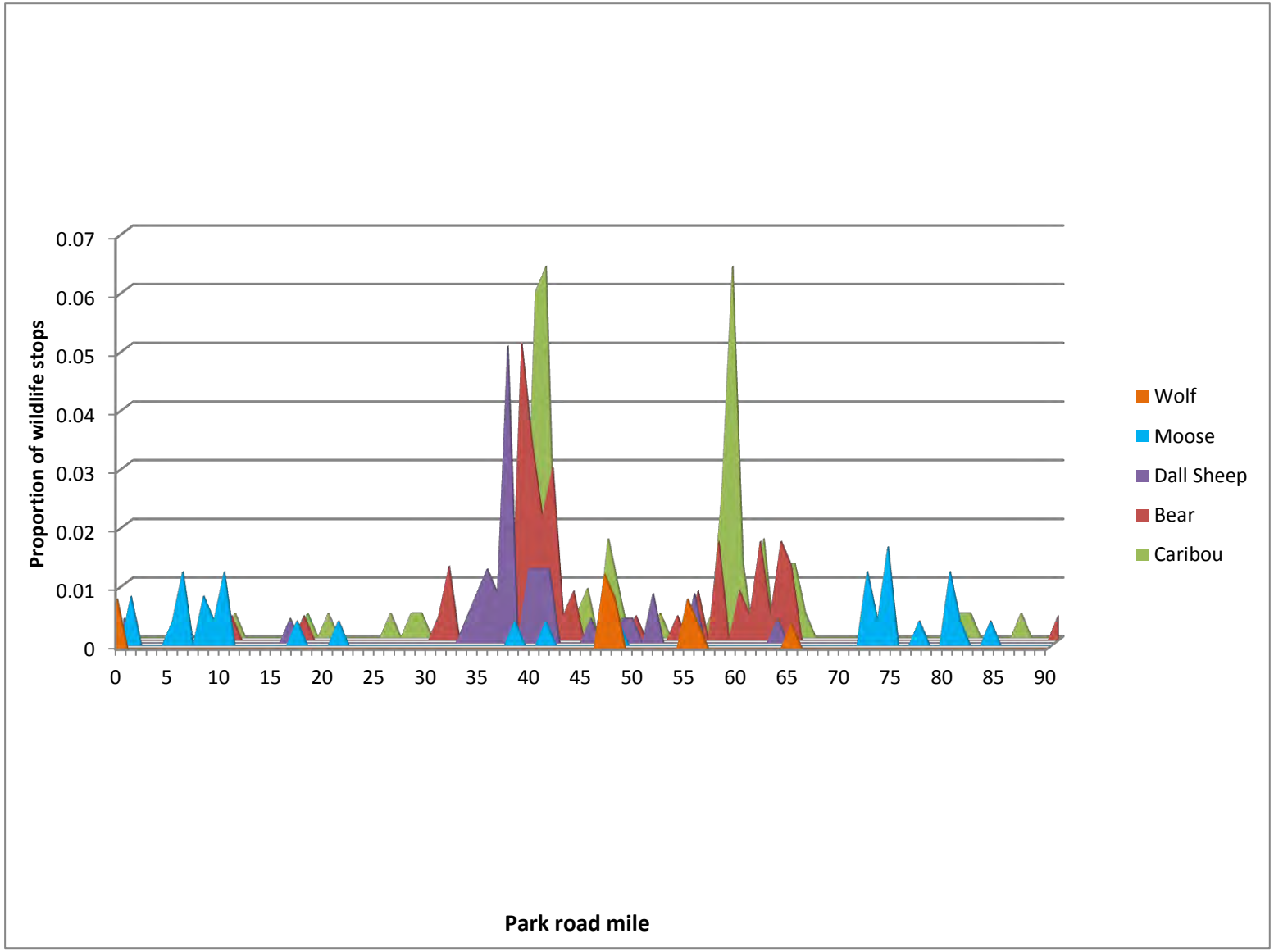


Figure 10. Wildlife sightings on the Denali Park Road entered in touch screen panels by bus drivers in 2009.

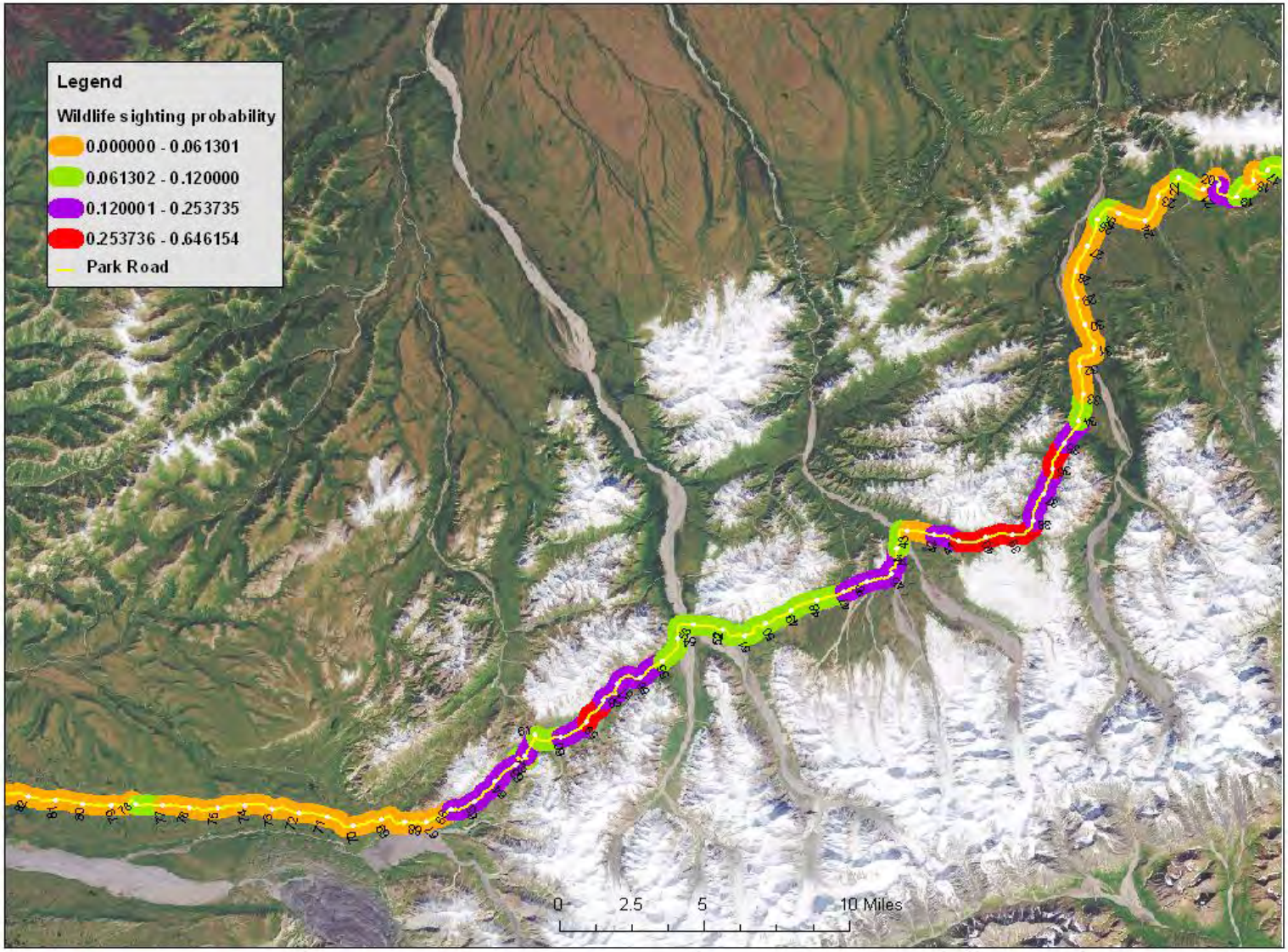


Figure 11. Probability of observing large mammals on bus trips on the Denali Park Road by mile, based on touch screen panel results from 2007 and 2008.

Temporal Trends in Wildlife Sightings

The number of groups of grizzly bear, moose and caribou seen per trip showed a slight decrease from 1995 to 2009, but none of the decreases were significant ($P \geq 0.05$, Figure 12). The number of groups of Dall's sheep and wolves seen per trip showed a slight increase from 1995 to 2009 but neither increase was significant ($P \geq 0.05$, Figure 12). Data from 1995 to 2006 were collected by written bus driver observations and data from 2007 to 2009 were collected by touch screen panels installed in buses (Table 5).

Figure 12. Mean numbers of groups of bear, caribou, sheep, moose and wolves observed annually per trip along the park road corridor, Denali National Park and Preserve, 1996-2008.

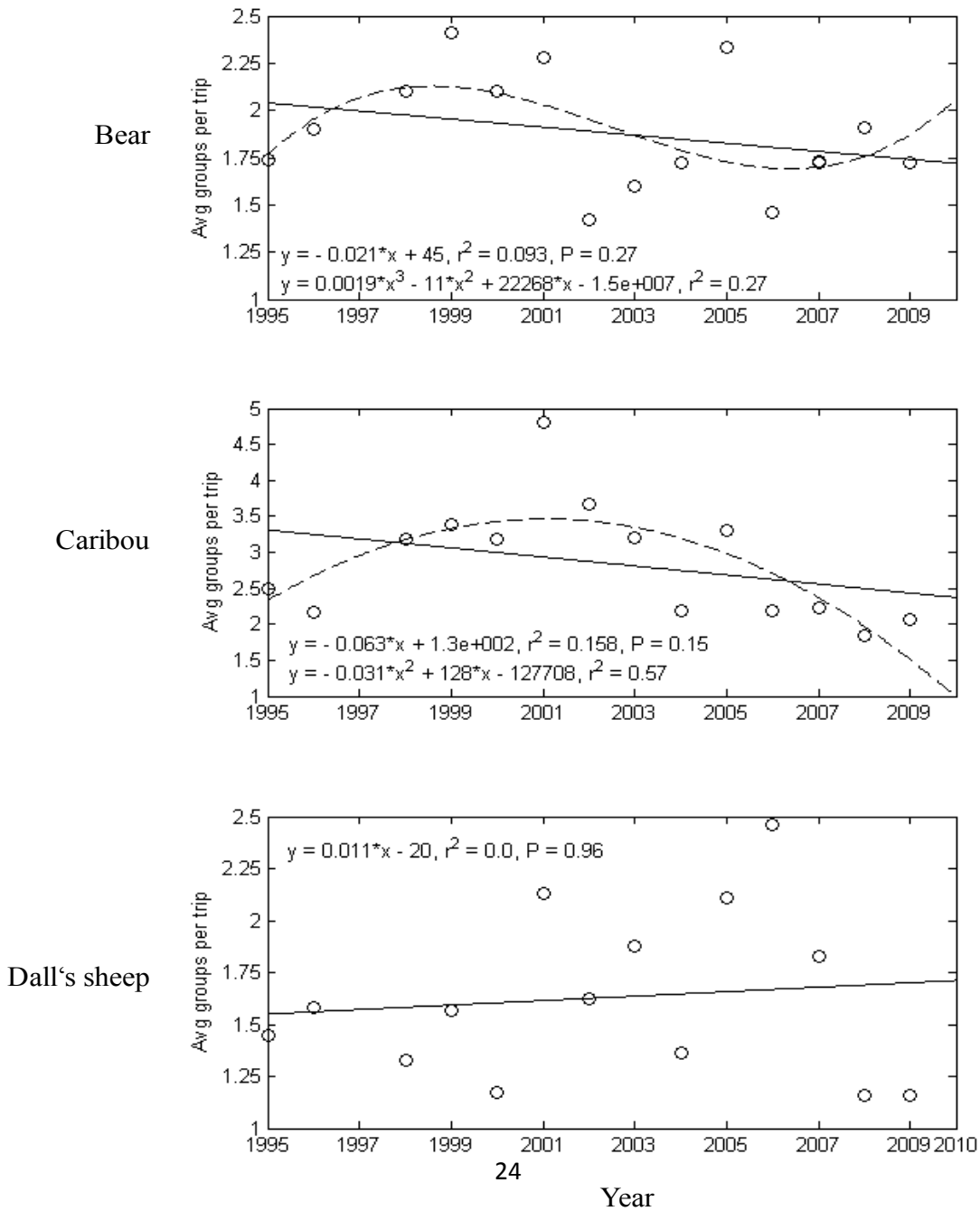
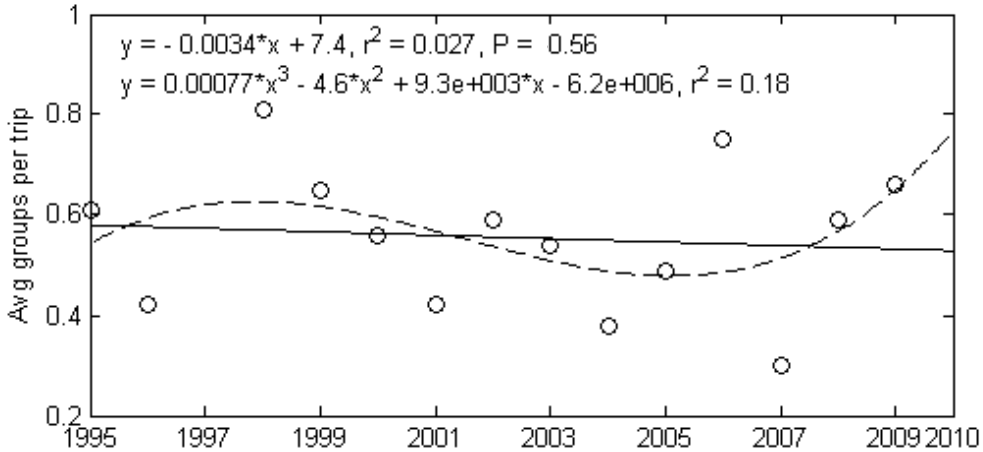


Figure 12. Mean numbers of groups of bear, caribou, sheep, moose and wolves observed annually per trip along the park road corridor, Denali National Park and Preserve, 1996-2008 (continued).

Moose



Wolf

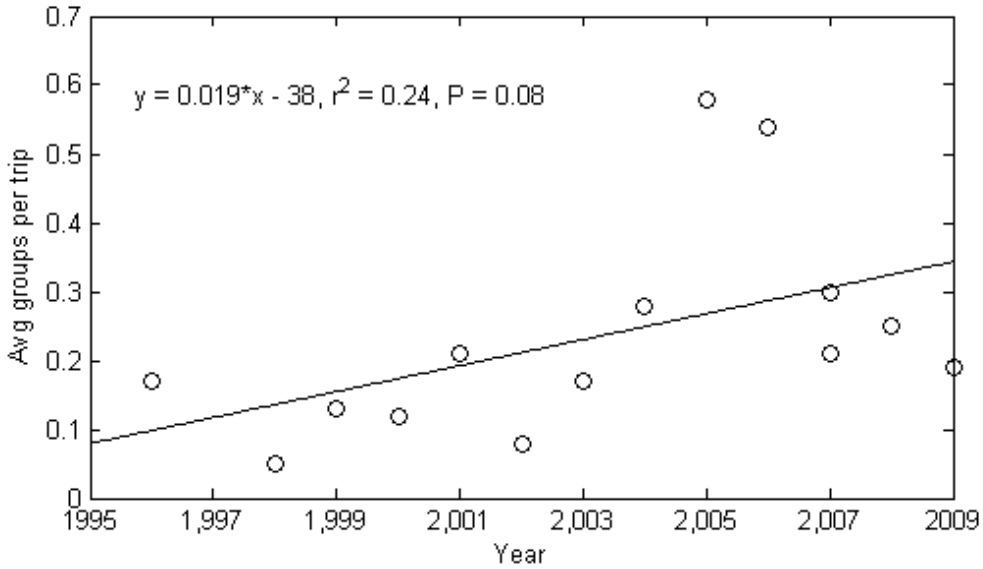


Table 5. Mean number of groups of large mammals recorded by bus drivers on trips in Denali National Park, 1995-2009 (Savage to Eielson, westbound, one trip per day).

			Groups per trip				
Year	Method	# trips	Caribou	Bear	Sheep	Moose	Wolf
1995	Written	78	2.6	1.7	1.5	0.6	-
1996	Written	107	2.2	1.9	1.6	0.5	-
1998	Written	68	3.2	2.1	1.4	0.8	0.1
1999	Written	86	3.4	2.4	1.6	0.7	0.1
2000	Written	88	3.0	2.2	1.2	0.5	0.1
2001	Written	69	4.8	2.2	2.2	0.4	0.2
2002	Written	80	3.7	1.4	1.6	0.6	0.1
2003	Written	63	3.3	1.6	1.9	0.6	0.2
2004	Written	78	2.1	1.8	1.3	0.4	0.3
2005	Written	87	2.4	1.8	1.6	0.4	0.4
2006	Written	62	2.1	1.4	2.6	0.8	0.6
2007	Written	43	2.2	1.8	1.9	0.3	0.2
2008	Touch Screen	52	2.1	2.0	1.2	0.7	0.2
2009	Touch Screen	26	2.1	1.6	1.2	0.7	0.2

Comparison of Data Collection Methods

There was a significant difference in the number of groups of sheep recorded by park staff road observations (4.2±2.7, n=9) compared to the number of groups recorded by either bus driver written observations (1.7±1.4, n=42, P<0.05) or touch screen panel entries (1.3±1.1, n=71, P<0.05 for both comparisons, Table 6). There was no significant difference in the numbers of bear, caribou, or moose observed between the three collection methods (Table 6).

Table 6. Comparison of mean (with standard deviation) sightings of wildlife by three collection methods in 2007 (Savage to Eielson, westbound, one trip per day).

	Touch Screen	Bus driver written	NPS staff observations
Bear	1.7 (1.5)	1.5 (1.3)	1.7 (1.1)
Caribou	1.5 (1.3)	1.8 (1.6)	2.1 (1.4)
Sheep	1.3 (1.1)	1.7 (1.4)	4.2 (2.7)
Moose	0.1 (0.4)	0.2 (0.4)	0.3 (0.5)

Night-time Traffic and Potential Impacts on Wildlife Sightings

Due to issues of noncompliance with quiet nights in 2006, only quiet night data from 2007 and 2008 were used in this analysis. Traffic levels were significantly lower on quiet nights than regular nights in both 2007 and 2008 at all counters (t-test, $P < 0.05$).

Each sampling method showed an increase in the number of recorded wildlife sightings on Monday mornings after quiet night compared to regular mornings, but the increase was not statistically significant for any of the three methods either year (t-test, $P > 0.05$,Table 7).

Table 7. Results of t-tests comparing the number of large mammal groups observed on bus trips on the park road on mornings after nights of minimal traffic (quiet) versus after nights of normal traffic levels (regular) in 2007 and 2008. Means are presented for three different sampling methods with standard deviation and p values of test results.

	2007			2008		
Sampling method	Regular	Quiet	*P*	Regular	Quiet	*P*
Average	4.8 (2.0)	7.1 (4.6)	0.09	6.3 (3.4)	7.9 (4.3)	0.13
Most	8.2 (4.0)	8.5 (4.7)	0.85	7.9 (4.4)	9.9 (3.8)	0.14
Random	5.1 (3.1)	7.6 (5.3)	0.14	6.1 (4.1)	7.5 (5.0)	0.29

In a secondary analysis we compared night-time traffic volumes for 2007, 2008 and 2009 to subsequent morning wildlife sightings. For this analysis we used the data from the Tek28 counter. The data from 2008 represented a year with very little night-time traffic while 2007 was abnormal with high levels of night-time construction traffic for Igloo Canyon road reconstruction and the construction of the Eielson Visitor Center. Data from 2009 was similar to data from 2008 but with a period of high traffic volume in late July (Figures 13 and 14).

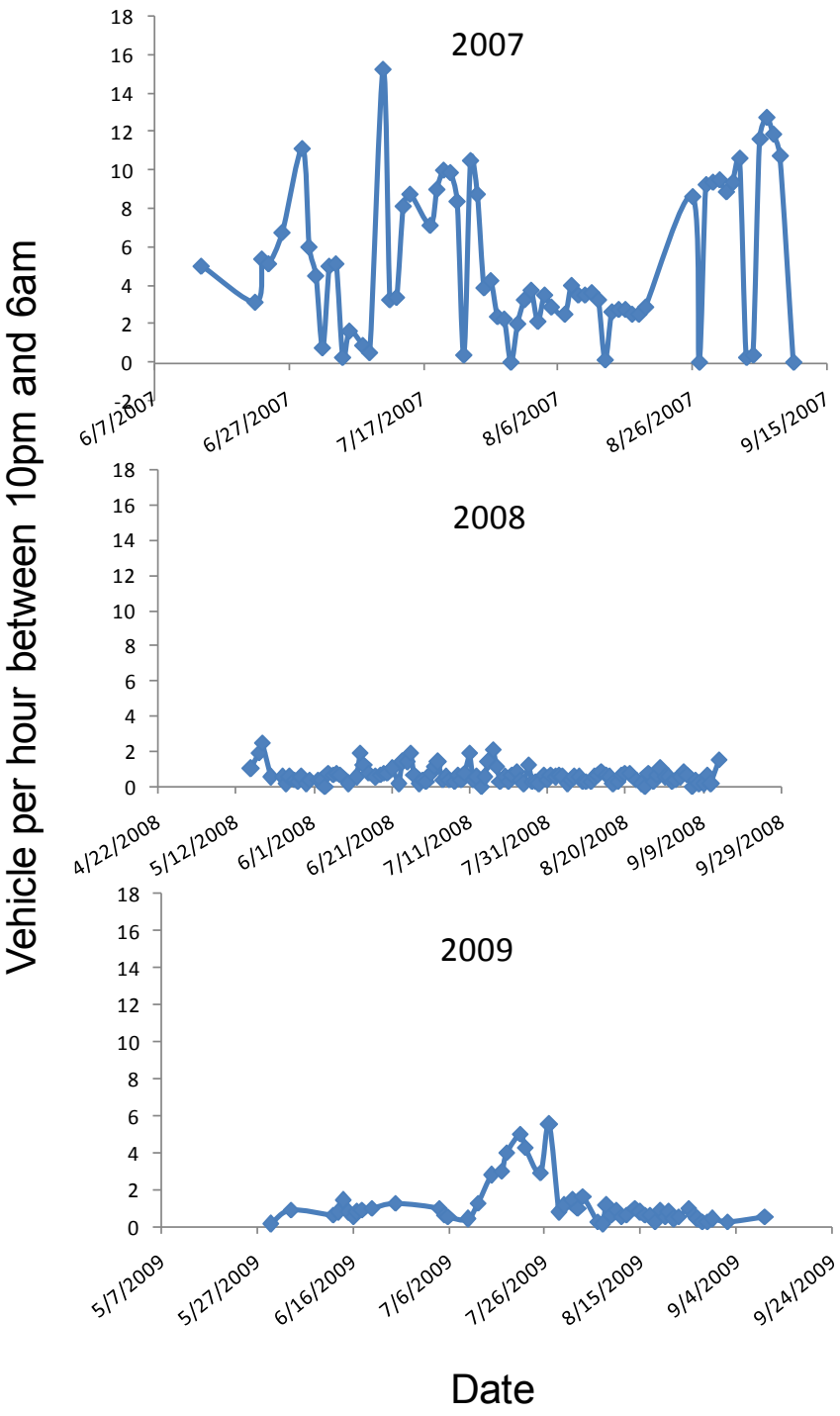


Figure 13. Night time traffic levels counted at Mile 28 on the Denali Park Road for 2007, 2008 and 2009. For a given date, the reported average vehicles per hour is representative of traffic on that date from midnight to 6am and from 10pm to midnight on the previous day.

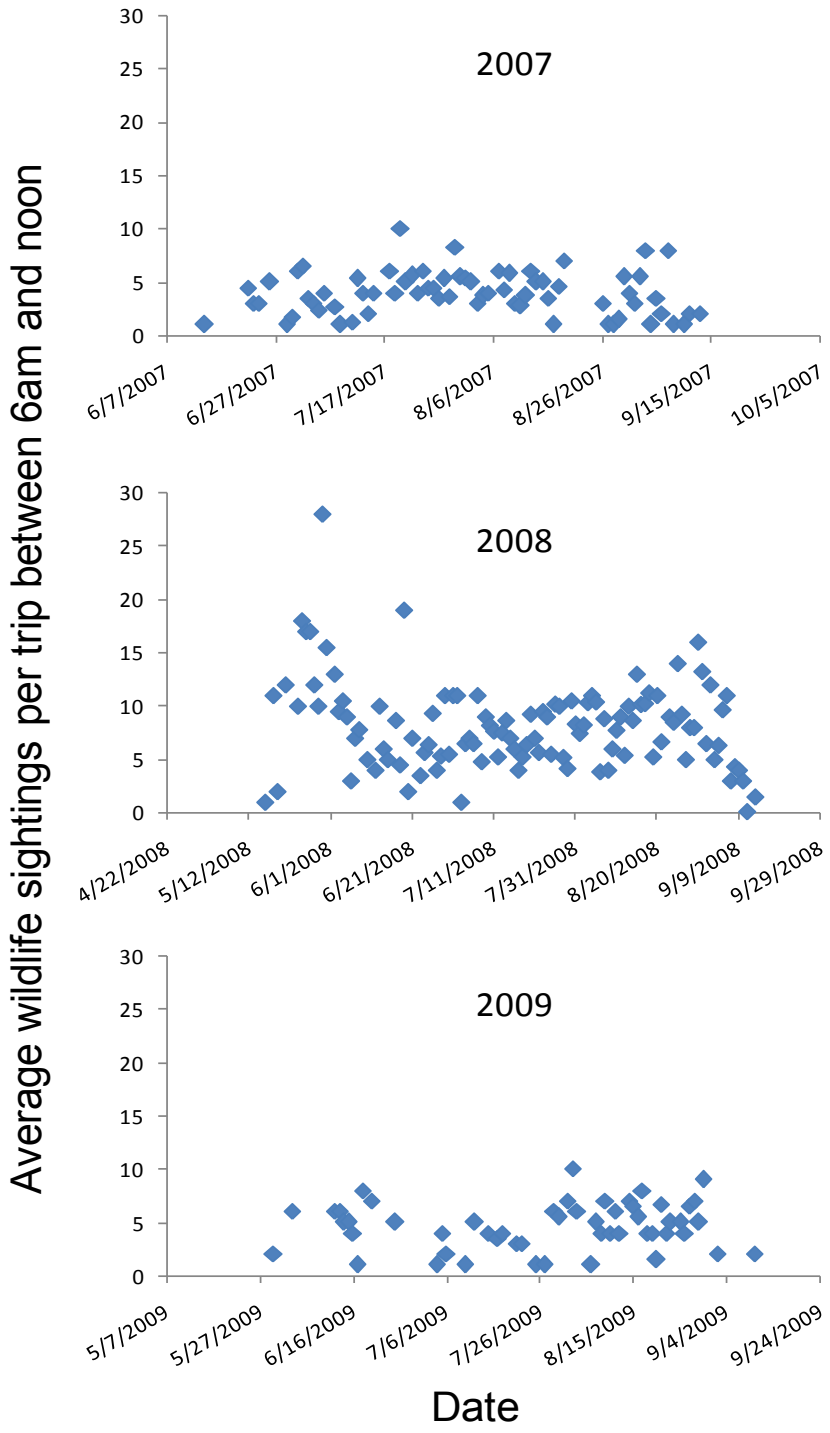


Figure 14. Morning wildlife sighting on the Denali Park Road for 2007, 2008 and 2009. For a given date, the reported average wildlife sighting is the sum of the average number of groups of grizzly bears, caribou, Dall's sheep, moose or wolves seen for all trips recording data.

We conducted statistical analyses to detect significant differences between traffic levels and wildlife sightings data between years using single-factor ANOVA and Tukey‘s test. Results indicated that night-time traffic levels in 2007 were significantly different from night-time traffic levels in 2008 and 2009 ($P<0.005$). For wildlife sightings, data from 2008 were significantly higher than those in 2007 and 2009 ($P<0.005$).

We then pooled the data for all years to compare night-time traffic levels with wildlife sighting the following morning. A least-squares linear regression of these pooled data indicate a significant decline in morning wildlife observations with increasing traffic levels at night ($P < 0.005$; Figure 15). We then binned traffic levels into 6 bins, 0-1, 1-2, 2-3, 3-4, 4-9 and > 9 vehicles per hour. This resulted in a significant single-factor ANOVA ($P<0.005$) and the Tukey test indicated that morning wildlife sightings following night-time traffic levels of 0-1 vehicles per hour were significantly higher than morning wildlife sightings following night-time traffic levels >2 vehicles per hour (Figure 16). These results are not surprising as most of the data in the 0-1 vehicles per hour bin are from 2008, when morning wildlife sightings were significantly higher than both 2007 and 2009. Hence the high wildlife sightings in 2008 may be biasing the results when all years are pooled.

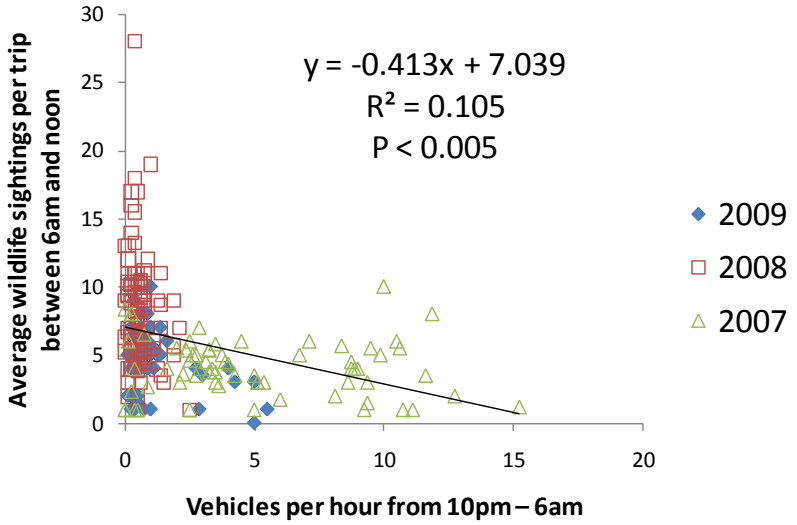


Figure 15. Comparison of night-time vehicles per hour and the number of groups of wildlife seen the following morning. Pooling all of the data there is a significant decline in wildlife sightings with increasing night-time traffic levels.

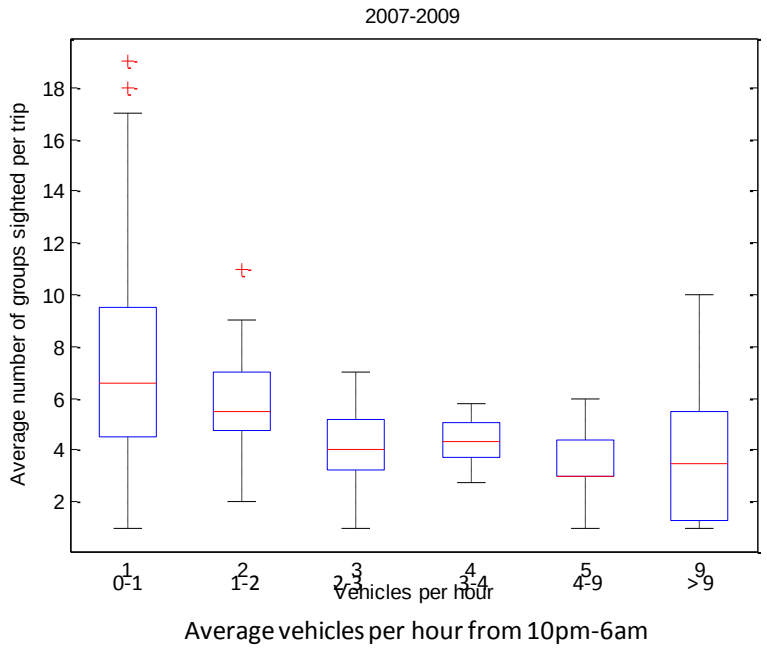


Figure 16. Comparison between the average number of vehicles per hour from 10pm to 6am and the average number of wildlife groups sighted per trip the following morning between 6am to noon for pooled data from 2007, 2008 and 2009. A significant single-factor ANOVA (P<0.005) and Tukey test indicates that wildlife sightings the morning following night-time traffic levels of 0-1 vehicles per hour are significantly higher than wildlife sightings the morning following traffic levels that are greater than 2 vehicles per hour. No significant differences are detected when 2008 data are removed. In the graph, red lines represent the median values, edges of the boxes represent the 25th and 75th percentiles, black bars represent the range of the data not considered to be outliers, and red crosses represent outliers.

To eliminate year effects, we further evaluated the impacts of higher night-time traffic levels on morning wildlife sightings within a season for 2007 and 2009. In 2007, there was a period from July 26 to August 19 when traffic levels remained low (< 6 vehicles per hour) compared to before and after these dates (Figure 17). During this period, night-time traffic levels averaged 2.78 vehicles per hour while before and after this period night-time traffic levels averaged 6.44 vehicles per hour. These values were significantly different based on a Student‘s T-test (P<0.005). Similarly, average morning wildlife sightings were higher during this time period (4.57 groups per trip) compared to before and after this time period when they averaged 3.69 groups per trip. These values were significantly different (P=0.045).

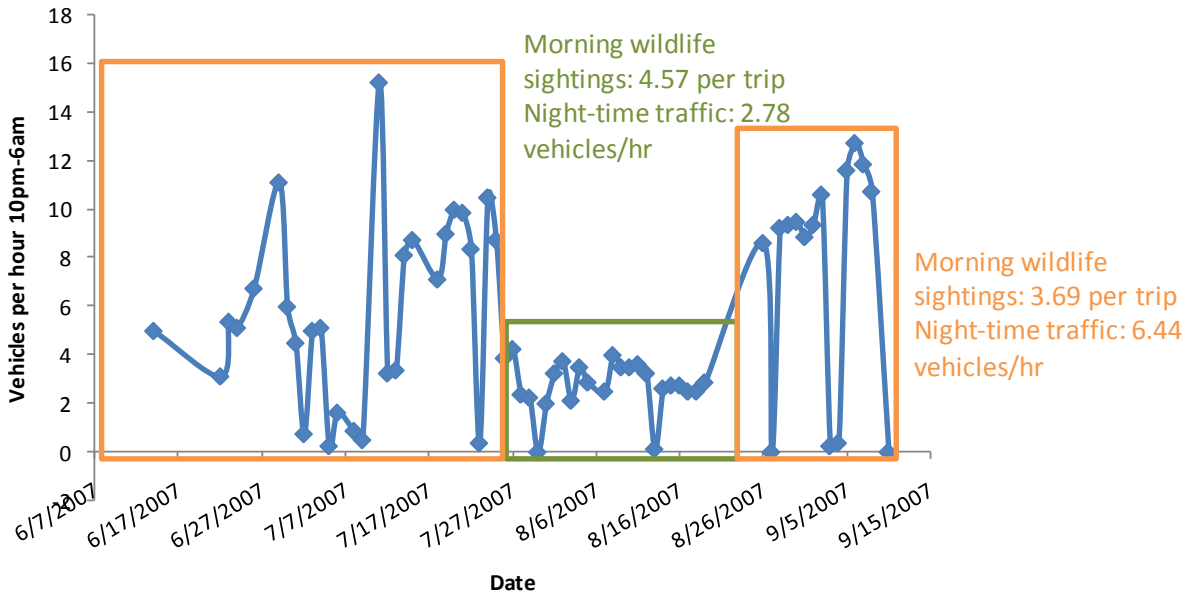


Figure 17. Night-time traffic levels in 2007. Data are shown only for those nights when there was corresponding wildlife sightings data the following morning. Traffic volumes outlined in green were significantly lower than traffic volumes outlined in orange ($P < 0.005$). Number of groups of wildlife groups observed per trip the following morning (6am to noon) were significantly higher for the dates outlined in green compared to the dates outlined in orange ($P = 0.045$).

Reverse conditions were found in 2009, where there was a period from July 15 to July 27 when traffic levels were high (average 3.91 vehicles per hour) compared to before and after this time period (average 0.71 vehicles per hour; Figure. 18). Traffic levels were significantly different between this period of high traffic and before and after the time period ($P < 0.005$). Correspondingly, morning wildlife sightings were significantly lower during this time period compared to before and after ($P = 0.025$; Figure 18).

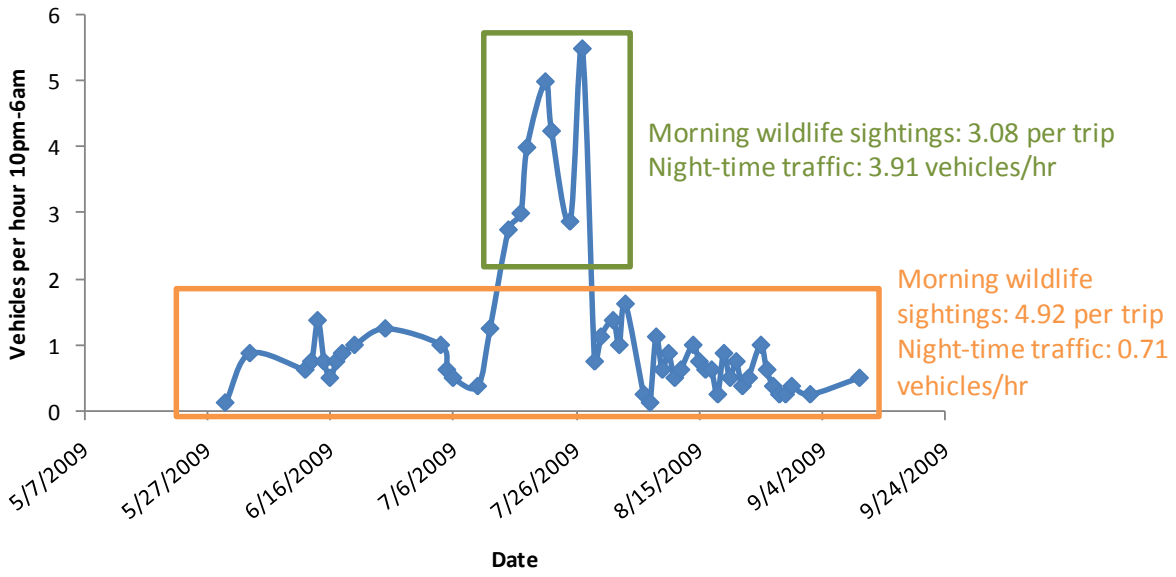


Figure 18. Night-time traffic levels in 2009. Data are shown only for those nights when there was corresponding wildlife sightings data the following morning. Traffic volumes outlined in green were significantly higher than traffic volumes outlined in orange ($P < 0.005$). Number of groups of wildlife observed per trip the following morning (6am to noon) were significantly lower for the dates outlined in green compared to the dates outlined in orange ($P = 0.025$).

A more detailed analysis of the time period from July 12 – 27, 2009 (when higher night-time traffic volumes occurred; Figure 19) shows a significant negative correlation between night-time traffic levels and subsequent morning wildlife sightings (Figure 20). Once night-time traffic levels returned to _normal‘ (for 2009) levels, morning wildlife sightings correspondingly increased.

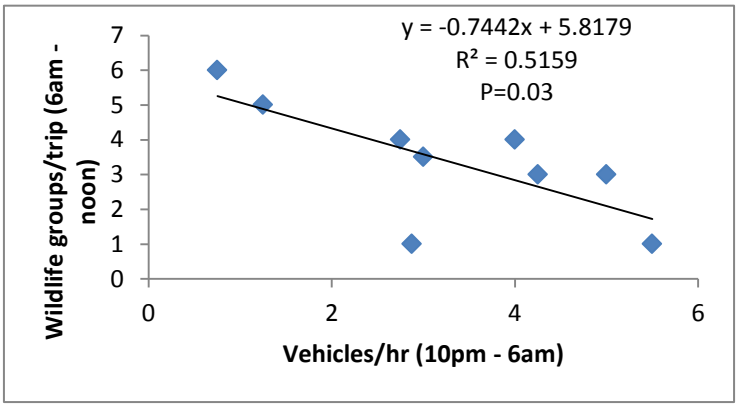


Figure 19. Relationship between nightly traffic volume and subsequent morning wildlife sightings from July 12 – 27, 2009. Solid line represents a significant least-squares linear regression ($P = 0.03$).

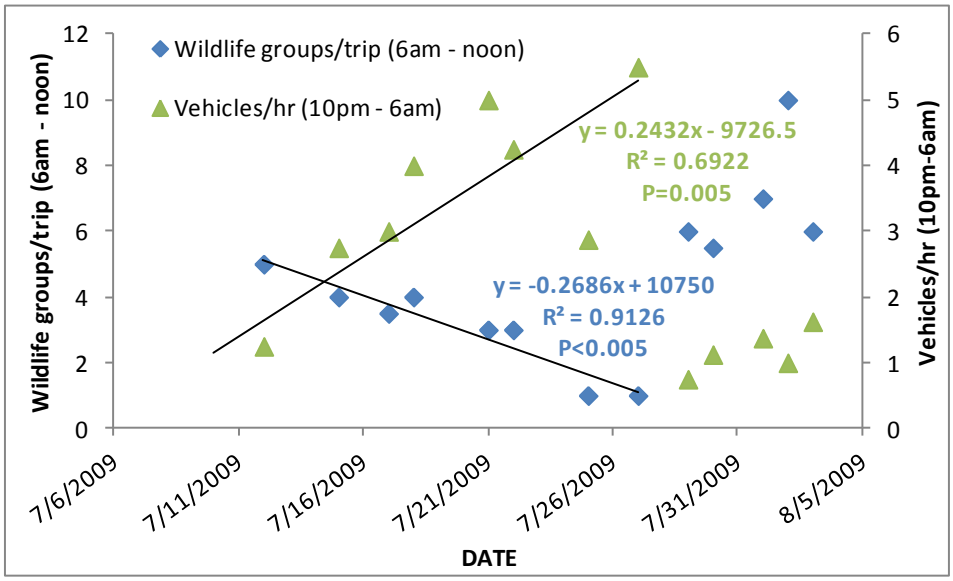


Figure 20. Nightly traffic volumes (green triangles) and subsequent morning wildlife sightings (blue diamonds) from July 12 – August 3 2009. Solid line represents a significant least-squares linear regression (P = 0.03).Morning wildlife sightings declined as night-time traffic levels increased up to July 27. Lower traffic levels measured from July 29 – August 3 corresponded to higher morning wildlife sightings.

Current Conditions of Social Indicators

The studies conducted by University of Vermont (Manning and Hallo 2010) found a number of indicators that appeared to be important to visitor experience on the road, but for the purposes of the capacity study and for use in the traffic model, three indicators of vehicle crowding on the road were considered. The indicators are the number of vehicles at wildlife stops, number of vehicles at rest areas, and the number of vehicles in a viewscape. Manning and Hallo (2010) created social norm curve to describe the acceptability of various crowding levels (Table 8). Three levels of vehicle numbers were retained for each indicator representing a low use (Preference), medium use (Typically seen) and high use (Acceptable) levels based on survey respondent results to the questions ―how many vehicles would you prefer to see", ―how many vehicles did you typically see", and ―how acceptable are each of these use levels" respectively. The VMP will propose the park's standard for each of the indicators.

Table 8. Potential values for the standards for each social crowding indicator on the park road obtained from a survey of visitors using the park road conducted in 2007. Listed are numbers of vehicles that would be the maximum acceptable at any given time.

Indicator (number of vehicles at)	Low (Preference)	Medium (Typically seen)	High (Acceptable)
Wildlife Stops	1.75	3.06	4.85
Rest Areas	2.24	3.57	5.48
Stony Viewscape	2.43	3.80	5.95
Mile 55 Viewscape	2.17	3.51	5.68

Rest Stops

From 2007 to 2009, Eielson Visitor Center had the highest average number of vehicles (6.0±3.8, *n*=29) followed by Teklanika (3.1±1.6, *n*=63), Toklat (3.2±2.0, *n*=69), Polychrome (2.7±2.0, *n*=51; data are for 2007 and 2008 only because the rest stop facilities were removed in 2009 and Polychrome became a scenic stop only), and Primrose (3.0±1.4, *n*=52, Table 11). All rest stops experienced vehicle levels above the high crowding value, with a maximum of 16 vehicles observed at Eielson, nine at Polychrome, 11 at Toklat, seven Teklanika, and six at Primrose.

Table 9. Average and maximum number of vehicles recorded at rest stops by NPS staff.

Rest Stop	Vehicles	Max
Primrose	3.0 (1.4)	6
Teklanika	3.1 (1.6)	7
Polychrome	2.7 (2.0)	9
Toklat	3.2 (2.0)	11
Eielson	6.0 (3.8)	16

Since all rest stops, except Polychrome, have large and dedicated parking areas, it is difficult to place these values in the context of Manning and Hallo (2010). The VMP will use the rest stop design standards to determine the vehicle limits for those rest areas rather than results of Manning and Hallo (2010). However, Polychrome is in a very different location from the other rest stops and does not have dedicated parking locations. Comparing the observed data to the results of the Manning and Hallo (2010) for Polychrome, 61 % of the observations had 2 or fewer vehicles, meeting the Low standard from Table 8. Eighty percent of the observations met the Medium standard and 91% met the High vehicle number standard.

Vehicles at Wildlife Sightings

Using road observation data from 2007 to 2009, we calculated the overall mean number of buses at a wildlife stop (with at least one bus present) as 1.7 ± 0.97 (n = 205), with a maximum of six buses observed at any one time. Mean number of all vehicles at a wildlife stop with one or more

vehicle present was 1.9 ± 1.3 (n =231). We observed VTS more frequently at wildlife stops with one or more vehicle present, with 52% of all observed stops having at least one VTS bus present. In order of prevalence, at least one TWT bus was present at 39% of all stops, 17% for private vehicles, 11% for an official government vehicle, 9% for lodge buses, and 3% for DNHTs. Twenty percent of private vehicles at wildlife stops had professional photographer permits.

Using the values from Manning and Hallo (2010), the percent of observations of vehicles at wildlife stops that exceeded the high value for vehicle numbers was less than 5% for all management sections. The low and medium value for vehicles at a wildlife stop was exceeded by more than 5% only in the Teklanika to Eielson section, (Table 10). Adding one vehicle to the values from Manning and Hallo (2010), to account for the observer‘s bus, these exceedance rates drop to 10% or less for the low value, 7% or less for the medium value, and 0% for the high value (Table 11).

Table 10. Percent of NPS staff observations that meet or exceed low, medium, and high values for vehicles at wildlife stops by management sections on the Denali Park Road. Currently there are two management sections on the park road, Savage to Teklanika and Teklanika to Wonder Lake. One alternative in the Vehicle Management Plan will propose a new management section from Eielson to Wonder Lake. These values represent the range that the Vehicle Management Plan is considering for setting standards.

	Low		**Medium**		**High**	
	Success rate	**Exceedance rate**	**Success rate**	**Exceedance rate**	**Success rate**	**Exceedance rate**
	≤ 2	**≥3**	**≤ 3**	**≥ 4**	**≤ 5**	**≥ 6**
Savage-Teklanika	97	3	98	2	99	1
Teklanika-Eielson	83	17	91	9	98	2
Eielson-Wonder Lake	100	0	100	0	100	0
Savage-Wonder Lake	78	22	90	10	97	3

Table 11. Percent of NPS staff observations that meet or exceed low, medium, and high values for vehicles, adding one vehicles to the Manning and Hallo (2010) results to account for the observer vehicle, at wildlife stops by management sections on the Denali Park Road. These values represent the range that the Vehicle Management Plan is considering for setting standards.

	Low		Medium		High	
	Success rate	Exceedance rate	Success rate	Exceedance rate	Success rate	Exceedance rate
	≤ 3	≥4	≤ 4	≥ 5	≤ 6	≥ 7
Savage-Teklanika	98	2	99	1	100	0
Teklanika-Eielson	91	9	94	6	100	0
Eielson-Wonder Lake	100	0	100	0	100	0
Savage-Wonder Lake	90	10	93	7	100	0

Viewscapes

In 2009, we conducted 10.1 hours of observation of the number of vehicles within the mile 62 (Stoney) and mile 55 viewscapes (the same viewscapes used in the Manning study). The mean number of vehicles observed in both viewscapes was 1.2±1.2, n=259. We observed a mean of 1.2±1.1, n=135 vehicles in the mile 55 viewscape, and a mean of 1.3±1.2, n=124, in the Stony viewscape at mile 62. We observed a maximum of five vehicles in both viewscapes. No observations of six or more vehicles were observed in either viewscape.

No observations exceed the high value for vehicles in a viewscape, and less than or equal to 5% of observations exceed the medium value, while less than 20 % of observations exceed the low value for either viewscape (Table 12). Adding one to each of the values for numbers of vehicles, to account for the observing vehicle, no observations exceeded either the medium or high number of vehicles and the low number of vehicles was exceeded less than 10% of the time (Table 13).

Table 12. Percent of NPS staff observations that meet or exceed low, medium, and high values for vehicles in a viewscape on the Denali Park Road that are potential standards for the Vehicle Management Plan. Results are presented for each viewscape separately, with and without zero counts (counts when no vehicle other than the observer is in the viewscape).

	Low		Med		High	
	Success rate ≤ 2	**Exceedance rate ≥3**	**Success rate ≤ 4**	**Exceedance rate ≥ 5**	**Success rate ≤ 6**	**Exceedance rate ≥ 7**
Mile 55-no zeros	82	18	99	1	100	0
Mile 55-zeros	87	13	99	1	100	0
Stony-no zeros	84	16	95	5	100	0
Stony-zeros	89	11	97	3	100	0
Both-no zeros	83	17	98	2	100	0
Both- zeros	88	12	98	2	100	0

Table 13. Percent of NPS staff observations that meet or exceed low, medium, and high values for vehicles, adding one vehicles to the Manning and Hallo (2010) results to account for the observer vehicle, in a viewscape on the Denali Park Road that are potential standards for the Vehicle Management Plan. Results are presented for each viewscape separately, with and without zero counts (counts when no vehicle other than the observer is in the viewscape).

	Low		Med		High	
	Success rate ≤ 3	**Exceedance rate ≥4**	**Success rate ≤ 5**	**Exceedance rate ≥ 6**	**Success rate ≤ 7**	**Exceedance rate ≥ 8**
Mile 55-no zeros	93	7	100	0	100	0
Mile 55-zeros	95	5	100	0	100	0
Stony-no zeros	91	9	100	0	100	0
Stony-zeros	94	6	100	0	100	0
Both-no zeros	92	8	100	0	100	0
Both- zeros	94	6	100	0	100	0

Discussion

Traffic Monitoring

Traffic volume counts from the Savage traffic counter are not significantly different from average hourly traffic calculated from Savage Check Station data and bus schedules. However, data from the Savage traffic counter required careful cleaning to remove run away counts common in the early hours of the morning, the cause of which are unknown. In 2009, we replaced the Sprite counter located at Savage with a classification counter (Apollo™, Diamond Traffic, Oakridge, Oregon) designed to give more accurate volume counts as well as information about vehicle speed and type. In future analyses, we hope this classification counter will provide accurate data about bus and non-bus traffic past the check station.

Wildlife Sightings

Information on wildlife sightings from bus drivers is a useful data set although we found mixed success obtaining reliable data and engaging drivers in data collection. From 1996 to 2007, a select number of bus drivers recorded written data about wildlife sightings (location, species and number sighted) on westbound trips to Eielson (Burson et al. 2000). In an effort to include wildlife stop information in the traffic model and use available technology to collect and manage wildlife stop information, touch screen panels were introduced as a data collection method in 2006. Touch screen panels provide more accurate location information than written observations since it is linked to GPS position data collected by a GPS modem installed in the bus. Since the data downloads directly into a database, staff time needed for data management and entry is reduced. However, the touch screen panels do have some deficiencies which hopefully can be addressed in the future. The panel software currently only encodes for wildlife stop location and species type. This provides frequency and location of wildlife groups, but not number of individuals in a group. Also, data collected by the panels can be incomplete for a number of reasons. First, bus drivers are reluctant to use touch screen panels and may use them infrequently, if at all. Second, drivers may use panels to record the first sighting of a species, but neglect to enter subsequent sightings. Third, a different driver may be assigned to a panel equipped bus every day, resulting in variance in collection quality. Finally, technical problems in the touch screen panel software or malfunction of the GPS unit can cause the panel to malfunction or not collect data.

Our regression methods for wildlife sightings from 1996 to 2009 differs from the regression analysis from Burson et al (2000) since we used the number of groups, rather than individuals seen per trip. In addition, our regression analysis used data collected by two collection methods, bus driver written observations and touch screen panel observations. This inconsistency may have created a false trend in the regression; however, a comparison of methods in 2007 showed that the number of wildlife groups recorded did not differ significantly between the two methods.

Recent research suggests that the size of the Denali caribou herd has been stable since the mid 1990‘s (Adams and Roffler 2009). Less rigorous population monitoring has been conducted for other large mammal species in Denali, although there is some indication that sheep populations have been stable since mid-1990‘s (Putera and Keay 1998, Phillips 2009), while moose numbers in the eastern portion of the park may have declined in recent years (Owen and Meier 2009). Variations in number of groups of wildlife seen are likely explained by variance in group size (in

the case of caribou and sheep), natural fluctuations in annual population, and vagaries in data collection.

The high variation in wildlife sighting data underscores the need for a long term data set to more accurately represent status and trends. We are currently developing protocols to replace the driver-collected data with staff observations, although we will continue to collect data from both sources for several years.

Night Time Traffic

The lack of a significant impact of _quiet nights‘ (one night of low traffic per week) on wildlife observations the following morning, especially in 2007 when _normal night‘ traffic levels were very high, demonstrates that single nights of limited traffic does not have a large impact on wildlife observability. However, the within season analysis for 2007 demonstrated that a sustained period of low traffic volume, in this case over 3 weeks, did result in an increase in morning wildlife sightings. Similarly in 2009, wildlife sighting decreased during 2 weeks of high night time traffic volumes, returning to _normal‘ for that year once traffic levels dropped. Based on these data, some suggestions for possible management strategies include:

1) Spread night-time contractor traffic out over several nights to keep hourly traffic under 2-3 vehicles per hour.
2) Pulse heavy traffic over a few consecutive nights followed by a period (at least one week) of low nightly traffic volume.
3) For high traffic volume nights in 2007 (> 40 total vehicles between 10pm and 6am), high traffic levels were sustained all through the night. Reducing early morning traffic (~2-6am) may help to reduce impacts on wildlife sightings.

Current Condition of Social Indicators

We did not use null values when calculating current conditions for rest stop and wildlife stop crowding standards on the park road to better represent conditions visitors would encounter, and mimic the conditions a visitor experiences. The indicator standards were created based on visitor experience and we tried to reflect that in our observations. We presented the viewscape conditions in two ways to illustrate the difference in meeting and exceeding standards, especially the low standard. Management decisions can help clarify the desired method for analyzing this standard in the future. It should be noted that the number of vehicles at rest areas or at wildlife stops across the day maybe significantly lower than what we present here because we excluded zero values.

The current method for counting number of vehicles at a rest stop includes staff vehicles parked at a rest stop for long periods during staff duty hours or for maintenance, which inflates the number of events that exceed the standard. The viewscape standards are not reflective of traffic on the road from Savage to Toklat since both sites are past Toklat, where many TWTs turn around. Due to travel times on the road and the opportunistic nature of data collection, there was a tendency for vehicle counts to occur during the same time period during the day. In the future, we will establish a monitoring protocol with a set of systematic time periods to monitor at each location to ensure that a reflective sample is obtained.

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Appendix A. Literature Review

Denali Road/Wildlife Studies: Summary 2009

This document in some ways duplicates previous work by Joe Van Horn to summarize the findings of studies implemented at Denali to investigate the impacts of traffic on the park road to wildlife, generally the ―big five" species (bear, moose, Dall's sheep, wolves, caribou). We'd like to note that his bibliography and summary are an important resource and we are using portions of his work in this document. The objective of this appendix is to review and compile the results of previous road/wildlife work to address specific needs of the Vehicle Management Plan (VMP) currently being created by park management. In the bibliography listed below, works we feel are significant contributions to the understanding of wildlife-traffic interactions or visitor experience on the park road are marked with "**" or ―++" respectively. Below each citation is a summary of findings and for some works a discussion of the significance of these findings relative to the needs of the VMP, including any mechanistic links of numbers or behavior of vehicles to wildlife impacts.

Albert, D. M., and R. T. Bowyer. 1991. Factors related to grizzly bear-human interactions in Denali National Park. Wildlife Society Bulletin. 19:339-349.
Summary: Bears show a greater inclination to approach people in developed area such as the park road, interactions in backcountry area were strongly correlated with level of human use along the park road, some nonhabituated bears may be displaced into the backcountry by high levels of use in frontcountry.

Beattie, J. B. 1984. 1984 Road/wildlife report. Denali National Park and Preserve, Denali Park, AK, USA.
Summary: Data on wildlife sightings when the road was open to all private vehicles, not significant due to low sample size.

****Beattie, J. B. 1986. Effects of traffic and construction on caribou along the Denali National Park Road. Denali National Park and Preserve, Denali Park, AK, USA.**
Summary: (Abstract adapted) Effects of traffic, pedestrian, a gravel crusher and construction site activity on caribou migrating along the park road corridor were documented June-July 1984-1985. Significantly smaller groups were observed roadside than at distant control sites. Groups with calves occurred at farther distances from the road than groups without, and spent a greater proportion of their time in energy consumptive behaviors when near the road. Elapsed time spent in energy consuming behaviors increased when more stimuli were present. Insect harassment may increase caribou tolerance to the road and stimuli: groups with calves had shorter reaction distances and some bulls sought the slightly elevated and vegetation free roadbed for relief from insects. Only half of the caribou groups observed attempting to cross the park road or crusher site were successful (100% cross), a quarter were partially successful, and a quarter were completely unsuccessful. Road crossing was greatest between 1800- and 0700 hr when there was little traffic and no construction activity.

Discussion: Beattie observed some interesting and potentially significant effects of traffic on caribou in her study. Unfortunately, she does not link her findings to traffic volume in a way that

is useful for determining thresholds for potential impacts. Also, her analysis could have been more robust. She was hampered by sample size issues stemming from an over categorization of her data, forcing her to use contingency tables to analyze much of her data and thereby weakening the strength of her results or censoring data from her analysis due to small sample sizes. While the presence of insects was an important factor to consider, using insect presence as a covariate in analyses would have more clearly isolated traffic effects. Some impacts should be noted. First and probably the most supported observation was that half of the caribou that approached the road did not successfully cross and that most successful crossings occurred at night when traffic levels were low. She does not detail number of vehicles present during these crossing attempts. Beattie examined caribou group size and behavior in relation to distance to the road in a number of different ways. Ironically, caribou groups were closer to the road when there were more vehicles present. This is probably because more vehicles stopped to watch caribou closer to the road. Caribou did show longer energetic reactions when there were more vehicles present; however, again she does not give us any idea of what number of vehicles may be a problem. Beattie‘s results also suggest that larger groups, especially groups with calves remained farther from the road. Without taking habitat use into consideration, especially when insects are present, it is difficult to accept this finding. Groups with calves spent more time in energy consuming behaviors near the road, which does suggest that groups with calves may be more sensitive to disturbance within the road corridor. Driving behaviors where vehicles moved parallel to groups seemed to be especially disturbing as were loud noises and people approaching on foot. Berm height of the road was also considered a hindrance. The reduction in private vehicles allowed on the road since this study was done probably addresses some of the issues of pedestrian disturbance. Ensuring that vehicles driving the road are as quiet as possible and that any changes to the road bed do not create a berm that is a hindrance to crossing are probably the most useful management recommendations from this report.

Beattie, J. B. 1985. Caribou reactions to traffic and construction along the Denali National Park Road, Alaska. Denali National Park and Preserve, Denali Park, AK, USA.
Summary: Yearly report/draft for the 1986 final by same author.

Belant, J. L., J. A. Paynter, K. E. Stahlnecker, and V. V. Ballenberghe. 2006. Moose distribution relative to human development in a national park. Alces 42:33-39.
Summary: Evaluated seasonal habitat use and distances to the park road and developed areas. Moose were closer to the park road than expected during summer and autumn and farther than expected from developed areas in autumn. However, when habitat use was considered, distances moose were located from roads were similar to expected during each season. Moose were farther from developed area in autumn, but this may have been because moose choose more open habitats for rut and most developed areas were located in spruce forest or tall shrub. The study concludes that moose did not appear to be strongly influenced by human development or activity.

****Burson, S. L., Belant, J. L., Fortier, K. A., and W. C. Tomkiewicz III. 2000. The Effect of traffic on wildlife in Denali National Park. Arctic 53(2):146-151**
Summary: This study compared number of wildlife sightings along the Denali Park Road to previous studies and found a decrease in moose sightings, a slight increase in bear sightings and no change in sheep and caribou sightings over time. The decrease in moose sightings

corresponded with a decrease in the moose population and a decrease in sightability with the growth of new vegetation. The increase in bear sightings could be due to increase in sighting of females with young. Variation in sheep and caribou sightings could be explained by yearly population changes, use of available habitat and seasonal movements. The study was unable to measure adverse effect of traffic on wildlife.

Discussion: This study compares data collected on wildlife sightings and wildlife behavior (bear, sheep, caribou and moose) in 1995-97 to previous studies (Tracy 1977, Singer and Beattie 1986, Looney 1992, and Taylor et al 1997). They found no significant difference in the number of sightings among the studies except for moose, which was attributed to a moose population decline. They witnessed few negative reactions of wildlife to traffic, but the ones they did note were by animals within 100 m of the road. This paper provides a simple analysis that is useful and seems well done.

Burson, S. L., Belant, J. L., Fortier, K. A., and W. C. Tomkiewicz. 1997. The suitability of bus drivers for monitoring large animal abundance. Denali National Park and Preserve, Denali Park, AK, USA.

Summary: (Abstract adapted) To determine whether data collected by park bus drivers could be used to monitor trends in abundance of caribou, grizzly bear, moose and Dall‘s Sheep, authors compared observations of bus drivers with National Park Service biologists during June-August 1995-1997. Although bus drivers observed fewer caribou, bears, and sheep than did biologists, the observed trends were consistent across years. There was no statistical difference in the number of moose observed by bus drivers and biologists. We believe that bus drivers can provide reliable data for long term monitoring of caribou, grizzly, bear, Dall‘s sheep and moose in Denali National Park.

Discussion: They recommend using 3 bus drivers to collect wildlife sighting data with NPS oversight and training. This program was continued through 2008 with volunteer drivers collecting wildlife sighting data each season. One problem encountered with this program was the time needed to enter the data sheets into a database and then someone to summarize and report the results. In 2006, data entry was about a year behind and reports had not been summarized for a few years. In 2006, NPS began installing LCD touch screen panels into 20 buses in order to collect data about reasons for buses stopping along the road, including for wildlife sightings, as part of the 2006-2009 road capacity study. The benefits of the touch screen panels are that the data is remotely downloaded into an Access database, reducing the time needed for data entry and quality control; more drivers have the potential to enter data reducing the potential for biases from using only a few drivers; a lot more data can be collected; and the data is automatically geo-located and therefore spatially and temporally more accurate. The downside is that it seems to be more difficult to get the majority of drivers interested in collecting the data (vs. just a few very interested volunteers) and that data collection may be less consistent. In 2009, no drivers volunteered to collect the written observations. We recommend that new concessions contracts in the future require the installation and use of the touch screen panels in buses.

Burson, S. 1999. Park road use/wildlife observations and monitoring. Denali National Park and Preserve, Denali Park, AK, USA.
Summary: Data from 1999 consistent with findings from previous years of the study.

Burson, S. 1998. Park road use/wildlife observations and monitoring. Denali National Park and Preserve, Denali Park, AK, USA.
Summary: Species distribution and abundance varied by month and probability of seeing wildlife varied by species type and month.

Burson, S. 1997. Park road use/wildlife observations and monitoring. Denali National Park and Preserve, Denali Park, AK, USA.
Summary: Species distribution and abundance varied by month and probability of seeing wildlife varied by species type and month.

Burson, S. and K. Fortier. 1996. Park road use/wildlife interactions: behavioral observations and monitoring. Denali National Park and Preserve, Denali Park, AK, USA.
Summary: Compared wildlife sightings from 1995 and 1996. Number of sightings of each species per trip were similar. No statistical tests were presented.

Dalle-Molle, J. 1980. Traffic and Wildlife. Memorandum. Denali National Park and Preserve, Denali Park, AK, USA.
Summary: Author recommends the following management actions: place a moratorium on further traffic volume and frequency increases, form a task force to make recommendations on study topics, submit budget requests for research in areas suggested by the task force, and address traffic volume issues in the upcoming general management plan.

****Dalle-Molle J. and Van Horn, J. 1991. Observations of vehicle traffic interfering with migration of Dall's Sheep (*Ovis dalli dalli*), in Denali National Park, Alaska. Canadian Field-Naturalist 105:409-411.**
Summary: The article recounts two observations of attempted crossing of the park road by bands of sheep to access summer habitats. The article argues that sheep have habituated to traffic and tolerate vehicles where the road traverses steep terrain in Denali National Park, but have not habituated in areas where the road is more than one km or more from seasonal ranges (no citation for this).

Discussion: From their observations, sheep are still alert and aware of vehicle traffic between 400 and 500 m from the road.

****Dean, F. C. and Tracy, D. M. 1979. McKinley's shuttle bus system and the management of traffic impact on wildlife. U. S. Forest Service Recreational Impacts on Wildlands, Seattle, WA, October 1978:263-270.**
Summary: Both the percentage of caribou that showed a reaction to traffic and humans, and the ratio of strong to mild reactions decreased with caribou's distance from the road. Caribou along road show a greater disturbance rate than those in areas with little to no human disturbance. Sheep near the road tend to be more sensitive than caribou to noise made by vehicles of people.

Discussion: This paper discusses the results from Tracy (1977). It notes potential impacts to ground squirrel populations from frequent collision mortality. A threshold for disturbance to caribou was noted, with frequent and strong reactions from caribou within 100m of the road, and reduced reactions from caribou >400 m from road. Caribou within 200 m had reduced foraging efficiency compared to those >200 m. Sheep seem to be even ―more sensitive" than caribou when close to the road. The authors discuss the need for noise reduction, from both buses and passengers in buses (passenger noise has since been addressed by bus driver protocols at wildlife stops). They also discuss the problems of vehicles forming ―fences" and splitting groups of animals or preventing crossing, and recommend spacing vehicles 30 to 50 m apart when stopped. The authors mention a disproportional negative effect of visitors leaving vehicles, which has since been addressed to some extent by reducing the number of private vehicles allowed on the road and by driver protocols that prohibit letting passengers off buses near wildlife.

Fortier, K., Tomkiewicz, C., and G. Olson. 1996. Park road use/wildlife interaction monitoring a pilot effort. Denali National Park and Preserve, Denali Park, AK, USA.
Summary: Presents some preliminary data on wildlife behavioral observations, no discussion or analysis of data.

Hastings, B. C. 1992. Evaluation of research and management needs for managing people and wildlife along the Denali road. Denali National Park and Preserve, Denali Park, AK, USA.
Summary: The Report suggests refining goals for wildlife on the park road, and defines the species of concern, using radio telemetry data to gather more data on species, and to clearly define the population of concern. The report also calls for defining animal activities away from road (from telemetry data) and near road (behavioral studies), in addition to recording wildlife-traffic interactions, and defining how habituation to people and vehicles currently affects animals and will affect them in the future. The author suggests clearly defining the experience NPS wants to provide for the visitor, clearly defining current traffic conditions, determining whether current levels of trafficare affecting wildlife, and describing the effect of increased vehicle numbers and other traffic factors (e.g.. speed, slowing vs. stopping) on wildlife response. The author suggests building a simulation model from data collected in previous studies to help managers predict wildlife responses to increases in traffic, and recommends creation of a social science survey to define visitors experience and expectations.

Kellem, J. 2000. Park road use/wildlife observations and monitoring. Denali National Park and Preserve, Denali Park, AK, USA.
Summary: This study presents data from the 2000 summer season of driver-collected data on wildlife observations. The findings are consistent with the previous five years, with variation likely explainable by natural variations in wildlife distribution and population. No statistical tests are provided.

****Looney, B. 1992. Interpretive aspects of visitor observations of wildlife along the Denali National park Road corridor 1980-1990. Thesis. Humbolt State University, Humbolt, California, USA.**

Summary: This study reports number of wildlife sightings of seven species of animals along the Denali park road and interpretive strategies for dealing with wildlife sightings. Anecdotal claims are provided, of moose disturbed by road traffic and increasing habituation of bears and wolves to traffic.

Discussion: The valuable information in this thesis is the sighting numbers (number of individuals seen and percent of trips observed) collected over a decade for bear, sheep, moose, wolves and caribou. There is also some sighting information provided on foxes and eagles. He has broken down the number of sightings by road section, which is also helpful. But Looney does not provide any statistics to support his claims that observations of different species ―declined," harassment has ―increased" and habituation has ―increased" for some species over the time period. He apparently ―eye-balled" the data to make these claims and backed them up with anecdotal observations. While his observations are interesting and useful in supporting some indication of effects to wildlife by traffic and visitors, he does not provide any data that supports a cause and effect relationship between traffic and wildlife impacts.

++Miller C. A., and R. G. Wright. 1998. Visitor satisfaction with transportation services and wildlife viewing opportunities in Denali National Park and Preserve. A Final Report.
Summary: Visitor satisfaction was found to be high, consistent with Singer and Beattie (1986) and Harrison (1975). There has been no apparent decrease in visitor satisfaction since the inception of the visitor transportation service.

****Putera J. A. and Keay J. A. 1998. Effect of vehicle traffic on Dall sheep migration in Denali National Park, Alaska. Final report. U. S. Geological Survey, Biological Resources Division, Denali National Park, Alaska, USA.**
Summary: Denali's Dall sheep population employs migration in spring to the Alaska Range from the Outer range and back in the fall. All ewe-like sheep (ewes and young rams) and lambs migrate or attempt to migrate to Alaska Range from Primrose Ridge and Mt Wright, while the majority of adult rams remain in the outer range. The migration routes cut across the park road and migration attempts in spring are sometimes thwarted by vehicle traffic, resulting in an alteration of diurnal movements and up to a 2 week delay in some migrations. Fall migration attempts observed were all successful, but several ram groups were delayed in crossing the road by vehicle traffic.

Discussion: This study provides some useful quantitative information about traffic and sheep behavior. It also provides some of the most complete aerial sheep survey data for this decade (1990's). Sheep generally approached the road to cross during the middle of the day. Groups that successfully crossed spent an average of 16.8 minutes to cross from 100 m north of the road to 50 m south of the road. Groups that approached the road when no vehicles were present took only about 6 minutes to make the crossing. The authors provide some interesting information about vehicle numbers and intervals between vehicles (i.e. during spring migration ―gaps" between vehicles were about 5 minutes on average at migration corridors), but do not do a good job of tying numbers of vehicles or behavior of vehicles to impacts. They recommend enforcing no-stopping zones 100 m on either side of sheep migration corridors during migration (June 1 –

30 and August 15 – October 1) and that vehicles stop at least 50 from sheep observed along the road.

Singer, F. J. 1982. The public transportation system in Denali National Park 10 years later: A re-evaluation of visitor attitudes and wildlife viewing opportunities. Progress report draft. U.S. Department of Interior, National Park Service, Anchorage, AK.
Summary: This is a preliminary report of findings in 1982. The Arctic paper listed below has better details of findings for the 2 year study summarized.

****++Singer F. J., and Beattie J. B. 1986. The controlled traffic system and associated wildlife responses in Denali National Park. Arctic. 39:195-203.**
Summary: Visitor satisfaction with the transportation system increased from the levels seen in 1973-74. Sightings of moose and grizzlies decreased between 1973-74 and 1982-83., but sightings of caribou and sheep remained constant. Wildlife was found closer to the road than in 1973-74, suggesting that some animals had become habituated to the road. Periods of unlimited vehicle access in fall produced an increase in the number of people out of their vehicles, and more animals responded with flight and increased flight distances.

Discussion: This paper has lots of great information and some nicely quantified data on wildlife sightings and vehicles. Moose and bear sightings in 1982-1983 had significantly declined from 1974-74 levels, although the decline in moose sightings was probably due to an overall population decline. The authors don‘t provide much insight into the decline in bear sightings and actually comment in their discussion that given the 50% increase in vehicle traffic on the road since 1974, bear sightings have ~~d~~ecreased only a minor amount". They don‘t really note any significant effects to wildlife, although they do note the disproportionate impacts of visitors outside of vehicles, especially during the fall road lottery. Distance from the park road influenced the behavioral responses of all 4 species, with animals closer to the road showing more intense behavioral reactions. Increasing numbers of vehicles present increased the behavioral response of caribou and bears, although the authors don‘t provide much information on vehicle numbers near groups except that the mean number of vehicles near wildlife groups was 3.6 during the restricted access season and 6.2 when the road was open to all private vehicles.

Singer, F. J. 1986. Dynamics of caribou and wolves in Denali National Park, 1898-1985. Conference on Science in the National Parks 1986:117-157.
Summary: The Denali Caribou Herd declined from 20,000-30,000 animals in 1940 to 1,200-1,500 by 1968. During this time, the Denali Caribou Herd experienced two major declines. The decline from 1942-1947 could be due to emigration to the west. This decline was probably not due to predation by wolves because wolves numbers were low during this period, although predation from wolves and grizzlies could have contributed to as second decline from 1963-1968. Human disturbance and hunting are unlikely causes for the two declines. Winter and spring severity could have played a role in caribou population declines, but the correlation is not clear except that deeper snow resulted in higher predation rates by grizzlies in 1965.
****Taylor, D. L., K. D. Vogt, and J. Warburton. 1997. A system for monitoring impact of Denali park road traffic on wildlife. Biological Sciences Report: USGS/BRD/BSR-1997-0001.**

Summary: Objectives of this project were to develop a method to detect year to year changes in numbers of 5 species (moose, bear, sheep, caribou, and wolves) observed by visitors using the required shuttle buses and tour buses. Bus drivers served as observers for the study over 4 years. The report provides calculations of mean number of animals observed per bus trip for 5 species, the percentage of visitors observing the 5 species annually, variation in numbers observed across a season and among years, and possible impacts of traffic volume. Numbers of private vehicles and photographers allowed on the road were thought to have a negative effect on the number of Dall‘s sheep, moose and wolves observed. There was little variation in the location (milepost) of sightings among years for all species observed.

Discussion: There are so many tables and graphs in this report that it‘s challenging to figure out what the point is. Essentially, they were trying to establish a monitoring protocol and collected tons of data over 4 years and presented results summarized in every way they could imagine, so there‘s a lot of data here to reference or use as a comparison in the future. The authors calculated sightability of each species as a percentage of visitors instead of bus trips like most of the other studies, which is unfortunate, although Burson et al. (2000) recalculate this to make it more comparable. The data show that wildlife sightings along the road do correlate with overall population numbers where those are known. They conducted a multivariate analysis and suggest that the results show a decrease in wildlife sightings with the total number of private vehicles on the road each year. It‘s hard to believe this result. With only two years of data included in this analysis, summed traffic numbers for each year is a coarse way to examine this issue and the results could simply reflect inter year variation, but it‘s hard to tell because they don‘t provide detailed results (parameter estimates, standard errors, etc.).

****Tracy, D. M. 1977. Reactions of wildlife to human activity along Mount McKinley National Park road. Thesis. University of Alaska, Fairbanks, USA.**
Summary: Abstract (adapted) This thesis evaluated the impact of human activities on wildlife along the park road. The author quantifies reactions of caribou, moose, Dall‘s sheep, brown bears, and red fox during 100 trips along the road and 300 hours of intensive observations in 1973-1974. Backcountry and near-road mammal densities were determined in seven plots. Avoidance behavior to human presence was noted. Many individual animals appeared habituated to human activities. All species exhibited a 50% ―no visible response” rate between 50-100 m from the road and few visible responses were shown by animals beyond 400 m.

Tracy, D. M., and F. C. Dean. 1978. Possible wildlife responses to stipulated highway design criteria for Mount McKinley National Park Road. National Park Service, Denali Park, AK, USA.
Summary: Wildlife impacts due to changes in road design could include the following: increases in vehicular and predator -caused deaths, decreased crossings of the road by microtines, increase in snow banks leading to difficulty crossing road, loss of habitat, modification of roadside vegetation, a visual and physical break in habitat, increased surface disturbance which could lead to more invasive species, increased dust and associated tooth wear, and increased construction noise and disturbance which could lead to temporary or permanent abandonment of home ranges.

Van Horn, J. 2004. Road traffic/wildlife studies: summary of issues past studies.

Summary: This is a bibliography with some of the findings of major road wildlife studies summarized.

Yost A. C., and G. R. Wright. 1998. Management recommendations for monitoring wildlife responses to road traffic in Denali National Park and Preserve, Alaska. Final Report. USGS Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, ID.
Summary: This article presents an argument that previous study designs did not provide accurate descriptions of animal densities near the park road due to varying visibility along the road corridor. No measurable influence of road traffic levels on caribou and grizzly distributions was found. Moose were found farther from road where traffic levels are the highest, although distribution could be explained by habitat association, climatic factors, and physiological and security needs.

Yost, A. C. 1998. The effect of road traffic on moose, caribou, and grizzly bear distribution in Denali National Park and Preserve, Alaska. Thesis. University of Idaho, Moscow, USA.
Summary: Abstract (edited) The author used a wildlife monitoring system in 1996 using 19 landscape level viewsheds divided into 4 strata with each stratum corresponding to a decrease in traffic volume. Density estimates were higher in only one backcountry area for moose, no backcountry area for caribou and two backcountry areas for grizzly bears. The number of moose sightings was significantly lower than expected within the first 300 meter zone from the road; caribou and grizzly bear sightings were significantly higher within the 601-900 meter zone; moose sightings were significantly higher and caribou sightings were significantly less than expected in the 901-1200 meter zone. Caribou and grizzly bear sightings were associated with higher elevations during late June and July and lower elevations in early June and August. Moose may have avoided the first 200 meters of the road but the spatial structure of willow patches appeared to be more influential in their distribution. Some caribou showed caution when encountering road traffic, but no pattern of avoidance.

****Yost A. C., and R. G. Wright. 2001. Moose, caribou, and grizzly bear distribution in relation to road traffic in Denali National Park, Alaska. Arctic 54(1):41-48.**
Summary: The distribution of moose suggests traffic avoidance, but could be explained by spatial distribution of forage, the patch nature of the habitat and elevation changes along the road corridor. Caribou distribution is explained by seasonal transitions and use of calving areas with no significant evidence of avoidance of the park road. The number of grizzly bears near the road in relation to road traffic levels is inconsistent, leading to the conclusion that traffic has little influence on bear distribution.

Discussion: The authors compared wildlife densities in plots near the road and ―control areas" away from the road. The only ―effect" they found was for moose to be found less than expected within 300 m of the road, but they note that this could be due to the distribution of habitat. Generally, their discussion refers heavily to the possible influence of habitat on the densities of animals observed, and suggests that some consideration of habitat effects should have been included in the analysis.

Appendix B. 2008 Peak Season VTS Schedule

June 8 - Aug. 20, Westbound

Depart Riley Creek Campground	Depart WAC	Depart Savage Campground	Depart Sanctuary Campground	Depart Teklanika Campground	Depart Teklanika Rest Area	Depart Igloo Campground	Depart Polychrome	Depart Toklat	Depart Eielson Visitor Center	Depart Wonder Lake
	Bus/Driver spend night at WL, pick up at Kantishna and return eastbound next morning.									8:00 AM
	Bus/Driver spend night at WL and return eastbound next morning.									
	5:30 AM	6:00 AM	6:25 AM	6:40 AM	7:00 AM	7:10 AM	8:10 AM	8:40 AM	10:15 AM	11:40 AM
	6:00 AM	6:30 AM	6:55 AM	7:10 AM	7:30 AM	7:40 AM	8:40 AM	9:10 AM	10:45 AM	
	6:15 AM	6:45 AM	7:10 AM	7:25 AM	7:45 AM	7:55 AM	8:55 AM	9:25 AM	11:00 AM	12:25 PM
	6:30 AM	7:00 AM	7:25 AM	7:40 AM	8:00 AM	8:10 AM	9:10 AM	10:05 AM		
	6:30 AM	7:00 AM	7:25 AM	7:40 AM	8:00 AM	8:10 AM	9:10 AM	9:40 AM	11:15 AM	
	6:45 AM	7:15 AM	7:40 AM	7:55 AM	8:15 AM	8:25 AM	9:25 AM	9:55 AM	11:30 AM	12:55 PM
	7:00 AM	7:30 AM	7:55 AM	8:10 AM	8:30 AM	8:40 AM	9:40 AM	10:10 AM	11:45 AM	
7:00 AM	7:10 AM	7:45 AM	8:10 AM	8:25 AM	8:40 AM	8:50 AM	9:50 AM	10:20 AM	11:55 AM	1:20 PM
	7:15 AM	7:45 AM	8:10 AM	8:25 AM	8:45 AM	8:55 AM	9:55 AM	10:25 AM	12:00 PM	1:25 PM
	7:30 AM	8:00 AM	8:25 AM	8:40 AM	9:00 AM	9:10 AM	10:10 AM	10:40 AM	12:15 PM	
	8:00 AM	8:30 AM	8:55 AM	9:10 AM	9:30 AM	9:40 AM	10:40 AM	11:10 AM	12:45 PM	
	8:15 AM	8:45 AM	9:10 AM	9:25 AM	9:40 AM	9:50 AM	10:50 AM	11:20 AM	12:55 PM	2:20 PM
	8:30 AM	9:00 AM	9:25 AM	9:40 AM	10:00 AM	10:10 AM	11:10 AM	11:40 AM	1:15 PM	
	9:00 AM	9:30 AM	9:55 AM	10:10 AM	10:30 AM	10:40 AM	11:40 AM	12:10 PM	1:45 PM	
	9:15 AM	9:45 AM	10:10 AM	10:25 AM	10:45 AM	10:55 AM	11:55 AM	12:25 PM	2:00 PM	3:25 PM
	9:30 AM	10:00 AM	10:25 AM	10:40 AM	11:00 AM	11:10 AM	12:10 PM	1:05 PM		
	9:30 AM	10:00 AM	10:25 AM	10:40 AM	11:00 AM	11:10 AM	12:10 PM	12:40 PM	2:15 PM	
	10:00 AM	10:30 AM	10:55 AM	11:10 AM	11:30 AM	11:40 AM	12:40 PM	1:10 PM	2:45 PM	
	10:15 AM	10:45 AM	11:10 AM	11:25 AM	11:45 AM	11:55 AM	12:55 PM	1:25 PM	3:00 PM	4:25 PM
	10:30 AM	11:00 AM	11:25 AM	11:40 AM	12:00 PM	12:10 PM	1:10 PM	1:40 PM	3:15 PM	

June 8- Aug. 20, Westbound (continued)

Depart Riley Creek Campground	Depart WAC	Depart Savage Campground	Depart Sanctuary Campground	Depart Teklanika Campground	Depart Teklanika Rest Area	Depart Igloo Campground	Depart Polychrome	Depart Toklat	Depart Eielson Visitor Center	Depart Wonder Lake
	11:00 AM	11:30 AM	11:55 AM	12:10 PM	12:30 PM	12:40 PM	1:40 PM	2:10 PM	3:45 PM	
11:00 AM	11:10 AM	11:40 AM	12:05 PM	12:20 PM	12:35 PM	12:45 PM	1:45 PM	2:15 PM	3:50 PM	5:15 PM
	11:15 AM	11:45 AM	12:10 PM	12:25 PM	12:45 PM	12:55 PM	1:55 PM	2:25 PM	4:00 PM	5:25 PM
	11:30 AM	12:00 PM	12:25 PM	12:40 PM	1:00 PM	1:10 PM	2:10 PM	3:05 PM		
	12:00 PM	12:30 PM	12:55 PM	1:10 PM	1:30 PM	1:40 PM	2:40 PM	3:10 PM	4:45 PM	
	1:00 PM	1:30 PM	1:55 PM	2:10 PM	2:30 PM	2:40 PM	3:40 PM	4:10 PM	5:45 PM	
	2:00 PM	2:30 PM	2:55 PM	3:10 PM	3:30 PM	3:40 PM	4:40 PM	5:10 PM	6:45 PM	
2:00 PM	2:10 PM	2:45 PM	3:10 PM	3:25 PM	3:40 PM	3:50 PM	4:50 PM	5:20 PM	6:55 PM	NA
	3:00 PM	3:30 PM	3:55 PM	4:10 PM	4:30 PM	4:40 PM	5:40 PM	6:35 PM		
4:00 PM	4:10 PM	4:45 PM	5:10 PM	5:25 PM	5:40 PM	5:50 PM	6:50 PM	7:20 PM	8:25 PM	
5:15 PM	5:25 PM	5:55 PM	6:20 PM	6:35 PM	7:00 PM	7:10 PM	8:15 PM			

June 8-August 20, Eastbound

Depart Kantishna	Depart Wonder Lake	Depart Eielson Visitor Center	Depart Toklat	Depart Polychrome	Depart Igloo Campground	Depart Teklanika Rest Area	Depart Teklanika Campground	Depart Sanctuary Campground	Depart Savage Campground	Arrive WAC (approx.)
8:45 AM	NA	10:25 AM	11:20 AM	11:45 AM	12:25 PM	12:45 PM	12:50 PM	1:05 PM	1:25 PM	1:55 PM
	6:30 AM	7:55 AM	8:50 AM	9:15 AM	9:55 AM	10:15 AM	10:20 AM	10:35 AM	10:55 AM	11:25 AM
	11:40 AM	1:10 PM	2:00 PM	2:20 PM	3:00 PM	3:20 PM	3:25 PM	3:40 PM	4:00 PM	4:30 PM
		10:45 AM	11:35 AM	11:55 AM	12:35 PM	12:55 PM	1:00 PM	1:15 PM	1:35 PM	2:00 PM
	12:25 PM	1:55 PM	2:45 PM	3:05 PM	3:45 PM	4:05 PM	4:10 PM	4:25 PM	4:45 PM	5:15 PM
			10:05 AM	10:30 AM	11:15 AM	11:35 AM	11:40 AM	11:55 AM	12:15 PM	12:45 PM
		11:15 AM	12:05 PM	12:25 PM	1:05 PM	1:25 PM	1:30 PM	1:45 PM	2:05 PM	2:30 PM
	12:55 PM	2:25 PM	3:15 PM	3:35 PM	4:15 PM	4:35 PM	4:40 PM	4:55 PM	5:15 PM	5:45 PM
		11:45 AM	12:35 PM	12:55 PM	1:35 PM	1:55 PM	2:00 PM	2:15 PM	2:35 PM	3:00 PM
2:15 PM	NA	4:00 PM	4:55 PM	5:20 PM	6:00 PM	6:20 PM	6:25 PM	6:40 PM	7:00 PM	7:30 PM
	1:25 PM	2:55 PM	3:45 PM	4:05 PM	4:45 PM	5:05 PM	5:10 PM	5:25 PM	5:45 PM	6:15 PM
		12:15 PM	1:05 PM	1:25 PM	2:05 PM	2:25 PM	2:30 PM	2:45 PM	3:05 PM	3:30 PM
		12:45 PM	1:35 PM	1:55 PM	2:35 PM	2:55 PM	3:00 PM	3:15 PM	3:35 PM	4:00 PM
3:15 PM	NA	5:00 PM	5:50 PM	6:10 PM	6:50 PM	7:10 PM	7:15 PM	7:30 PM	7:50 PM	8:15 PM
		1:15 PM	2:05 PM	2:25 PM	3:05 PM	3:25 PM	3:30 PM	3:45 PM	4:05 PM	4:30 PM
		1:45 PM	2:35 PM	2:55 PM	3:35 PM	3:55 PM	4:00 PM	4:15 PM	4:35 PM	5:00 PM
	3:25 PM	4:55 PM	5:45 PM	6:05 PM	6:45 PM	7:05 PM	7:10 PM	7:25 PM	7:45 PM	8:15 PM
			1:05 PM	1:30 PM	2:15 PM	2:35 PM	2:40 PM	2:55 PM	3:15 PM	3:45 PM
		2:15 PM	3:05 PM	3:25 PM	4:05 PM	4:25 PM	4:30 PM	4:45 PM	5:05 PM	5:30 PM

June 8-August 20, Eastbound (continued)

Depart Kantishna	Depart Wonder Lake	Depart Eielson Visitor Center	Depart Toklat	Depart Polychrome	Depart Igloo Campground	Depart Teklanika Rest Area	Depart Teklanika Campground	Depart Sanctuary Campground	Depart Savage Campground	Arrive WAC (approx.)
		2:45 PM	3:35 PM	3:55 PM	4:35 PM	4:55 PM	5:00 PM	5:15 PM	5:35 PM	6:00 PM
	4:25 PM	5:55 PM	6:45 PM	7:05 PM	7:45 PM	8:05 PM	8:10 PM	8:25 PM	8:45 PM	9:15 PM
		3:15 PM	4:05 PM	4:25 PM	5:05 PM	5:25 PM	5:30 PM	5:45 PM	6:05 PM	6:30 PM
		3:45 PM	4:35 PM	4:55 PM	5:35 PM	5:55 PM	6:00 PM	6:15 PM	6:35 PM	7:00 PM
6:10 PM	NA	7:50 PM	8:40 PM	9:00 PM	9:40 PM	10:00 PM	10:05 PM	10:20 PM	10:45 PM	11:15 PM
	5:25 PM	6:55 PM	7:45 PM	8:05 PM	8:45 PM	9:05 PM	9:10 PM	9:25 PM	9:45 PM	10:15 PM
			3:05 PM	3:30 PM	4:15 PM	4:35 PM	4:40 PM	4:55 PM	5:15 PM	5:45 PM
		4:45 PM	5:35 PM	5:55 PM	6:35 PM	6:55 PM	7:00 PM	7:15 PM	7:35 PM	8:00 PM
		5:45 PM	6:35 PM	6:55 PM	7:35 PM	7:55 PM	8:00 PM	8:15 PM	8:35 PM	9:00 PM
		6:45 PM	7:35 PM	7:55 PM	8:35 PM	8:55 PM	9:00 PM	9:15 PM	9:35 PM	10:00 PM
8:15 PM	Bus/Driver spend night at WL and return eastbound next morning.									
			6:35 PM	7:00 PM	7:45 PM	8:05 PM	8:10 PM	8:25 PM	8:45 PM	9:15 PM
Bus/Driver spend night at WL, pick up at Kantishna and return eastbound next morning.										
				8:15 PM	8:55 PM	9:20 PM	9:25 PM	9:45 PM	10:05 PM	10:35 PM

Appendix C. General Vehicle Schedules: 2008 hourly average traffic past Savage Check Station by vehicle type and month

Key to acronyms in vehicle schedule table

TWT	Tundra Wilderness Tour
DNHT	Denali Natural History Tour
Kant Exp	Kantishna Experience
VTS	Visitor Transportation System
DBL	Denali Backcountry Lodge
CD/NF	Camp Denali/North Face Lodge
Poly	Polychrome
Wonder	Wonder Lake
Kant	Kantishna
NPS apprvd	Permits approved by NPS
GOV	Government
Pro Pho	Professional photographers
Tek	Teklanika
ROW	Right of way

May	Tour				VTS					Lodge			Bus Total	Non Bus							Nonbus Total	All Vehicle Total
	TWT		DNHT	Kant Exp						DBL	KRH	CD/NF		Permit Type								
	Destination																					
	Toklat	Stony	Mile 17	Kant	Poly	Toklat	Eielson	Wonder	Kant	Kantishna				NPS apprvd	GOV	Pro Pho	Tek	ROW	Employee	Other		
Hour																						
0													0						0.0	0.1	0	**0**
1													0								0	**0**
2													0								0	**0**
3													0								0	**0**
4													0								0	**0**
5	1.6	0.2	0.2										2		0.1			0.0	0.1		0	**2**
6	2.7	1.2	2.1										6	0.2				0.0		0.0	0	**6**
7	1.4	1.6	2.3			0.9				0.0	0.0	0.0	6	0.8	0.5		0.0	0.0			1	**8**
8	0.3		0.9			1.1				0.0	0.0	0.1	2	0.4	2.6			0.0	0.0	0.2	3	**6**
9			0.7			1.1				0.0	0.1	0.0	2	0.1	1.7		0.1	0.3	0.0	0.3	3	**5**
10			0.4			1.1				0.1	0.0	0.0	2	0.7	1.7		0.3	0.1	0.2	0.5	4	**5**
11			0.2			0.7				0.0	0.1	0.0	1	0.9	1.1		0.2	0.1	0.0	0.4	3	**4**
12			0.1			0.7				0.1	0.0	0.0	1	0.0	0.7		0.2	0.3	0.1	0.4	2	**3**
13	0.7	0.5	0.8			0.7				0.0	0.0	0.0	3	0.4	0.8		0.5	0.4	0.0	0.3	2	**5**
14	0.9	1.4	3.3			0.6				0.0	0.0	0.2	6	0.9	0.7		0.1	0.6	0.2	0.2	3	**9**
15			0.4										0	0.7	0.4		0.7	0.4	0.1	0.5	3	**3**
16			0.1							0.1	0.0	0.0	0	0.2	0.4		0.7	0.5	0.1	0.1	2	**2**
17			1.0										1	0.1	0.3	0.1	0.6	0.3	0.3	0.3	2	**3**
18			0.3							0.0	0.0	0.0	0		0.2		0.5	0.2	0.1	0.2	1	**2**
19													0	0.0	0.2		0.1	0.0	0.3	0.3	1	**1**
20													0				0.1	0.1	0.2	0.0	0	**0**
21													0	0.0	0.0				0.0	0.2	0	**0**
22													0					0.0		0.2	0	**0**
23													0						0.0		0	**0**
TOTAL	**8**	**5**	**13**	**0**	**0**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**33**	**6**	**11**	**0**	**4**	**4**	**2**	**4**	**31**	**64**

June	Tour				VTS					Lodge			Bus Total	Non Bus							Nonbus Total	All Vehicle Total
	TWT		DNHT	Kant Exp						DBL	KRH	CD/NF		Permit Type								
	Destination													NPS apprvd	GOV	Pro Pho	Tek	ROW	Employee	Other		
	Toklat	Stony	Mile 17	Kant	Poly	Toklat	Eielson	Wonder	Kant	Kantishna												
Hour																						
0													0		0.0	0.0		0.1	0.0	0.1	0	**0**
1													0			0.0			0.0	0.1	0	**0**
2													0							0.0	0	**0**
3													0			0.0				0.1	0	**0**
4													0			0.1				0.1	0	**0**
5	0.1	2.9	0.3					0.8					4	0.1	0.0	0.1		0.1	0.1	0.1	0	**4**
6	0.2	5.6	2.6			0.8	1.6	1.5		0.4	0.0	0.0	13	0.2	0.3	0.3		0.1	0.2	0.1	1	**14**
7	0.4	4.6	2.1				1.5	0.8	0.8	1.2	1.4	0.1	13	0.6	0.6	0.1	0.0	0.0	0.0	0.1	2	**14**
8	0.0	0.9	1.7	0.8			1.5	0.8	0.8	0.0	0.1	0.0	7	0.4	4.5	0.1	0.0	0.1	0.1	0.4	5	**12**
9			1.5			1.0	1.5	0.8		0.0	0.0	0.0	5	0.2	2.4	0.2	0.2	0.1	0.0	0.3	3	**8**
10			1.2				2.3	0.8		0.0	0.0	0.0	4	0.4	1.3	0.1	0.5	0.3	0.1	0.4	3	**7**
11			0.2			1.0	0.8	0.8	0.8				4	0.8	1.0	0.0	0.6	0.3	0.1	0.4	3	**7**
12			0.3				0.8	0.8		0.0	0.0	0.0	2	0.2	0.6	0.1	0.5	0.2	0.1	0.3	2	**4**
13	1.1	1.4	0.9				0.8			0.1	0.0	0.4	5	0.4	1.0	0.1	0.5	0.2	0.2	0.4	3	**7**
14	2.5	2.6	3.3				0.8		0.8	0.9	1.0	0.3	12	0.9	0.8	0.1	0.5	0.3	0.1	0.2	3	**15**
15	0.2	0.3	0.3			1.0							2	0.8	0.4	0.1	0.5	0.1	0.2	0.2	2	**4**
16													0	0.1	0.3	0.2	0.5	0.1	0.2	0.2	2	**2**
17			1.2		1.0								2	0.1	0.3	0.1	0.7	0.1	0.2	0.3	2	**4**
18													0	0.1	0.1	0.1	0.7	0.2	0.2	0.7	2	**2**
19													0	0.2	0.3	0.1	0.5	0.1	0.3	1.3	3	**3**
20													0	0.2	0.4	0.1	0.4	0.0	0.3	1.3	3	**3**
21													0	0.1	0.3	0.0	0.2	0.1	0.2	1.5	2	**2**
22													0	0.0	0.1	0.0	0.1	0.1	0.1	0.5	1	**1**
23													0	0.0	0.0	0.0	0.0		0.1	0.3	0	**0**
TOTAL	**5**	**18**	**15**	**1**	**1**	**4**	**12**	**7**	**3**	**3**	**3**	**1**	**71**	**6**	**15**	**2**	**6**	**3**	**3**	**9**	**43**	**114**

July	Tour				VTS					Lodge			Bus Total	Non Bus							Nonbus Total	All Vehicle Total
	TWT		DNHT	Kant Exp						DBL	KRH	CD/NF		Permit Type								
	Destination																					
	Toklat	Stony	Mile 17	Kant	Poly	Toklat	Eielson	Wonder	Kant	Kantishna				NPS apprvd	GOV	Pro Pho	Tek	ROW	Employee	Other		
Hour																						
0													0		0.0	0.0	0.0				0	**0**
1													0								0	**0**
2													0								0	**0**
3													0					0.0		0.0	0	**0**
4													0							0.0	0	**0**
5	0.1	3.4	0.7					1.0					5	0.0			0.0	0.0	0.0	0.0	0	**5**
6	0.1	5.8	2.6			1.0	2.0	2.0		0.4	0.0	0.0	14	0.3	0.2	0.1	0.0		0.2	0.0	1	**15**
7	0.4	4.7	2.5				2.0	1.0	1.0	1.6	2.0	0.0	15	0.5	0.9	0.1	0.1	0.1	0.0	0.2	2	**17**
8	0.1	0.8	1.7	1.0			2.0	1.0	1.0	0.0	0.1	0.0	8	0.3	4.8	0.0	0.1	0.1	0.0	0.4	6	**14**
9			1.4			1.0	2.0	1.0					5	0.4	1.7	0.0	0.3	0.1	0.0	0.2	3	**8**
10			0.8				3.0	1.0		0.0	0.0	0.0	5	0.3	1.2	0.1	1.5	0.2	0.1	0.2	4	**8**
11			0.2			1.0	1.0	1.0	1.0				4	1.0	1.0	0.1	1.2	0.3	0.1	0.2	4	**8**
12			0.3				1.0						1	0.4	0.7	0.0	1.1	0.3	0.0	0.3	3	**4**
13	0.5	1.8	1.0				1.0			0.0	0.0	0.5	5	0.4	0.9	0.0	0.8	0.2	0.1	0.2	3	**7**
14	1.7	3.4	3.4				1.0		1.0	1.0	1.0	0.3	13	0.8	0.7	0.1	1.2	0.3	0.1	0.2	3	**16**
15	0.2	0.4	0.6			1.0				0.0	0.0	0.0	2	0.7	0.5	0.1	0.9	0.2	0.2	0.2	3	**5**
16							1.0			0.0	0.0	0.0	1	0.2	0.3	0.0	1.5	0.2	0.1	0.2	3	**4**
17			1.3		1.0								2	0.2	0.2	0.1	1.3	0.2	0.2	0.4	3	**5**
18													0	0.1	0.2	0.1	1.3	0.2	0.2	0.7	3	**3**
19													0	0.2	0.2	0.0	0.8	0.1	0.3	1.6	3	**3**
20													0	0.1	0.2	0.0	0.6	0.2	0.5	2.6	4	**4**
21													0	0.1	0.1	0.0	0.3	0.1	0.1	3.9	5	**5**
22													0	0.1	0.0		0.4	0.0	0.1	0.9	2	**2**
23													0	0.0			0.0		0.1	0.1	0	**0**
TOTAL	**3**	**20**	**16**	**1**	**1**	**4**	**16**	**8**	**4**	**3**	**3**	**1**	**81**	**6**	**14**	**1**	**14**	**3**	**3**	**13**	**52**	**133**

August	Tour				VTS					Lodge			Bus Total	Non Bus							Nonbus Total	All Vehicle Total
	TWT		DNHT	Kant Exp						DBL	KRH	CD/NF		Permit Type								
	Destination													NPS apprvd	GOV	Pro Pho	Tek	ROW	Employee	Other		
	Toklat	Stony	Mile 17	Kant	Poly	Toklat	Eielson	Wonder	Kant	Kantishna												
Hour																						
0													0			0.0	0.0		0.0		0	0
1													0						0.0		0	0
2													0	0.0							0	0
3													0							0.0	0	0
4													0								0	0
5	0.0	2.4	0.6					0.6					4		0.0	0.0		0.0		0.0	0	4
6	0.2	5.7	1.3			0.6	1.7	1.6		0.3	0.0	0.0	11	0.3	0.1	0.1	0.0	0.0	0.2	0.0	1	12
7	0.2	4.8	1.5			0.4	2.0	1.3	1.0	1.4	1.6	0.0	14	0.5	0.8	0.1	0.0	0.1	0.0	0.5	2	16
8	0.0	1.1	0.8	1.0		0.1	1.9	1.3	1.0	0.0	0.1	0.0	7	0.4	4.8	0.2	0.0	0.1	0.1	0.2	6	13
9			0.7			1.0	1.9	1.0					5	0.4	2.2	0.1	0.3	0.1	0.1	0.3	4	8
10			0.4				2.5	1.0	0.4				4	0.3	1.1	0.1	1.1	0.2	0.0	0.3	3	7
11			0.3			0.6	1.3	1.0	0.6				4	1.0	0.9	0.2	0.9	0.3	0.1	0.2	4	7
12			0.1			0.4	0.6						1	0.1	0.5	0.1	0.9	0.5	0.1	0.4	3	4
13	0.5	1.9	0.8				1.0		0.4	0.0	0.1	0.4	5	0.4	0.9	0.1	1.0	0.3	0.1	0.2	3	8
14	1.4	3.4	1.9				1.0		0.6	1.0	0.9	0.4	11	0.7	0.6	0.1	0.6	0.4	0.2	0.2	3	14
15	0.2	0.5	0.5			0.6		0.4		0.0	0.0	0.0	2	0.5	0.4	0.1	1.0	0.3	0.2	0.4	3	5
16								0.6		0.0	0.0	0.0	1	0.2	0.3	0.1	1.2	0.2	0.2	0.4	3	3
17			0.9		0.6								2	0.1	0.3	0.1	1.3	0.3	0.3	0.3	3	4
18													0	0.1	0.2	0.1	1.5	0.2	0.2	0.9	3	3
19										0.0	0.0	0.0	0	0.2	0.2	0.1	1.0	0.2	0.4	2.4	4	4
20													0	0.1	0.1	0.1	0.8	0.1	0.4	3.0	5	5
21													0	0.1	0.1	0.0	0.4	0.1	0.2	3.3	4	4
22													0	0.0	0.0		0.3	0.0	0.1	0.3	1	1
23													0				0.0		0.0	0.0	0	0
TOTAL	2	20	10	1	1	4	14	9	4	3	3	1	71	5	14	2	12	4	3	13	53	124

Sept	Tour				VTS					Lodge			Bus Total	Non Bus							Nonbus Total	All Vehicle Total
	TWT		DNHT*	Kant Exp						DBL	KRH	CD/NF		Permit Type								
	Destination													NPS apprvd	GOV	Pro Pho	Tek	ROW	Employee	Other		
	Toklat	Stony	Mile 17	Kant	Poly	Toklat	Eielson	Wonder	Kant	Kantishna												
Hour																						
0													0								0	0
1													0								0	0
2													0								0	0
3													0								0	0
4													0							0.0	0	0
5	0.0	0.7	0.5										1		0.0				0.1		0	1
6	0.0	5.5	2.6				0.3	0.3		0.1	0.0	0.0	9	0.1	0.2	0.2		0.0	0.0	0.0	1	9
7	0.3	5.7	1.6			0.3	1.3	1.3	1.0	0.8	0.8	0.0	13	0.5	0.6	0.0			0.1	0.9	2	15
8	0.0	1.0	2.1	1.0			2.0	1.3	1.0	0.0	0.1	0.0	8	0.4	4.0	0.1	0.1	0.1	0.0	0.4	5	14
9			3.2			1.0	1.3	1.7					7	0.3	1.6	0.1	0.2	0.1		0.5	3	10
10			1.8				2.0	0.3	1.0				5	0.6	1.1	0.0	1.3	0.2	0.1	0.5	4	9
11			0.3				1.3	0.3					2	0.8	1.1	0.2	0.7	0.2	0.1	0.2	3	5
12						1.0	0.7						2	0.2	0.5	0.1	0.8	0.3	0.2	0.3	2	4
13	0.3	2.7	2.1				0.3		0.9	0.0	0.0	0.3	7	0.3	0.7	0.1	0.7	0.1	0.2	0.3	3	9
14	0.4	3.5	2.2				0.3			0.6	0.6	0.1	8	0.5	0.7	0.1	0.6	0.2	0.1	0.1	2	10
15			0.3					0.9					1	0.8	0.2	0.2	0.7	0.2	0.4	0.1	3	4
16													0	0.1	0.1	0.3	0.6	0.3	0.0	0.3	2	2
17			0.9										1	0.1	0.2	0.5	1.1	0.1	0.3	0.4	3	4
18													0		0.1	0.0	0.8	0.1	0.2	0.9	2	2
19													0	0.3	0.1	0.1	0.6	0.1	0.5	2.1	4	4
20													0		0.3	0.3	0.5		0.3	3.1	5	5
21													0	0.0		0.1	0.1	0.1	0.1	3.8	4	4
22													0	0.0		0.1		0.0		0.4	1	1
23													0			0.0					0	0
TOTAL	1	19	18	1	0	2	9	6	4	1	1	0	64	5	12	3	9	2	3	14	48	111

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.

NPS 184/115738, July 2012

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U.S. Department of the Interior

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