



Winter Road Plowing in Denali National Park and Preserve

Monitoring Activities 2014 -2015

Natural Resource Data Series NPS/DENA/NRDS—2015/790





ON THIS PAGE

Visitor gets out of their car to photograph caribou in drainage off the Park Road in March 2015. NPS photo by Ralph Anderson

ON THE COVER

Mountain Vista Rest Area parking lot at Mile 12.6 of the Park Road in March 2015. NPS photo by Jessica Toubman

Winter Road Plowing in Denali National Park and Preserve

Monitoring 2014-2015

Natural Resource Data Series NPS/DENA/NRDS—2015/790

Jessica Toubman, Bridget L. Borg, William C Clark, and Dave Schirokauer

National Park Service
Denali National Park and Preserve
PO Box 9
Denali National Park, AK 99755

May 2015

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

Please cite this publication as:

Toubman, J., B. Borg, W.C. Clark, and D. Schirokauer. 2015. Winter road plowing in Denali National Park and Preserve: Monitoring 2014-2015. Natural Resource Data Series NPS/DENA/NRDS—2015/790. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	v
Tables.....	vi
Acknowledgments.....	vii
Abstract.....	viii
Introduction.....	1
Methods.....	2
Weather	2
Park Visitation.....	3
Visitor Center Statistics.....	3
Total Vehicle Traffic Estimates.....	3
Mountain Vista Vehicle Counts	3
Commercial Use and Interest	4
Wildlife.....	4
Wildlife Sightings and General Observations	4
Fifteen-minute Wildlife Behavioral Observations	4
Soundscape.....	5
Visitor and Resource Protection.....	6
Budgets.....	6
Results.....	7
Weather	7
Park Visitation.....	7
Visitor Center Statistics.....	7
Total Vehicle Traffic Estimates.....	9
Mountain Vista Vehicle Counts	13

Contents (continued)

	Page
Commercial Interest	14
Wildlife.....	15
Wildlife Sightings and General Observations	15
Fifteen-minute Wildlife Behavioral Observations	18
Soundscape.....	18
Visitor and Resource Protection.....	20
Budgets.....	21
Discussion and Future Studies	23
Weather	23
Visitor Use Numbers and Traffic Counts	23
Wildlife Observations.....	24
Budgets.....	24
Soundscapes	24
VRP	24
Suggestions for future years	24
Literature Cited	27
Appendix 1. Natural Soundscape Report.....	28
Appendix 2. 2015 Roving Schedule for REP staff	36
Appendix 3. Wildlife Behavioral Observation Datasheets	37
Appendix 4. Description of Time and Exercise potentially lost under Winter Road Opening Conditions to Kennels dogs.....	39

Figures

	Page
Figure 1. Study area of Park Road from Park Headquarters to Mountain Vista Rest Area.....	2
Figure 2. Number of visitors entering the Murie Science and Learning Center (MSLC) in Denali National Park and Preserve, AK during winter months (November-February) by year.....	8
Figure 3. Number of visitors entering the Murie Science and Learning Center (MSLC) in Denali National Park and Preserve, AK between February 15 and March 15 each year.	8
Figure 4. Minimum traffic count by vehicle type on the Park Road past mile 3 during 2014 winter monitoring from a motion sensor camera.	10
Figure 5. Minimum traffic count by vehicle type on the Park Road past mile 3 during 2015 winter monitoring from a motion sensor camera.	11
Figure 6. Road use by hour past the mile 3.3 camera in 2014 and 2015 combined.....	12
Figure 7. Wildlife observations by species and group size during winter monitoring on the Denali Park Road in 2014.	15
Figure 8. Wildlife observations by species and group size during winter monitoring on the Denali Park Road in 2014.	16
Figure 9. Wildlife observations by species and group size during winter monitoring on the Denali Park Road in 2015.	17
Figure 10. Wildlife observations by species and group size during winter monitoring on the Denali Park Road in 2015 (the observation on March /13 is of 35 Ptarmigan).	17
Figure 11. - Map showing NMSIM model depicted the propagation of noise from a car travelling 35 miles per hour.	19
Figure 12. Map showing NMSIM model depicted the propagation of noise from a car travelling 35 miles per hour.	20
Figure A1. A photograph of the Hines Creek sound monitoring station, taken 12/05/2013.	29
Figure A2. A map showing the location of the Hines Creek soundscape station with respect to the park road. Coordinates of the site were N 63.71061°, W -149.07915° WGS84.....	29
Figure A3. Map showing NMSIM model depicted the propagation of noise from a car travelling 35 miles per hour. In this scenario the car travels to milepost 3.3 of the park road.	33

Figures (continued)

	Page
Figure A4. Map showing NMSIM model depicted the propagation of noise from a car travelling 35 miles per hour. In this scenario the car travels to milepost 12.5 of the park road.	34

Tables

	Page
Table 1. Traffic estimates for days of the week using the motion sensor camera at mile 3.	13
Table 2. Vehicles Present at Mountain Vista Rest Area	14
Table 3. Estimated budget costs for operations related to plowing the Park Road from February 1 to March 15.....	21
Table A1. Date Ranges for which valid Sound Pressure Level data were collected.	28
Table A2. Summaries of Noise Events By Source	30
Table A3. Summaries of Maximum Sound Pressure Level, Variation in Maximum Sound Pressure Level, and the number of observations used in the summary.	31
Table 4. NOISEMAP Simulation Model (NMSim) input parameters with a justification for their selection in this specific case and notes on potential limitations.	32

Acknowledgments

Assistance with the monitoring and data compilation came from many members of the DENA NPS staff and VIP's including: D. Abbe, R. Anderson, M. Armington, E. Beavers, D. Betchkal, W. Clark, J. Duckett, P. Homan, M. James, M. King, J. Korhut, W. Mahovlic, H. McKenny, S. McLane, B. Napier, P. Owen, B. Schroeder, P. Sousanes, and R. Tingue.

Abstract

To increase the range of recreation opportunities along the Denali Park Road during winter months, an Environmental Assessment was completed in February 2013 that evaluated opening the Park Road earlier in winter to allow visitors to travel into the park in private vehicles. The Finding of No Significant Impact, signed in June 2013, identified the alternative which allows road plowing from Headquarters (mile 3) to Mountain Vista Rest Area (mile 12.6) starting February 1 and continuing into the spring season when the road is normally cleared. The early winter plowing will occur for three to five years on a trial basis with park staff monitoring the impact on financial and natural resources, and visitor experience. This report summarizes the findings from the first two winters of plowing, 2014 and 2015, and makes suggestions for future years of monitoring.

Findings include:

- Visitors use the Park Road to access the park following early winter road opening, particularly on weekends. March is the most popular month of the winter to visit and by looking at the visitor center numbers, there is a pattern of increasing visitation in February and March that started in 2013, the year before plowing occurred.
- Each year, approximately 1000 vehicles used the Park Road during the one month of winter monitoring with 68-76% of the total traffic classified as private vehicles. There was little commercial use.
- In 2014, moose were the most commonly observed species and in 2015 caribou were by far the most commonly observed species. There were no observations of wildlife running or walking from vehicles down the Park Road.
- To date, there were few vehicles observed idling in the parking lot, even on cold days.
- Cost estimates for the first two years were higher than the proposed budget in the EA due in part because it did not consider costs to the Resources or Interpretation Divisions.

Introduction

In June, 2013, the NPS approved the Preferred Alternative in the Winter Road Plowing Environmental Assessment (EA) to open the Park Road to Mountain Vista Rest Area at mile 12.6 by mid-February each year for a three to five year trial period. The plan aims to maintain the opportunities for backcountry winter recreationalists while simultaneously allowing more visitors in vehicles access to an additional nine miles of the Park Road. Denali National Park and Preserve is a vast area that provides visitors of all abilities with opportunities for superlative, inspirational experiences in keeping with its legislative mandates. The EA allowed commercial vehicles to travel to Mountain Vista with a Commercial Use Authorization (CUA) provided by the NPS.

Prior to 2014, in accordance with the 2006 Backcountry Management Plan, once the bus transit season ends in mid-September, private vehicles were allowed on the Park Road as far as Teklanika Rest Stop (mile 30) when conditions allowed. The road beyond Park Headquarters (mile 3) was not maintained for vehicle traffic after late September and when enough snow accumulated, the road was closed at mile 3. During winter months, one lane of the park road was routinely packed to allow maintenance traffic to mile 7, but the road was not plowed beyond mile 3 until the operations for the Spring Road Opening (SRO) occurred in mid-March. After the snow was cleared and conditions permitted, the Park Road was opened to the public to Mountain Vista (mile 12.6) or Savage River (mile 15) around April 1, and eventually to Teklanika by mid-April.

During the trial period, as required by the EA, park staff is monitoring visitor use levels, wildlife sightings and behavior, and soundscapes and documenting costs associated with opening the Park Road. Park managers can then assess the costs and benefits of opening the Park Road in winter to Mountain Vista. Depending on the findings, the NPS may eliminate the plowing effort or continue it annually. If new information shows that an earlier opening may have positive results, the park could undertake additional compliance to evaluate an earlier date for plowing and opening the road.

The following mitigation measures were included in the EA to address concerns that wildlife may be negatively impacted by increased vehicle traffic:

- If wildlife begins to use the plowed road in winter as a primary travel route, a seasonal reduction in speed limit may be implemented.
- Resource staff will notify park management if a wildlife conflict develops. Park management and staff will work together to determine if a road closure may be needed to protect wildlife.
- During years with high snowfall, wildlife may be attracted to traveling on the plowed road. Park staff will monitor the number of incidents of animals unintentionally being chased on the road by motor vehicles and the data will be reviewed at the end of the study.

Starting in 2014, the Road Ecology Program (REP) began collecting wildlife observation data to support the implementation of these mitigation measures. This report summarizes the first two years of the winter plowing; monitoring will continue for the duration of the trial period.

Methods

The study area is along the Denali Park Road from the Headquarters gate (mile 3.3) to the Mountain Vista Rest Area (mile 12.6), which included the Mountain Vista Rest Area parking lot and the “musher’s parking lot” immediately west of the entrance to the rest area (Fig. 1).

The monitoring period extends from mid –February when the Park Road was opened to the public to Mountain Vista through the Sunday closest to March 15 (the estimated date when normal spring plowing operations would begin). For the purpose of this report, monitoring dates were:

2014: February 15 (Saturday) to March 16 (Sunday) – 30 days

2015: February 14 (Saturday) to March 15 (Sunday) – 30 days

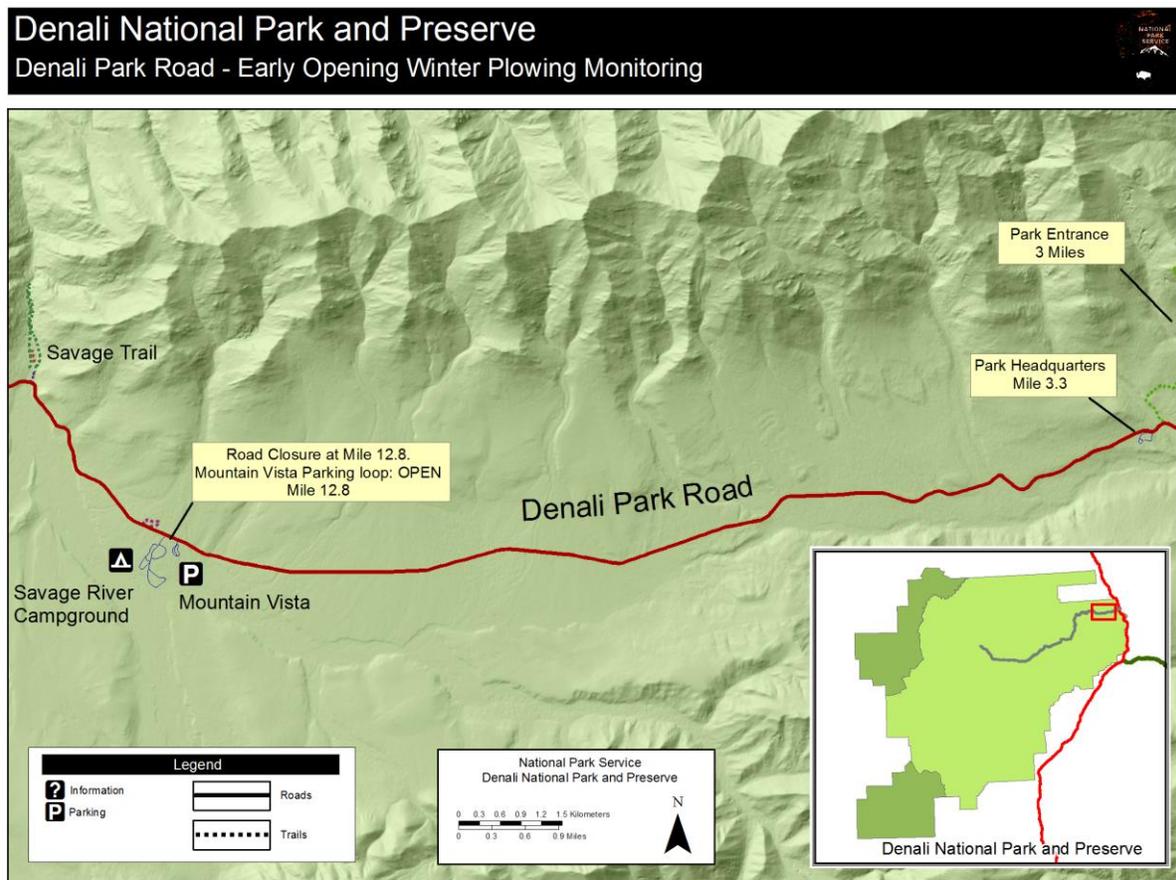


Figure 1. Study area of Park Road from Park Headquarters to Mountain Vista Rest Area.

Weather

Monthly and seasonal weather summaries were compiled for Denali National Park by the NPS Central Alaska Network Inventory and Monitoring Program

(<http://science.nature.nps.gov/im/UNITS/CAKN/vitalsign.cfm?vsid=36>, Pam Sousanes, personnel communication).

Park Visitation

Visitor Center Statistics

The Murie Science and Learning Center (MSLC), located at mile 1.4 of the Park Road, operates as Denali National Park's winter visitor center from mid-September to May 14. Since the MSLC opened in the fall of 2005, staff counted visitors entering the building and submitted their findings to the park as winter visitor use numbers. The protocols for counting have varied slightly though the years. In 2015, the count reflected the number of unique individuals entering each day, whereas in previous years, staff generally counted the number of people passing through the door, regardless if they had entered earlier. NPS and MSLC staffs were not counted if entering for work purposes. In addition to reporting visitor statistics, MSLC front desk staff provided observations on unanticipated visitor use.

Total Vehicle Traffic Estimates

REP staff used motion sensor cameras deployed near mile 3.3 to collect data on vehicle traffic. Reconyx Hyperfire brand cameras (Reconyx, Holmen, WI) were set during the monitoring period each year and programmed to take 3 rapid-fire photos for each motion trigger. In 2014 and 2015 a west-facing camera on a spruce tree past the gate at mile 3 was set to capture vehicles traveling in east and westbound lanes.

REP staff downloaded data from the camera weekly and reviewed and classified triggers of the photos as one of the following: heavy equipment, government vehicles, commercial vehicles, private vehicles, unidentified, or pedestrian/non-motorized. Vehicles that were captured in more than one photo were only counted once. Some fast-moving traffic moved out of range before a photo was captured. If evidence of a car passing was captured (blowing snow, glare from rear lights), it was documented as indeterminate vehicle. Darkness and heavy snow events made it difficult to identify vehicles by type.

In 2014, to estimate total round-trip traffic past mile 3.3, the number of vehicles captured by the camera was divided by two. In 2015, the estimate was made by counting "westbound" traffic. In both years, pedestrians were removed from the total vehicle count and it was assumed all traffic went through the gate twice.

The efficiency of the motion sensor camera at capturing traffic was evaluated during two observation periods in 2015 in varying weather conditions. For these ground-truthing tests, observers sat near the camera and recorded all vehicle passes by vehicle type and travel direction and compared their observations with the vehicles captured by the camera during the same time.

Mountain Vista Vehicle Counts

In 2014 and 2015, REP staff recorded the numbers of parked vehicles at the Mountain Vista Rest Area during all scheduled wildlife roves. The number of vehicles at the Rest Area parking lot were recorded when the staff first arrived (time= 0) and after 15 and 30 minutes to give a snapshot of vehicle use. Observers recorded the number of parked vehicles by vehicle type (commercial, government, private vehicles, and heavy equipment) along with the current weather conditions (precipitation and visibility). The total count included vehicles in the "musher's parking lot" west of

Mountain Vista and did not include the government monitoring vehicle. In 2015, at each time interval, the outside temperature (using the car's thermometer) and the number of idling vehicles were also recorded.

The number of roves to Mountain Vista was reduced from three times a day in 2014 to twice a day in 2015 after consulting with previous REP staff. A roving schedule for wildlife observations and Mountain Vista was created to sample each weekday (Monday - Friday) at least twice and each weekend day at least three times during the monitoring period. Roves occurred during daylight hours when visitors were more likely to visit (9 am – 6 pm, see sampling schedule, Appendix 2).

Commercial Use and Interest

Denali National Park Concessions Management Specialist (Martha Armington) provided the number of Commercial Use Authorizations (CUA) issued to companies to provide Road Based Winter Vehicle Tours in 2014 and 2015. The Program Director of Alaska Geographic at the MSLC provided information about their guided winter trips in 2015.

Wildlife

Wildlife Sightings and General Observations

Visitor Resource Protection (VRP) Rangers and REP staff (observers) used Trimble Juno GPS units (Trimble, Sunnyvale, CA) to record data on wildlife sightings including species, number, location, other vehicles present and general behaviors while patrolling the Park Road between mile 3 and Mountain Vista. VRP Rangers collected wildlife sighting data during patrols and REP staff traveled to Mountain Vista 2-3 times on every scheduled sampling day.

Observers recorded all wildlife seen from the Park Road and behavior of moose (*Alces alces*), caribou (*Rangifer tarandus*), wolf (*Canis lupus*), Dall sheep (*Ovis dalli*), grizzly bear (*Ursus arctos*) and other notable wildlife species (e.g., lynx; *Lynx canadensis*) with the Juno using modified protocols from the summer Ride, Observe, and Record (ROAR) program. Observers logged wildlife sightings and recorded the species, number of individuals, sexes of individuals if identifiable, distance from the road, direction from the road, and the number and type of other vehicles present at the wildlife stop. The observer's government vehicle was included in the count of vehicles present at the wildlife stop. Wildlife behavior during the stop, including any behavioral changes that occurred while traffic was present was noted in comments. Each species seen was recorded as separate feature (i.e. if a moose and a caribou were seen in the same area, it would be recorded as two wildlife sightings).

More than one observer could record data on a given day and data were collected during west and east bound trips, therefore the sightings did not represent a unique count of individuals seen, but a count of the number of wildlife sightings recorded by the observers.

Fifteen-minute Wildlife Behavioral Observations

In addition to the wildlife sighting data, REP staff conducted fifteen minute behavior observations of the following wildlife species when they were seen within 500 meters of the Park Road: moose, caribou, wolf, and other notable wildlife (e.g., porcupine). Behavioral observations were recorded

using protocols modified from a previous NPS study of wildlife sightings and behavior (Fortier et al. 1995).

When a target species was observed, the animal's behavior when first seen was noted along with any changes associated with the monitoring vehicle's approach. Observers parked the vehicle in a position to maximize visibility of the animal, while attempting to minimize adverse effects on the animal and maintaining safety. After the vehicle was stopped, observers recorded wildlife sighting data on the Juno. Observers then began a fifteen minute behavioral observation period using the Wildlife Behavioral Obs Datasheet (See Appendix 3 for 2014 and 2015 datasheets).

Observers chose a focal individual and documented all behaviors, stimulus (i.e. vehicle passes, bikers, etc.) and distance to stimulus. When possible, observers selected the individual closest to the road. A range finder was used to estimate distances. When animals were moving too quickly or if poor visibility made it impossible to identify one, observers documented general behaviors of the group. In 2014 observers recorded every change in behavior of a focal individual and the distance and angle of stimulus (vehicles) at each recorded behavior change. In 2015, the protocols were updated to document general behaviors and record only major shifts in behavior (i.e. from feeding/traveling to walking or running). In all observations there was a "stimulus" present due to the observer's vehicle. Initial reactions to the observer vehicle were recorded as a response to stimulus, subsequent behavioral responses were recorded when new stimulus first arrived (vehicle approaching) or if there was a change in the stimulus (visitor exiting vehicle, etc.).

Observers concluded the wildlife behavior observations after fifteen minutes unless the animal moved out of view earlier or an unusual interaction occurred such as the individual or group responded to a stimulus. At the end of the observation period, observers recorded their location (by the milepost on the Park Road to the 1/10 of a mile) and current weather conditions along with a brief narrative of the complete wildlife encounter.

The 2015 data for behavior of all species crossing the road was summarized by looking at the narratives of the encounters. The common behaviors of caribou and moose for 2015 were summarized by looking at only the times behavioral changes were noted, not the length of the behaviors.

Soundscape

The soundscape near mile 7.5 was monitored in 2012, 2013 and 2014 by the Natural Sounds and Night Skies staff (Betchkal, 2013; D. Betchkal, unpublished, Appendix 1). The study began on 12/05/2013 in an effort to collect data describing soundscape condition before the road was opened on 02/15/2014. A sound station was set up at Hines Creek and sound data were successfully collected and analyzed for the periods from 12/05/13 through 12/17/13 and 01/18/14 through 02/02/14 before the road was opened. The station remained in the field throughout the period affected by the management action, collecting data from 02/20/14 through 02/27/14.

In addition to empirical observations at Hines Creek, a spatial analysis of the area of the park affected by opening the road was also conducted. To perform such an analysis, NOISEMAP

Simulation Model, or NMSim (Wyle Labs) was used to create a mathematical model of noise propagation that accounts for attenuation effects of terrain, ground cover, weather, and atmospheric composition. NMSim is the NPS-preferred predictive noise modelling software, the same model has been used for predictive purposes in high-integrity scientific studies of noise at both Yellowstone National Park and Grand Canyon National Park.

Visitor and Resource Protection

Statistics were provided by Visitor and Resource Protection (VRP) Rangers in 2014 and the Alaska Region Communication Center (ARCC) in 2015.

Budgets

Each division estimated costs related to early season Park Road opening and document potential impacts to normal operations due to the plowing. This included salaries of paid employees, costs of housing for winter volunteers, equipment purchased, and in the case of the park kennels – operational programs that were not possible due to early winter road opening.

Results

Weather

In February 2014, temperatures were cold with a monthly average temperature of 0.7 °F, almost 7 degrees colder than the average of the latest climate period of 1981-2010. A total of 5.9 inches of snow fell during February, which brought the total snowfall to 50.6 inches for the 2013-2014 season, 10.1 inches less than the average. The average temperature for March was 1.8° F warmer than normal and 2.5 inches of snow fell for the month, compared to the latest climate average of 6.8 inches.

February 2015 started out colder than average and then temperatures climbed to near record highs during the third week. There was very little snow accumulation during the month. Only 0.9 inches was recorded, which is 11% of what normally falls during February. March continued the trend of a warm spring with temperatures 2.9 F above normal and the snowfall was 4.3 inches total, about 54% of the normal amount for the month according to data collected between 1981 and 2010. The Park Road was closed once during the monitoring period due to accumulating snow in 2015, from 5 PM on February 28 to 10 AM on March 1.

Park Visitation

Visitor Center Statistics

Statistics from MSLC staff show increasing visitation in the months of February and March over the last 4 years, with particularly large jumps every March between 2012- 2015 (Fig 2). Only looking at March, there was a 71% increase in visitation between 2012 and 2013 (before road plowing occurred) and an increase of 42 % from 2014 to 2015. Monthly visitation during the other winter months (November - January) remained low compared to February and March.

The MSLC visitor counts during the hypothetical monitoring period from February 15 to March 15 showed an increase in visitor numbers, with the greatest increase occurring between 2012 and 2013 at 76% (Fig 3).

Number of visitors entering the Murie Science and Learning Center (MSLC) in Denali National Park and Preserve, AK during winter months (November-February) by year.

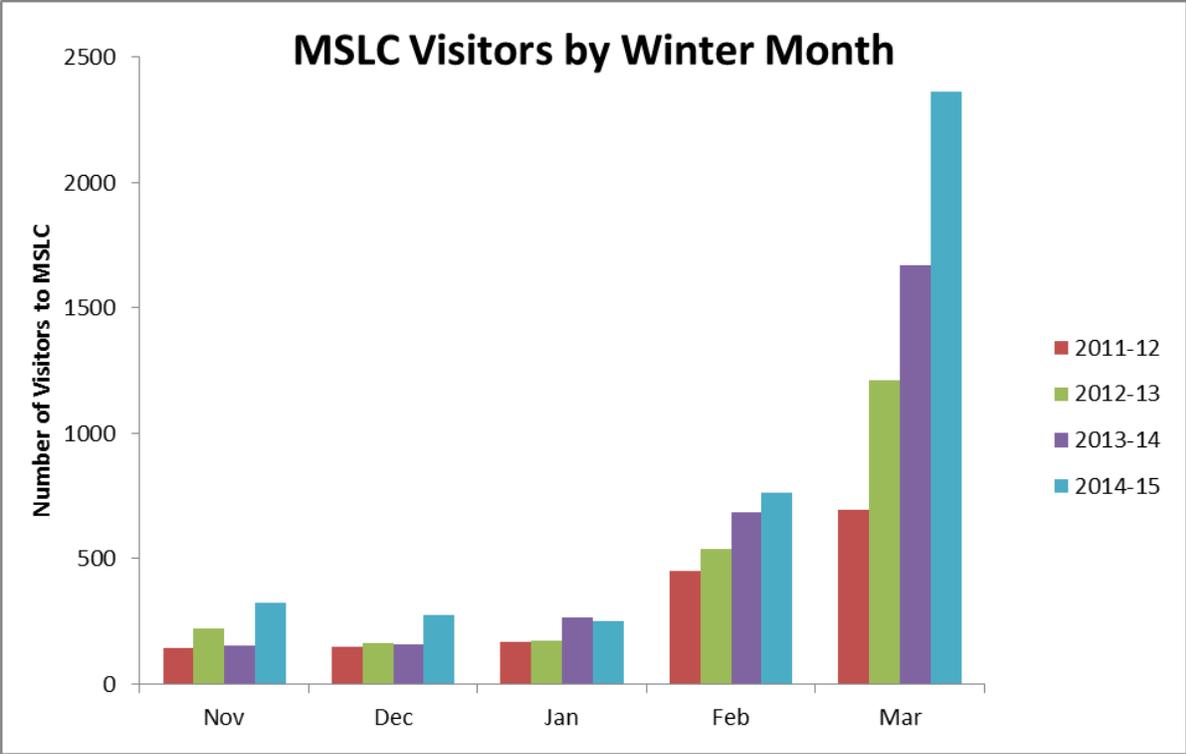


Figure 2. Number of visitors entering the Murie Science and Learning Center (MSLC) in Denali National Park and Preserve, AK during winter months (November-February) by year.

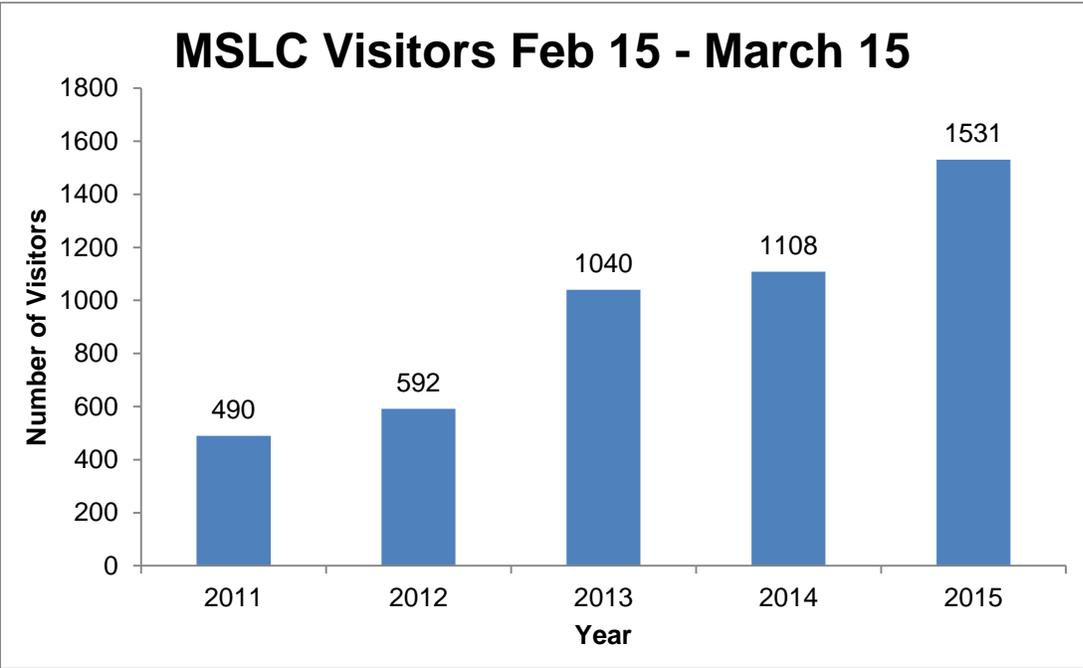


Figure 3. Number of visitors entering the Murie Science and Learning Center (MSLC) in Denali National Park and Preserve, AK between February 15 and March 15 each year.

MSLC staff provided additional information on winter visitor center visitation in 2015. The Iditarod sled dog race re-started in Fairbanks this year, bringing the popular event to this area for the first time since 2003. On March 8, the day between the ceremonial start in Anchorage and the re-start in Fairbanks, 192 visitors came to the MSLC, more than were at Denali's Winterfest on Saturday, February 28. Taiwanese tour groups arrived every Sunday in March with ten to fifty people. However, their van was only seen driving the Park Road once during the monitoring period. A group of Chinese college students coming to Alaska on spring break from US universities was also observed. They came in groups of about 6 people and were also observed at the Morris Thompson Visitor Center in Fairbanks.

Total Vehicle Traffic Estimates

Ground-truthing of the Reconyx motion sensor camera was conducted twice in 2015, where an observer documented all vehicles passing the camera and compared the results with the captured photos. On February 28, during one hour of observation with heavy snowfall, 50% of westbound traffic was captured (3 out of 6) and 15% (2 out of 13) of eastbound traffic was captured by the Reconyx cameras. On March 14, 30 minutes of observation on a clear day resulted in 100% capture of both the east and westbound traffic (20 out of 20). From March 1 to March 15, REP staff drove the speed limit by the camera four times a day on wildlife observation days (20 round trips) and found the camera captured the vehicle on 80% of westbound trips and 60% of eastbound trips.

The motion sensor camera caught 1003 vehicles going past mile 3 in 2014 and 960 vehicles in 2015. Private vehicles were the largest volume of the traffic by far, representing 687 trips, or 68 % of the total traffic in 2014 and 731 trips or 76 % of the total in 2015. Peaks in traffic occurred predictably during weekends and holidays (Fig.4, Fig. 5).

Commercial vehicles were uncommon to identify on the traffic camera. One bus was documented in 2014, and in 2015 there were 2 commercial passenger vans and 2 trucks used by the dog sled concessionaire observed.

Government vehicle traffic remained consistent at 22% for both years with 225 trips in 2014 and 214 trips in 2015; this includes the heavy equipment needed to maintain the road such as graders, dump trucks, plows and the steamer truck. Pedestrians made up 6% of the overall camera data in 2014 with 61 trips and in 2015, pedestrians were 7% of the trips with 71 people captured on the camera. Monitoring in 2015 found the vast majority of the pedestrians were NPS staff and residents. No bikes were observed traveling past mile 3 either year. Moose set off the camera twice at night in 2014.

The highest level of traffic for both years occurred between 12 PM– 3PM (Fig 6) and the majority of trips occurred on weekends. (Fig.4, Fig. 5, Table 1).

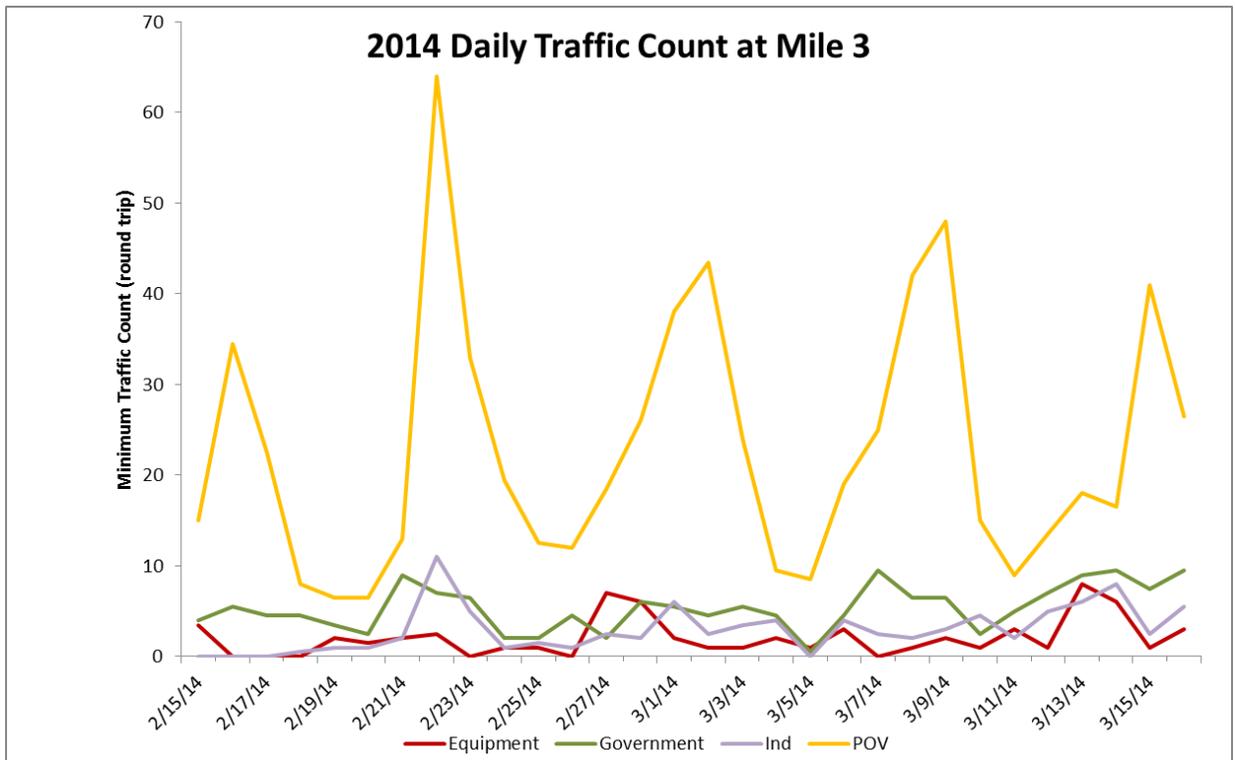


Figure 4. Minimum traffic count by vehicle type on the Park Road past mile 3 during 2014 winter monitoring from a motion sensor camera. Vehicles were classified as government, heavy equipment (Equipment) private vehicles (POV), or undetermined or indeterminate vehicles (Ind).

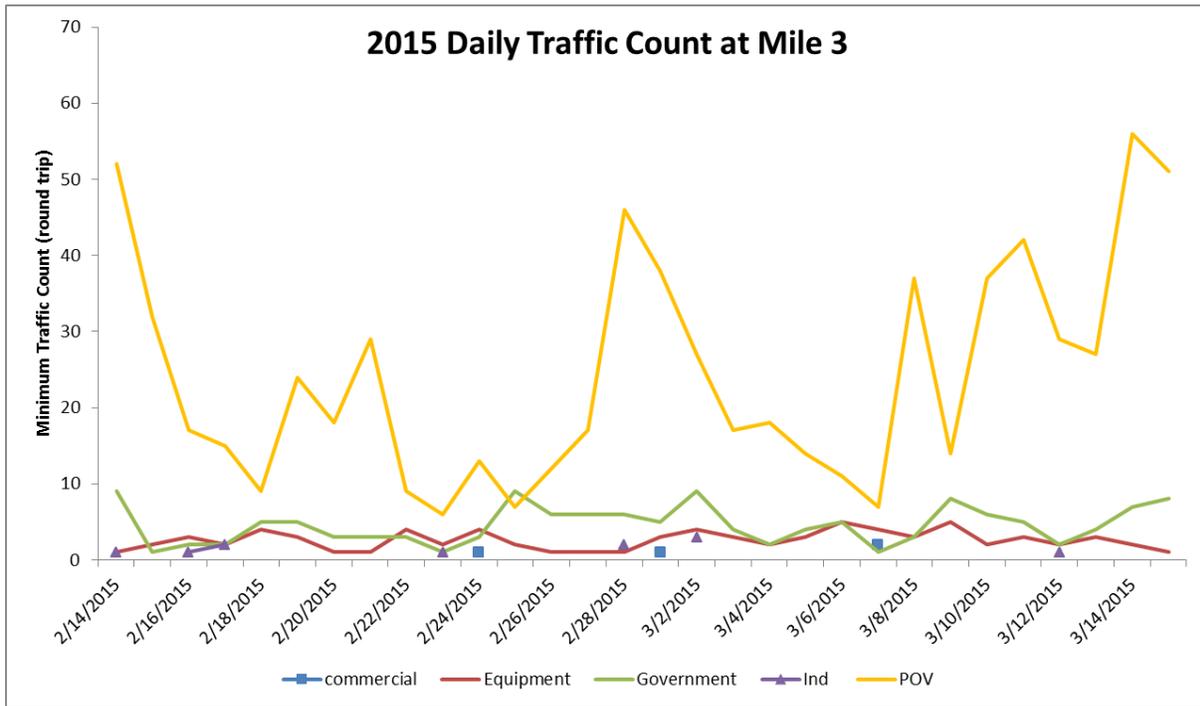


Figure 5. Minimum traffic count by vehicle type on the Park Road past mile 3 during 2015 winter monitoring from a motion sensor camera. Vehicles were classified as commercial, heavy equipment (Equipment), government, indeterminate vehicles (ind) or private vehicles (POV).

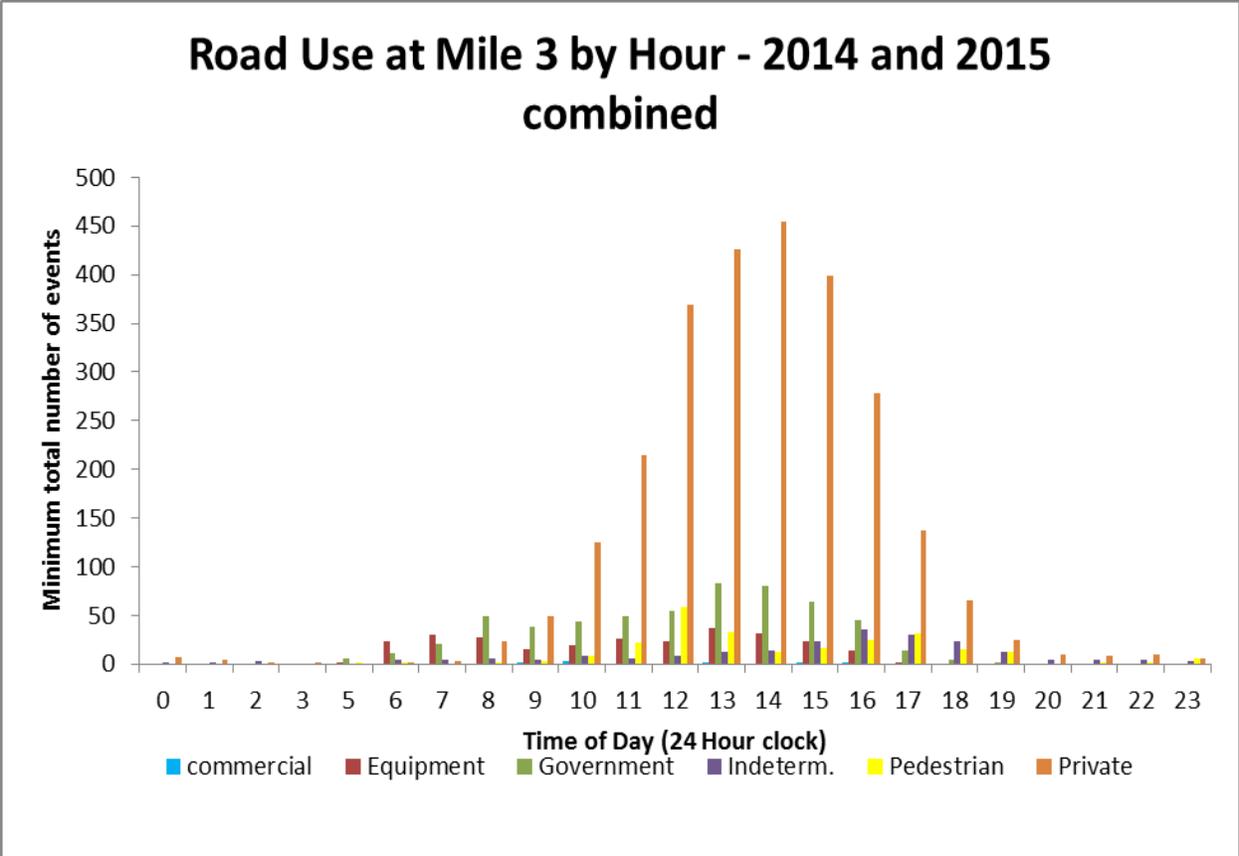


Figure 6. Road use by hour past the mile 3.3 camera in 2014 and 2015 combined. Note: these are not round trips.

Table 1. Traffic estimates for days of the week using the motion sensor camera at mile 3. 2014 traffic estimate was created by dividing total number of observed trips by 2. The one commercial bus recorded was included under non-government on a Sunday. 2015 traffic estimate was created by counting only the westbound traffic to account for round trips.

2014	Equipment	Government	Indeterminate	Non-government	Total
Monday	3	14.5	9	81	107.5
Tuesday	6	16	8	39	69
Wednesday	4	15.5	7	40.5	67
Thursday	19.5	18	13.5	62	113
Friday	14	34	14.5	80.5	143
Saturday	10	30	22	200	262
Sunday	6	32.5	16	185.5	240

2015	Commercial	Equipment	Government	Indeterminate	Personal	Total
Monday		14	20	5	64	103
Tuesday	1	11	15	2	82	111
Wednesday		11	21		76	108
Thursday		9	17	1	79	106
Friday		10	18		73	101
Saturday	2	9	26	3	190	230
Sunday	1	13	20		167	201

Mountain Vista Vehicle Counts

In 2014, observers recorded 165 observations at the Mountain Vista parking during the monitoring period. The average number of vehicles was 3 (SD 3.35) and the majority of use occurred between 1:00 pm and 3:00 pm. The maximum of 22 vehicles was observed during Winterfest on Saturday, February 22, 2014 (Table 2). In 2014, the mean and standard deviation of visitor use was higher on Mondays compared to other weekdays and was likely a reflection of the President’s Day holiday on February 17. Mid-week had the lowest average use, while weekends and holidays had the highest and most variable amount of use. There were no observations on Tuesdays.

In 2015, REP staff recorded 115 observations at Mountain Vista parking lot during the monitoring period. The average number of vehicles was 3.70 (SD: 3.25) and the maximum number observed was 16 on the Saturday of Winterfest, February 28. Wednesdays and Thursdays showed the lowest mean. Fourteen vehicles were counted idling during the entire monitoring period and the maximum number of vehicles observed idling in the parking lot at the same time was one. Counts for the week of March 7 – 14 were affected by 4 private overnight vehicles associated with the dog sled concessionaire.

Both years, the majority of non-government vehicles appeared to be private vehicles; the commercial traffic included one bus (in 2014), one van for a school group guided by Alaska Geographic (2015),

and two trucks seen unloading sled dogs for a trip for Earthsong Lodge clients (2015). No heavy equipment was observed parked either year at Mountain Vista during the monitoring times.

Table 2. Vehicles Present at Mountain Vista Rest Area

2014	Personal vehicles		Government		Total Vehicles		
	Mean (SD)	Max	Mean (SD)	Max	Mean (SD)	Max	<i>n</i> *
Sunday	3.91 (3.02)	12	0.27 (0.52)	2	4.21 (3.11)	13	33
Monday	2.73 (2.52)	7	0.20 (0.41)	1	2.93 (2.58)	7	15
Wednesday	1.25 (1.54)	4		0	1.25 (1.54)	4	12
Thursday	1.57 (1.25)	4		0	1.57 (1.25)	4	30
Friday	1.80 (1.24)	4	0.17 (0.38)	1	1.97 (1.45)	5	30
Saturday	3.64 (5.04)	22	0.02 (0.15)	1	3.67 (5.03)	22	45

In 2014, the mean (with standard deviation) and maximum number of vehicles observed at the Mountain Vista Rest Area during observations conducted between February 15 and March 15, 2014. No data was collected on Tuesdays in 2014.

2015	Personal vehicles		Government		Total Vehicles (includes 3 commercial)		
	Mean (SD)	Max	Mean (SD)	Max	Mean (SD)	Max	<i>n</i>
Sunday	3.82 (2.46)	8	0.29 (0.47)	1	4.12 (2.52)	9	17
Monday	3.92 (1.88)	7	0.42 (0.51)	1	4.33 (1.72)	7	12
Tuesday	4.00 (4.47)	11		0	4.25 (4.28)	11	12
Wednesday	0.58 (0.51)	1		0	0.58 (0.51)	1	12
Thursday	0.94 (1.66)	5	0.44 (0.51)	1	1.39 (1.58)	5	18
Friday	1.89 (2.25)	6	0.72 (0.57)	2	2.26 (1.79)	6	18
Saturday	5.77 (3.01)	13	0.77 (1.21)	3	6.69 (3.44)	16	26

In 2015, the mean (with standard deviation) and maximum number of vehicles observed at the Mountain Vista Rest Area during observations conducted between February 14 and March 15, 2015.

**n* indicates sample size of the number of observations.

Commercial Interest

In 2014, three companies acquired Commercial Use Authorizations (CUA) to provide Road Based Winter Vehicle Tours in Denali: Alaska Alpine Adventures, AIE Tours, and Traverse Alaska. However, none of these companies provided winter tours on the Park Road in February or March based on their activity report to the NPS Concessions office.

In 2015 (as of April 17), two companies held permits for Road Based Winter Vehicle Tours in Denali: Alaska Alpine Adventures and Traverse Alaska plus the non-profit organization Alaska Geographic offered winter guided day trips. Alaska Geographic led three groups this winter at Mountain Vista during the monitoring period: two groups associated with Earthsong Lodge in Healy and a school group from Anchorage.

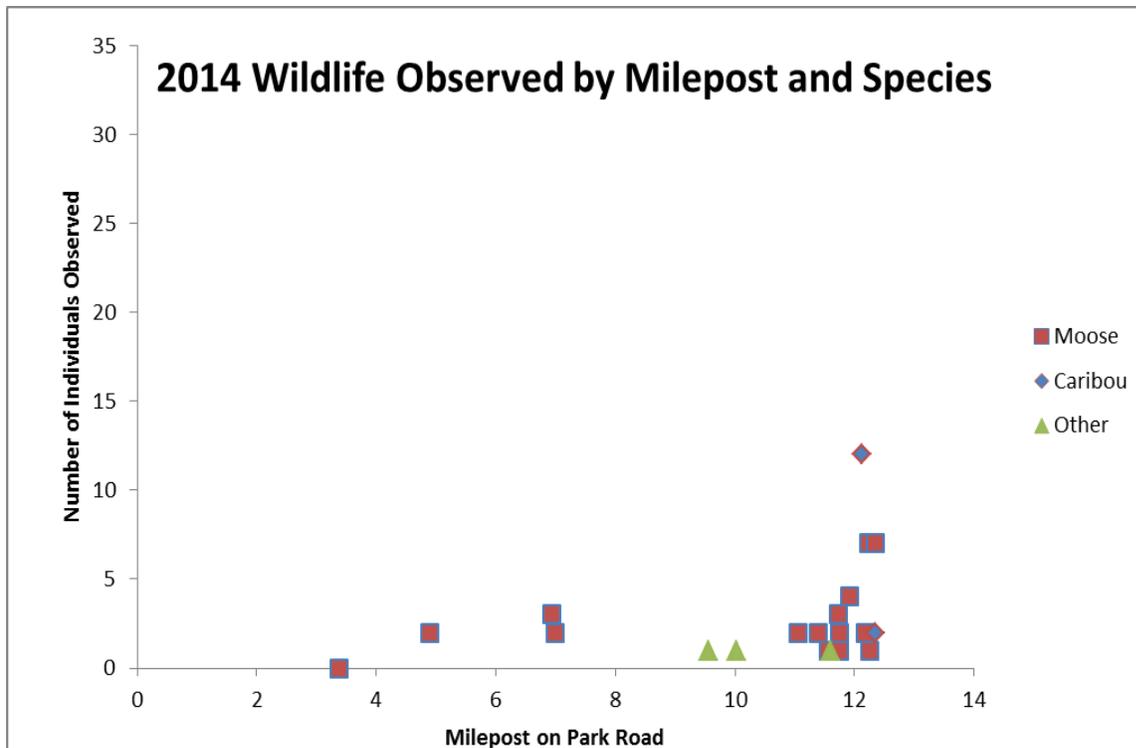


Figure 8. Wildlife observations by species and group size during winter monitoring on the Denali Park Road in 2014.

In 2015, observers collected data on forty-two trips during the monitoring period. This included fourteen trips with no wildlife sightings and twenty-eight trips with a total of sixty-one sightings of targeted wildlife species. The majority of sightings were of caribou at 69% of all recorded sightings (42 sightings, group size: 1 to 22). The next most frequent species was moose (17 sightings, group size: 1 to 3), followed by one sighting of 2 wolves and one sighting of 35 ptarmigan. Most sightings (70%) were between mile 11 and 13 (Fig. 9, Fig.10).

At nine of the sixty-one sightings there were private vehicles present at the wildlife stop. There were three stops with two vehicles and one stop with three vehicles (all private vehicles).

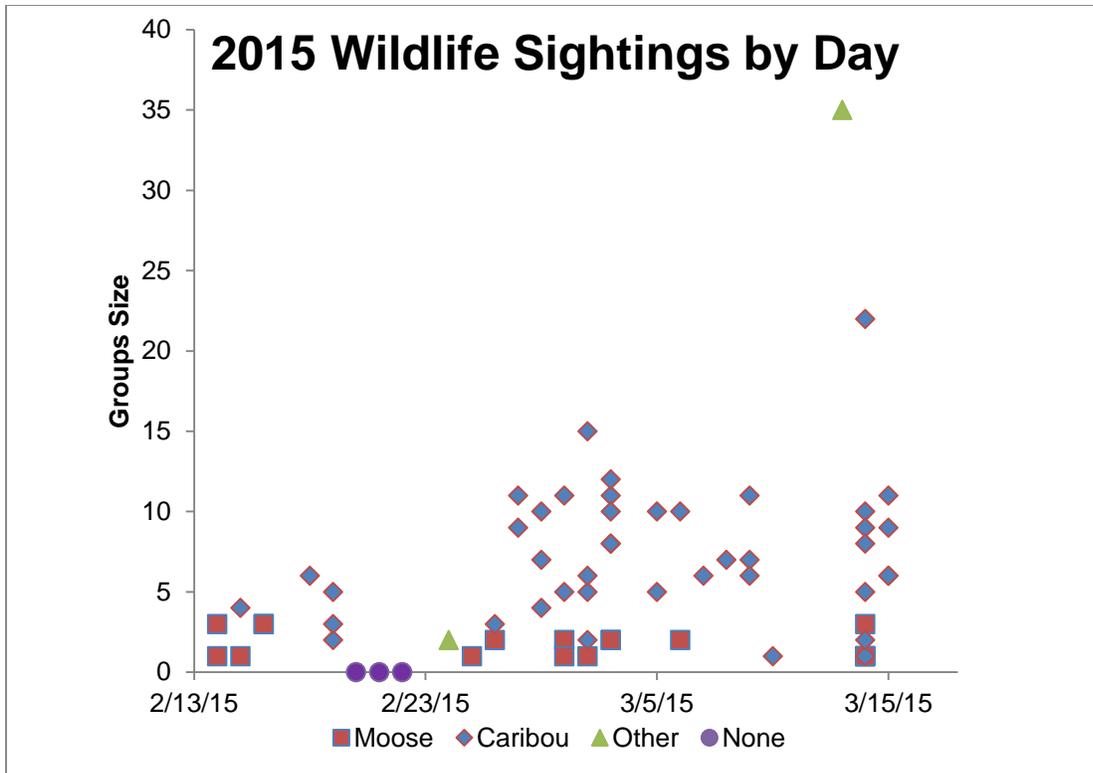


Figure 9. Wildlife observations by species and group size during winter monitoring on the Denali Park Road in 2015.

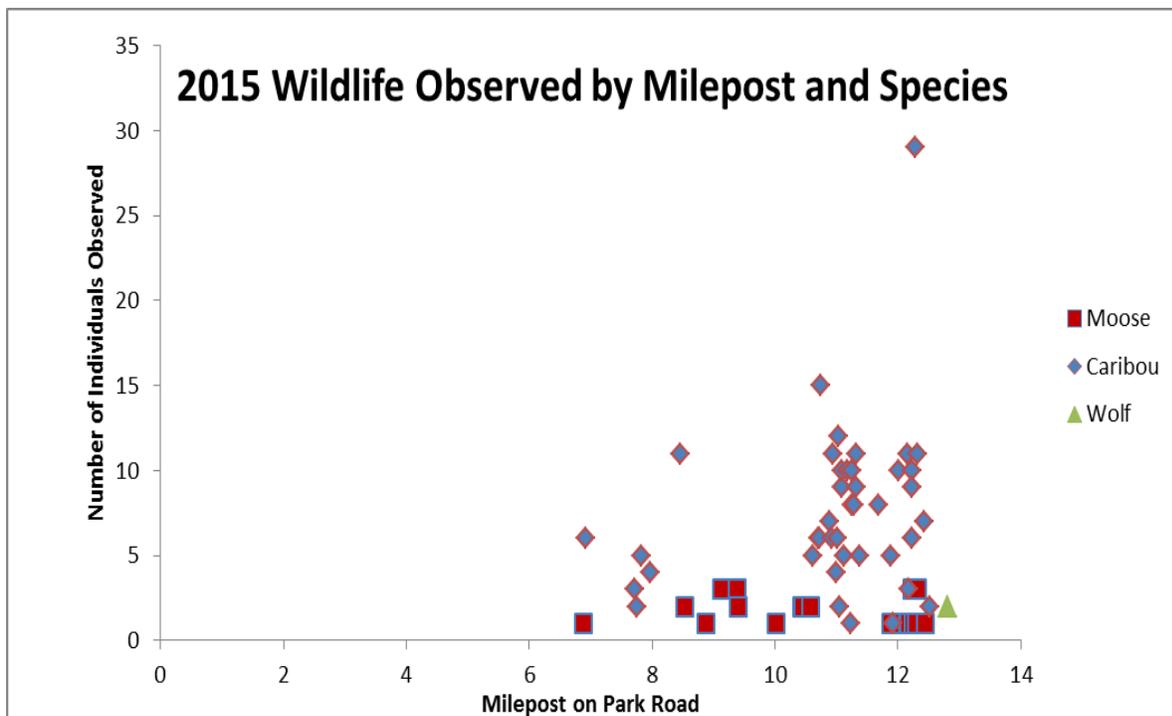


Figure 10. Wildlife observations by species and group size during winter monitoring on the Denali Park Road in 2015 (the observation on March /13 is of 35 Ptarmigan).

Fifteen-minute Wildlife Behavioral Observations

In 2014, observers conducted fifteen wildlife behavior observations, twelve for moose, two for caribou, and one porcupine. In those observations, there were three apparent responses by moose to vehicles on the road (trotting or running away from the stimulus), but none of the animals observed responded by running on the road away from stimulus.

In 2015, observers conducted twenty-seven wildlife behavioral observations of wildlife on the Park Road, made up of twenty-three caribou, three moose and one wolf. There were no documented cases of animals running down the Park Road away from stimulus (i.e. vehicle traffic). There were eight observations of wildlife crossing the Park Road during these observations, and during those crossings the snow cover or berms did not appear to be a barrier. There were three cases of caribou changing direction (off the road) while they were attempting to cross the road with private vehicles present, and three cases of the caribou not changing direction while in the process of crossing the road. In the case of the one moose crossing the road, it did not change direction after the arrival of the observer's vehicle. Due to poor visibility immediately before and after crossing the road, the behavior of the one wolf cannot be summarized.

Using 2015 data, the most common behaviors for caribou were walking or walking away (21% of total behaviors documented) followed by feeding (20%) and standing (19%). The most common behavior documented in moose was walking (4 out of the 6 behaviors noted) followed by standing (1 observation) and feeding (1 observation).

On March 14 at 9:38 AM, the observed caribou spent the observation period (from 9:55 to 10:12 AM) feeding on the immediate shoulder of the Park Road where the equipment had scraped off the snow or walking along the road. When the observer's vehicle approached the caribou slowly after the observation period, the caribou trotted away north when the vehicle was forty meters away.

Soundscape

Study of noise before and after the Park Road was plowed show marked differences in the soundscape of the Hines Creek (mile 7.5) area from 2013 to 2014. The number of vehicles detected increased by about 25 events, from about 20 to 45 vehicles per day. This represents more than twice the number of events from previous 24-hour averages from before the road opened in winter (D. Betchkal, unpublished).

The maps below (Fig. 11 and 12) show the simulated propagation of noise from a car traveling 35mph to mile 3 and traveling to Mountain Vista using the NMSIM model.

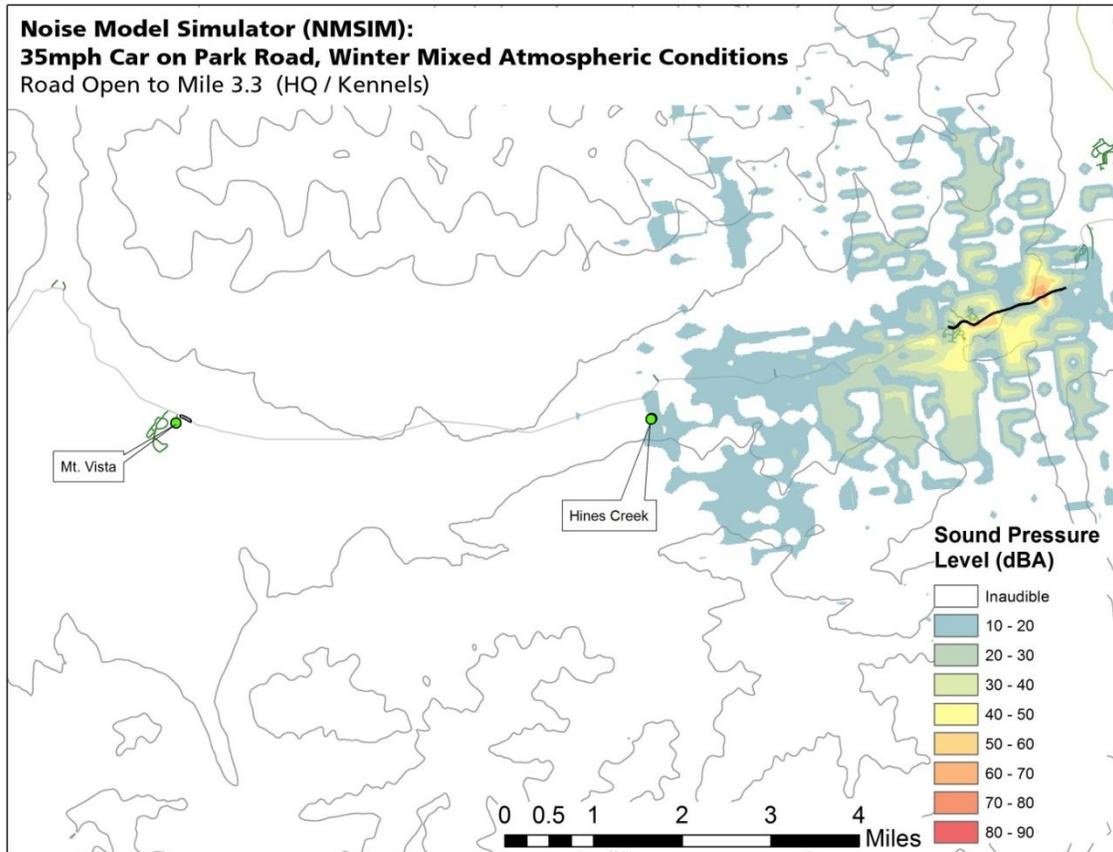


Figure 11. - Map showing NMSIM model depicted the propagation of noise from a car travelling 35 miles per hour. In this scenario the car travels from the park entrance (mile 0) to Headquarters (mile 3.3) of the Park Road.

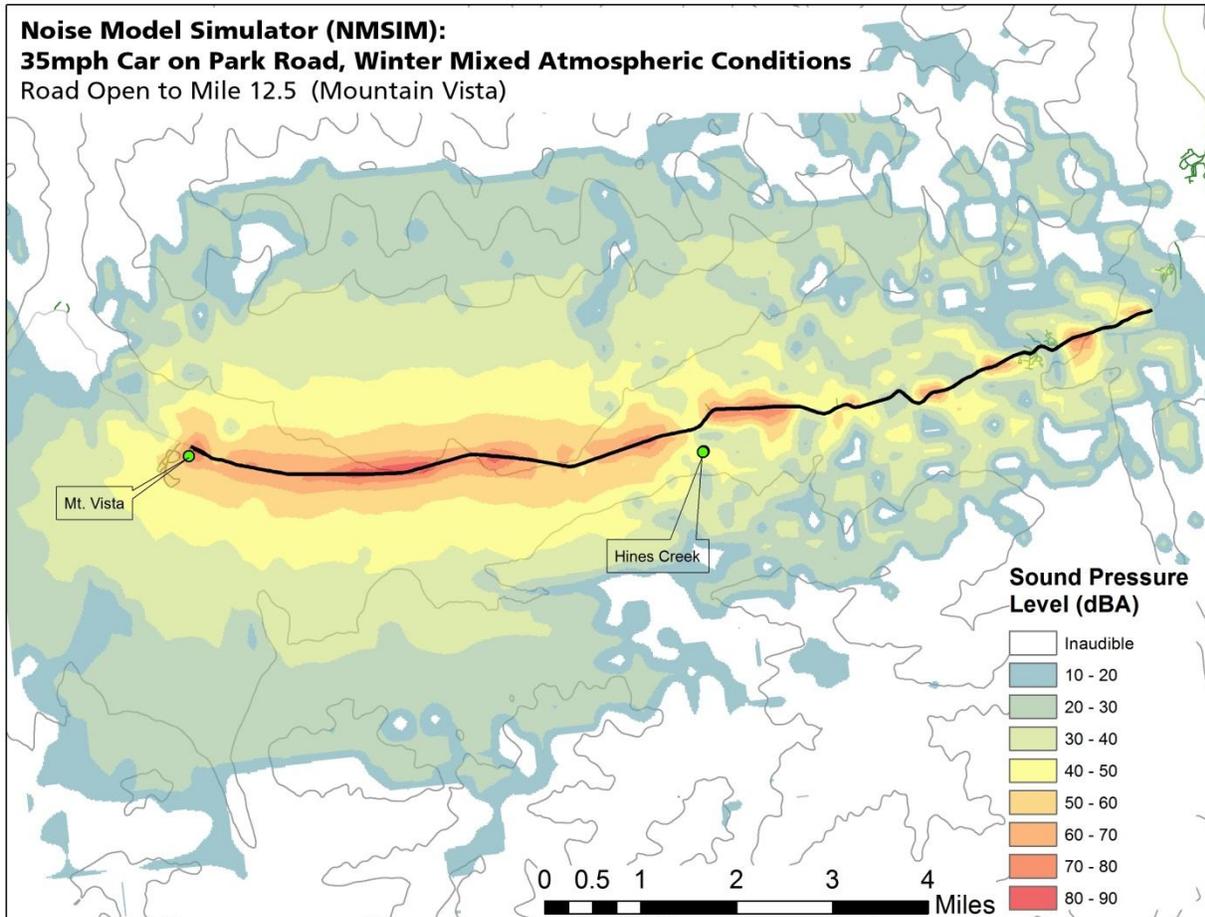


Figure 12. Map showing NMSIM model depicted the propagation of noise from a car travelling 35 miles per hour. In this scenario the car travels from the park entrance (mile 0) to Mountain Vista (mile 12.6) of the Park Road.

Visitor and Resource Protection

2014

- Three requests for visitor assistance, all involving vehicles off the road
- Ten traffic violations reported: two citations for expired registration, one citation for speeding, and seven to eight verbal warnings (all speeding except for one passenger in an open truck bed)
- No Emergency Medical Services or Search and Rescue requested

2015

- Eight requests for visitor assistance including: two jump starts (one government employee, one visitor who left car overnight) and two visitors with vehicles off the road (mile 11 and mile 9)
- Five traffic violations reported: four verbal warnings and one citation for unsafe operations
- No Emergency Medical Services or Search and Rescue requested

Budgets

Division	2014	2015
Resources	\$8,284	\$10,648
Maintenance	\$13,155	\$22,000
Interpretation	\$9,599	\$1,745
VRP	\$1,868	\$2,140
Total	\$32,906	\$36,533

Table 3. Estimated budget costs for operations related to plowing the Park Road from February 1 to March 15. The Maintenance budget for 2015 was a very rough estimate and may be clarified in the future.

Resources Division: In 2014, all costs were related to winter monitoring of the Park Road during plowing. This included REP staff wages, housing for a winter volunteer and soundscape monitoring efforts. 2015 costs cover a GS-6 seasonal to lead the monitoring, fuel and the wages of year round REP staff (GS-9 and GS-7) helping on the project.

Maintenance Division: The 2014 costs are all from the road department and include bringing on a road crew laborer early, fuel, and materials. The 2015 is a rough estimate from the Roads Supervisor for labor and fuel costs for the road crew and Building and Utilities.

Interpretation (including Kennels) Division: Prior to road opening, the NPS kennels staff departed from the park's kennel at mile 3 by dog team and traveled the Park Road. The alternative mushing route from the kennels to Mountain Vista, the Spring Trail, had hazardous sections of sloping ice in 2014 and 2015 which prohibited travel by dog team except for very experienced mushers with small teams.

In 2014, costs incurred by the kennels operations included salaries of paid staff to: collaborate with local mushers and management to design a trailhead at Mountain Vista for dog teams, scout new overland routes from Mountain Vista to Sanctuary Campground (mile 23) to avoid the road, and overtime costs for staff to load and truck the dogs back and forth to Mountain Vista. Equipment was designed, purchased, and/or modified to allow for the kennels truck to be used for more frequent winter use (generator, new dog ramp, chains, gas).

The costs are lower in 2015 partly due to lower staffing levels at the kennels than previous years and the dog teams being west of Savage for most of February and March. Costs reflect actual time logged by the staff to truck dogs to Mountain Vista, consulting and producing signs for the winter trailhead, and support of the Artist in Residence (AIR) Program based at Upper Savage Cabin (mile 13). Preparing for the AIR program was not included since artists would be housed elsewhere in Denali if the road was closed.

Visitor and Resource Protection Division: Rangers roughly estimated about two hours a day were spent at a minimum patrolling the Park Road during the trial period in 2014. That year, three incidents of vehicles sliding off the road required response and the time was factored into the

additional costs. In 2015, the ARCC center reported that VRP rangers patrolled past mile three 46 times and spent about 2.5 additional hours assisting visitors or issuing warnings or citations. The cost estimate used the average patrol ranger's hourly wage as provided by the acting North District Ranger in February 2015.

Discussion and Future Studies

Weather

The last two years, March temperatures were warmer than the normal climate period (between 1981 and 2010), and snowfall was below normal. These conditions could in part explain the increase in visitation during these two months in the prior two years.

Visitor Use Numbers and Traffic Counts

Visitors use the Park Road to access the park following early winter road opening, particularly on weekends. March is the most popular month of the winter to visit and according to MSLC numbers there is a pattern of increasing visitation in February and March that began in 2013, the year before plowing occurred, but continues to grow.

From the discussion with 2014 staff and ground-truthing observations in 2015; we can assume the traffic count provided by the motion sensor camera was less than the actual traffic numbers on the Park Road. Thus the vehicle counts from the camera give the minimum vehicle count. One theory of why vehicles are not captured is the Reconyx camera used were designed for wildlife observations and not the speed of vehicle traffic.

Using the motion sensor camera, vehicle use of the Park Road during the monitoring period was comparable the last two years with around 1000 vehicles using the Park Road with 68-76% of the total traffic classified as private vehicles. There was little commercial use observed in 2014 or 2015 (1 commercial bus in 2014, and 4 commercial vehicles in 2015).

There were slightly fewer vehicle trips in 2015 which may be partially attributed to poor weather on two consecutive Saturdays during the monitoring period, February 28 and March 7. Observations in 2015 demonstrated the camera missed more traffic with precipitation (snow) and also the NPS closed the Park Road at mile 3 on the afternoon of Winterfest (February 28), the busiest day of the monitoring period in 2014. Due to poor visibility and accumulating snow on March 7, the MSLC staff recommended against driving the Park Road to visitors.

The high number of unidentified vehicles in 2014 (90) can be partly attributed to counting both east and west bound traffic that year, because eastbound traffic is more likely to trip the camera and not be captured due to the angle of the sensor. Since REP staff only counted westbound traffic in 2015, it was easier to identify each vehicle, and only eleven were undetermined. It can be difficult to identify commercial vans since similar ten-passenger vans are available for rent in Alaska.

For both years, the average number of vehicles at Mountain Vista was between three and four. The roving times at Mountain Vista were set to coincide with when visitors were likely to be there, so it is unknown how much use occurs there between 4:30 PM and 10 AM the next morning.

There were few vehicles observed idling in the parking lot, even on cold days. Vehicles that were observed driving through the Rest Stop without stopping were not recorded.

Wildlife Observations

In 2014, moose were the most commonly observed species and in 2015 caribou were by far the most commonly observed species. Observers did not document any wildlife having difficulty moving off the road or over snow berms.

Budgets

The estimated costs associated with early winter road opening are higher than the approximated cost (\$25,203) presented in the Road Plowing EA as it estimated the costs for Resources and Interpretation as zero dollars. Park divisions found it difficult to estimate actual cost of operations that would have occurred if the road was closed and the costs provide in this report represent only rough estimates

Interpretation submitted a description of lost time and exercise potentially lost by the park kennels dogs due to an early winter road opening (Appendix 4). For the purpose of capturing a dollar figure for future cost to the kennels, the acting assistant kennels manager added up the extra number of hours it would take to do all runs out of Mountain Vista and counted them as overtime. They submitted possible options for getting the dogs out enough in February and early March including flattening, widening, and fixing drainage issues on the Spring Trail, hiring extra staff, or budgeting for significant overtime for existing staff.

Soundscapes

The natural soundscape was affected farther into the park's Wilderness by plowing the Park Road to Mountain Vista due to vehicle traffic. Another soundscape study of the area is proposed for the winter of 2016 and should include monitoring in early March.

VRP

There were more visitor assist requests in 2015 but fewer traffic violations reported. During the monitoring period, five vehicles went off the road but there were no reported injuries. One vehicle was that was left overnight for a week needed battery assistance. There were no medical or search and rescue requests during the monitoring period associated with the early winter road opening.

Suggestions for future years:

- Continue monitoring with a full time winter seasonal GS-06 or GS-05 from late January to early April to monitor, analyze, and summarize vehicle traffic, wildlife sighting and wildlife behavioral observations associated with early road opening as long as the trial period extends.
- To obtain a more accurate vehicle count, replace one Hyperfire 400Reconyx camera with the security-style Reconyx camera designed to capture traffic. The SM750 Hyperfire License Plate Camera can capture vehicles moving up to 50 mph and takes 2-3 frames per second when triggered. However, this model is recommended to negative 20 degrees F whereas the 400Reconyx is rated to negative 40.
- Currently, there is little information collected about the type of activities visitors are participating in while in the park and how they view their experience. A survey of winter

visitors before and after road opening in the winter of 2015-2016 could enhance our understanding of the types of activities and experiences visitors seek during winter months.

- Comment cards from visitors regarding winter and shoulder season recreation (October-April) should be collected and evaluated as requested by the EA.
- For the final assessment of the costs and benefits of winter road plowing; detailed division estimates need to be made on potential expenses in addition to the current costs of keeping the road open. This might include: warming shelters, emergency communication, re-route of winter trails for kennels operations, and additional staffing model if visitor needs are not being met (Maintenance, Interpretation, VRP).
- Revisit the protocols for wildlife observations; the information is excessive for what the REP is monitoring for in winter and were designed for two people (one watches while the other documents). With one observer, the behavior is not noted while the previous behavior is being written down. The original 1995 report mentions “the amount and detail of observational information exceeded the staff’s capability to reduce and analyze it in a timely fashion.” (Fortier et al 1995) For all wildlife within 300 m of park road- observe for 15 minutes and create more generalized observations. All observers should clearly document animals followed or “chased” along the Park Road.

Literature Cited

- Betchkal, D. 2013. Acoustic monitoring report, Denali National Park and Preserve – 2012. Natural Resource Data Series. NPS/DENA/NRDS—2013/589. National Park Service. Fort Collins, Colorado. Published Report-2204780.
- Betchkal, D. 2014. Natural Soundscapes/Opportunities for Solitude in Wilderness (Winter Road Opening Report 05 06 2014). National Park Service Unpublished Report, Denali National Park, Alaska.
- Fortier, K. and C. Tomkiewicz. 1995. Park Road Use/Wildlife Interaction Monitoring: A Pilot Effort. Denali National Park (unknown if published).
- National Park Service. 2013. Winter Road Plowing in Denali National Park, Finding of No Significant Impact, Denali National Park and Preserve, Alaska
- Sousanes, P. and K. Hill. (NPS). Central Alaska Network Weather Summaries web site <http://science.nature.nps.gov/im/UNITS/CAKN/vitalsign.cfm?vsid=36> (accessed April 2015)

Appendix 1. Natural Soundscape Report

Natural Soundscapes/Opportunities for Solitude in Wilderness

By David Betchkal, Alaska Region Soundscape Specialist (2014. Unpublished)

In 2012, a soundscape inventory was conducted along the park road corridor as a contribution to the affected environment portion of the Winter Road Plowing EA. Detailed results of the original inventory are included in the 2012 Denali Acoustic Monitoring Annual Report. (Betchkal, 2013.) Due to battery issues in cold weather, only about 10 days of data were collected in this initial effort, which lasted from 02/12/2012 through 02/21/2012.

The Hines Creek monitoring station was redeployed during the winter of 2013-2014 to monitor the effect of opening the road on the soundscape of Denali's wilderness. It was fielded on 12/05/2013 in an effort to collect additional data describing soundscape condition before the road was opened on 02/15/2014. Data were successfully collected and analyzed for the periods from 12/05/13 through 12/17/13 and 01/18/14 through 02/02/14 before the road was opened. The station remained in the field throughout the period affected by the management action, collecting data from 02/20/14 through 02/27/14. Periods of data collection are summarized in Table 1.

Before Road Was Opened	After Road Was Opened
02/12/2012 – 02/21/2012	02/20/2014 – 03/14/2014
12/05/2013 – 12/17/2013	
01/18/2014 – 02/02/2014	

Table A1. Date Ranges for which valid Sound Pressure Level data were collected.

The Hines Creek station was located above near MP 7.5 of the road and the 7-mile Gravel Pit. The area is an open boreal forest of white spruce and dwarf birch (the latter was eventually covered with snow during sampling.) To the north of the site was a steep drop into the Hines Creek drainage, which runs roughly parallel to the road.



Figure A1. A photograph of the Hines Creek sound monitoring station, taken 12/05/2013.



Figure A2. A map showing the location of the Hines Creek soundscape station with respect to the park road. Coordinates of the site were N 63.71061°, W -149.07915° WGS84. Microphone position was above the elevation of the road along this stretch.

A. Soundscape Observations at Hines Creek

Empirical observations of noise before and after the road was opened show marked differences in the soundscape of the Hines Creek area. The number of vehicles detected increased by about 25 events, from about 20 to 45 vehicles per day. This represents more than twice the number of events from previous 24-hour averages. Comparisons in event detection rates are shown in Table 2.

A similar comparison was made for sound pressure levels by source type. These data are summarized in Table 3. Immediately apparent is the difference in maximum sound pressure level for road traffic distant from Hines Creek (on the Parks Highway, for instance, or the entrance area of the park road,) and traffic closer to the site. Distant traffic had a median in the 18 – 19 dBA range and traffic on the open road had a median in the 36 – 38 dBA range. Distant events were often near the threshold of detectability, whereas closer vehicles were clearly audible over Denali’s quiet winter conditions. Road maintenance operations were the loudest group of vehicles. Monitoring data suggest that the frequency and sound pressure level of park maintenance operations both increased after the road was opened. Low-flying aircraft events likely associated with NPS wolf capture operations from 03/03/14 – 03/06/14 increased both the median L_{max} and the event rate for aircraft during the period during which the road was opened. Without these events, soundscape impacts due to aircraft would have been very similar across each period.

	Before (2012)	Before (2013-14)	After (2014)
Days Sampled	10	28	22
Aircraft Events Per Day	23.3	21.9	26.1
Total Vehicle Events Per Day	4.6	19.4	45.1
Close Vehicle Events Per Day	1.0	1.4	38.6
Ratio, Close : Total	20.8%	7.4%	85.5%

Table A2. Summaries of Noise Events By Source

Source	Before (2012) 10 days			Before (2013-14) 28 days			After (2014) 22 days		
	Median Lmax	Median Abs. Dev. Lmax	Event Count	Median Lmax	Median Abs. Dev. Lmax	Event Count	Median Lmax	Median Abs. Dev. Lmax	Event Count
Jets	38.6	6.2	89	36.7	6.5	275	41.5	6.9	117
Propeller Aircraft	35.0	9.4	131	36.0	7.5	336	41.5	6.5	435
Helicopters	28.7	4.8	13	20.0	1.5	3	45.8	12.9	23
Distant Vehicles	17.9	3.1	38	18.2	1.9	502	18.9	3.1	144
Vehicles on the Opened Road (General)	-	-	0	37.4	-	1	36.6	3.7	759
Heavy Maintenance Vehicles on the Road	29.9	4.9	10	31.4	11.4	39	46.7	5.6	90

Table A3. Summaries of Maximum Sound Pressure Level, Variation in Maximum Sound Pressure Level, and the number of observations used in the summary. Note that the event count is not normalized by sampling time and thus cannot be interpreted as a rate nor compared across sampling periods. Instead the count is meant as an indication of the reliability of the L_{max} estimate reported.

B. Modelling Noise Effects of Winter Plowing

In addition to empirical observations at Hines Creek, an accurate spatial analysis of the area of the park effected by opening the road was also conducted. In order to perform such an analysis, NOISEMAP Simulation Model, or NMSim (Wyle Labs) was used to create a mathematical model of noise propagation that accounts for attenuation effects of terrain, ground cover, weather, and atmospheric composition. NMSim is the NPS-preferred predictive noise modelling software, as it was found to be both the most likely to produce unbiased results and to have the lowest overall error for the calculation of audibility metrics. (Miller et al, 2003) It has been used for predictive purposes in high-integrity scientific studies of noise at both Yellowstone National Park and Grand Canyon National Park. (FICAN 2005; Hastings et al 2006; Fristrup and Joyce, 2012)

Input parameters of the model were designed to be as close as possible to environmental conditions of late winter in the Hines Creek and Savage River drainages. Source parameters were chosen to estimate as closely as possible vehicle behavior on the road. Table 4 is a concise list of parameters, their descriptions, and justification. Basic notes on the limitations of each choice are also included.

Table 4. NOISEMAP Simulation Model (NMSim) input parameters with a justification for their selection in this specific case and notes on potential limitations.

Parameter	Choice	Source of Information	Justification	Limitations / Possible Sources of Error
Source Type	Average Car/Truck on Asphalt	DOT Integrated Noise Model (INM) database	About 80% of observations upon road opening were personal vehicles. The road surface is asphalt.	Ice or snow on road surface and/or winter tires may affect characteristics of noise at the source. No such source exists in the INM database at this time.
Source Speed (mph)	35	Posted speed limit of park road, on-site observations of drivers in vicinity of MP 7.5	Although some vehicles certainly travel faster or slower than the limit, turns in the vicinity of MP 7.5 keep the typical speed of vehicles close to the posted limit.	Vehicle engines do not operate at a constant speed. Instead, they revolve faster while travelling uphill, or slower before turning corners, etc. Noise effects due to these short-term fluctuations is outside the scope of this report.
Source Height (ft)	2 feet above road	Median measurement of cars / trucks	Observation from a typical set of Alaskan vehicles.	Software only allows integer choices of source height.
Air Temperature on the Ground (°C)	-5.888	Sound station thermometer. Median over all sampling periods (07:00 - 20:00 hours only)	Broad, daytime hours were chosen because most visitation occurs during daytime hours. Using the entire day's temperatures would have resulted in model conditions that inaccurately cold.	Actual air temperature probably varies considerably over the landscape and will affect the propagation of sound over spatial scales small enough to be outside of the scope of this report.
Thermal Gradient (°C / 1000 Meters)	-5.500	Conventional Dry Adiabatic Lapse Rate	Because most road traffic occurred from 12:00 to 17:00, the atmosphere was considered to be well-mixed during most noise events. A thermal gradient of -5.5° C per kilometer is a convention of atmospheric science for well-mixed atmospheric conditions.	Actual thermal gradients during winter conditions in Denali vary widely and therefore the propagation of acoustic noise can also greatly vary. The proportion of time over which different atmospheric conditions prevail are unknown at this time.
Relative Humidity, Air (%)	83.465%	Sound station relative humidity gauge. Median over all sampling periods (07:00 - 20:00 hours only)	Broadly-defined daytime hours were chosen because most visitation occurs during daytime hours. Using the entire day's humidity gives a value that only differs by 0.01%, but a method consistent with temperature was still utilized.	This parameter affects how quickly sound is attenuated by absorption, an effect which is strongest at high frequencies. Vehicle noise is almost entirely radiated at frequencies less than 1250 Hz. Therefore, error in relative humidity is not expected to contribute much error to an estimate of broadband SPL.
Thermal Turbulence (K/s ²)	0.120	NMSim Default	Not enough information is available about the local atmosphere to improve upon the default value.	The default is probably not chosen for Alaskan winter temperature conditions.
Kinetic Turbulence (m ^{4/3} /s ²)	0.008	NMSim Default	Not enough information is available about the local atmosphere to improve upon the default value.	The default may or may not be chosen for mountainous terrain.

Table 4. NOISEMAP Simulation Model (NMSim) input parameters with a justification for their selection in this specific case and notes on potential limitations (continued).

Parameter	Choice	Source of Information	Justification	Limitations / Possible Sources of Error
Roughness Length (m)	0.5	Stull 2000, "Meteorology for Scientists and Engineers"	Davenport-Wieringa roughness length for a "very rough" area, defined as an area where objects of height H are separated by spaces of about 10H, or a "landscape with bushes, young dense forest, etc..."	Roughness length classes are only coarse estimates as opposed to a direct measurement. However, wind speed was not incorporated in this model - therefore changing the roughness length input may not have a large effect on sound propagation.

The two following maps show model results for the above inputs. The only variable that was changed between runs was the length of road open to the public. Results are reported as sound pressure level (SPL) in A-weighted decibels (or, in other words, physical measurements of SPL adjusted for the sensitivity of human hearing.) SPL values are shown as a grid of 25 m² blocks.

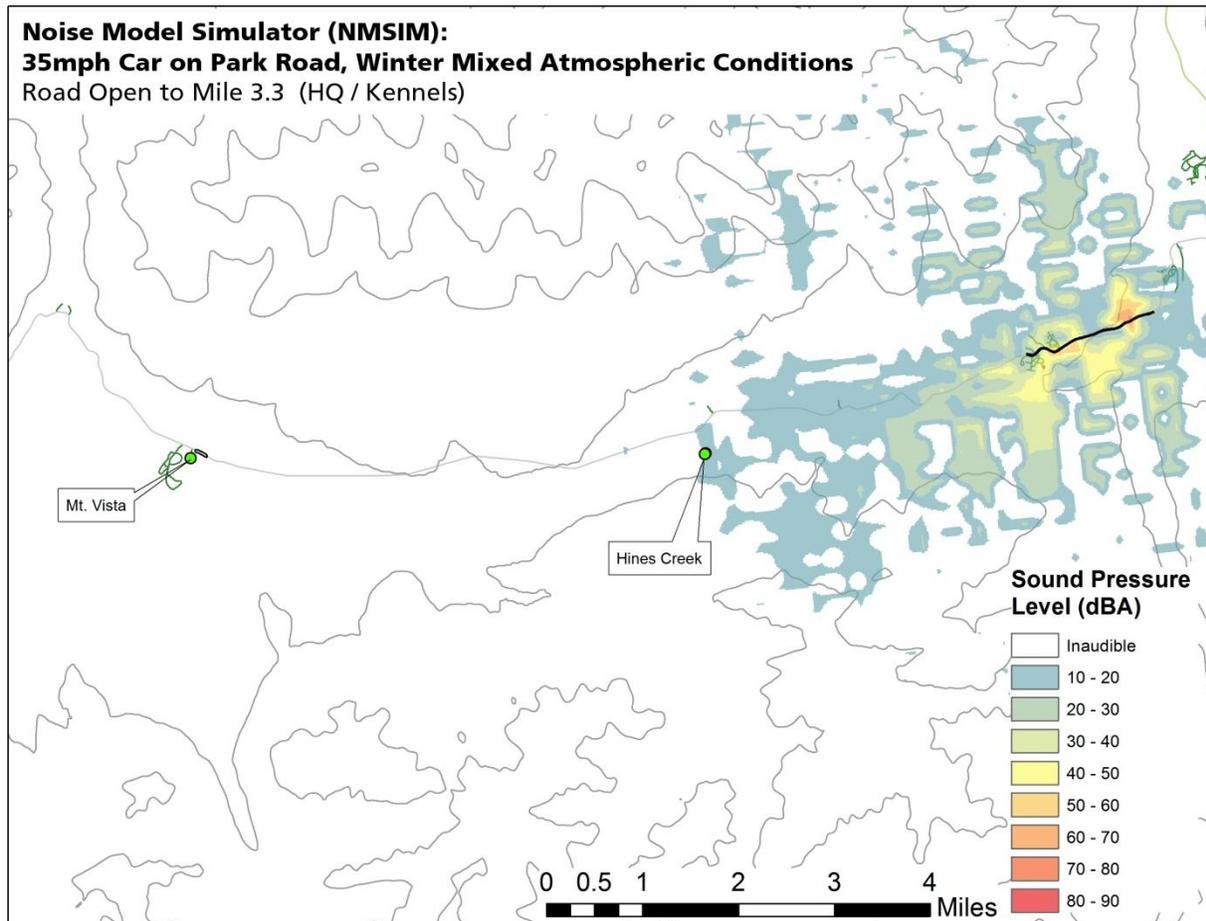


Figure A3. Map showing NMSIM model depicted the propagation of noise from a car travelling 35 miles per hour. In this scenario the car travels to milepost 3.3 of the park road.

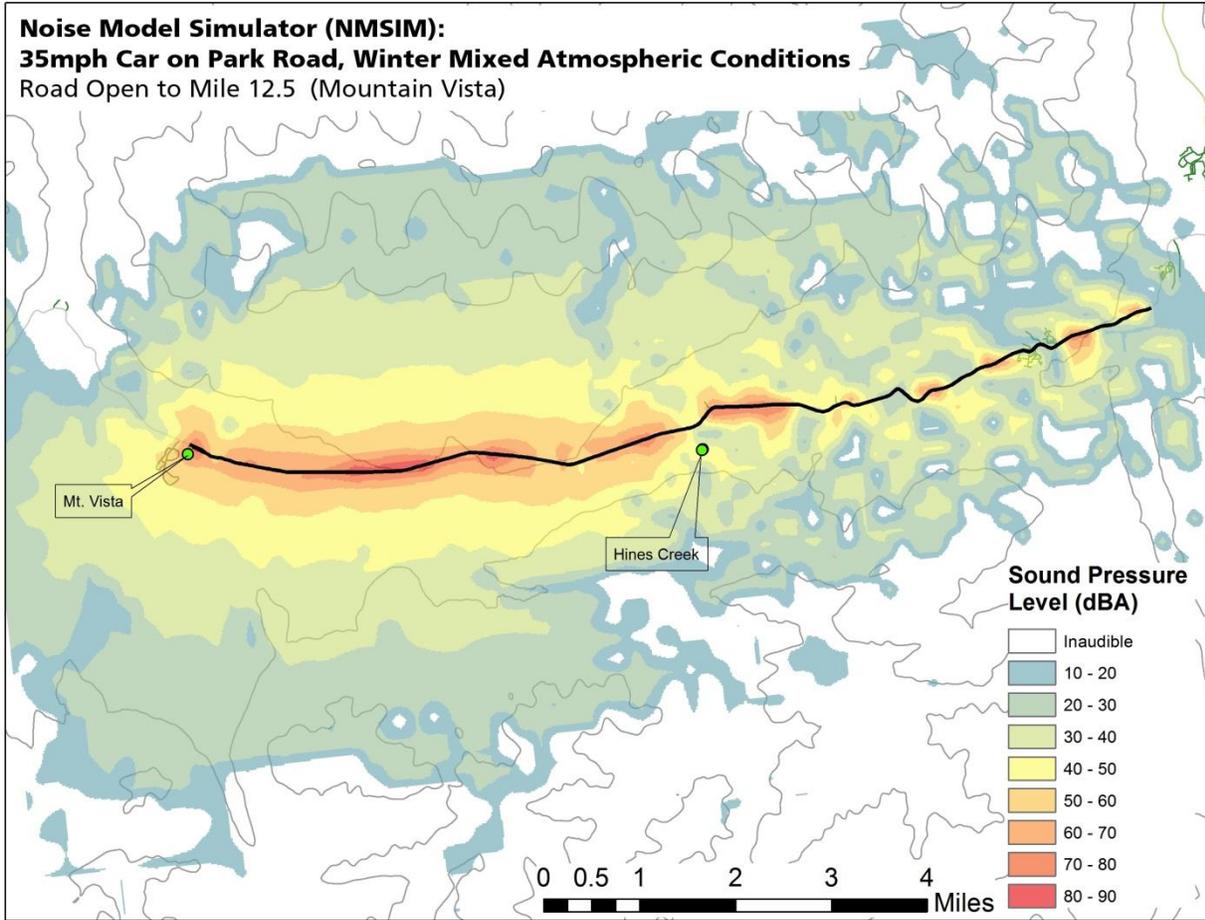


Figure A4. Map showing NMSIM model depicted the propagation of noise from a car travelling 35 miles per hour. In this scenario the car travels to milepost 12.5 of the park road.

References

- Betchkal D. 2013. Acoustic monitoring report, Denali National Park and Preserve – 2012. Natural Resource Data Series. NPS/DENA/NRDS—2013/589. National Park Service. Fort Collins, Colorado. Published Report-2204780.
- Hastings, Aaron L., Gregg G. Fleming, and Cynthia SY Lee. 2006. Modeling sound due to over-snow vehicles in Yellowstone and Grand Teton National Parks.
- Federal Interagency Committee on Aviation Noise. 2005. Assessment of Tools for Modeling Aircraft Noise in the National Parks.
- Fristrup, K., Joyce, D., Formichella, C., Leumas, C. 2012. Modeling Noise from Snow Vehicles in Yellowstone National Park. Draft Technical Report. National Park Service. Fort Collins, Colorado.
- Miller NP and Others. 2003. Aircraft Noise Model Validation Study. HMMH Report No. 295860.29. Harris Miller Miller And Hanson Inc. Burlington, MA. Published Report-571139.

Appendix 2. 2015 Roving Schedule for REP staff

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	15 9 and 1	16 Holiday	17	18 noon and 4	19 9 and 1	20 check camera?	14 11 and 3
	22	23	24 noon and 4	25 10 and 2	26 11 and 3	27 11 and 3	21
	1 noon and 4	2 10 and 2	3	4	5 noon and 4	6 9 and 1	7 noon and 4
	8	9 noon and 4	10 10 and 2	11	12	13 noon to 4	14 9 and 1
	15 11 and 3						
	3	2	2	2	3	3	4
Shift times							
9 and 1 = 8-4:30							
10 and 2 = 8 - 4:30							
11 and 3 = 9 - 5:30							
12 and 4 = 9:30 - 6 (weekdays) or 10 - 6:30 (weekends)							

Winter Wildlife Behavioral Observations Data Sheet										Data Entered <input type="checkbox"/>		Access: Wildlife Files										
Rover File:	Derrill Park Road Winter 2014																					
Observer(s):	Date:	End Time:	Wildlife Observation Number:	Location:	Time	Species:	Number of Individuals	Number of Females	Number of Males	Number of Females	Number of Males	Number of Young	Position: 1, 2, 3	Stimulus Before	Activity	Perpendicular Dist. to road	Distance from Stimulus	Angle from Stimulus	Visibility Impaired from You	Distance Impaired from You	Notes	
Start Time:	Direction of Travel: Westbound, Eastbound	Visibility: Great, OK, Poor	Precipitation: light rain, rain, freezing rain, light snow, snow, none	Cloud Cover: clear, partly cloudy (<50% cloud cover), overcast (>50% cloud cover)																		
↓ tbl/Animals	(if group is acting as a unit, only one ID for the group. If splitting into individuals, a new ID per animal)	tblBehaviorObservations	BehaviorID	Time	Stimulus	Behavior Change	Duration (seconds)	Distance Moved	Perpendicular Dist. to road	Distance from Stimulus	Angle from Stimulus	Visibility Impaired from You	Distance Impaired from You	Notes								
AnimalID	Time	Species: B, C, M, S, W or O	Number of Individuals	Number of Females	Number of Males	Number of Young	Position: 1, 2, 3	Stimulus Before	Activity	Perpendicular Dist. to road	Distance from Stimulus	Angle from Stimulus	Visibility Impaired from You	Distance Impaired from You	Notes							
tblBehaviorObservations	BehaviorID	Time	Stimulus	Behavior Change	Duration (seconds)	Distance Moved	Perpendicular Dist. to road	Distance from Stimulus	Angle from Stimulus	Visibility Impaired from You	Distance Impaired from You	Notes										
↓ tbl/Animals	(if group is acting as a unit, only one ID for the group. If splitting into individuals, a new ID per animal)	tblBehaviorObservations	BehaviorID	Time	Stimulus	Behavior Change	Duration (seconds)	Distance Moved	Perpendicular Dist. to road	Distance from Stimulus	Angle from Stimulus	Visibility Impaired from You	Distance Impaired from You	Notes								
AnimalID	Time	Species: B, C, M, S, W or O	Number of Individuals	Number of Females	Number of Males	Number of Young	Position: 1, 2, 3	Stimulus Before	Activity	Perpendicular Dist. to road	Distance from Stimulus	Angle from Stimulus	Visibility Impaired from You	Distance Impaired from You	Notes							
tblBehaviorObservations	BehaviorID	Time	Stimulus	Behavior Change	Duration (seconds)	Distance Moved	Perpendicular Dist. to road	Distance from Stimulus	Angle from Stimulus	Visibility Impaired from You	Distance Impaired from You	Notes										

Appendix 4. Description of Time and Exercise potentially lost under Winter Road Opening Conditions to Kennels dogs

Jennifer Raffaeil, Kennels Manager.

2014

Lost Exercise and Training Time		
<p>Wasn't sure how best to capture the costs of not getting dogs out as regularly for exercise and training in the month of February. I tried to capture the issues on the worksheet "Lost Exercise Time." In a nutshell, whether there is a project or patrol needed or not, the dogs still need to get out regularly in order to stay in shape, avoid behavior problems, and reinforce their training and good habits.</p> <p>Adults need to get out for 3-6 hours/day (more as they get closer to the Wonder Lake trip), 4-5 times/wk Puppies need to get out for 1-2 hours/day, 5-7 times/week Injured dogs need easy exercise as they recover.</p> <p>The Spring Trail in a normal year has icy sections that make it challenging and sometimes unacceptably hazardous for inexperienced mushers. 2014 was one of the particularly bad years. This puts extra pressure on the permanent or returning seasonal staff (if any) as the only ones who can safely take dogs out on this route. Loading/unloading and driving to Mountain Vista takes an additional 4 hours for teams and sleds, making what used to be a half-day event into a whole day event. Loading puppies and skijor equipment takes less time, but it still adds about 2 extra hours to a training skijor run.</p> <p>There are probably many possible options for solving the problem of getting the dogs out enough in February including flattening, widening, and fixing drainage issues on the Spring Trail, hiring extra staff, or budgeting for significant overtime in February and have staff work longer days, among others. For the purpose of capturing a dollar figure, I've simply added up the extra number of hours it would take to do all runs out of Mountain Vista and counted them as overtime. This is the cheapest, though probably not the most viable option. Adding an additional permanent experienced musher or two (around ~\$70,000 each) or fixing the trail are better, but much more expensive options, but ones that would also have other benefits for the park and park operations.</p>		
<p>Adult dogs exercise: 4.5 trips * 4 xtra hours = 18 hrs OT/week * 4 weeks = 72 hrs for GS9 + GS5</p>		
<p>GS9: \$810/week for 4 weeks</p>		<p>\$ 3,240</p>
<p>GS5: \$600/week for 4 weeks</p>		<p>\$ 2,400</p>
<p>This also depends on there being at least 2 volunteers as well, who are often new to mushing, but by February have at least 2-3 months of experience under their belts.</p>		
<p>Puppy training: Normally done as 1-2 hour skijoring trips 5-7 days/week. 6 trips * 2 xtra hrs to transport = 12 hrs OT/week for GS9 for 4 weeks</p>		<p>\$ 2,160</p>

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 184/128541, May 2015

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov