National Park Service
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Denali National Park and Preserve

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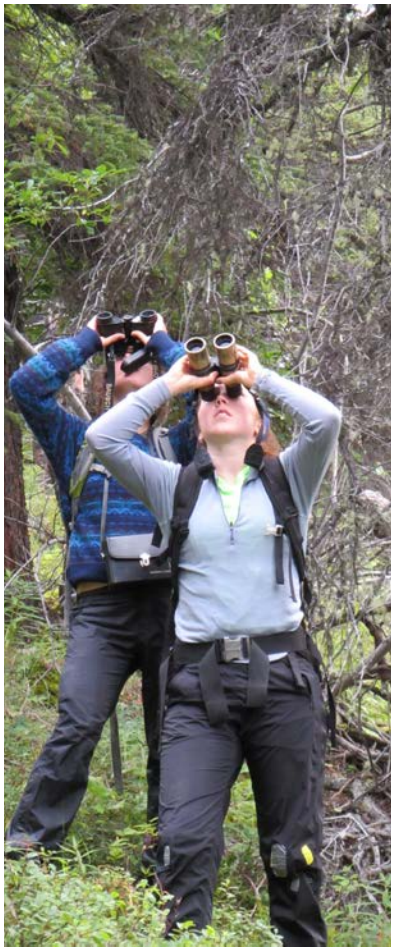

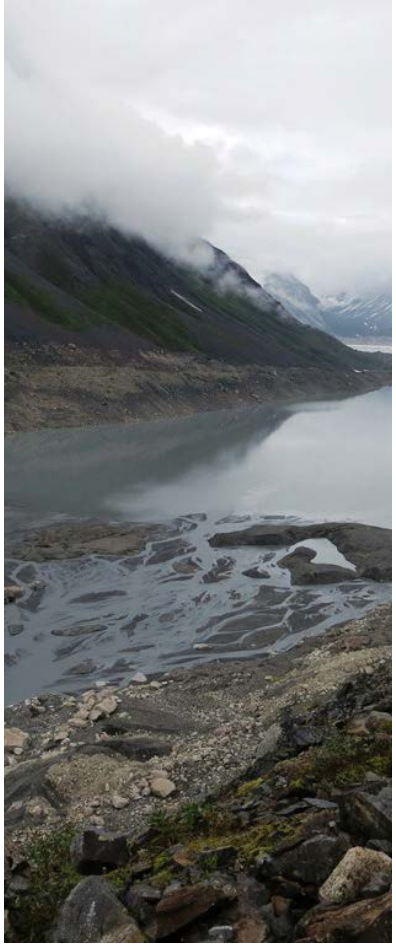

Summary of Current Resource Projects 2015

This document is available in color—for viewing or printing—on the Denali National Park and Preserve website at the following link: www.nps.gov/dena/learn/nature/scienceresearch.htm

All photos courtesy of National Park Service, unless otherwise indicated.

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Managing the Denali Park Road Visitor Experience

by William C. Clark
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The Denali Park Road Final Vehicle Management Plan and Environmental Impact Statement (VMP) was approved by the Alaska NPS Regional Director in September 2012. A tremendous effort went into the crafting of the VMP; more than six years of scientific study and four years of planning, analysis, and public input. The VMP establishes a set of indicators and standards, which provide guidance for the management of vehicles on the Denali Park Road west of the Savage Check Station (mile 14.84). The plan was developed to ensure that visitors have a high-quality experience, wildlife and other park resources are protected, and the unique and historic character of the Denali Park Road is maintained.

Due to the VMP's scope (15-20-year plan) and complexity (75 miles of roadway with upwards of 90 buses per day making unpredictable stops), there is some amount of uncertainty and unpredictability of how the ecological and transportation systems will respond to management actions. It is precisely because of this uncertainty that the VMP embraces an adaptive management strategy.

Adaptive management is a decision-making process whose goal is to reduce uncertainty through system monitoring and self-evaluation. That is, as the transportation system (i.e. scheduling and volume) is adjusted for optimization and the results are monitored and better understood, managers will use the new information to further adjust the system to meet the standards and goals of the VMP.

Methods

The Road Ecology Program (REP) assesses the ecological system in four ways as changes to the transportation system are made. We 1) annually monitor seven indicators outlined in the VMP to determine if standards are met, 2) annually quantify changes in wildlife sightings from the road, 3) collect data that is used by park wildlife biologists to assess changes in wildlife populations (long-term monitoring programs), and 4) evaluate the impact of new traffic patterns and volumes by comparing data before and after traffic modifications Before-After-Control-Impact (BACI) study).

The VMP includes annual examination of seven (7) indicators (Figure 1) with quantifiable standards:

1. Number of vehicles at a wildlife stop
2. Number of vehicles at rest stops and the Eielson Visitor Center
3. Number of vehicles in established viewscapes
4. 10-minute gaps in traffic at established Dall's sheep crossings every hour
5. Amount of time a hiker waits for bus pickup (not including the Wilderness Access Center depot)
6. Hourly nighttime traffic (10:00 p.m. to 6:00 a.m.)
7. Hourly large (>80,000 pounds gross weight) vehicle traffic

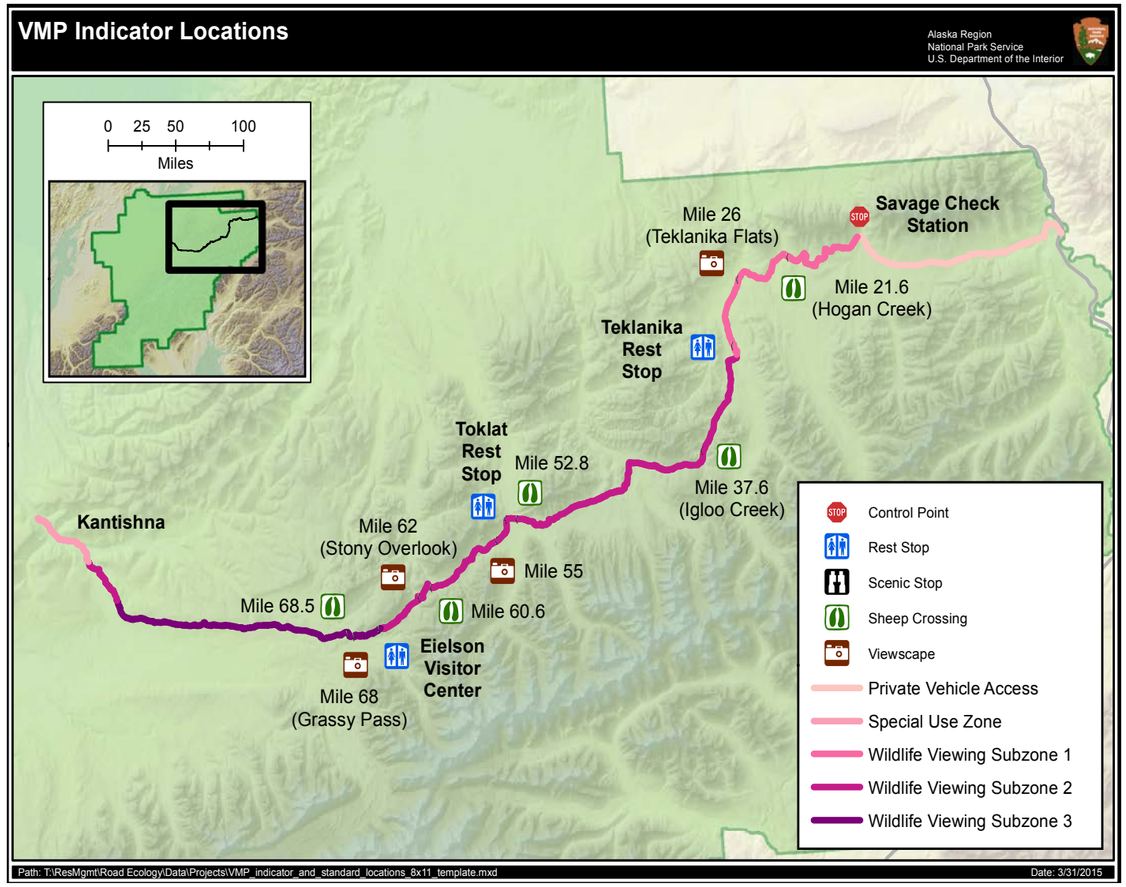

Figure 1

From 2012-2014 data on the seven indicators established in the VMP were collected using three methods: 1) GPS systems installed in ~160 buses and government vehicles, 2) NPS staff field observations, and 3) a youth and volunteer bus ridership program (Ride Observe and Record; ROAR). Careful analysis of the 2013 and 2014 (>2.4 million) GPS data points from the vehicle fleet (method #1 above) supported that data quality decreased from 2013 to 2014 requiring substantial effort to quality check and prepare for analysis. Management concluded that, given the total costs, the fleet-based GPS system was insufficient to satisfactorily implement the VMP for future monitoring years. Thus, for 2015 greater focus and effort will be directed into NPS staff field observations and the ROAR program.

Results from the 2014 Field Season

Despite the data quality, a lot of valuable and valid data were obtained in 2014. Approximately 6,700 bus trips by the concessionaire, Doyon-Aramark, were counted in the 2014 monitoring year. Together with the traffic associated with lodge buses, government vehicles, professional photographers, private in-holders, and miscellaneous other trips 830,000 GPS points were collected in 2014. The ROAR program made 1,529 rest stop evaluations and 1,878 wildlife observations. REP staff made 870 2-minute rest stop observations, 148 sheep gap observations, and 1,220 2-minute viewscape observations.

Results

Many of the tier-one standards were met; however some were exceeded.

1. The standard for the number of vehicles at wildlife stops was met in all three wildlife viewing subzones.
2. The standard for the number of buses parked at any one time at rest stops was met based on NPS and ROAR observational data. The GPS data showed four occasions where standards were exceeded, once at Teklanika, twice at Toklat, and once at Eielson.
3. The standard for the total number of vehicles parked at any one time at rest stops was met based on NPS and ROAR observational data. The GPS data showed one instance the standard was exceeded at Teklanika; 19 total vehicles.
4. The standard for the number of concurrently visible vehicles in each of the four viewscapes was met (n=1,220).
5. Maintaining at least one ten-minute gap in traffic at least 90% of the time was met at two of the five sheep gaps. Sheep gaps near Hogan Creek (84.6%, n=26), east of Teklanika ("Sheep Hill") (85.3, n=34), and Big Stony Creek (82.9%, n=35) failed to meet the standard. Traffic counters were found to be effective for monitoring sheep gaps and should be installed at additional locations to provide accurate assessments of current conditions.
6. The standards for night-time traffic were met at two traffic counter locations (Toklat and Stony) and exceeded at four other locations (Teklanika Campground, Teklanika Gate, Sable Pass, and Grassy Pass).
7. The standards for hiker wait time were met.

How this data will be used

Monitoring results will be used to adjust traffic schedules and address management of different road users as described in the VMP (e.g., professional photographers, Teklanika Campers). The VMP will provide guidance for the next 15 to 20 years. Implementation of the plan is occurring in stages. During 2013-2015, park staff will develop the specific methods for implementing and reporting results using adaptive management as outlined in the VMP. Full implementation will occur when a new concessions contract to operate the park's public transportation system is in place and special park regulations—to change the vehicle limit from 10,512 per year to 160 per day—are updated in the U.S. Code of Federal Regulations.

Monitoring Wildlife and Visitor Use During Winter Road Opening

by Jessica Toubman, Road Ecology Winter Seasonal
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In June 2013, the NPS approved a Winter Plowing Environmental Assessment (EA) plan to open the Denali Park Road about one month earlier than the traditional opening date. As part of the plan, the road will be opened to the Mountain Vista Rest Area at mile 12.6 by mid-February each year for a 3-5-year trial period. During this time, park staff is monitoring soundscapes, wildlife sightings and behavior, and visitor use levels and documenting costs associated with opening the road early. After the trial period, park managers will assess the costs and benefits of a winter road opening for subsequent years.

Methods

The Road Ecology Program (REP) oversees the collection of wildlife observation and traffic use data during the trial period. The winter plowing monitoring period extends from mid-February when the Park Road is opened to the public to Mountain Vista Rest Area to the Sunday closest to March 15, which is the estimated date when normal spring plowing operations would begin. The monitoring dates for this report were:

- 2014: February 15 (Saturday) to March 16 (Sunday) – 30 days
- 2015: February 14 (Saturday) to March 15 (Sunday) – 30 days

Wildlife Behavioral Observations

Visitor Resource Protection (VRP) Rangers and REP staff used Trimble Juno GPS (Junos) units to record data on wildlife sightings including species, number, location, and general behavior while traveling the Park Road from headquarters (mile 3) to Mountain Vista and back to headquarters. VRP Rangers collected information as part of their regular patrols and REP staff roved to Mountain Vista 2-3 times on scheduled sampling days during daylight hours.

In addition to the Juno data, REP staff conducted fifteen minute wildlife behavior observations using protocols modified from previous NPS studies of wildlife behavior. Sightings and behavior of the following wildlife species were recorded within 500 meters of the park road: moose, caribou, wolf, Dall Sheep, grizzly bear and other notable wildlife (e.g., lynx,).

Visitor Use Monitoring

In 2014 and 2015, REP staff monitored vehicle traffic at the Mountain Vista Rest Area for 30 minutes prior to returning east during scheduled wildlife roves. They recorded the number of parked vehicles in 15 minute intervals by vehicle type (commercial, government, private vehicles, and heavy equipment). The count included vehicles in the new "musher's parking lot" west of Mountain Vista in 2015, and did not include the government monitoring vehicle. Information on outside temperature and number of idling vehicles was added in 2015.

Estimates of overall traffic use were obtained using motion sensor cameras along the Park Road. In 2014 and 2015 a west facing camera just past the headquarters gate was set up to capture vehicles traveling in both the east and westbound lanes. REP staff reviewed all photos and classified passing cars as heavy road equipment, government vehicles, commercial vehicles, private vehicles, unidentified, or pedestrian/non-motorized.

In 2014, the total number of vehicles captured by the camera was divided by two to estimate the minimum number of round trips past mile 3. In 2015, the estimate of round trips was made by counting only "westbound" traffic, as ground-truthing showed that eastbound traffic was often not captured by the camera.

Results

Wildlife Behavioral Observations

2014:

REP and VRP staff collected data on wildlife sightings during 34 trips between Feb 15 and March 16 including 13 trips with no wildlife sightings. There were a total of 21 wildlife sightings and the majority of sightings were moose (16 sightings, group size: 1 to 7 individuals), followed by caribou (2 sightings, group size: 2 to 12), porcupines (2 sightings of the same porcupine), and lynx (1 sighting). Most wildlife sightings occurred near milepost 12. Occasionally more than one staff member recorded data on a given day and data were collected during west and east bound trips, thus some of these sightings may represent the same individual or group documented twice.

REP staff conducted 15-minute wildlife behavioral observations on all wildlife observed within 500 meters of the road. During 15 observation periods recorded in 2014, there appeared to be three

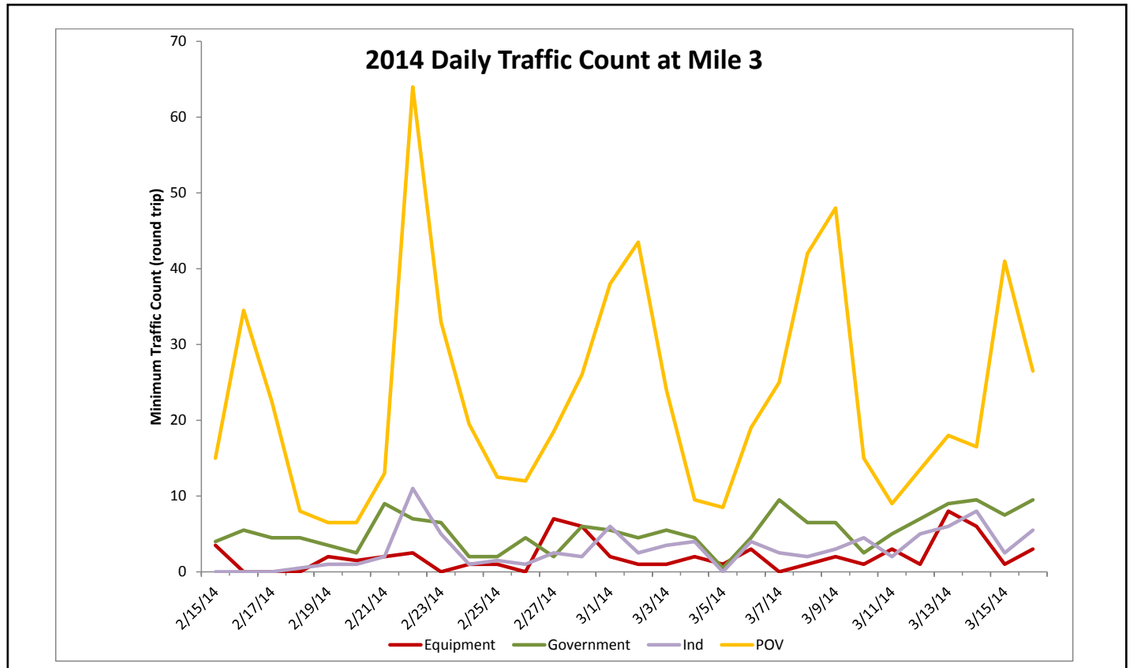

Figure 1: Minimum traffic count and vehicle type on the Park Road past mile 3 during 2014 winter monitoring from motion sensor camera by vehicle type. Vehicles were classified as government, heavy equipment (Equipment) private vehicles (POV), or undetermined or indeterminate vehicles (Ind).

documented responses by moose to vehicles on the road (trotting or running away).

2015:

REP and VRP staff collected data on 42 trips between Feb 14 and March 15, including 14 trips with no wildlife sightings. There were a total of 61 sightings of targeted wildlife species; the vast majority were caribou (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 were between mile 11 and 13. Similar to 2014, some of these sightings represent the same individual or group documented twice.

Visitor Use Monitoring

2014:

A minimum of 1003 round trips traveled past the mile 3 gate from February 15 to March 16. There were 687 trips by private vehicles, 90 trips by indeterminate vehicles, and one trip by a commercial bus. The remaining 225 trips were by road equipment and other government vehicles. The majority of all trips occurred on weekends (Fig 1).

2015:

A minimum of 960 round trips traveled past mile 3 from February 14 to March 15. There were 731 trips by private vehicles, 11 trips by indeterminate vehicles, and 4 by commercial operators (including the dog sled concessionaire). The remaining 214 trips were by road equipment and other government vehicles (Fig. 2). Seventy-one (71) pedestrians were documented on the camera. They were overwhelmingly NPS staff or residents.

Ground-truthing of the motion sensor camera has shown that traffic was missed during precipitation (snow) events. Thus, lower vehicle trip numbers in 2015 may be partially attributed to poor weather conditions on March 7. Additionally, a closure of the Park Road at mile 3 on the afternoon of Winterfest (February 28) limited access. Both were Saturdays - the busiest day of the week in 2014.

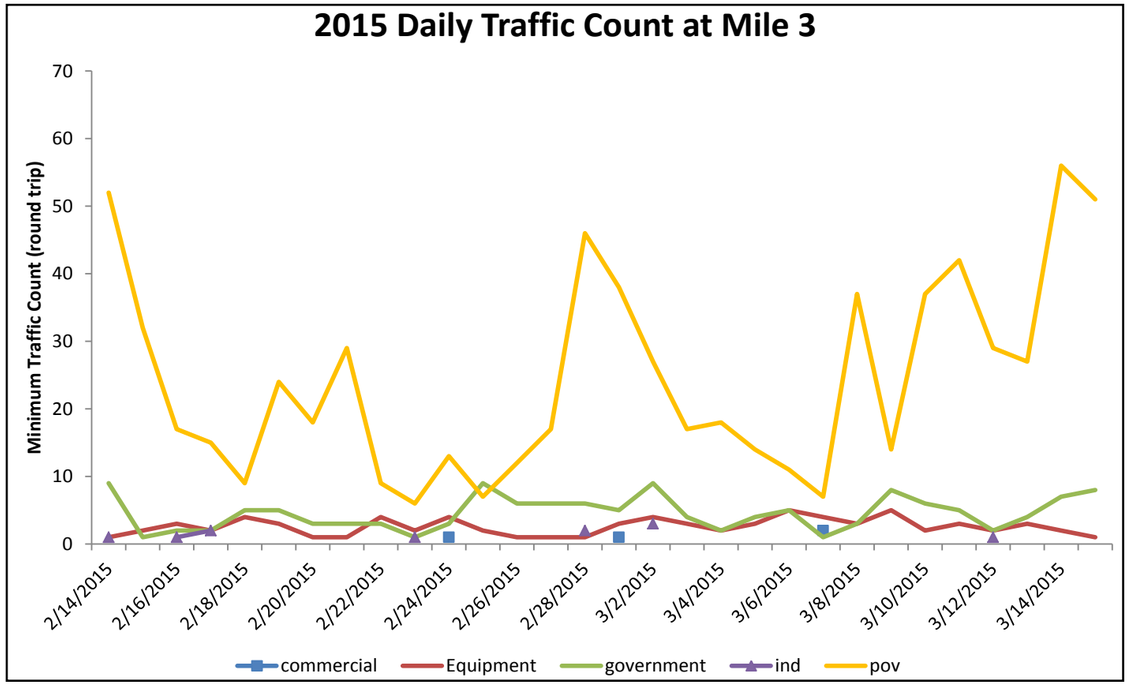

Figure 2: Minimum traffic count and vehicle type on the Park Road past mile 3 during 2015 winter monitoring from motion sensor camera. Vehicles were classified as commercial, heavy equipment (Equipment), government, indeterminate vehicles (ind) or private vehicles (POV)

Mountain Vista parking observations

2014:

REP staff recorded 165 observations at the Mountain Vista parking during the monitoring period. The vast majority of non-government vehicles appeared to be private vehicles; only one commercial bus was observed. 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. 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 1).

2015:

REP staff recorded 115 observations at Mountain Vista parking lot during the monitoring period. Again, the majority of non-government vehicles are private vehicles; one commercial van was recorded and two trucks associated with the dog sled concessionaire. Counts for the week of March 7 – 14 were affected by 4 private overnight vehicles associated with the dog sled concessionaire. The average number of vehicles was 3.70 (SD: 3.25) and the maximum number observed was 16 at Winterfest on Saturday, February 28, during a snowstorm. The maximum number of vehicles observed idling in the parking lot at the same time was one (Table 1).

A full report of the findings from 2015 and 2014 will be available in the summer 2015.

Table 1 - Mountain Vista Rest Area Data

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.

2014	Personal vehicles		Government		Total Vehicles		
	Mean (SD)	Max	Mean (SD)	Max	Mean (SD)	Max	*n**
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*

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.

2015	Personal vehicles		Government		Total Vehicles (includes 3 commercial)		
	Mean (SD)	Max	Mean (SD)	Max	Mean (SD)	Max	*n*
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*

**n* indicates sample size.

Wilderness Stewardship and Backcountry Management

By Rob Burrows
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Celebration and reflection in 2014 of 50 years of the Wilderness Act wilderness brought a reaffirmation for preserving wilderness character across the nation. The primary affirmative mandate of the 1964 Wilderness Act is that land management agencies preserve the wilderness character of all areas designated as wilderness, which includes 2 million acres of Denali. National Park Service policies extend this to areas not yet designated but that are eligible wilderness, another ~4 million acres of Denali.

Protecting the wilderness character of Denali is not only a legal mandate, but vital to preserving this vast intact ecosystem and the wilderness values it exemplifies. Monitoring certain conditions and indicators using the best available science is an important effort in tracking and preserving wilderness character, protecting Denali's resources, and in providing opportunities for high quality visitor experiences in the backcountry. Efforts are underway to annually monitor the indicators of visitor experience and resource conditions that are identified in Denali's 2006 Backcountry Management Plan. This monitoring is an inter-divisional and interdisciplinary team effort. Recent fruits of this effort are mentioned in the next column, see these documents for more details.

- State of the Backcountry Report was published in 2014. It provides, for the first time, a report documenting the current state of Denali's wilderness character. You can download a PDF of the report here:

  https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=510741&file=DENA_State_of_the_Backcountry_Final.pdf

- Wilderness Character Map. In conjunction with Peter Landres and James Tricker of the Aldo Leopold Wilderness Research Institute, park staff have completed a wilderness character map. The report will be available later in 2015. Using the wilderness character framework, this map uses various digital spatial (GIS) datasets that represent degradation to the 5 wilderness character qualities.

- Informal (social) Trail Status Report. Most of the Denali backcountry has a "no formal trails" policy outside of busy nodes along the Denali Park Road as per the 2006 Backcountry Management Plan. Thus informal trail formation is of concern when trying keep adhere to the Denali "no formal trails" policy. The first report of a partial inventory of informal trails was published in 2014:

  https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=499805&file=DENA_Informal_Trails_Monitoring_Final.pdf

  The focus of this first effort was along the park road where a total of 323 informal trails were identified. More extensive trail networks have been documented in 14 backcountry units.

Soundscape Inventory and Monitoring Program

By Davyd Betchkal
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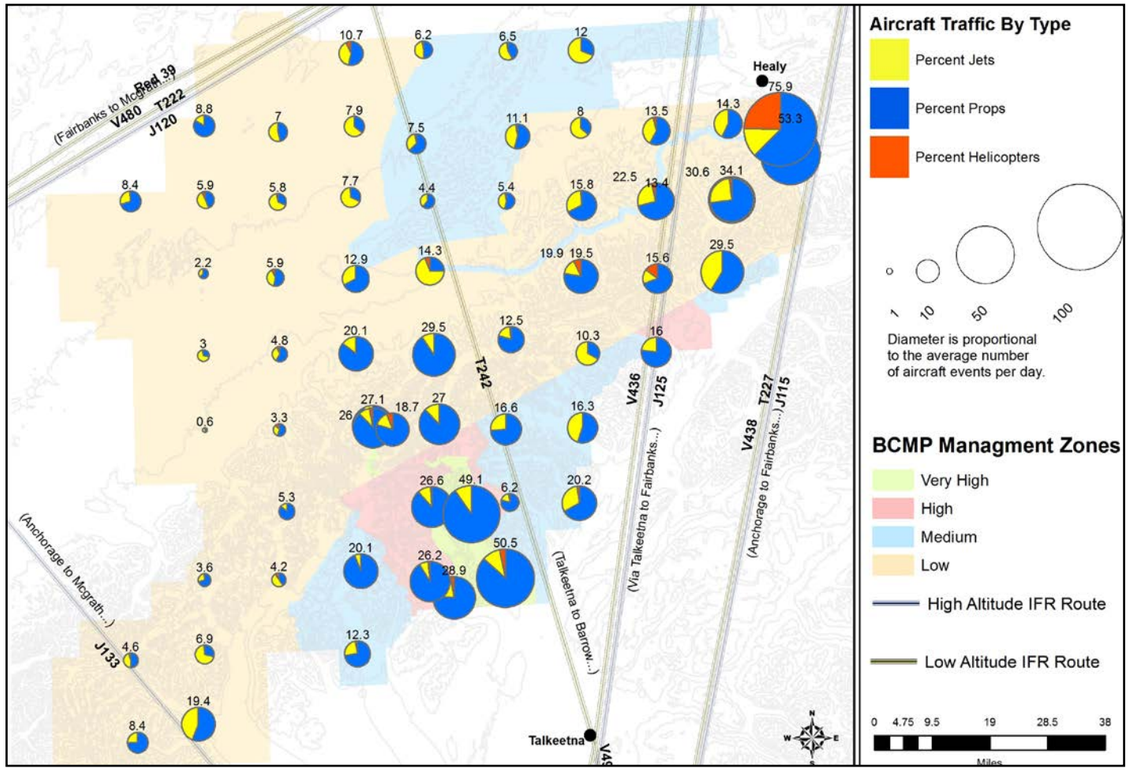
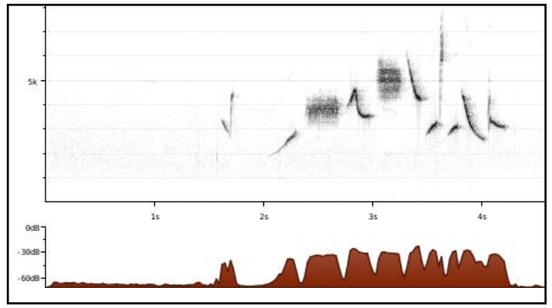
Soundscape research has been underway at Denali since 2001. Natural and human-generated sounds are being systematically inventoried across the entire landscape of the park, including popular backpacking areas, Mt. McKinley climbing routes, and along the park road. From digital recordings and sound levels that have been documented, park staff can calculate the percentage of time and the number of times per day that sounds are audible as well as the calibrated sound level (loudness) of important events. The sound-level data are used to compare the levels of human-made sounds to the natural ambient levels. Sound data are also converted into a visual representation - or spectrogram - from which a trained technician can identify aircraft overflights. Each aircraft is categorized by propulsion type (propeller plane, jet plane, or helicopter) for further understanding of daily traffic patterns.

Monitoring in 2014:

Soundscape staff implemented the seventh season of a revised systematic sampling plan in 2015, deploying seven automated sound monitoring stations and rotating them among 10 locations. These locations were: two winter-season sites, 6 Central Alaska Network (CAKN) Inventory & Monitoring grid points, 1 location to monitor commercial use on the Ruth Glacier, and 1 location to understand use at the McKinley National Park Airport. Over the ten-year period from 2006 through 2015, stations are scheduled to be placed at six new locations each year—each randomly selected from a 10x10 Km grid of 60 points spread evenly throughout the park. As the inventory comes to completion in 2015, a greater amount of work has been conducted on special projects – such as the focused study of specific noise sources within Denali, specific areas of interest, or assisting other parks in the Alaska region with soundscape issues. In 2014, eight sites were sampled outside of Denali: two in Noatak National Preserve to monitor aircraft use during the sport hunting season, and six in Gates of the Arctic National Park



Aircraft traffic as recorded at summer sound stations, with pie charts to show proportion of flights by aircraft type (piece of pie), and magnitude of aircraft events (size of pie).



(Upper graph) Spectrogram notation of a Fox Sparrow song, recorded at Fourth-of-July Creek in Denali National Preserve. (Xeno-Canto record XC118416)

and Preserve to collect baseline data in response to the State of Alaska's proposed construction of an industrial road to the community of Ambler, AK – a portion of which would be routed through the preserve.

From the acoustic data processed since 2006, Denali's natural soundscape is primarily characterized by the energy of wind and water – and at certain times or locations, the striking absence of that energy. In fact, the natural ambient level is usually logarithmically related to wind speed. The quietest level (when not limited by the instrumentation, itself,) is typically governed by the distance from nearby water sources and their power. Overlain upon these steady physical sounds are seasonal or daily cycles affected by sunlight or temperature. For instance, insect flight, bird song, and debris flows down steep-walled valleys all follow a unique but predictable daily pattern of occurrence related to light energy.

Human caused noise also follows a definite spatial-temporal pattern. At locations near common flightseeing routes, traffic rates commonly exceed 30 overflights per day. At landing strips, it is common to hear more than one-hundred. On the other hand, locations father away from common flightseeing routes rarely exceed ten overflights per day. This variation in traffic becomes clearer when visualized spatially. The following map shows a pie-chart breakdown of traffic by aircraft type for every site sampled in the inventory to date. The radius of the pie-chart circle is proportional to the average number of aircraft overflights per day.

In 2014, selections of bird song and calls were compiled from longer soundscape recordings to contribute to Xeno-Canto, a worldwide collaborative bioacoustics project. As described on the project's website, "Xeno-canto uses the evolving possibilities of the internet to: popularize bird sound recording worldwide, improve accessibility of bird sounds, & increase knowledge of bird sounds... Recordings are here for: enjoyment, education, conservation, & science."

175 recordings from 51 locations across Denali and the state of Alaska have been contributed to the project so far. These represent 54 species of birds, most of which are the northern-most example of the species on Xeno-Canto. Of these 31 were added as new species in 2014. Acoustic monitoring across a range of habitats has benefitted the detection of species rarely-recorded in North America - such as the Golden Eagle (Aquila chrysaetos), Great Grey Owl (Strix nebulosa), Wandering Tattler (Tringa incana), Long-tailed Jaeger (Stercorarius longicaudus), Whimbrel (Numenius phaeopus), and American Golden-plover (Pluvialis dominica).

Denali is continuing to develop the usefulness of sound stations in monitoring avian population, especially for estimates of occupancy, species richness or phenological timing. Because soundscape data have a large spatial extent, they can help extend management knowledge from traditional passerine surveys to greater areas of the park.

Denali's Xeno-Canto profile can be found here:
http://www.xeno-canto.org/recordist.php?id=NPYDVIEFTA
(or simply by searching "xeno canto Denali")

Upcoming work:

In 2015, the Denali soundscape inventory will be concluded by finishing the six remaining Inventory & Monitoring grid points. In addition, information will be collected at several of the portal airstrips to inform management about current aviation uses of the park.

Detailed soundscape reports can be found on the NPS Integrated Resource Management Applications (IRMA) website, here: **http://www.nature.nps.gov/publications/nrpm/nrds.cfm** by searching for "Betchkal OR Withers". A quick and easy-to-use interactive data map complete with a selection of audio clips can be found on the park website, here:
http://www.nps.gov/dena/naturescience/soundscape.htm

Administrative Overflights Monitoring

By Britta Schroeder
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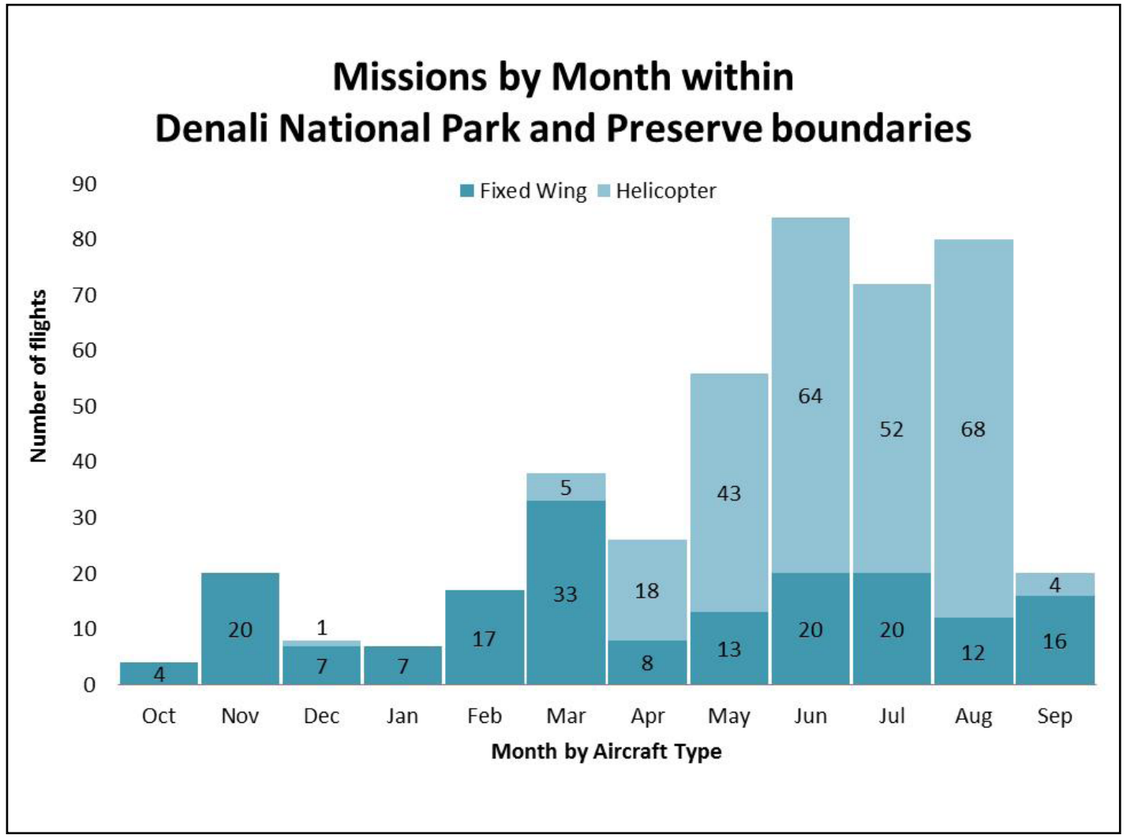
During the year 2014, administrative aircraft passing through Denali National Park and Preserve airspace were tracked spatially. This was the third year of monitoring and evaluated the amount of air traffic generated by park missions, as required in the Director's Order on Soundscape Preservation and Noise Management. This project also contributed to the monitoring efforts called for within the 2006 Backcountry Management Plan. Monitoring also documents adherence to the Best Management Practices as established by the Federal Advisory Committee on Denali Overflights.

The study area consisted of airspace within the boundaries of Denali National Park and Preserve. Based on noise propagation studies done previously, a thirteen kilometer buffer was created around the park for inclusion within the park soundscape analysis. The Federal Advisory Committee's Best Management Practices avoidance zone was also included for further analysis. Flights tracks were documented using GPS flight-following data to assess where and what types of flights were occurring in and around the park.

Of the 432 administrative flights in park airspace during 2014, the majority supported mountain operations and fees (173 flights). Over half (59%) of the flights were conducted by helicopter. Less than 6% of those flights took place in the park avoidance zone, and of those flights, most were associated with wildlife management. All totaled, administrative flights spent roughly 71% of the flight hours within the park soundscape.



Backside Lake 2014 Monitoring Results

By Rob Burrows, Wilderness Resources Specialist
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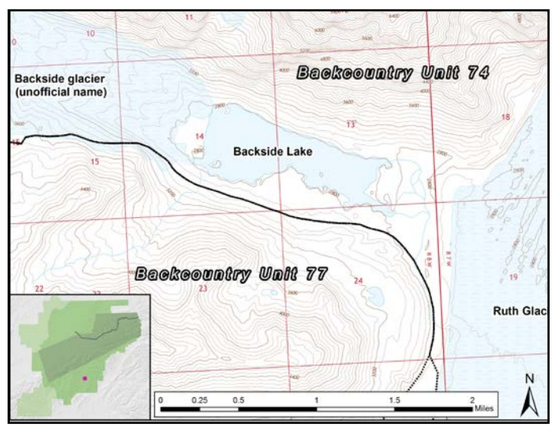
Backside Lake is located on the south side of the Alaska Range immediately adjacent to the lower Ruth Glacier at 2780 feet (see map). Currently, Backside is the only lake within the park that is being utilized for commercial float plane landings. Commercial landings are authorized there through the authority of Type III Concession Contracts, which authorize the holders to provide "Glacier landing air taxi and/or glacier landing scenic air tours for the public on glaciers within the boundaries of the 1980 south side park and preserve additions". At the present time, there are four concessioners authorized to provide these services. Private float planes may land on the lake as well. In addition, there is a gravel air strip located approximately one-half mile southeast of the lake. This access coupled with beautiful alpine terrain suitable for hiking and backpacking experiences are a desirable combination not readily available elsewhere within the park. Through air travel, visitors are inserted above timberline to explore glaciers, glacial lakes, alpine meadows, non-technical peaks and generally the grandeur of the Denali high country.



Numerous management overlays exist in the location of Backside Lake. As defined by the Denali National Park and Preserve Final Backcountry Management Plan of 2006 (the Plan), Backside lies within Management Area A, and well as within the Ruth Glacier Special Use Area. The purpose of Management Area A is defined in the Plan to "provide a diversity of opportunities for wilderness recreational activities that are relatively accessible to day-users and to those who have limited wilderness travel skills or equipment." The Ruth Glacier Special Use Area is defined in the Plan to "provide for high use of transportation services during the season when large numbers of day users are accessing the Ruth Amphitheater. Seasonal, May – September." In addition the Plan states that "Air taxi landings could occur throughout the park additions and preserve. To be considered an "air taxi" landing, the majority of passengers on the flight must either be dropped off or picked up from a day trip or overnight stay and passengers do not remain with their airplane while on the ground. 'Scenic air tour landings' are distinguished by passengers remaining with their airplane while on the ground. Scenic air tour landings will be allowed on glaciers in all areas designated as Management Area A." The Denali Superintendent has authorized these to take place on the lake as well.

Eight trips by 18 NPS staff from five work divisions made observations at Backside Lake between June 13 and September 12, 2014 on trips that varied from 3 to 10 days. Staff camped close to the lake and did day hikes similar to the base camping guides and clients and were present to make observations for a total of 49 full days out of a possible 86 days of the summer season (57% of total observed).

The primary CUA holder had mixed compliance with 2014 NPS CUA specific activity stipulations. However, they consistently practiced good sanitation, erected and maintained working bear fences around camps, and practiced appropriate hiking dispersion to protect soils and vegetation. CUA holders are stipulated to "have only one hiking group in the area at a time. This limit applies to both Day Hiking and Overnight Hiking groups; a CUA holder who provides both Day Hiking and Overnight Hiking services in the same area must limit the number and coordinate the movement

of their groups to adhere to this requirement. A short overlap of groups arriving at or departing the area while waiting for air taxi transportation is allowed." However, this was violated on 68% of the trips.

Staff observed at least 17 species of wildlife in the vicinity of Backside Lake including nesting/rearing rock ptarmigan and semi-palmated plovers. Bears were observed in the area on 12 days. All observations were of black bears except one sighting of a grizzly bear. Bears were commonly seen on the alpine tundra benches and ridges to the south of Backside Lake. There were three occurrences of bears entering the camps of NPS staff. No damage was done, nor did bears get into human food. However they were relatively unafraid of humans and one black bear pawed at a tent with the human occupants inside.
Estimates of visitor use numbers at and around the lake come from two sources 1) self-reported data from the concession and CUA holders; 2) observations by NPS staff.

Observations from NPS staff indicate that the vast majority of visitor use is guided. According to the CUA holder reported data they guided 385 people, of which 72% were day visitors and 28% were overnight.

Generally, the amount of people and aircraft use observed by NPS staff seems to concur with that reported by concession and CUA holders, however the goal of NPS observations was not to capture absolute numbers of people, but rather to observe encounters with aircraft and people and their current activity (day hiking, backpacking, base camping at the lake, and briefly landing during a scenic air tour (SAT)). The only discrepancy between the data reported by commercial operations and NPS is regarding SAT landings. The NPS observed 13 SAT landings during observation days, whereas only 2 were reported. The definition for SAT used by field observers assumed that landings with a stopover of less than an hour that did not drop off or pick up people were SATs. However, passengers embarking and disembarking from the plane was not specifically tracked by NPS staff but all of the landings field observers identified as SATs beached on the NW corner of the lakeshore, which is not a convenient drop off location for longer day hikers or overnight users.

Field observers did not focus on capturing numbers of individual people that visited the area, but rather the number of encounters with other groups of people. Encounters with other groups are an important Plan indicator because they affect opportunities for solitude and movement of groups back and forth across the same areas have an effect on informal trail impacts.

The numbers of encounters with other groups were somewhat inflated by the presence of NPS staff since they were another group to be encountered. While removing the NPS group could drop the observed indicator to the level at or below the standard, the data including the NPS is considered valuable because their observations represent what an additional group base camping by the lake may experience. While very few private groups were observed, it is likely that word will spread about this area and it will receive more independent/ private visitors in future years.

Since NPS observers noted if other groups exclusive of themselves camped within sight of each other it was possible to remove that impact from calculating the indicator, which brought the percent of days exceeding the standard from 41% to 10%.

Encounters with modern equipment were driven primarily by seeing float planes on the lake. A few small landscape modifications such as cairns (many of which marked the gravel airstrip as well as trails), float plane anchor, and evidence of an old campsite were included in the encounters, but CUA holder camps are not included in this number even though these camps had electric bear fences, buckets for food storage, toilet buckets, and tent pad excavations. Counting any of these landscape modifications, but particularly the CUA camps pushes the "No landscape modifications allowed for visitor use" indicator out of compliance.

Condition	Indicator	Standard for Ruth Glacier Special Use Area (to be within standard, the number of exceeded observations should be 5% or less of total observations, unless stated otherwise)	Observed Conditions at Backside Lake, 2014
Social Conditions	Encounters with other groups of people	High – up to 5 encounters/day	14% of observed days exceeded
	Encounters with large groups (>6)	Yes – of the 5 groups up to 2 may have 6 or more people.	8% of observed days exceeded
	Camping Density	Low – always able to camp out of sight and sound.	41% of days observed exceeded (with NPS staff included) With NPS staff removed from the mix 10% of days observed exceeded the standard.
	Accessibility	Low-Very Low: NPS management generally determines the degree of accessibility such that visits to these areas require significant time commitment, some specialized backcountry travel skills, advance planning, and a high degree of self-reliance	An assessement of accessibility was not conducted during this study.
	Administrative Presence	Medium – Rangers may make routine visitor contacts, so visitors may be aware of administrative presence. Visitors may occasional encounter staff or permitted researchers involved in monitoring and research.	NPS rangers and staff made routine visitor contacts in 2014.
Resource Conditions	Trail and Campsite Disturbance	Medium – Occasional social trails and campsites. Similar to Old Park.	There is no place in the Old Park Backcountry with similar use and impacts to the impactted area adjacent to Backside Lake. Inform trails and campsites expanded in size between 2013 and 2014.
	Evidence of Modern Human Use	Medium – 3 encounters/day with modern equipment and landscape modifications	20% of observation days exceeded 3 encounters. This is primarily driven by floatplane landings (85% of observations).
	Landscape modifications allowed for visitor use?	No	CUA holder campsites, trail markers, and float plane anchor are all mitigations for visitor use
	Encounters with litter and human waste	Low – 5% of visitors surveyed encounter.	27% of days observed, staff encountered litter.
	Natural Sound Disturbance	See separate summary	See separate summary

Table A.

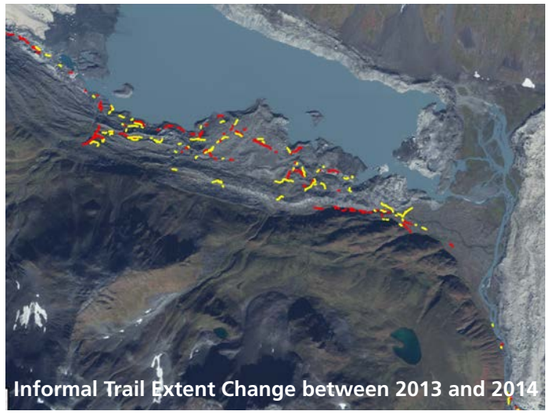
Comparison of observations with the Plan indicator standards. Eight of the nine Plan indicators had standards that were exceeded during this study (Table B and C). Standards that are exceeded up to 25% of the time are highlighted yellow, whereas those above are highlighted in red.

The level of informal trail disturbance appears to be similar to Old Park 1 management area where there are trail impacts around nodes and much larger unimpacted or lightly impacted areas surrounding the nodes. However the level of campsite disturbance is very different than anywhere in the backcountry of OP1 because of the concentration of campsites near to the shore of Backside Lake. Informal trail length expanded by 3.5% between July 2013 and August 2014. Informal campsite impacts increased 927% from 75 m^2 impacted to 770 m^2.

The Backside Lake site was located in the Ruth Glacier Special Use Area, which is to be managed for a 'Very High' level of soundscape impact. Despite these very high thresholds, soundscape conditions created by air traffic are chronically out of standard.

Measuring the rate and overall number of aircraft takeoffs at Backside Lake was the second major purpose behind deploying a sound station in the area. Over the sampling period from 05/15/2014 through 09/11/2014 (a period of 119 days) there were 155 takeoffs counted from Backside Lake. There were 140 landings/takeoffs from K2's self reported data and NPS contracted flights between 5/15 and 9/11. The higher count as determined from the soundscape station data could be from private aircraft landings/takeoffs and/or errors of interpretation in the soundscape data. In addition K2 had 5 ski plane takeoffs/landings in mid April 2014 for skiiers.

The first take off event of the summer season occurred on 06/15/2014 (which concurs with K2's data), a month into the soundscape record, which



means the effective sampling period is only 88 days. Over this shorter period, 20 days (or 23%) had no takeoffs during the day. The maximum number of takeoffs in a day was 6, occurring on 06/23/14. The median was 1.0 takeoffs per day, while the average was 1.8 takeoffs per day.

Although it is not an official indicator, it is worth considering noise free interval (NFI) at Backside Lake as well. A noise free interval is simply the typical quiet time between successive noise events. As such it is the experiential manifestation of traffic rate. The two are inversely related such that as the number of noise events increases from zero, NFI drops quickly at first and then asymptotically approaches zero. For instance, with a median traffic rate of 50 events per day, the median noise free interval at Backside Lake in 2014 was four minutes. Only 3% of intervals were longer than 4 hours.

Soundscape Indicator	Soundscape Standard	Exceedance of the Standard at Backside Lake, 2014
Percentage of time noise was audible during any hour.	Noise is audible no more than 50% of any hour. (30 minutes cumulatively in an hour.)	9.5% of hours exceeded the standard.
Number of noise events per day.	No more than 50 events per day.	49.1% of days exceeded the standard. Maximum Sound Pressure Level of a noise event.
Maximum Sound Pressure Level of a noise event.	Noise shall not exceed 60 dBA.	13.7% of events exceeded the standard.

Table B.

Backcountry Management Plan (NPS 2006) indicators and standards for the Ruth Glacier Special Use Area (Very High) soundscape management zone. Exceedance of each standard is summarized for Backside Lake during the summer of 2014.

Plants and Vegetation

CAKN Aspen Phenology Monitoring

By Carl Roland and Fleur Nicklen
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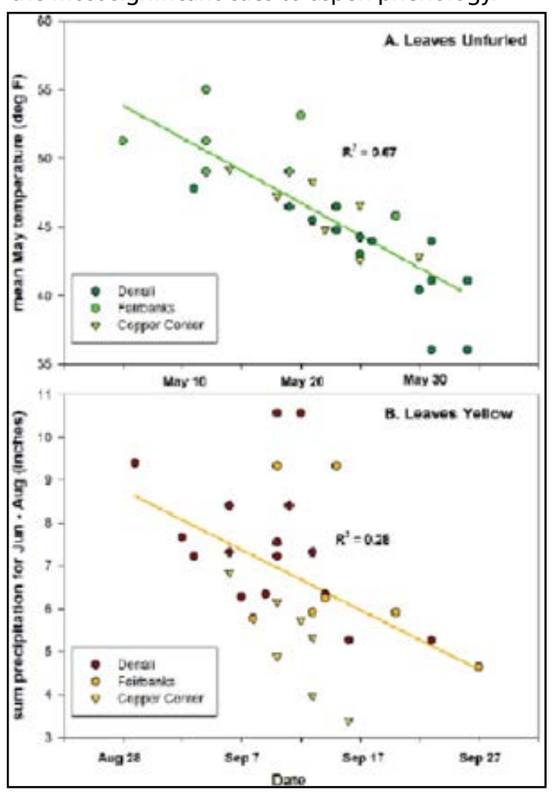
Purpose:

The Central Alaska Network monitors phenology because there is considerable evidence from studies around the world that climate change is advancing the timing of flowering and leaf-out and extending the growing season of plants in northern latitudes and high elevations. A longer growing season has important consequences for plant growth and reproduction, plant-animal interactions like herbivory and pollination, and factors interacting with climate such as carbon exchange and albedo. Our objectives are to determine whether the dates of aspen flowering, leaf-out and senescence are changing over time and what climatic variables are the most significant cues to aspen phenology.



Implementation:

The CAKN began monitoring the timing of flowering, leaf-out and senescence in aspen (Populus tremuloides) in Denali in 2005, and started making observations in Fairbanks and Copper Center in the intervening years. Aspen was chosen because it is a circumpolar species studied by other phenology monitoring programs in the country.

Results:

Initial findings show leaf-out in aspen is highly correlated with spring temperatures: just within the Denali plots leaf-out occurred up to 19 days earlier with a 10° F increase in mean May temperature (Fig 1A). Including the other sites data, we find an increase of 15 degrees in mean May temperature shifts the unfurl date forward by nearly a month. The climate driver of senescence is less clear. So far the data show weak a negative correlation between senescence and summer precipitation, that is, leaves turned yellow sooner in rainier summers (Fig. 1B). The growing season length (# of days between unfurl and senescence) varied from year to year—for example, the longest growing observed in Denali was 114 days and the shortest was 95 days, representing a possible 18% variability in time available for growth and development. For comparison the shortest and longest growing seasons in Copper Center were 107 and 119 days and 117 and 133 days in Fairbanks (note: fewer observations years in these areas) . Overall, these observations suggest warmer springs will lead to earlier green-up and longer growing seasons, while drier summers and autumns may lead to later senescence.

Figure 1. (Left)- Each point represents the date of leaf unfurling (A) or date of leaves yellow (B) for years in which measurements were made in Denali (2005-14 for two plots), Copper Center (2008-14 for one plot) and Fairbanks (2010-14 for one plot, 2012-14 for a second plot) in relation to mean May temperature (A) and precipitation sum during June - August (B) measureed at the climate station closest to the respective aspen plots. Date of unfurling is defined at the date by which all trees at the plot had open leaves. Leaves yellow is defined at the data by which all trees' in the plot had leaves were >50% yellow.

Off-Road Vehicle (ORV) Impacts

By Sarah Stehn
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The Cantwell Traditional Use Area, located in the areas around the town of Cantwell, allows subsistence users to operate off-road vehicles (ORV) for subsistence hunting purposes. ORV use is permitted on three established trails or routes within the Cantwell Traditional Use Area, totaling approximately 11km: the Windy Creek Trail, the Pyramid Peak Trail and along the Cantwell Creek Floodplain Route. To ensure that excess resource damage does not occur because of this allowance, beginning in 2006, Botany program staff has conducted annual monitoring to document trail use, extent, and condition - including any impacts or incursions beyond established trails (Figure 1).

Figure 1. Resources staff records ORV trail condition in the Cantwell Traditional Use Area.

Overall, trail use remains stable across the area. It is likely that the same users are using the trails in the same way each year to fulfill their subsistence hunting needs. Trail conditions vary among the different trails, but in general increased signage and marking of routes and boundaries appears to have concentrated ORV impacts to smaller areas. Additionally, areas of past ORV incursion are showing signs of recovery (Figure 2), indicating that further incursions in those areas have been avoided. Monitoring will continue in 2015.

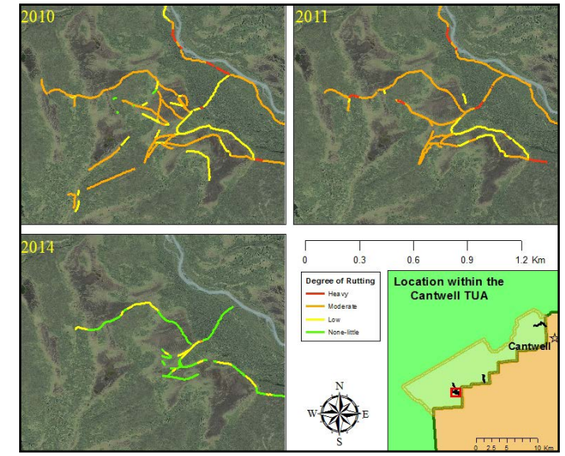

Figure 2. - This area west of the Cantwell Creek floodplain is trending towards recovery, albeit slowly, from damage caused by illegal ORV use prior to 2006. GPS mapping has revealed reduction in trail length and damage severity classes.

CAKN Surface Temperature Along an Elevation Gradient

By Carl Roland and Fleur Nicklen
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Purpose:

The impetus for this project came from the observation that treeline, shrubline, and tundraline are about 200 to 400 meters higher in Wrangell-St. Elias (WRST) and Yukon-Charley Rivers (YUCH) relative to Denali. This difference in vegetation line may be due to warmer growing season temperatures in the eastern, more interior part of the state, where WRST and YUCH are located, but we need more detailed climate data then is currently available to answer this question. This project seeks to fill in this gap and explain the observed differences in vegetation line between the eastern AK parks and Denali.

Implementation:

Starting in the spring of 2010, we placed air and soil temperature sensors (10cm into mineral soil) every 125 m in elevation along a north and south transect on Mt. Healy for the duration of the growing season. Starting in 2013 we placed sensors reliable in winter conditions on the Mt. Healy transects as well as in YUCH in the Ogilvie Mtns. In 2014 we additionally installed sensors in WRST off the Nabesna Rd. When we installed the

temperature sensors, we measured the depth of the living material (moss, lichen, forbs or dwarf shrubs) and the depth the organic layer in the soil (decomposing organic material). In 2014, we got the first growing season and over winter data from 3 parks (Fig. 1).

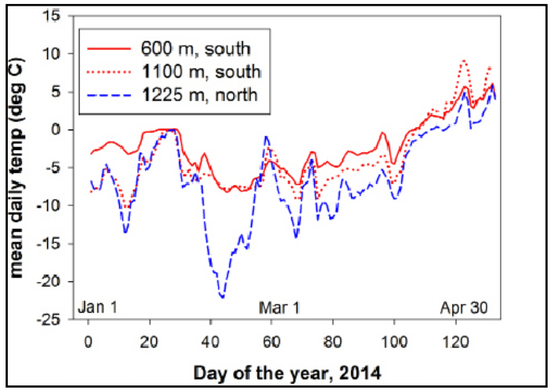

Figure 1. Mean daily temperatures recorded from Jan 1 to Apr 30 at three locations along the Mt. Healy surface temperature transects.

Results:

Comparison of temperatures from Denali and the parks in the eastern part of the state will have to wait until this summer when we collect the data from the sensors currently recording temperatures in the three parks. We do have some overwinter data from Denali, but most of the sensors were left recording. The initial winter data shows soil temperatures averaged around -5° C during Jan and Feb, except for one plunge to -22° C in mid Feb 2014 at the highest elevation sensor. This may correspond to a wind event. Growing season temperature data from 2010-2014 gives us information about variation in temperature along north and south-facing elevation gradients in Denali. In general the growing season air temperatures were similar on the north and south side of Mt. Healy, but the soil temperature was colder on the north side compared to the south side (Fig.2). Air temperature decreased with increasing elevation as you would expect. Soil temperatures, on the other hand, generally increased with increasing elevation and were colder on the north side of the mountain. The depth of living and organic mat was strongly inversely correlated with soil temperature (Fig.2). This pattern results in having a greater temperature disparity between the air and soil at lower elevations and little difference at high elevations. The difference between air and soil temperatures is most dramatic on north aspects (Fig. 2), which creates extreme growing conditions for plants. On the north slopes with thick living and organic mats, plants' roots experience near freezing conditions while their branches exist in much hotter conditions.

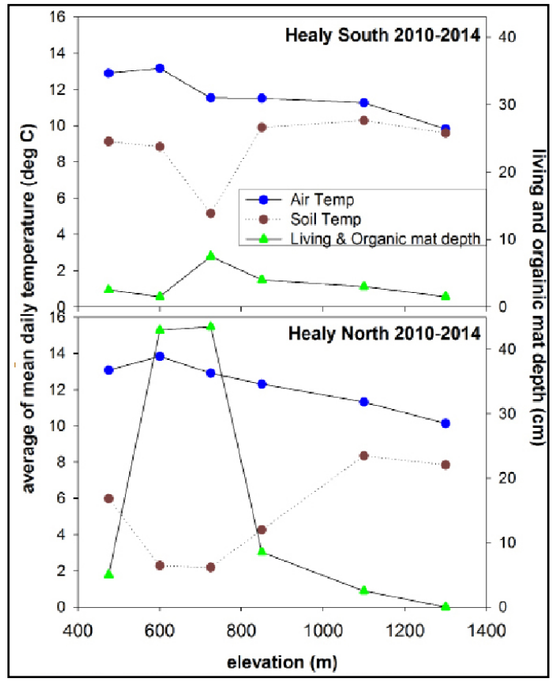

Figure 2. Average of mean daily temperature between June 1 and August 31 for the years 2010-2014 as well as the depth of living mat and organicmaterial for six different elevations on Mt. Healy north and south.

Monitoring Dust Pallative Use along the Park Road

By Sarah Stehn
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To reduce road dust created by vehicular traffic, park maintenance crews apply an aqueous solution of calcium chloride (CaCl2) to the surface of the park road. The application reduces dust and the subsequent need to replace fine materials lost from the road as dust, but also has the potential to adversely affect ecosystems adjacent to the road. The addition of CaCl2 in high quantity has the ability to alter soil chemistry and subsequently the naturally occurring balance of ions available for plants and micro-organisms.

The National Park Service has thus developed a monitoring plan to assess and monitor the possible effects of applying CaCl2 to the park road on soil, water, and vegetation. In 2005, park staff installed 15 pairs of lysimeters (instruments designed to sample water from within the topsoil) at Mile 15, 18, 22, 23, 27, 29, 31, 41, 49, 58, 60, 65, 71, 80, and 88 - one lysimeter was buried near the road, and one about 10 meters away. Water samples are collected annually from lysimeters (Figure 1) and nearby water bodies to test chloride concentration.

2014 was a relatively cool and wet year, and thus less CaCl2 was applied, over fewer road miles, to the park road than last year which was hot and dry (Figure 2). Overall, application of CaCl2, both in terms of total mileage and application concentration, has decreased over time, as park maintenance personnel have learned the most effective times and concentrations at which to apply the compound (Figure 2). However, because an accumulation of CaCl2 over many years (Figure 3) may be what affects the roadside biota the most, monitoring will always be necessary. Staff will continue to monitor the 15 soil lysimeter stations in 2015, and perform other analyses of soil and vegetation chemistry to further investigate possible implications of 10 years of CaCl2 application.

Figure 1. (left) Staff collecting soil water from a soil lysimeter buried along the park road. These white bottles are left out for parts of two days (overnight) in late August. During the rest of the year, no evidence of the soil lysimeters or monitoring is visible from the park road

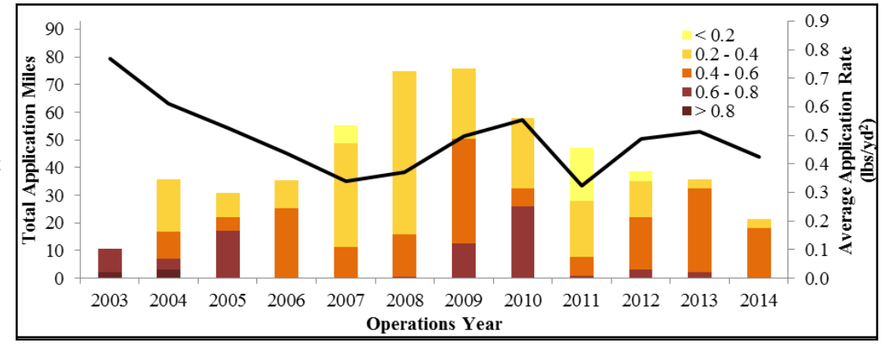

Figure 2. Application of $CaCl_2$ across years. Bars show total miles affected by application and the proportion of the proportion of those miles receiving different concentration of $CaCl_2$ (lbs/yd^2). Line shows the average application rate per year across all miles in which $CaCl_2$ was applied.

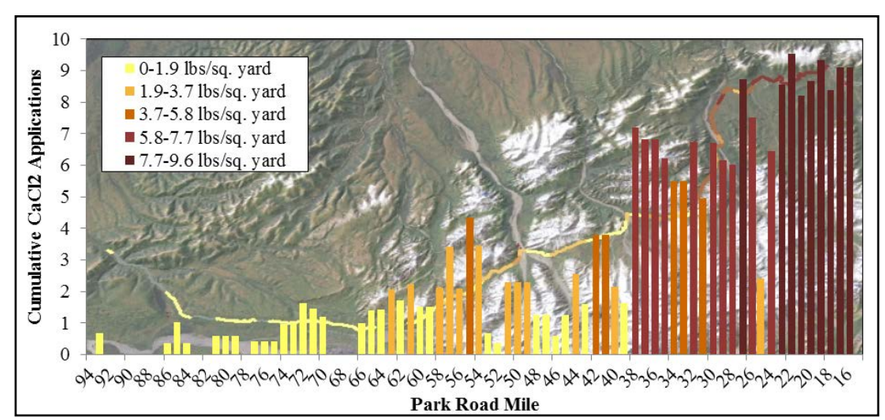

Figure 3. Cumulative $CaCl_2$ applications per mile of the Denali Park Road

Denali Tree Ring Analysis

By Carl Roland and Fleur Nicklen
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Purpose:

Changes in climate are anticipated to alter ecosystem structure and function within the boreal forest. Such changes are not likely to occur uniformly over a heterogeneous landscape. A first step in understanding how boreal forest tree species distribution may look in the future is to quantify tree growth response to climatic variability in different topographic and site conditions. Our objective here was to quantify basal area growth response of the two most abundant trees species in Denali, Picea glauca and Picea mariana, to climate across a landscape variable in slope, aspect, elevation and permafrost cover.

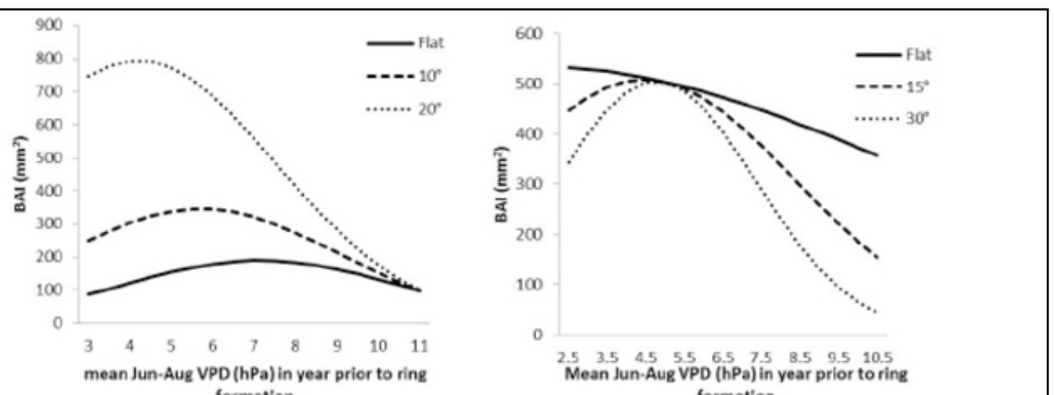
Implementation:

As a part of the CAKN vegetation monitoring program, we extracted cores from four trees near each monitoring plot (if there were trees to core). To date we have cored nearly 2000s trees across Denali, Wrangell-St. Elias and Yukon-Charley. The tree ring labs at Middlebury College and the University of Greifswald measured the rings and assigned a year to each annual growth ring. For the Denali project, we used tree ring measurements from 500 trees cored from 222 plots sampled in the Denali vegetation monitoring grid to inform linear mixed models of the relationship between yearly basal area growth (BAI), climate variables and landscape position.

Results:

Highest Picea mariana growth occurred on steep slopes in years with rainfall much higher than average and low vapor pressure deficit (VPD). Low VPD occurs during cool conditions and high VPD occurs in hot dry conditions. P. mariana growing in areas with GsSFS (growing season frozen soil) accumulated 25% less wood annually (240mm2 to 180mm2) and did not benefit from high rainfall compared to P. mariana not on GsSFS.

Picea glauca growth in response to climatic conditions was largely dependent on slope angle and elevation. Highest P. glauca growth occurred on flat slopes at low elevations without GsSFS in years when Jun-Aug rainfall was a little below average and when VPD values were slightly lower than the 1903-2009 average. The presence of GsSFS reduced P. glauca growth by a third (503 mm2 to 330 mm2). P. glauca responded positively to Jun-Aug rainfall when growing on moderate to steep slopes, but negatively when growing on flat slopes. Trees at low elevations, where growing season conditions are warmer, decreased growth in response to increasing Jun-Aug VPD, while P. glauca growing near the limit of treeline increased growth. The mean summer VPD at headquarters would have to rise from the 1903-2009 mean of 5.9 hPa to 11.7 hPa for P. glauca at treeline to accrete more wood annually than trees at the lowest elevations in Denali. Overall, increasing future temperatures are likely to benefit high elevation tree growth, but decrease P. mariana growth on steep slopes and P. glauca growth in low, flat areas. Areas were permafrost may degrade have the potential of having > 25% increase in tree growth.



BAI (mm²) growth response of *Picea mariana* (left) *and Picea glauca (*right) growing in Denali National Park to the observed range of mean Jun-Aug vapor pressure deficit (VPD) during the years 1903-2009 at different plot slope angles. Model parameters not displayed are held at mean value.

White Spruce Cone Production and Seed Viability Monitoring

By Sarah Stehn and Carl Roland
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Within the Rock Creek drainage near Park Headquarters, botany program staff has monitored a set of permanent plots since 1992. In these set of plots, located at treeline and in the forest, staff document diameter growth, cone production (Figure 1), seed production (Figure 2), and seed viability (Figure 3) of white spruce (Picea glauca) annually.

Figure 1. Botany interns use binoculars to count white spruce cones on Forest trees.

Data indicates that spruce cone production occurs on approximately 3 year cycles, with climate conditions of the preceding years being the deciding factors in both seedfall and seed viability. For example, recent research from these plots suggests that an optimal cone production year will arise after two wet summers and low snow winters (in which reserves for cone growth are stored), followed by a warm and dry early summer (when cones are initiated), and capped with a wet, cool summer just before seed dispersal (when cone maturation is complete).

Figure 2. A seed trap awaits for white spruce cone and seedfall. Traps are set out (as pictured) at the end of summer, and retrieved for seed counting in the spring

Fewer cones were produced in 2014 than 2013, one of the highest cone production years in the Rock Creek drainage since 1992 (Figure 4). 1998 and 2000 remain the highest production years. However, data collected in Rock Creek has allowed a better understanding that cone production does not necessarily equate to viable seed production. In fact, the novel he results of this project were published in the international ecological journal Oecologia by Carl Roland and others, where you can read about more detailed results of this program (see reference on the next page). In summary, slightly different climatic factors control seed viability, and thus a large number of cones do not necessarily contain a high percentage of viable seed. Monitoring of the Rock Creek plots will continue in 2015, adding to one of the longest-term records of white spruce seed production and viability in Alaska.

Figure 3. White spruce seeds are quite small, but attached to a large wing. A dissecting microscope is used to confirm their identity as they are sorted for seed germination trails, enacted to test seed viability each year.

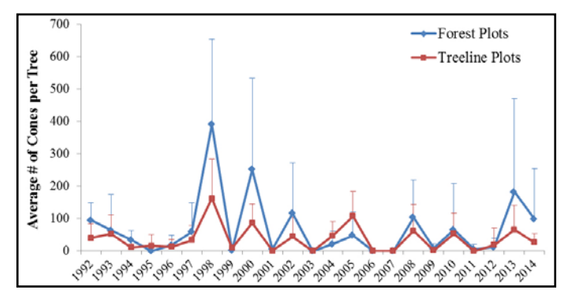

Figure 4. Annual cone production of white spruce trees in the Rock Creek drainage. Data points represent the average cone production among 15 trees at 3 sites each in the forest or treeline. Error bars show the standard deviation between trees.

Reference:

Climate sensitivity of reproduction in a mast-seeding boreal conifer across its distributional range from lowland to treeline forests. By Carl Roland, Joshua Schmidt, and Jill Johnstone; Oecologia (2014) 174:665-677.

Native Seed Collections

by Wendy Mahovlic
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Wendy Mahovlic, along with 7 SAGA (Southeast Alaska Guidance Association) volunteers and other volunteers collected a total of 26 lbs (uncleaned weight) of native seeds for revegetation projects. These voluneers donated a total of 390 hours and made it possible to revegetate 2.25 acres with native seeds.

Seed collections were made at the east and west ends of the park:

	East	West
Headysarum alpinum	4 lbs	2 lbs
Elymus sp	8 lbs	4 lbs
Hedysarum mackenzil	6 lbs	0 lbs
Leymus Innovatus	0 lbs	1 lb
Oxytopis campestris	0 lbs	8 lbs
Arnica lessingii	0 lbs	1lb
Total	18lbs	8 lbs

Eradication of Invasive Plant Species

by Wendy Mahovlic
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Wendy Mahovlic, a.k.a., the Dandelion Queen, along with a Student Conservation Association (SCA) intern and volunteers, including some from SAGA (Southeast Alaska Guidance Association), pulled a total of 3163lbs of invasive plant species in 2014 (see table on next page). Volunteers and the SCA intern invested 1524 hours in eradication efforts.

Plant Species Removed	Common Name	Pounds Removed	Location Where Removed
Hordeum jubatum	Foxtail Barley	1079 lbs	Miles 237.25 and 238 Parks Hwy; scattered Mile 1-2 park road, Shaffer Bldg, CLA Bldg., Kennels Road
Taraxacum officinale	Dandelion	891 lbs	Mile 1 - 43, Mile 72 - 92 of the park road
Vicia cracca	Bird Vetch	515 lbs (lots of dirt)	Mile 240 and 231 Parks Hwy and Denali Education Center. Mile 1 Park Rd.
Crepis tectorum	Narrowleaf Hawk's-Beard	493 lbs	Sewage Lagoon, Mile 1 of the park road, Bus parking lot
Melilotus alba	White Sweet Clover	85 lbs	Mile 232.5 and Mile 238 Parks Highway
Lupinus polyphyllus	Bigleaf Lupine	60lbs	Mile 7 pull-out Park Rd.
Galeopsis bifida	Hempnettle	1lb	Kantishna Horse Corral
Linaria vulgaris	Yellow Toadflax	1 lbs	Railroad tracks, Denali Depot
Trifolium pratense	Red Clover	3lbs	Mile 1 Park Rd.

Hundreds of pounds of invasive plant species were pulled in 2014 (listed here in order of pounds pulled).

Wildland Fire

Wildland Fire

By Larry Weddle, Fire Management Officer
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Fire Highlights for 2014:

There were no wildfires in Denali in 2014. There are six years of the previous 30 years (1995-2014) where no wildfires were detected in Denali. The fire season in 2014 started off in May with indications of being a potentially extreme season with fire danger conditions very high throughout much of the Park. However the extremely dry conditions abated prior to the portion of the season where natural ignitions occur due to lightning. Damp conditions persisted throughout the remainder of the fire season.

On numerous occasions in 2014, the Western Area Fire Management staff at Denali cooperated with the State of Alaska's Division of Forestry and supported multiple fires in the lower 48. Managing fires, outside of the park, was accomplished by implementing the "Closest Forces" concept: NPS personnel assisted suppression actions on wildfires throughout the central and eastern portion of the state. For example, the Fire Exclusive Use Helicopter was utilized as a reconnaissance platform on the Popavich fire outside of Healy, supporting the State of Alaska's Division of Forestry, Fairbanks Area and was assigned to the 100 Mile creek fire, supporting the Military Zone. Denali's staff assisted the State of Alaska's Division of Forestry, Mat-Su, Tok , and Kenai-Kodiak Area's in support of suppressing numerous fire starts in the early spring, plus sent staff multiple times with the Interagency Type 2 Hand Crew in support of fires in the lower 48. Denali staff also detailed to the Zion Helitack crew in support of their operation and attended the Grand Canyon Helicopter Academy.

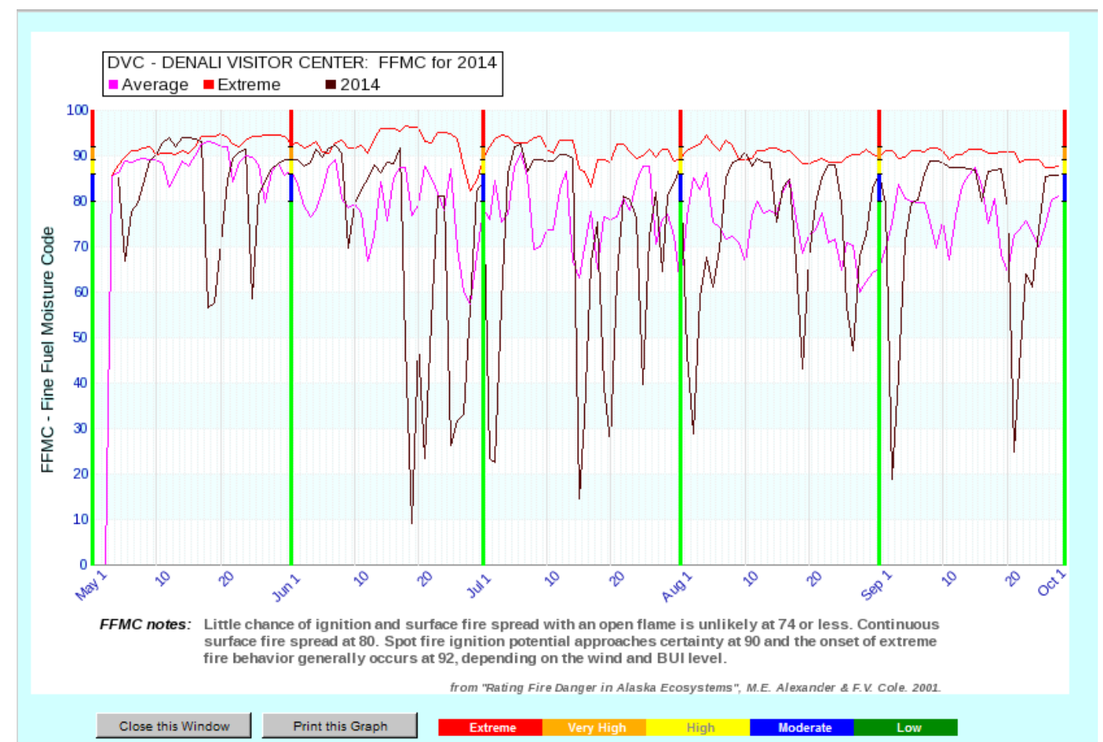


Figure 1. FFMC (Fine Fuel Moisture Code) represents the moisture content of litter and cured fine fuels. It expresses the ease of ignition and fuel flammability. This graph depicts the data from May to October of 2014 for the Denali Visitor Center weather station.

There were no wildfires and two prescribed fires in Denali in 2014:

Fire Name	Burn Period	Acres	NPS Acres	Fire Type	Comments
FY 2014 Admin Rd 1 RX Burn	12/19/13-12/24/13	7.18	7.18	Prescribed Fire[1]	Burning of biomass debris from roadside maintenance projects and haward fuels treatment project
Toklat Pile RX Burn	9/8/14- 9/10/14	1.85	1.85	Prescribed Fire[1]	Burning of biomass debris from roadside maintenance projects and haward fuels treatment project

[1] Prescribed fire is a fire ignited by management actions under certain, predetermined conditions to meet specific objectives related to hazardous fuels or habitat improvement. Prior to a prescribed fire, a written, approved prescribed fire plan must exist and NEPA requirements must be met.

Monitoring Wildland Fires

Denali National Park and Preserve has 3,359,449 acres (out of a total of 6+ million) that are covered by burnable vegetation. Eighty-nine percent of the burnable vegetation acres (2,983,460 acres) lie within "limited fire management options". These options allow fire to play its natural role in the ecosystem. Although some wildland fires are suppressed because they threaten natural or cultural values, the emphasis of the fire management program at Denali is on actively monitoring wildland fires while they burn, and on protecting individual isolated structures in the fire's path. Fire monitoring includes observing a fire from aircraft, digitally photographing and mapping its progress, and keeping an updated narrative of the fire's status and behavior. Current and forecasted weather over the fire area is also monitored to ensure that the fire will continue to burn only where allowed. Protecting isolated structures that lie in the fire's path is generally accomplished by setting up a water pump and sprinkler system on or around the structure as most structures tend to be located adjacent to water sources.

Creating Defensible Space Around Structures

The National Park Service (NPS) fire management program conducts hazardous fuel reduction projects around infrastructure, values at risk or near communities adjacent to park lands in order to provide defensible space and to mitigate wildfire hazards. Firewise is the name given to the creation of defensible space by thinning, limbing, or clearing space around infrastructure and structures.

Much of the built environment in Denali was constructed during the 1920s and 1930s. Structures were often built close to the forest edge or the forest has since grown back into the areas disturbed during construction. The photos below show how trees and brush have grown up between 2004, the last time hazard fuels reduction was done, and 2014 at the Stampede Mine; indicating the continued need for fuels reduction.

Hazardous fuels around structures in the developed and backcountry areas of Denali have or are being reduced to create a "defensible space" around the structures. Creating a defensible space includes clearing all flammable vegetation within 30', and thinning the vegetation that lies within 30' to 100' of the structure (cutting some trees, other vegetation; removing lower branches of trees). The defensible space reduces the risk of property damage in the event of a wildland fire and improves safety for visitors, residents, and firefighters.

Left: Stampede Mine brush grown up since 2004 before hazard fuels reduction.
Right: Stampede Mine after hazard fuels reduction. NPS photo 2014.

In 2014, fire management staff improved the defensible space (about 9 acres) at Toklat Road Camp and near Park Headquarters at the Rock House by trimming branches to varying heights from the ground to give a natural appearance. In addition, maintenance treatment to the Moose Creek Patrol Cabin, Stampede Mine, Little Annie Mine, and Gallop Cabin were completed in the summer of 2014.

During 2015, the fire staff plans to create or maintain defensible space for the Toklat Road Camp complex and near select aviation facilities. This will be the initial treatment for the northern portion of Toklat Road Camp and the Kantishna Helished and they will then enter a maintenance cycle after this year. Limbing and some cutting/thinning is planned in Toklat, around the front country and select aviation facilities as part of the cyclic maintenance and improvements to the past hazard fuels projects.

Throughout the defensible space projects, fire staff will provide Denali employees with project updates and other fire information. The fire crew documents hazard fuels thinning around backcountry structures using photos. Hazard fuel success stories are posted at:

http://www.nps.gov/fire/wildland-fire/connect/fire-stories/2014-parks.cfm

Defensible space projects planned for 2015

Project Name	Date	Acres	Treatment	Comments
PAIN Helished	5/13 - 9/26	.88	Maintain	Maintain defensible space
Toklat Road Camp (Unit 1, 2, 3, 4, 5, 6)	5/13 - 9/26	9	Initial and maintain	Create/improve defensible space
Optional Treatment				
Busia Cabin	5/13 - 9/26	1.09	Initial	Create defensible space
Kantishna Helished	5/13 - 9/26	.88	Initial	Create defensible space
C-Camp Cabins (Unit 5)	5/13 - 9/26	2.59	Maintain	Maintain defensible space
Murie Science and Learning Center	5/13 - 9/26	4.36	Initial and Maintain	Create/improve defensible space
Erratics	5/13 - 9/26	4.75	Initial	Evaluate need of defensible space
Evaluations				
Lower Windy Patrol Cabin	5/13 - 9/26	N/A	Evaluation	Evaluate need of defensible space
Upper Windy Patrol Cabin	5/13 - 9/26	N/A	Evaluation	Evaluate need of defensible space
Riley Creek Patrol Cabin	5/13 - 9/26	N/A	Evaluation	Evaluate need of defensible space
Lower Savage Patrol Cabin	5/13 - 9/26	N/A	Evaluation	Evaluate need of defensible space
Sushana Patrol Cabin	5/13 - 9/26	N/A	Evaluation	Evaluate need of defensible space
Lower East Fork Patrol Cabin	5/13 - 9/26	N/A	Evaluation	Evaluate need of defensible space
Lower Toklat Patrol Cabin	5/13 - 9/26	N/A	Evaluation	Evaluate need of defensible space
New Thorofare Patrol Cabin	5/13 - 9/26	N/A	Evaluation	Evaluate need of defensible space

Prescribed Fires Planned for 2015

Piles of cut vegetation or woody debris are sometimes created during a hazard fuels reduction project. These piles need to be burned in order to complete the firewise treatment for these sites. During 2015, staff plan to burn debris from past hazard fuels projects at the Headquarters, Toklat, Moose Creek Patrol Cabin and Stampede Mine.

Prescribed fires planned for 2015

Fire Name	Burn Date	Acres	Fire Type	Comments
FY 2015 Admin Rd 1 RX Burn	3/17/15 - 3/29/15	1.57	Prescribed Fire	Burn biomass debris from roadside maintenance projects and hazard fuels treatment projects
Moose Creek Patrol Cabin	2015	.86	Prescribed Fire	Burn biomass debris from hazard fuels treatment projects
Toklat Pile RX Burn	2015	1.9	Prescribed Fire	Burn biomass debris from roadside maintenance projects and hazard fuels treatment projects
Stampede Mine	2015	4.55	Prescribed Fire	Burn biomass debris from hazard fuels treatment projects
Optimal				
Kantishna RX Burn	2015	2.0	Prescribed Fire	Burn biomass debris from hazard fuels treatment projects
Glen Creek Debris	2015		Prescribed Fire	Burn burnable debris from reclamation project
Eldorado Creek Reclamation	2015		Prescribed Fire	Burn burnable debris from reclamation project

Denali Fire Management and Fire Ecology Program

To understand and maintain fire-adapted ecosystems, the Alaska NPS Fire Ecology program provides science-based information to guide fire planning, decisions, and fire management practices. The program focus areas are: provide effective evaluation of Alaska NPS fire management program activities and fire on the landscape through monitoring, (2) coordinate research and facilitating the use of scientific data, modeling, and technology to enhance the fire management program, and (3) provide fire ecology information and outreach to fire managers, other park staff, and the public.

Information about some of our findings in Denali are summarized in a Fire Ecology Fact Sheet:

http://www.nps.gov/akso/nature/fire/documents/FireEcology2011.pdf

Next are descriptions of fire ecology projects that were accomplished in 2014 and plans for 2015 in Denali.

Long term vegetation monitoring plots burn in 2013 fires

During the summer of 2013, Denali had 14 fires including several large fires with a total of 104,850 acres burned within the park boundary. Based on the fire perimeters it appeared that several Central Alaska Network Inventory & Monitoring (CAKN) vegetation mini-grids (75 total plots) were burned by three 2013 fires in the park. As mentioned above, burn severity strongly influences the impacts of fire on vegetation succession, lichen/moss consumption, and active layer thaw. However burn severity is often difficult to assess several years after a fire. Since many of these plots were not going to be re-measured by the CAKN vegetation crew for another 5 to 10 years, the NPS Fire Program worked with CAKN to develop a plan to monitor these burned plots for severity and initial fire effects.

In 2014, the Denali fire crew and regional fire ecologists measured burn severity and 1 year post-fire effects at two of the burned mini-grids (38 plots). A diversity of burn severities and vegetation types were sampled, including: black and white spruce forests, paper birch forests and tussock-

shrub tundra. Based on ocular cover estimates, the average vegetation cover 1 year post-fire are shown in Figure 1 for the black spruce forest plots sampled. In general the vegetation cover reflected expected changes 1-yr after a fire for the burn severity classes. Sites such as the mesic feathermoss black spruce forest plot shown in Figure 2 resulted in the high forb (herbaceous plant) cover after a relatively high severity burn occurred. A majority of the understory plants were fireweed and horsetail at this site, but the pale green and pink flowered plant in the 2014 photo was Cordyalis sempervirens, which will only flower for a few years after a fire disturbance, and then the seeds will lie dormant in the soil until the next disturbance.

The primary intent of monitoring the Inventory & Monitoring (I&M) plots for burn severity was not to assess how well the remote sensed dNBR burn severity maps worked, since the plots were established on a grid and not selected based on a range of severities. But determining how well the burn severity maps work for assessing severity at a random plot location is important. A comparison of the burn severity from the ground versus the burn severity dNBR from remote sensing showed a fairly good fit (r2 = 0.63, see Table 3). This suggests that the dNBR maps could be useful for assessing relative burn severity at the plot level.

Assessing these fires and plots provided an opportunity to improve our understanding of how fire changes vegetation, permafrost, soils and potential impacts of climate change. This data will provide information for the long term monitoring of natural fires for Denali. The project is an excellent example of a co-operative effort between the NPS Fire Program and the CAKN Inventory and Monitoring Program.

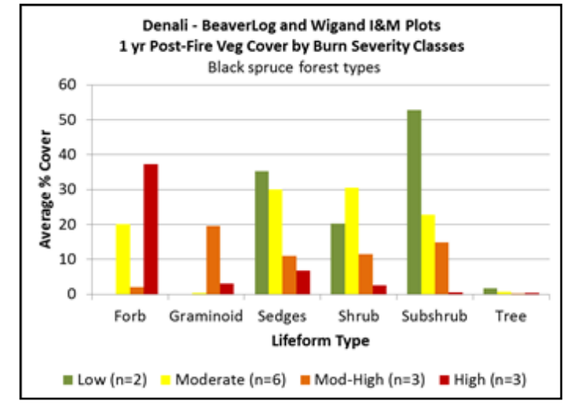
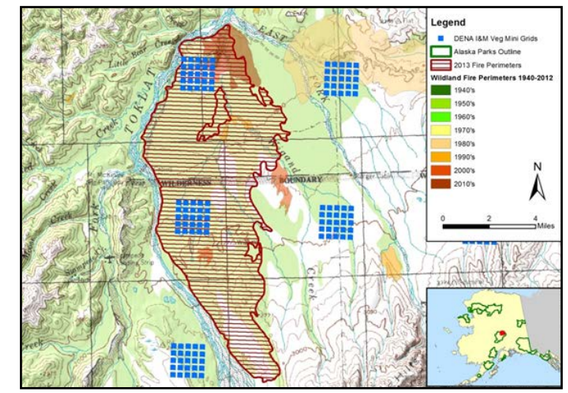


Figure 1. Comparison of average vegetation cover 1 year post-fire in black spruce plots at the Denali I&M plots that burned in 2013



The 2013 Toklat River East Fire burned through two grids (5x5 array of plots) established by the Central Alaska Network for monitoring vegetation.

Figure 2. Comparison of 'pre-fire' photo of a black spruce plot with thick feather moss and horsetail understory (left) and one year post-fire after a crown fire occurred in this area (right). Note the dense herbaceous cover that has re-grown one year post-fire in Denali National Park & Preserve. Denali BeaverLog Plot 15 (NPS CAKN Photo 2010 and NPS Fire Photo 2014).

How dry is it?
Fuel Moisture Sampling in Denali

The amount of moisture in various types of vegetation can help fire managers determine if a fire is likely to start and how it might behave once ignited. Fuel moisture strongly influences fire ignition potential and flammability. Beginning in 2012, fire ecologists from the National Park Service, Bureau of Land Management Alaska Fire Service and US Fish & Wildlife Service coordinated a large effort to monitor fuel moisture trends throughout AK. The AK NPS Fire Ecology Program established sampling sites in Denali near the Denali Visitor Center - Remote Automated Weather Station (RAWS). The data for all the sites in Alaska have been entered in the National Fuel Moisture Database. This information has been used for fire behavior modeling and to compare duff moisture to the Canadian Forest Fire Danger Rating System (CFFDRS) fire danger indices. Prior to this project, only minimal sampling of live fuel moisture has been done in Alaska. Efforts are planned to continue sampling in 2015. Learn more about fuel moisture sampling here:

http://www.frames.gov/partner-sites/afsc/events/previous-events/workshops/2013-fuel-moisture-sampling-workshop/

Denali Western Area Fire Management staff collect fuel moisture samples at the DVC RAWS site in Denali. 2013 NPS Photo.

Fire Ecology Projects Planned for 2015

Plans for the 2015 season include updating the fire monitoring plans for the Denali Fire Management Plan, the continuation of fuel moisture monitoring at the Denali Visitors Center RAWS station and completion of the Denali Hazard Fuels Monitoring report.

Fire Education

- Western Area Fire Management, the Regional Fire Communication and Education Specialist, and MSLC staff will continue to incorporate wildland fire management messages in select presentations.
- The Alaska Western Area fire staff will seek to promote the revised Alaska FIREWISE concept in 2015 and assist with Firewise workshops that teach community members how to reduce the combustible material around their homes to reduce the risk of wildland fire.
- Each year Fire Management staff provides updated maps and information about fires in and outside of the park. Fire danger information is also updated and posted at various locations. Three fact sheets are available—Wildland Fire Risk and Response: *Why are you cutting those trees? Where is all that smoke coming from?* And *Wildland Fire Ecology*

Wildlife

Wildlife Observations along the Park Road

By Bridget Borg
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"The possibility of observing free-roaming wildlife at close range […] in a rugged wilderness setting" is a defining feature of Denali National Park and Preserve as recognized in park management documents. Understanding how wildlife viewing opportunities may be influenced by a growing number of visitors prompted the first study of wildlife abundance and behavior along the park road in 1973. Since 1973, several studies investigated large mammal abundance and behavior along the park road. Each study had a slightly different overall objective and purpose, the data was collected from multiple platforms (from buses versus NPS vehicles), by observers of different trainings, and with variation in sample size (number of trips along the road), destination, and duration (round trip versus westbound recording only). Although data has been collected in a variety of ways, careful analysis of the data can investigate long term trends in the numbers of individuals, groups and behavior of animals visible from the park road. The wildlife sighting data recorded by bus drivers and trained observers constitutes a valuable long term data set that will continue to be collected into the future. This dataset is useful in monitoring wildlife viewing opportunities along the road, a critical part of the visitor experience which managers are tasked to maintain.

Beginning in 1996, bus drivers and park staff have recorded data on wildlife sightings the numbers of bears, moose, sheep, caribou, and wolves they see on trips along the park road every year. Initially, data was collected on paper data sheets, but starting in 2006, touch screen panels linked to GPS tracking units on twenty buses allowed the automated collection of wildlife stop data. From 2012 to 2014, message display terminals (MDTs) were installed in the entire bus fleet, in conjunction with a realtime GPS tracking system, replacing the touch screen panels.

Additionally, trained observers collect detailed information on wildlife sightings such as number of individuals and distance from the road. The use of trained observers to record wildlife stop attributes began in 2010, called the Ride Observe and Record (ROAR) project. ROAR observers use handheld GPS receivers for collecting detailed information about wildlife sightings along the park road. ROAR observers collected data on 158 round trips as far as Eielson in 2014, recording detailed information on 2642 wildlife stops along the park road.

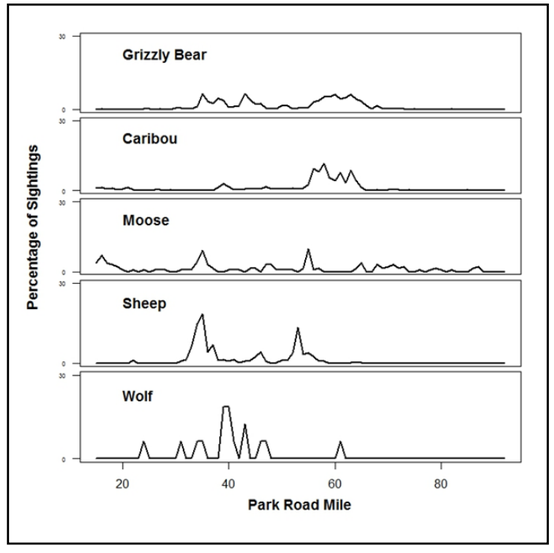
We calculate an annual sighting index which is a measure of how often observers on westbound trips to Eielson Visitor Center saw a member of a species in a given year. Although we believe that changes in this index are a good indicator of how overall chances of seeing a species might change over time, these rates are not direct estimates of a visitor's chances of seeing a given species in a year.

The annual sighting index, presented as a percentage of trips on which at least one individual of each of the "big five" species on a bus trip at least as far as Eielson Visitor Center in 2014 was:

- 66% for grizzly bears
- 70% for caribou
- 63% for Dall's sheep
- 29% for moose
- 6% for wolves

The 2014 sighting index for bear, caribou or moose were the lowest estimates from the time period from 1997-2014. From 1997 to 2013, the average index for bear, caribou and moose were 83%, 89%, 41% respectively. However, the reduction in the annual sighting index for these species may reflect a change in the proportion of sightings occurring during the westbound portion of the trip rather than a real reduction in the number of each species seen. In most years, a majority of sightings for each species were recorded during westbound travel, but in 2014, a roughly equal proportion of sightings for bear, caribou and moose were recorded during west and eastbound travel. The average number of bears seen per trip in 2014 (1.93) was slightly above the average from 1997-2013 (1.89), however the average number of caribou and moose seen in 2014 (2.51 and 0.39 respectively) were slightly less than the average seen from 1997-2013 (2.88 and 0.58 respectively).

The sighting index for sheep in 2014 was the same as in 2013 (63%) which was lower than the average sighting index for sheep from 1997-2013 of 79%. The probability of seeing a wolf in 2014 (6% of trips saw a wolf) was higher than the previous year when an estimated 4% of trips saw a wolf. The average sighting index for wolves from 1997-2013 was 17%.



Distribution of sightings by road mile (from 2014 data)

Bear Monitoring

By Pat Owen
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Grizzly Bear Monitoring – North

Bears continue to be radio collared and tracked on the north side of the Outer Range between the Kantishna Hills and the east end of the park. The objective of this study is to document the ecology of grizzly bears and their movements on the northeast portion of the park, especially outside the north park boundary where they may be subject to legal harvest and possible future intensive management efforts by the State of Alaska.

In 2014, bear capture was conducted May 21, 22, and 23 from a helicopter, with fixed-wing aircraft support. A total of six bears, three females and three males, were captured and fitted with GPS radio collars. Two bears were captured to remove GPS collars that did not release previously as scheduled. One male was captured but not collared to due large size (too big for collar).
GPS collars used in this study store location data on board and must be retrieved to acquire the data. Location data retrieved so far indicates that only one collared bear crossed the north park boundary. Since 2013, efforts have been concentrated on capture of bears closer to park boundaries that may have a higher likelihood of traveling outside the park. Since collars are programmed to acquire data for 3 years, location data from those bears will not be available until late 2015. There are currently 16 bears wearing radio collars as part of this study.

Plans for 2015 are to remove all radio collars in September to download and analyze location data. This field portion of this project will be brought to a close in anticipation of launching a new bear study in southern portions of the park in 2016.

Bear Management

By Pat Owen
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Bear problems at Denali escalated in the 1970's and 1980's. By 1982, Denali had the highest rate of backcountry bear incidents of any U.S. national park with a significant grizzly population and high backcountry use. Bears were getting food from backpackers and poorly-handled garbage, causing property damage, and injuring people. Between 1946 and 1983, 48 bears were relocated or destroyed in the park. Denali's Bear Management Plan (BMP) was developed to address bear problems and reduce bear-human conflicts.

By educating staff and visitors about bears and providing bear-resistant storage for food and trash, the park has dramatically reduced conflicts with bears and other wildlife. In 1984, Bear-Resistant Food Containers became mandatory for backcountry users. By 1985, incidents with bears in the backcountry had dropped nearly 90%. The last problem with a food-conditioned bear in one ofthe Denali campgrounds was in 1994. Since 1983, only four bears have been destroyed, one sent to a wildlife park, and two relocated by the National Park Service.

Between May 30, 2014 and September 18, 2014, 62 bear-human interactions were documented. These interactions were classified as 56 encounters and 6 incidents. The total of 62 BIMS this year marks a 51% increase from the previous year's total of 41 (Table 1). Of those interactions rated as encounters, 17 occurred in the frontcountry and 39 occurred in the backcountry. Of the 7 interactions classified as incidents this season, four occurred in the frontcountry and three occurred in the backcountry with two-thirds of each being property damage.

Backcountry:

Backcountry interactions between humans and bears increased from 27 in 2013 to 42 in 2014, an increase of 56%. Of these backcountry interactions, three were considered incidents. Of the three incidents, two involved property damage and one was a general incident. While there were encounters in which the reporting parties claimed they had been "charged" or "bluff charged," the narratives indicated that the bear never made contact or came closer than 3 meters. Since the Bear Management Plan defines an incident as involving a charge that results in contact, we did not include these reports in our incident statistics. The number of reported backcountry interactions increased while backcountry incidents stayed the same since last year; the number of incidents involving bears causing property damage remained the same.

Frontcountry:

In 2014, the reported frontcountry interactions increased 43% from 2013. There were 14 interactions in frontcountry areas in 2013 and 20 in 2014. Of all the interactions, 3 were considered incidents. One was a general incident with the other two being property damage.

Interactions	Frontcountry	Backcountry	Total
Encounters	17	39	56
Incidents	3	3	6
Control Actions	1	0	1
Total	**21**	**42**	**63**

Table 1. Bear-human interactions in Denali that were documented in 2014 in the Bear Incident Management System (BIMS) database.

Moose

By Pat Owen
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In 2013, moose surveys were conducted in two areas of the park important to subsistence users. The Cantwell and Yentna areas, both on the south side of the park, were surveyed in November and early December, 2013. Report of these surveys can be found in the Subsistence section of this document.

Denali was scheduled to conduct an extensive north side survey in Fall 2014. The survey area covers all areas within the park on the north side of the Alaska Range Mountains. This survey is Denali's contribution to Central Alaska Monitoring Network moose monitoring and is funded every three years. Unfortunately, snow conditions were not adequate to conduct the survey. Plans are to request funding to conduct the survey in Fall 2015.

Caribou

By Layne Adams
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Population dynamics of the Denali Caribou Herd have been investigated continuously at Denali National Park and Preserve since 1984. The long-term goal of this research is to document population trends, primary vital rates (calf production, calf recruitment, adult female survival), and other important population characteristics (female age structure, adult sex ratios) that determine the status of the Denali Caribou Herd. In addition, we are currently investigating the growth and survival adult males, and the fine-scale movements and habitat selection of both sexes. This progress report summarizes work conducted during October 2013-September 2014 (FY14).

Herd Size

The preliminary herd size estimate for September 2014 is 2,590; that number will be adjusted and finalized based on results of the 2015 census. This population estimate is consistent with continued slow growth of the Denali Herd at about 2-3% per year since 2003 (Figure 1).

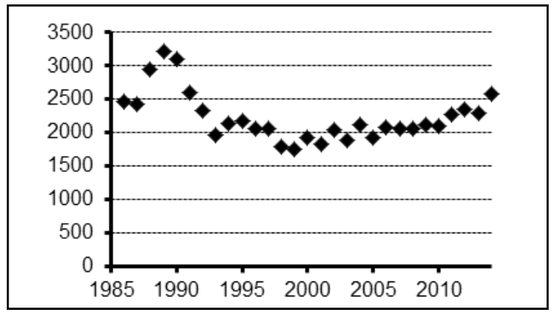

Figure 1. Late September population estimates for the Denali Caribou Herd, 1986-2014 (2014 estimate is preliminary).

Adult Sex Ratio

In September 2014, we determined an adult sex ratio of 44 bulls:100 cows. Adult sex ratios declined from an average of 56:100 during 1984-1989 to a low of 29:100 during 1997-98 as a result of increased mortality of males during severe winters in the late 1980s and early 1990s along with very low recruitment of calves. Bull:cow ratios have increased slowly since 1998 but are a still well below levels at the beginning of the study.

Calf Production and Survival

Productivity of cows ≥ 1 year old was estimated at 74% in mid-May 2014, based on 66 radiocollared females in the age-structured sample. The calf production has varied from 59% in 1990 to 92% in 1994 and is primarily influenced by the number of yearlings in the herd and the highly variable productivity of 2-year-olds.

During the mid-June 2014 postcalving surveys, we noted 28 calves:100 cows; by the late September composition count that ratio had declined to 23:100. Based on these measures of calf production and survival, and accounting for adult female survival between mid-May and late September, survival to fall was estimated at 30% for 2014 calves. Fall calf survival has averaged 27% over the last 11 years, compared to 42% and 15% during 1987-1990 and 1991-2003, respectively.

Female Survival and Age Structure

During October 2013 - September 2014, we estimated an annual mortality rate of only 5% for adult females, lower than the long-term study average of 12% (range of annual values = 2-23%). Females ≥ 13 years old made up 12% of the population. With continued moderate recruitment, the proportion consisting of these older females can be expected to decline over the next few years because it is made up of 14-17 year-olds that are nearing the end of their lives and there are few females 11-13 years old (2001-2003 cohorts that are the last from the period of very low recruitment) to come in behind them.

Based on data collected from radiocollared caribou since September 1986, age-specific survival rates of females are high during 2-7 years of age, averaging 0.94, then decline slowly during 8-13 years of age prior to declining markedly as individuals become senescent. The 2 oldest caribou females we have monitored died in May as they turned an estimated 20 years old.

Bull Growth Patterns

During September 2007-2014, we weighed 176 bulls ≥ 1 year old at their initial captures and recaptures to replace their radiocollars. In mid-September bull caribou should be at their maximum body for the year in preparation for the rut and ensuing winter. Overall, body weights of males ranged from 205 to 612 lbs. Body weights increased markedly with age from 1 to 6 years, gaining an average of 54 lbs each year, and plateaued at 509 lbs on average for bulls ≥ 6 years of age. Antler size was strongly correlated with body weights, thus mean antler length showed a similar pattern to body weight, increasing by 5.6 in/year for bulls 1 – 6 years of age, and averaging 48.6 in for bulls ≥ 6 years of age.

Adult Bull Survival

During our studies of bull survival since September 2007, we have noted that age-specific survival rates were high for males 1-4 years-old, averaging 88%. As bulls approached full adult size at 5 years of age and became active in the rut, their survival then declined to 77% and that level of survival continued through 6 and 7 years of age. After 7 years, survival dropped off markedly each year with very few caribou bulls surviving to 10 years. Interestingly, bulls ≥ 3 years old died predominantly during July – November (82% of annual mortality) with over half this mortality (44% of annual mortality) occurring prior to the onset of the rut in mid-September.

Movements and Habitat Selection

During September 2010-2013, we maintained a sample of 20 adult females instrumented with GPS collars that acquired and stored locations every 2 hrs. Those collars were retrieved in September 2013 and we are currently analyzing the mass of data collected. The same collars were rebuilt and redeployed in September 2014 on 20 adult males to replace their standard VHF radiocollars. An additional 20 males will be instrumented with GPS collars in September 2015. The bull collars are designed to automatically release after 3 years of data collection in September 2017 or 2018. The resulting data sets for females and males will be used to compare and contrast seasonal movements and fine-scale habitat selection patterns of the 2 sexes.

Dall's Sheep

By Steve Arthur
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Aerial Survey

No formal aerial surveys were conducted in Denali in 2014. The most recent extensive survey, in 2011, estimated a population of 2,321 sheep in areas north of the Alaska Range continental divide. Plans are currently being developed to repeat this survey during July 2015.

Ground-based Surveys

From 2008 to 2014, park staff conducted annual ground-based Dall's sheep surveys. Ground surveys allow closer and more careful observation of sheep and provide detailed and accurate herd composition data, but the areas that can be surveyed on foot are very limited. Although these data are useful as an indicator of changes from year-to-year, the results may not be applicable to the entire sheep population in Denali.

Denali staff conducted ground-based Dall's sheep surveys during June 6-10, 2014. These surveys classified sheep as lambs, ewes, yearlings, or rams (whenever possible, rams were also classified by horn size). The lamb productivity estimate was 15 lambs per 100 ewes and yearlings. This was greater than estimates from the previous 2 years, but still quite low compared to stable or increasing sheep populations (which generally exceed 20 lambs:100 ewes and yearlings). Since 2009, sheep productivity in Denali has ranged from 3-34 lambs per 100 ewes (Figure 1).

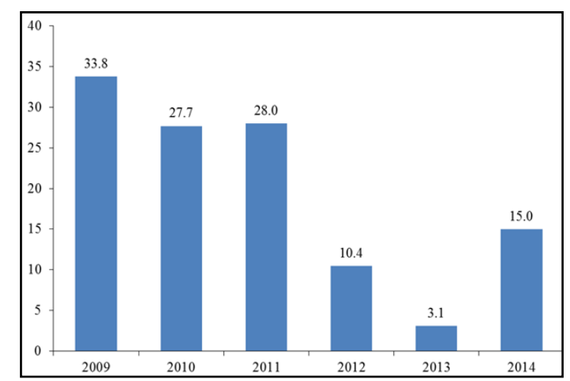

Figure 1. Ratio of lambs per 100 ewes and yearlings in Denali National Park and Preserve, 2009-2014.

Wolf Monitoring

By Steve Arthur
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Denali National Park and Preserve's wolves have been studied by researchers since 1939. Population estimates were not very accurate until 1986, when a large-scale wolf research project was initiated by David Mech and others. This project provided basic information necessary for effective wolf management. The current monitoring program consists of maintaining one or two radio-collared wolves in each known pack inhabiting the park north of the Alaska Range. Radio-collared wolves are located about twice per month, with additional locations during late September to early October to determine fall pack sizes and to count pups, and during March to determine late winter pack sizes. Telemetry locations acquired over one year (April—March) are used to determine the area of each pack territory. Counts of wolves in these packs and the area encompassed by the combined pack territories are used to estimate abundance and density of wolves. In addition, monitoring data are used to determine wolf movements, den locations, mortality factors, behavior, and population dynamics.

During 2014 – 2015, we monitored a total of 20 radio-collared wolves from 10 packs with territories at least partly within Denali (Figure 1). Two types of collars were used. Four wolves wore conventional VHF radio collars. Another 16 wolves carried GPS collars that determine the animal's location one or more times per day and transmit the data through the ARGOS satellite system.

In March 2015, the 10 marked packs included 47 wolves, and their combined territories covered an area of 18,820 square kilometers. An additional lone wolf was collared in March 2015, and tracks of an uncollared pack of at least 4 wolves were also detected. The total of 52 wolves (including the uncollared pack) counted in March 2015 produced an estimated density of 2.8 wolves per 1,000 square kilometers, which is the lowest density estimate since monitoring began in 1986 (Figure 1). The increased use of GPS collars during the past 10 years has improved our ability to estimate territory size, and consequently the estimate of the combined area occupied by wolves in our study area has generally increased. This partly explains why the current density estimate is low. However, the number of wolves actually counted each year has also declined, despite similar levels of monitoring effort, so it appears that the population has declined from levels seen during 2001 – 2003 (5.6 – 6.4 wolves per 1,000 square kilometers). Causes of the population decline are unknown, although several factors may be involved. These include low snowfall during the past several winters, which has reduced the vulnerability of caribou and moose to wolf predation, relatively poor pup recruitment, and mortality of wolves from both human and natural causes.

In 2014, at least 6 of the 10 collared packs denned and produced a minimum of 14 pups that survived until fall. One young male wolf from the East Fork pack, collared in December 2013, dispersed over 200 miles from Denali, eventually settling down in Yukon-Charlie National Preserve. Details of this trip were posted on the Murie Science and Learning Center's Research Highlights web site at: **http://www.nps.gov/articles/wolf-dispersal.htm**. Nine collared adult wolves died during 2014 – 2015; two were killed by other wolves, one died of apparent old age, one drowned, one starved, and one was legally shot by a trapper outside the park. Cause of death could not be determined for two wolves, although there was no evidence of human involvement. One young male wolf died during late February 2015, after becoming caught in a snare set outside the park. The wolf was able to break free from the snare's anchor wire and return to the park, but subsequently died due to blood loss caused by the snare. The Iron Creek East pack disappeared after both collared adult wolves died in September 2014. The breeding female died of starvation and her mate subsequently dispersed eastward. He evidently drowned while crossing the Toklat River, which was swollen from recent heavy rains. A new pair was located and radiocollared in the range previously occupied by this pack during March 2015. This pair was dubbed the Myrtle pack.

During early March 2015 we captured and radiocollared 13 wolves. These included 11 new wolves and 2 collared wolves that were recaptured to replace their radiocollars. Five of the new wolves were young males. These were equipped with newly-developed collars that include three-dimensional accelerometers, which enable researchers to determine the animals' activity (e.g., running, walking, resting) as well as their locations. One of the new captures, a lone male wolf, exhibited an abnormal condition known as follicular dysplasia, also known as "poodle coat". This condition is characterized by loss of the long guard hairs from much of the wolf's body, resulting in a wooly appearance due to the dense, short underfur that remains. This wolf died approximately March 31, evidently due to starvation. As of early May 2015, 3 additional wolves were known to have died. One of these was a collared male that was killed by other wolves. The others were a collared male and an uncollared female from the East Fork pack that were legally shot by a hunter outside of the park near the Stampede Trail. GPS data provided by the male wolf's collar indicated that he had spent most of the week before his death scavenging at a bait station established by a bear hunter within a mile of the location where he was shot.

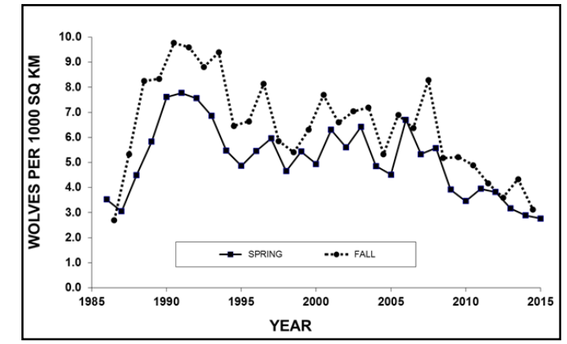

Figure 2. Spring and fall wolf density in Denali National Park and Preserve, 1986-2015.

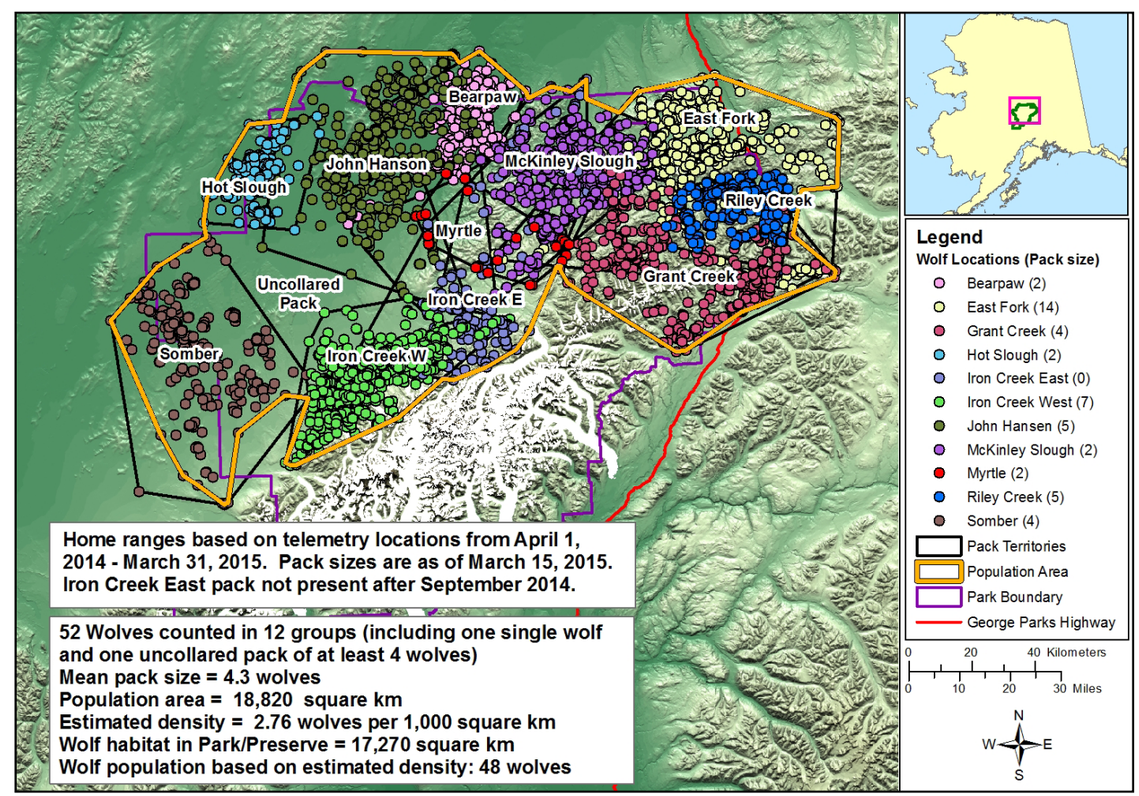

Figure 1. Wolf pack territories in Denali National Park and Preserve, March 2015

Wolf Viewing Project

By Bridget Borg
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From 2000 until 2010, the State of Alaska prohibited wolf hunting and trapping in two areas bordering the park, the Stampede and Nenana Canyon Closed Areas, in order to protect two of the park's three most-commonly viewed wolf packs. At the spring 2010 meeting of the Alaska Board of Game, the National Park Service submitted a proposal to extend the eastern boundary of the Stampede Closed Area. Instead, the Board of Game decided to eliminate both closed areas and allow hunting and trapping wolves in all areas bordering the park.

In 2010, Denali National Park and the University of Alaska Fairbanks, with the cooperation of the Alaska Department of Fish and Game, began a study of wolf movements, wolf survival, and wolf viewing opportunities along the Denali Park Road.

This study is investigating a variety of factors that might influence sightings of wolves on the park road including;

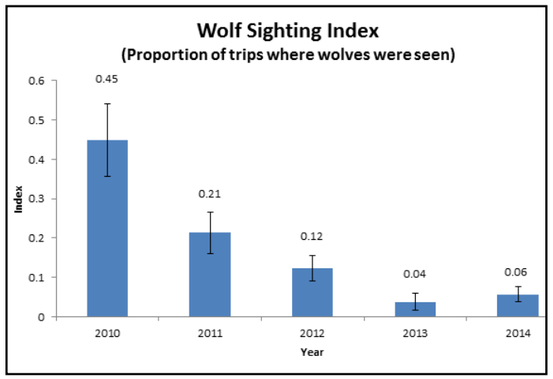
- Wolf abundance
- Harvest of wolves outside of park boundaries
- Den location
- Pack size and composition (adults, pups, etc.)\
- Individual behavior
- Pack social structure
- Pack proximity to the road

During the course of the study in 2012, the death of a breeding female from a pack that lived along the Denali Park Road was followed by a drop in wolf sightings. This was one of several instances where the death of an individual wolf, from legal trapping or hunting, sparked widespread media attention and concern in recent years. In order to improve our understanding of the implications of breeder mortality, we looked at changes in wolf pack fate, reproduction, and population growth following the death of breeders using data collected on 70 packs during the long-term study of wolves in Denali National Park. We published our findings in Journal of Animal Ecology:

Borg, B.L., Brainerd, S.M., Meier, T.J. & Prugh, L.R. (2015) Impacts of breeder loss on social structure, reproduction and population growth in a social canid. Journal of Animal Ecology, 84, 177–187

We found that breeder loss preceded or coincided with most documented cases of wolf pack dissolution (when a pack disbanded or was no longer found). However, the death of a breeding individual did not always lead to the end of a pack. In approximately two out of three cases where a breeder died, the pack continued. The sex of the lost breeder and the pack size prior to loss were important factors explaining pack fate following the death of a breeder as the probability of a pack continuing was less if a female died or if the pack was small prior to the death. The analysis also suggested that the death of a breeder had a greater influence if the wolf died during the pre-breeding or breeding season. Human-caused mortality rates were highest during the winter and spring, which correspond to the pre-breeding and breeding seasons for wolves such that harvest may lower the odds of pack survival because of this timing, especially when pack sizes are small.

However, higher rates of breeder mortality and pack dissolution did not correspond to lower population growth, indicating that the wolf population was resilient to the loss of breeding individuals at a population level. Wolves may compensate for the death of breeders in a variety of ways, such as rapid replacement of breeders or increased reproductive success the following year.



Additionally, as part of this study, we developed and report an annual wolf sighting index, which is a measure of how often observers on westbound trips to Eielson Visitor Center saw a wolf in a given year. We present the index in recent years using only trips by experienced observers. We believe that changes in this index are a good indicator of how overall chances of seeing a wolf might change over time, however these rates should not be interpreted as a direct estimate of a visitor's chances of seeing a wolf in any given year.

This issue of wolf harvest at the boundaries of protected areas and the potential for this harvest to influence visitor sightings of wolves is not unique to Denali. As gray wolves are delisted from Endangered Species Act and states take over management of wolves, which often includes hunting and trapping, wolf viewing opportunities in Yellowstone may be affected. In 2013, we began collaborating with Yellowstone National Park (YELL) to create an index of annual wolf sightings for the YELL and investigate how harvest of wolves outside of the park boundaries may influence those sightings. This study is expected to inform the NPS on how wolf management practices outside park boundaries impact wolf populations and the likelihood of seeing wolves within the park. Final analysis and peer-reviewed publications and reports from this analysis are slated for 2015.

Mesocarnivore Response to Wolf Presence, Prey Availability, and Snow Pack

By Steve Arthur
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During March 2012, Denali park biologists noticed an apparent increase in coyote abundance at a time when the population of wolves was decreasing. Increased coyote abundance throughout western North America has been attributed to the extirpation of wolves and is considered by many to be an example of "mesocarnivore release", which is defined as the expansion in range and/or abundance of a smaller carnivore following the reduction or removal of a larger predator. These effects can extend beyond the small carnivores to include their prey. For example, studies in Alaska have shown that high coyote populations in areas where wolves are scarce can greatly reduce the survival of Dall sheep lambs. Because wolves often kill coyotes, the presence of wolves might limit coyote abundance. However, wolves also subsidize coyotes by providing food in the form of ungulate carrion, so the net effect of wolves on coyote populations is unknown. In northern ecosystems, coyote populations fluctuate along with changes in abundance of their primary prey: snowshoe hares and voles. Population cycles of these small mammals could influence the degree to which coyotes rely on wolf-supplied carrion, and thus change the dynamics of the relationship between coyotes and wolves. Furthermore, competition between coyotes and other mesocarnivores is thought to be influenced by habitat characteristics, such as snow depth and density, which are also changing in response to long-term changes in climate.

Dr. Laura Prugh and graduate student Kelly Sivy of the University of Alaska Fairbanks initiated a study in the summer of 2012 to assess the relative importance of wolf activity, prey availability, and snow characteristics in determining the strength of mesopredator release of coyotes and resultant effects on the mesocarnivore community. These relationships are investigated by conducting winter track surveys and snow measurements, collecting carnivore scats, assessing prey abundance, and comparing movements of radiocollared wolves and coyotes. The study is continuing as a collaborative effort between UAF and Denali National Park and Preserve. In addition to providing increased understanding of the relationships among these species, this project will provide park managers with improved techniques for assessing and monitoring important furbearer species that have received relatively little attention in the past.

During 2013-2015, a total of 9 coyotes were captured and radiocollared with GPS-equipped collars. Data from these collars will be used to compare movements of coyotes with movements of radiocollared wolves to determine how the two species apportion the available habitat. Snow track surveys were conducted during the winters of 2012-2013 through 2014-2015 to assess abundance and distribution of wolves, coyotes, red fox, lynx, wolverine, and marten in relation to prey abundance, habitat type, and snow conditions. Carnivore scats were collected along these trails, which will be used to assess dietary overlap among carnivores and to estimate abundance of coyotes and foxes using DNA mark-recapture techniques. Camera traps were placed at wolf- and winter-killed ungulate carcasses to assess the amount of use by scavengers. Summer field work included surveys of hare abundance using fecal pellet counts and live-trapping of small rodents in various habitats along the Denali Park Road. Data from the first two years of the study are currently being analyzed and will form the basis of Kelly Sivy's M.S. thesis, which will be completed during summer 2015. Current plans are to continue the study with an additional graduate student, who will start work during fall 2015. An agreement was established between Denali and the North and West Alaska Ecosystem Studies Unit at UAF to provide partial support for continuing the work.

Snowshoe Hare and Willow Ptarmigan cycles

By Carol McIntyre
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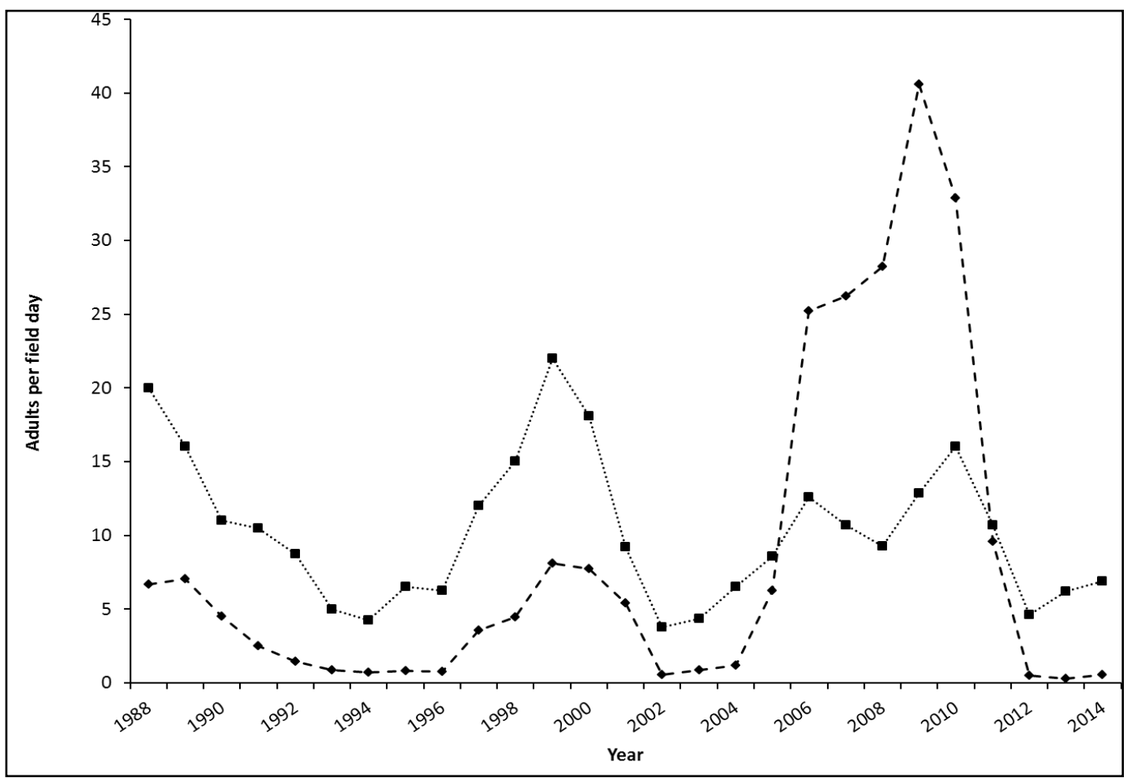
NPS biologists calculate annual indices of abundance for snowshoe hare and willow ptarmigan in Denali by recording the number of adults of each species detected during routine field activities and other survey work from mid-April through June. These data allow biologists to monitor the frequency and magnitude of the population cycles of each species over time.

The graph that follows shows the number of snowshoe hare (solid black diamonds) and willow ptarmigan (solid black squares) detected per field day from 1988 to 2014 in Denali. Our field data suggests that both species are in the increasing phase of their cycles. These long-term data are important for monitoring the amplitude and frequency of cycles of both species in Denali and across their range (see Krebs et al. 2013, Krebs et al. 2014).

Krebs, C.J., et al. 2013. Synchrony in the snowshoe hare cycle in northwestern North America, 1970-2012. Canadian Journal of Zoology 91: 562-572.

Krebs, C.J., et al. 2014. What factors determine cyclic amplitude in the snowshoe hare cycle? Canadian Journal of Zoology 92: 1039-1048.



Annual abundance indices for snowshoe hare (solid black diamonds) and willow ptarmigan (solid black squares) from 1988 to 2014, Denali.

Abundance and distribution of passerines

By Carol McIntyre
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Passerine birds are a vital sign of the NPS Central Alaska Monitoring Network (CAKN). Since the early 1990s, the National Park Service (NPS) has been collecting data to document changes in abundance and distribution of passerine birds in Denali, resulting in one of the longest running monitoring programs for these species in interior Alaska.

NPS scientists have used these data to:

1. Document changes in the abundance of several species including Wilson's Warbler and Fox Sparrow (see Schmidt et al. 2012)
2. Identify shifts in the distribution of other species including Arctic Warbler, Savannah Sparrow and Golden-crowned Sparrow in relation to observed changes in the distribution of vegetation communities
3. Examine how changes in dates of first detection and peak detection are related to weather and climate

We collect data annually along a series of standardized surveys on the Denali Park Road, McCarthy Road, Nabesna Road and in off-road areas in Denali, Wrangell-St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve. Our survey methods are similar to those used by the North American Breeding Bird Survey (BBS) except that we survey each sampling point at least three times each year and our surveys extend across the breeding season. Our repeat survey design allows us to conduct surveys for early nesting species including Boreal Chickadee and Ruby-crowned Kinglet as well as late arriving migrants including Alder Flycatcher and Arctic Warbler.

Surveys start about ½ hour before sunrise and take five to six hours to complete. At each sampling site, we record all the species we detect during a three-minute survey. We also record how and when we detected each bird, and a series of environmental variables such as weather conditions, insect levels, and background noise.

In 2014, we surveyed each roadside route 3 to 5 times between 17 April and 25 June (n = 1037 survey events). We did not conduct any off-road surveys in CAKN in 2014. The number of species detected on each route ranged from 31 to 56. The highest number of species detected occurred on the McCarthy Road route 1 (56 species) and the Denali Road route 3 (47 species). The most common species detected on the Denali roadside routes included Willow Ptarmigan, Orange-crowned Warbler, Yellow-rumped Warbler, White-crowned Sparrow, American Tree Sparrow, Fox Sparrow, Savannah Sparrow, Dark-eyed Junco, and Common Redpoll.

For more details about our sampling methods see:

Schmidt, J.H., C.L. McIntyre, and M.C. MacCluskie. 2013. Accounting for incomplete detection: What are we estimating and how might it affect long-term passerine monitoring programs. Biological Conservation 160:130-139.

Willow and Rock Ptarmigan Surveys

By Carol McIntyre
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As part of their statewide monitoring program for Rock and Willow Ptarmigan, the Alaska Department of Fish and Game (ADF&G) conducts standardized surveys along and near many roadways in interior and southcentral Alaska. Beginning in late April each year, ADF&G biologists count the numbers of territorial male Rock and Willow Ptarmigan that respond to a broadcast call at fixed survey locations along a series of survey routes from the Steese Highway to the Kenai Peninsula. Data from these surveys provides useful indices to help ADF&G monitor Rock and Willow Ptarmigan populations.

In 2014, ADF&G established several survey routes for both species in Denali National Park and Preserve, Alaska to be able to compare survey results with an adjacent area along the Denali Highway that receives considerable hunting pressure. These surveys will complement ongoing surveys conducted by the National Park Service in Denali through the Central Alaska Monitoring Network.

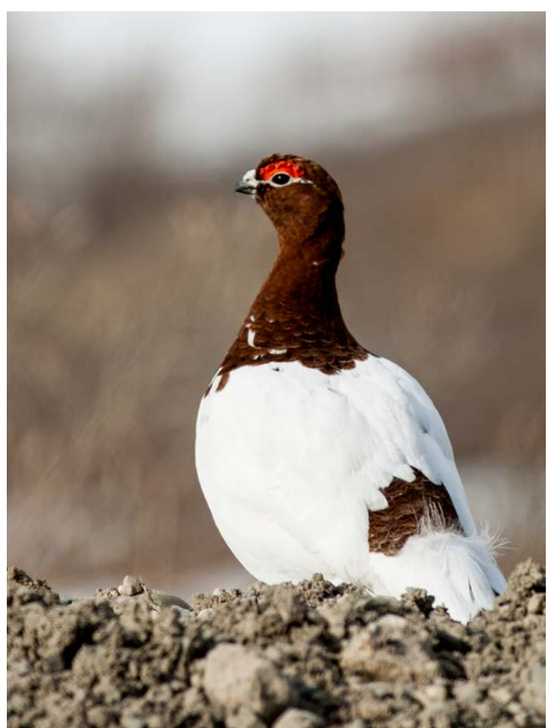
The ADF&G Willow Ptarmigan survey route begins 0.5 km west of the Savage River Bridge on the Denali Park Road and has 13 sampling points placed approximately every 0.8-1.0 km. ADF&G biologists counted 10 territorial male Willow Ptarmigan on the route on 3 May and 8 territorial males on the route on 8 May 2014. The Rock Ptarmigan survey route is about 0.6 km off the Denali Park road on the south side of Primrose Ridge and has 7 sampling points placed about 0.7 km apart. ADF&G biologists counted six territorial Rock Ptarmigan males on the survey on 4 May. Approximately half of the Willow and Rock Ptarmigan males were observed with hens at the time of each survey.

These surveys will continue in Denali for four more years (2015-2018).

For more information see:

Carrol, C.J. and R.A. Merizon. 2014. Status of grouse, ptarmigan, and hare in Alaska, 2014. Alaska Department of Fish and Game, Division of Wildlife Conservation, Region IV Office, 1800 Glenn Highway, Palmer, Alaska.

(http://www.adfg.alaska.gov/index.cfm?adfg=smallgamehunting.research)



Monitoring Territory Occupancy and Reproductive Success of Golden Eagles

By Carol McIntyre
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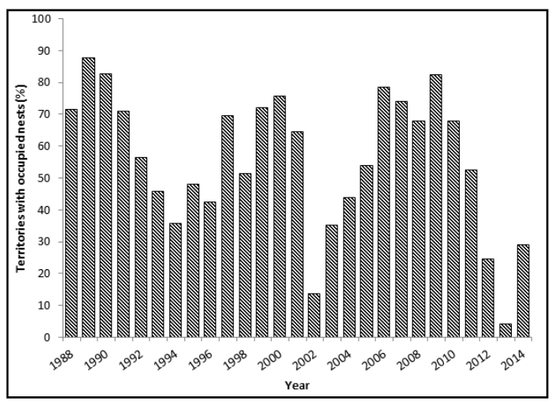
Golden Eagles are a vital sign of the NPS Central Alaska Monitoring Network. We have monitored territory occupancy and reproductive activities of Golden Eagles at 90 nesting territories in the northern foothills of the Alaska Range in Denali annually since 1988 using two standardized aerial surveys supplemented by additional ground surveys (McIntyre and Schmidt 2012). In 2014, we conducted the occupancy survey in late April and the production survey in mid-July using a R-44 helicopter.

Of the 86 territories monitored, 82 (94%) were occupied by a territorial pair of eagles. We documented occupied nests (those where eggs were laid) in 29% (n = 24) of the occupied territories. We documented nest success for 58% (n = 14) of the occupied nests. Mean brood size was 1.0 and the number of fledglings per occupied territory was 0.17. Eagle reproduction in Denali in 2014 (as measured by territories with occupied nests) was higher than in the past two years (see below), but remained low most likely due to the scarcity of snowshoe hare (McIntyre and Schmidt 2012).



Annual eagle reproduction based on territories with occupied nests.

In 2014, we also continued our efforts to identify the factors driving the decline in reproductive success of Denali's Golden Eagles (see McIntyre and Schmidt 2012) including:

- Documenting the age structure of the territorial population;
- Identifying interactions between territorial eagles and apparent floaters (eagles that are not territorial holders);
- Assessing nest site fidelity and turnover rates at nesting territories (in cooperation with the USGS Alaska Science Center molecular genetics lab);
- Describing the year round movements of Denali Golden Eagles (in cooperation with the US Fish and Wildlife Service); and
- Documenting changes in wintering habitat (in cooperation with West Virginia University).

Project scientists also continued efforts to protect occupied golden eagles nests from human disturbance (Fackler et al. 2014), published a short article about an unusual nest in Denali (McIntyre and Paulson 2015), and actively participated in ongoing research and management efforts for this species in North America in close cooperation with the US Fish and Wildlife Service and the US Geological Survey.

Our studies will continue in 2015 and include new fieldwork to tag a sample of territorial and juvenile Golden Eagles with highly precise telemetry units to identify migration routes, wintering areas, non-breeding areas and sources of mortality.

The Denali Golden Eagle Project was the National Park Service's nominee for US Fish and Wildlife Service's 2015 Presidential Migratory Bird Stewardship Award.

Literature cited

Fackler, P.L., K. Pacific, J. Martin, and C. McIntyre. 2014. Efficient use of information in adaptive management with an application to managing recreation near golden eagle nesting sites. PLoS ONE 9(8): e102434. doi:10.1371/journal.pone.0102434.

McIntyre, C.L., and M.D. Paulson. 2015. What came first, the nest or the egg? An unusual golden eagle nest observed in Denali National Park and Preserve, Alaska. Journal of Raptor Research 49: 98-101.

McIntyre, C.L., and J.H. Schmidt. 2012. Ecological and environmental correlates of territory occupancy and breeding performance of migratory Golden Eagles Aquila chrysaetos in interior Alaska. Ibis 154: 124-135.

The Critical Connections Program: studying the full life cycles of Denali's migratory birds

By Carol McIntyre
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"May the migrants survive the many new hazards in the south and continue returning each spring in the future, to contribute beauty and spirit to this northern wilderness"

-Adolph Murie 1963

Conserving migratory species is one of the greatest challenges facing the National Park Service (NPS), particularly as human activities spread across areas used by migratory animals. Migratory birds nesting in NPS areas present unique conservation challenges because they are influenced by conditions and events in more than one part of the world, including on their wintering areas that are often thousands of miles away from their protected breeding grounds. With support from the National Park Service, Alaska Geographic and the Denali Education Center, we are launching the Critical Connections Program to expand our knowledge about the year-round needs of the migratory wildlife of Alaska's National Parklands and to provide park managers and others with information essential for implementing effective conservation strategies for these migratory species. The first stage of the program focuses on: 1) studying the year-round movements of migratory birds that nest in Denali and assessing how conditions across their year-round range affect their ability to return to their northern breeding grounds and successfully produce young; and, 2) building the Alaska National Parklands Migratory Bird Atlas, an online reference tool that will contain all available information about the migration routes, stopover areas, wintering areas and conservation issues of migratory birds nesting in Alaska's National Parklands.

New opportunities for tracking bird movements

The development of miniaturized tracking technology including archival geolocators has produced a wave of new research about the migratory behavior and year-round needs of migratory birds (McKinnon et al. 2013). The results of these studies are providing new and often unexpected information about the lives of migratory birds, and are changing the way that scientists think about and study bird migration and bird ecology. For instance, scientists recently documented that migratory Northern Flickers found and used cavities throughout the year, even during migration when they travelled through unfamiliar areas, thus shedding new light on the importance of cavities for this species throughout the year, not just during breeding season (Gow et al. 2015). Results from another recent study demonstrated how migratory birds responded to unpredictable weather early in their breeding season. After traveling 5,000 kilometers from their wintering areas in Colombia to their breeding grounds in eastern Tennessee, Golden-winged Warblers evacuated their breeding territories in apparent anticipation of an approaching storm system that spawned 84 confirmed tornadoes and caused 35 human fatalities and more than one billion dollars in property damage (Streby et al. 2015). During this period, the birds left their breeding territories and flew 1,500 kilometers in 5 days along routes that were similar to the northern portions of their fall and spring migration routes. The birds returned to their breeding territories after the storm system passed through the area. This research showed how birds responded to the approaching storm system and provided new information to test hypotheses about the cues birds use to alert them to potentially harmful weather events. For instance, project scientists suggested that the birds sensed infrasound, or acoustic waves, from the developing weather system and left the area before it arrived. Second, this research indicated that birds that follow annual migratory routes can also take off on unplanned trips at other times of the year when conditions, such as harsh spring storms, require it (Streby et al. 2015).

New studies in Denali

In early July 2015, Critical Connections Program scientists Scott Weidensaul, Iain Stenhouse, Carol McIntyre and Laura Phillips will attach very small and lightweight geolocators on a sample of Gray-cheeked, Swainson's and Hermit Thrush in Denali. In 2016, these birds will be recaptured to retrieve the geolocators and obtain data on their round trip journeys between Denali and their wintering grounds. Using the tracking data, we will identify migration routes, stopover areas, and wintering grounds, describe migratory behavior, and start to assess how environmental conditions in these areas relate to survival and reproductive success. We also plan to tag other species in future years including Surfbirds, Long-tailed Jaegers and Merlins in Denali.

Literature cited

Gow, E.A., K.L. Wiebe, and J.W. Fox. 2015. Cavity use throughout the annual cycle of a migratory woodpecker revealed by geolocators. Ibis 157: 167-170.

McKinnon, E.A., K.C. Fraser, and B.J.M. Stutchbury. 2013. New discoveries in landbird migration using geolocators, and a flight plan for the future. Auk 130: 211-222.

Streby, H.M., G.R. Kramer, S.M. Peterson, J.A. Lehman, D.A. Buehler, and D.E. Andersen. 2015. Tornadic storm avoidance behavior in breeding songbirds. Current Biology 25: 98-104.

Physical Resources

Parkwide Climate Monitoring

By Pam Sousanes
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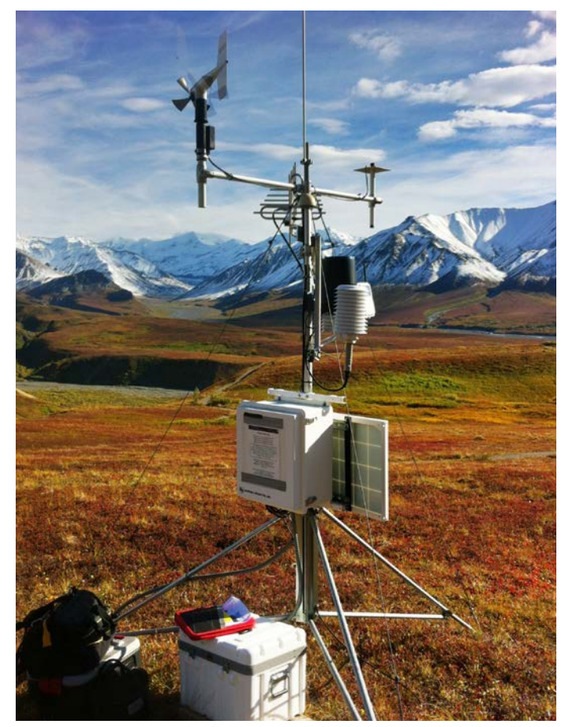
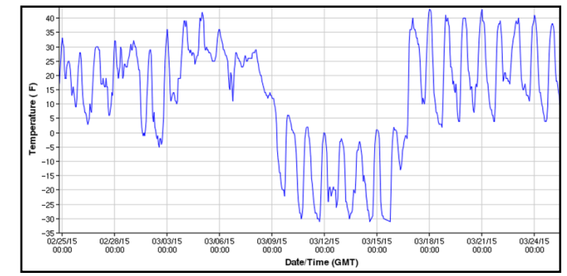
Climate is one of the critical vital signs used to monitor long-term change across the park landscape as part of the Central Alaska Inventory and Monitoring Network. There are 17 climate/weather/snow monitoring stations in addition to the park headquarters site that provide information on temperature and precipitation patterns across the park. Data are used to support other natural resource programs including wildlife distribution and abundance, avian productivity, vegetation studies, stream surveys, as well as input for practical management issues such as construction projects, road work, and aviation safety.

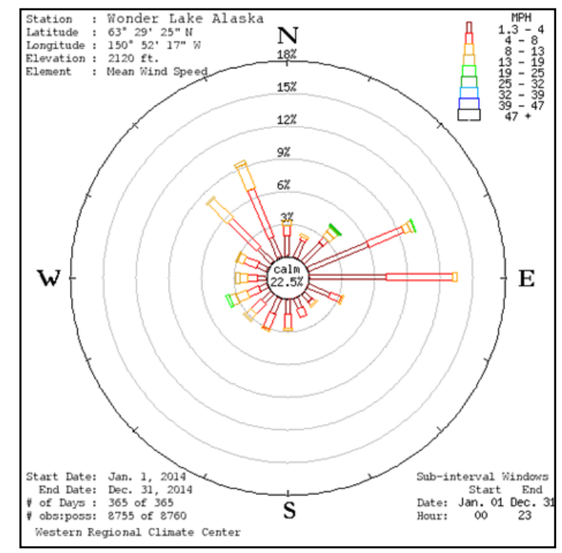
Most of these stations record air temperature, relative humidity, wind speed and direction, solar radiation, precipitation, snow depth, and soil temperatures. Annual data reports and seasonal weather summaries are available from the Central Alaska Network website. Weather data and data analysis tools are available for most of these stations from the Western Regional Climate Center (WRCC) and Mesowest websites.



Climate Station at Eielson Visitor Center



Graph of Stampede temperature data from the Mesowest website.



Wonder Lake 2014 wind rose from WRCC

Weather Monitoring at Park Headquarters

By Pam Sousanes
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Weather observations have been taken at the "McKinley Park" station at park headquarters since 1925. This is one of the few sites in the state with such a long and valuable record. This site is used to place current weather observations into context by comparing them to "normal" conditions. Normal is defined as the average climate over a 30-year period. The latest normal period is 1981-2010 (they are updated every 10 years). The entire 88 year record is used to identify the extremes.

2014 Weather Summary:

It was another interesting year for weather. The average annual air temperature was 30.2° F, 2.4°F warmer than normal and the 8th warmest year on record. The total precipitation for the year was 15.7 inches, which is 0.63 inches more than normal. Total snowfall for the 2013-2014 winter season was a meager 54.3 inches, normal is 76.8 inches.

January 2014 came in with a roar…the average temperature of 22.9 °F was almost 20 degrees warmer than average. This ranked as the 4th warmest January on record. On January 26th the high temperature hit 52 °F which set a new record daily high for January at this site, breaking the January 7th value of 51 °F from 1961. The temperatures cooled again in February with a monthly average temperature of 0.7 °F, almost 7 degrees colder than normal. Spring of 2014 was warm and dry in Denali, but transitioned into a cool wet summer – the average summer temperature was 51.4° F, which is 1.6° F cooler than normal. June temperatures were much cooler than normal; the average monthly temperature of 49.1° F was 3.7° F colder than normal. It warmed up again in the fall – the average fall temperature was 26.6° F, which is 2.5° F warmer than normal. November was warm and dry. The monthly average temperature was 18.9° F, 10°F warmer than normal and the warmest November since 2002. The average monthly temperature for December was 16.2°F, 9.3°F warmer than normal and the ninth warmest December in 88 years.

Below, are summaries of the 2014 climate data for temperature and precipitation collected at Park Headquarters, and compared with the 1981-2010 normal period.

2014

Temperature

- Maximum temperature 80° F recorded on July 7
- Minimum temperature -27°F on February 14
- Mean annual air temperature 30.2°F (1981-2010 normal is 27.8°F)

Precipitation

- Total Precipitation 15.69 inches
- Departure from Normal +0.63 inches
- Max. 24 hr precipitation 1.50 inches on June 26
- Total Snowfall 54.3 in. (7/1 to 6/30)
- Departure from normal -22.5 inches
- Maximum 24 hr snowfall 7.6 inches on Jan. 19

Denali Headquarters Average Monthly *Temperature*

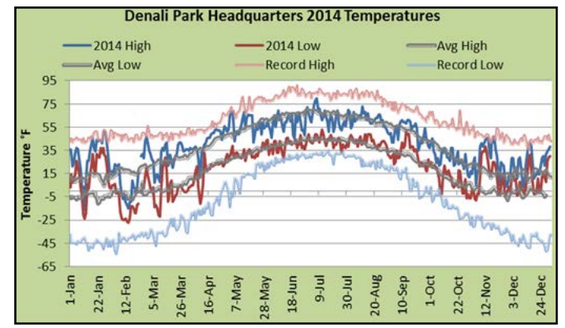
	2014	1981-2010 Average
January	22.9	3.1
February	0.7	7.6
March	15.2	13.4
April	28.9	27.9
May	45.1	42.8
June	49.1	52.8
July	53.2	55.6
August	51.8	50.6
September	41.4	40.4
October	19.5	22.9
November	18.9	8.9
December	16.2	6.9
Yearly Average	**30.2**	**27.8**

Red shading = warmer than normal; blue shading = cooler than normal

Denali Headquarters Average Monthly *Precipitation*

	2014	1981-2010 Average
January	0.90	0.63
February	0.41	0.54
March	0.27	0.39
April	0.01	0.40
May	0.48	0.87
June	3.66	2.15
July	4.61	3.22
August	2.31	2.71
September	2.25	1.70
October	0.45	0.78
November	0.05	0.75
December	0.29	0.92
Yearly Total	**15.69**	**15.06**

Red shading = dryer than normal; blue shading = wetter than normal



Snow Surveys

By Pam Sousanes
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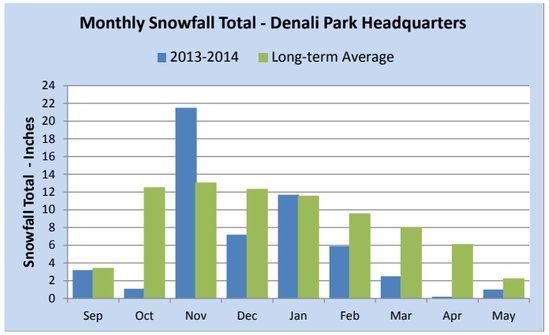
Snow surveys include ground measurements at snow courses or aerial surveys where an observer will fly by a marker and count the exposed crossbars to determine the snow depth.

In the winter of 2013-2014, park staff conducted snow surveys in Denali during the survey window (last 3 days of each month) during the winter season. Thirteen snow courses and aerial snow markers were surveyed throughout the season. The following narrative describes the 2013-2014 season:

The first persistent snow came on October 29, 2013 at park headquarters and the last day of snow for the season was May 6, 2014. The total snowfall for the season was 54.3 inches, which is 70% of normal. November was the snowiest month followed by January. The other winter months had snowfall totals that were well below normal.



The first day of persistent snow at Kantishna was on September 27, 2013 and the last day was May 6, 2014. By December 1, Kantishna had 12 inches of snow on the ground with a snow water equivalent (swe) of 2.3 inches. By February that had increased to 18 inches of snow with 3.8 inches of swe, which is 119% of normal. On the south side of the range the early season snow depths ranged between 14 inches at Chelatna Lake to 51 inches at the higher elevation site at Dutch Hills, above normal for the early measurements. Snow continued to fall through January and February and sites on the north side of the range were near normal. The south side received very little snow during the same time and the conditions by the end of February showed that most of the sites were well below normal.

March was a dry month in interior Alaska, but due to the earlier snowfalls the snowpack was near normal on the north side of the Alaska Range. The south side snow markers were about 83% of normal. The snowpack across most of the state greatly diminished across the state. Due to warm temperatures during the second half of April, most low elevation sites in the Interior, Western Alaska, Southcentral and Southeast Alaska have melted out. The Dutch Hills site on the south side was the only site that was above normal for the last survey on the first of May. The other sites had melted out some and had snow depths that were between 30 and 70% of normal. There was 14 inches of snow at Tokositna Valley on May 1, last year there was 44 inches on the same date.

The total precipitation for the winter season at Tokositna was 29.8 inches since October 1, 139% of normal. At Kantishna the winter total precipitation was 7 inches, normal is 5.0 inches; this site was also 139% of normal for the 2013-2014 season.

Snow telemetry (SNOTEL) site at Kantishna

Mercury Monitoring

By Andrea Blakesley
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Mercury is a global contaminant that is transported into Denali in very low concentrations, but has the capacity to bioaccumulate (become more concentrated) as it reaches higher trophic levels in the food web. In spring 2014, researchers installed a mercury analyzer at the park air quality monitoring station. The analyzer measures gaseous elemental mercury (GEM), and is part of the nationwide Atmospheric Mercury Network (AMNet).

In a separate mercury monitoring project, citizen scientists began collecting dragonfly larvae in 2012 as bioindicators of mercury in the environment. Dragonfly larvae prey on insects and small fish, and they can live for several years before emerging as adults. This allows mercury to accumulate in their tissues over time. Dragonfly larvae collected from Denali in 2012 and 2013 contained relatively low amounts of mercury in comparison to most other parks sampled that year. This project will continue in 2015.

Air Quality Monitoring

By Andrea Blakesley
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Continuous air quality monitoring has been conducted in the park since 1980 at a station near Park Headquarters. Sampling occurs through several nationwide air quality monitoring networks, which measure atmospheric deposition, ground-level ozone, sulfur and nitrogen oxides, fine particles, visibility, and associated meteorological parameters. A second station in Trapper Creek, established in 2001, also measures fine particles and visibility through the nationwide IMPROVE monitoring network (Interagency Monitoring of Protected Visual Environments).

While Denali has some of the cleanest air measured in the United States, small amounts of industrial and agricultural contaminants from other continents make their way into the park each year in a recurring seasonal pattern. The peak concentrations of international contaminants generally occur in the late winter and spring. Local and regional emissions are also measured in the park in small quantities each year. During summer, naturally-occurring wildfire smoke is the primary contributor to air quality degradation.

More information about the National Park Service air quality monitoring program can be found at the following web site: **www.nature.nps.gov/air/**

Visability Webcam

By Andrea Blakesley
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The Denali visibility webcam is part of a nationwide network operated by the NPS Air Resources Division. During summer, the camera takes a picture of the Alaska Range once every 15 minutes, and the image is transmitted to the web via satellite. The webcam home page also displays current ozone and weather data from the air quality monitoring station near Park Headquarters. All images are archived throughout the summer for a long-term visual record of visibility, one of the air quality related values (AQRVs) protected under the Clean Air Act.

www.nature.nps.gov/air/WebCams/parks/denacam/denacam.cfm

Monitoring and Understanding the Active Igloo Debris Slide

By Russell Rosenberg and Denny Capps
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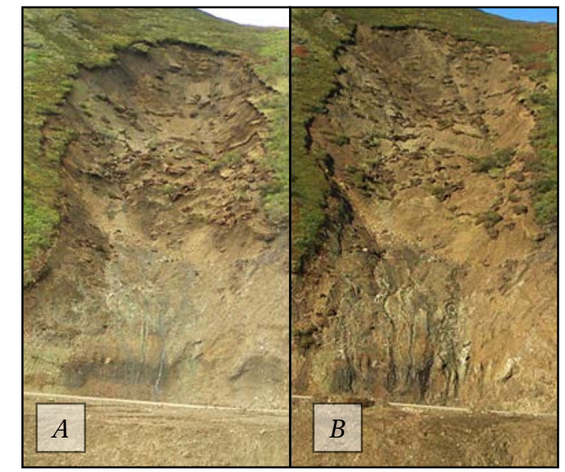
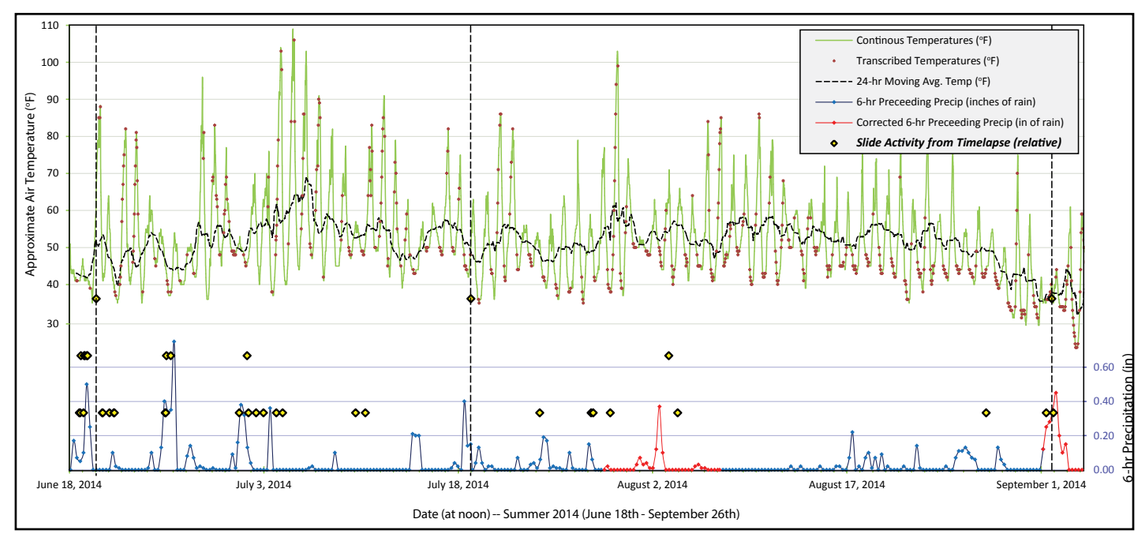
Following the October 23rd, 2013 discovery of the initial ~600'x110', ~30,000 cubic yard, debris slide which covered the park road near mile 38 above Igloo Creek (further referred to as the Igloo Debris Slide), park geoscientists have continued to monitor and study the area. Site monitoring, including time-lapse photography, reveals continued activity and evolution of the scarp throughout the summer of 2014, often associated with rapid, high intensity, precipitation events. Only a small amount of material ever reached the park road and none of these motions posed a direct hazard to visitors. However, occasional larger events may be contributing to the loading of a sizeable mass of material within the central portion of the scarp that, if it failed, has the potential to release material onto the road. Study of the Igloo Debris Slide highlights the dynamic nature of the Earth in Denali, but also the concerns associated with natural hazards.

Monitoring an Active Landslide

We employed the use of time-lapse photography, precipitation and temperature instruments, in addition to various GPS and remote sensing techniques to record landslide activity and associated environmental variables. Continuous time-lapse photography allows us to accurately time the initiation and duration of events, visually estimate the volume of events, and a record of the type of motion occurring. Comparison of photos allows us to see the evolution of the footprint and character of the scarp through time. We use GPS and remote sensing methods to more accurately quantify the amount of material being displaced within the scarp over longer durations. Patterns or changes in these data give us important information about what environmental conditions affect slide activity the most, if the type of activity is changing, and if activity is accelerating or decreasing over time.



Time lapse imagery of the Igloo Debris Slide. Note the evolution of the upper left hand side of the scarp and the addition of material in the middle of the slide area. Photo A – 6/20/2014; Photo B – 8/22/2014



Igloo Debris Slide Activity During 2014

During the monitoring period from June through September, photo comparison and remote sensing reveal an overall retreat of the scarp accompanied by an overall reduction in slope. Although the time-lapse footage shows abundant, low volume, shallow, soil slumps, the majority of the material displaced during the monitoring period occurred during large precipitation events that displaced several hundred cubic meters of material each. Isolating the triggers associated with larger events helps us determine under what conditions the Igloo Debris Slide is most active and poses the most potential risk to visitors.

Understanding Landslide Activity

Variables such as earth materials and slope angle can vary within a given slope, but tend to be relatively fixed in time and do not typically cause a slope hovering near the stability threshold to move back and forth across that line. Rather, increased pressure from fluids within the hill slope from rapid or prolonged precipitation, or thawing permafrost as the temperature spikes, are likely to cause acute failures. The results of our monitoring demonstrate that increased slide activity correlates best with high intensity rainfall. Landslide activity does not correlate well with air temperature shifts. We are still investigating the influence of prolonged rainfall and saturation of the hillslope, and the possible longer term effects of thawing permafrost as the scarp matures.

Mitigation and Future Work

None of the events recorded during 2014 would have posed a direct hazard to anyone present along the park road. However, because all active landslides have the potential for future instability, the park is working to determine potential risk to visitors and mitigate it effectively. The park currently places "no stopping" signs in the area of immediate concern, has a dug a small catch basin below the scarp, and is actively engaged with experts at the National Park Service-Geologic Resources Division to monitor the changing risk to individuals traveling past this point. We will continue to monitor the Igloo Debris Slide during the summer of 2015, and plan to incorporate additional temperature probing as a method of assessing the potential for increased scarp degradation resultant from thawing permafrost. All of these efforts are meant to keep visitors to the park safe as they enjoy the dynamic Earth that Denali National Park and Preserve showcases.

Monitoring Slope Motion along the Savage River Loop Trail

By Russell Rosenberg and Denny Capps
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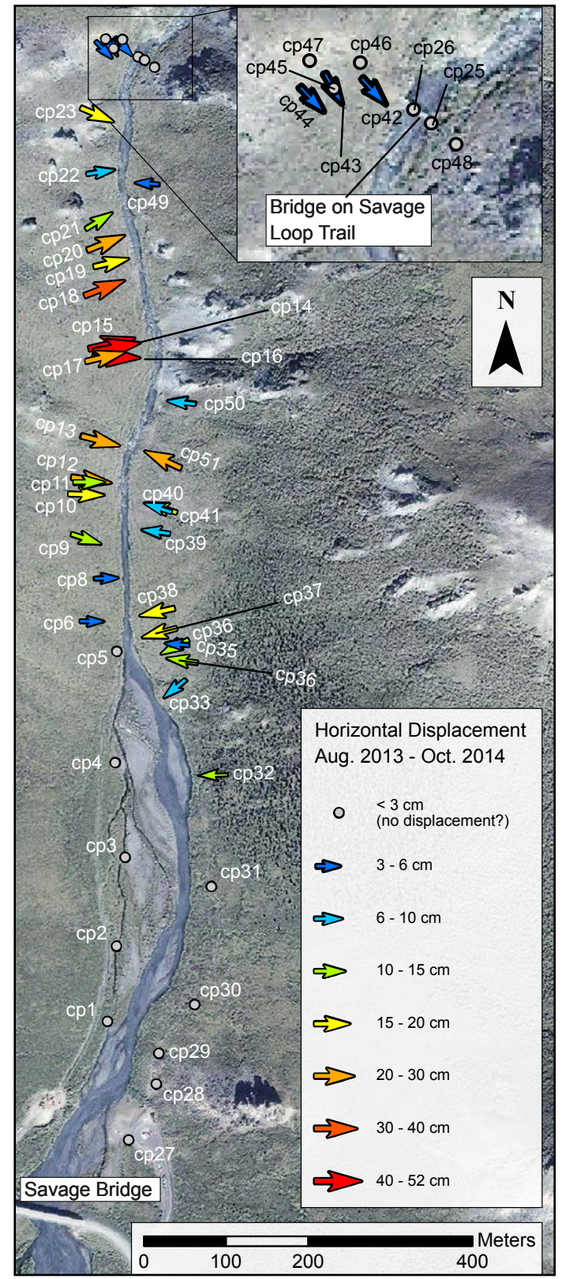
The Savage River day use area is a popular destination for many visitors to Denali National Park. The trails and infrastructure in the area receive significant use, however, the area also displays geomorphic indications of significant downslope motion, frequent trail erosion, and documented damage to the wooden hiking bridge at the far end of the Savage River Loop Trail. In order to aid decision making about future infrastructure and trail maintenance in this area, we developed and implemented a repeat GPS survey of monuments along the trail. With these data we hope to quantify downslope movement, identify the fastest moving areas, and better understand the geologic mechanisms at work.

We installed ~50 survey monuments along the Savage River Loop Trail, with slightly higher monument densities in areas with higher likelihoods of rapid downslope movement and/or importance to trails and infrastructure. Given considerations for Denali's wilderness, these survey monuments are extremely low visibility depressions of only a few millimeters drilled into strategically located boulders on the hill slope. GPS survey monuments were installed during the mid to late summer of 2013 and were relocated through the use of detailed photo documentation in October, 2014. We utilized a precision GPS unit that can resolve any change of greater than ~3 cm in monument location between repeat surveys.

The annual downslope horizontal motion recorded at many of our survey markers was much higher than anticipated. The average recorded horizontal downslope motion was ~12 cm with about half our sites recording motion of greater than 10 cm and several sites recording ~50 cm of motion. These values are significantly greater than we anticipated assuming that the majority of slope mobility in the area was a result of a geomorphic process called solifluction - where seasonal freeze and thaw in moist soils creates downslope movement. However, these rates would be among the highest rates of solifluction in the world, leading us to suspect that additional motion at depth is involved.



Annual horizontal displacement of monuments along the Savage River Loop Trail. Displacements less than ~3 cm are near to the resolution limit of the RTK GPS.

The results of this study were initially intended to inform the Denali National Park trails crew regarding trail building and maintenance decisions. To this end, these data identify areas of rapid downslope motion where trails are likely to be rapidly degraded or moved downslope into the river and eroded entirely, and they may assist in determining the best repair plans for the wooden hiker bridge at the north end of the canyon loop which is being actively deformed and compressed by convergent downslope movement of material at both ends of the bridge. These data may also help to inform the park and the Federal Highway Administration (FHWA) on the construction of a proposed pedestrian bridge just north of the park road. The proposed bridge would span the Savage River near the two parking lots that currently mark the two ends of the Savage Canyon Loop Trail. While survey data from future years and the results of a FHWA well monitoring study in the same location are needed for any engineering-level decisions, preliminary data indicate that area around the proposed bridge site is relatively stable.

Toklat River Floodplain Monitoring

By Maisie Richards

The Denali Gravel Acquisition Plan authorizes gravel to be removed from the Toklat River floodplain in alternate years to support maintenance needs of the Denali Park Road. Beginning in 2004, and continuing in every even year, approximately 22,200 cubic yards of gravel are excavated from the river using methods designed to mimic natural processes. Inherit to the park's dedication to adaptive management is a motivation to understand and minimize impacts to natural systems. This requires an understanding of how sediment moved through this reach prior to gravel extraction and whether a balance between aggradation (deposition) and degradation (incision) has since been altered.

Colorado State University has partnered with DENA to investigate the response of the section of floodplain experiencing gravel extraction using temporally and spatially nested data. These data consist of detailed topographic monitoring in areas of interest using precision GPS, continuation of valley-spanning cross-sectional data, Terrestrial LiDAR, airborne LiDAR and potential incorporation of a new airborne photogrammetric technique. The data acquired will be used to create surfaces (see Figure 1) to locate areas of aggradation or degradation and alterations to channel form across varying temporal and spatial scales, and to identify areas to avoid or target with gravel excavation. This will contribute to an ongoing analysis of the severity of disturbance to the health of this river and its implications for Park infrastructure and management. Quantification of the effects of gravel mining on this river has implications for the National Park Service's management policies, gravel-extraction techniques applied by other land management organizations, and similar instances of river resource extraction worldwide.

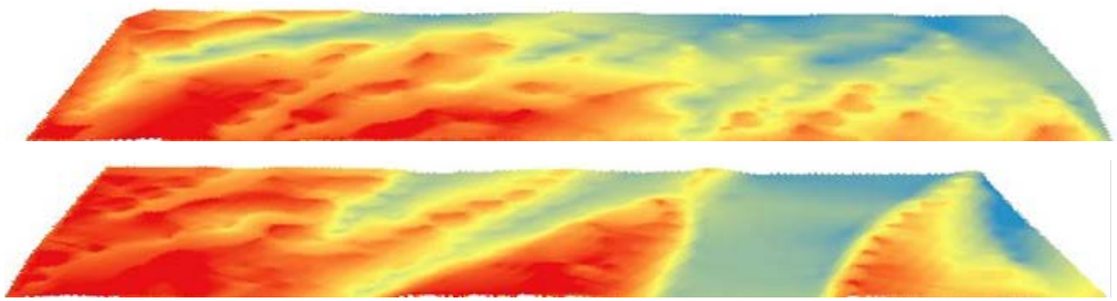


Figure 1: Preliminary topographic data collected in 2014 with precision GPS to determine changes in surface elevation of floodplain. Surfaces represent one section of active floodplain of the Toklat River across a three-week time scale. Red represents higher elevation and blue represents lower elevation. The lower surface occurred 3 weeks prior to the upper surface. These two figures demonstrate that substantial scour and deposition was measured, though an overall trend of aggradation or degradation has yet to be determined.

Glacier Monitoring

By Rob Burrows
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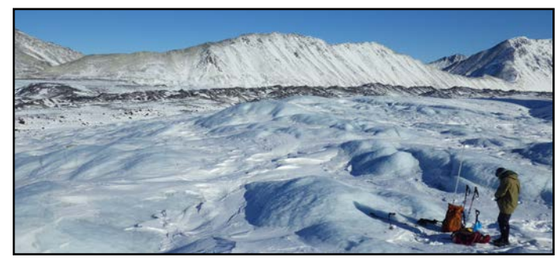
Glaciers are the enigmatic sculptors of the mountains. They are a sensitive indicator and powerful symbol of climate change. Almost all glaciers across the globe are thinning and retreating in unison from the warming climate. Denali's glaciers are no exception, however the highest elevation glaciers that sit on the roof of North America are robust and not seeing as dramatic loss as many other glaciers in Alaska and the world. Denali is a stronghold for glaciers because the high mountains provide a cold and snowy refuge, the best habitat for glaciers.

Why monitor glaciers?

Glaciers are integral components of the region's ecosystem. Glacier behavior affects other components of the ecosystem, such as rivers, microclimate, and the creation and destruction of terrestrial and aquatic habitat.

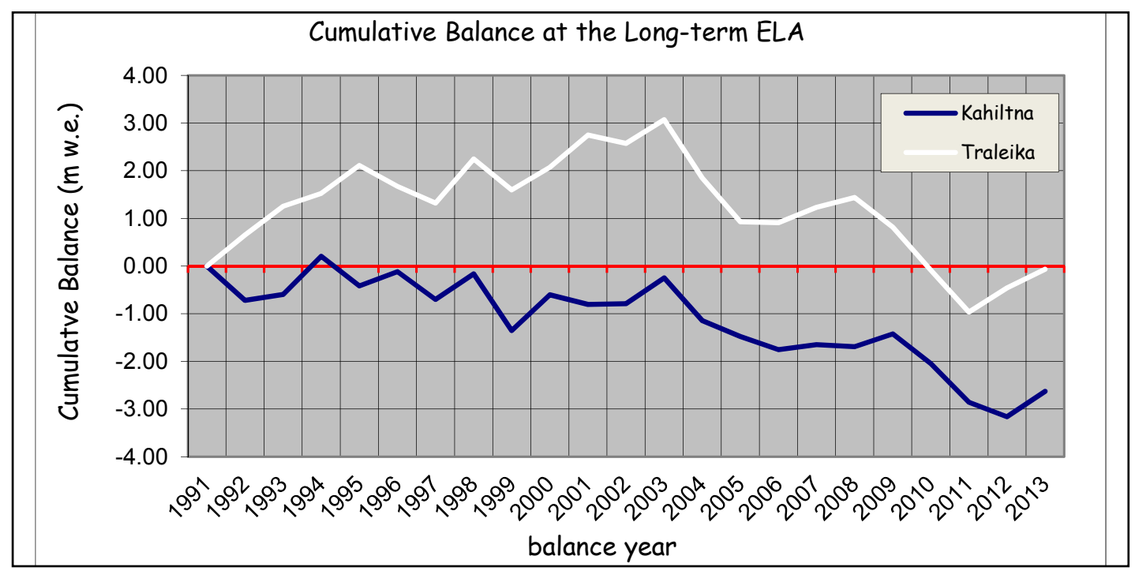
Monitoring seasonal snow accumulation and ice loss at points on a glacier surface provides unique data on high elevation climate variability and trends. Such data is difficult and expensive to obtain using an instrumented climate station. Measuring total winter snow accumulation in the early spring and summer snow and ice melt provides data on winter precipitation and average summer temperature (and in some cases snowfall) that are important to the mountain environments that glaciers occupy.

Glaciers have been a feature of scientific interest since the first explorations of geologists in the early 1900s. The NPS has been conducting long term monitoring since 1991, below are recent updates on those efforts.



Recent Monitoring Results

- In 2013 the Kahiltna and Traleika glaciers were monitored for mass balance at index sites for the 22nd year.
    - Thanks to the assistance of the South District Ranger staff based out of Talkeetna for their support with aviation and safety.
    - Thanks to the assistance of NPS Kennels for the support to conduct measurements on Traleika Glacier in March 2015. Stay tuned for those results in a future edition.
- In 2013 the Traleika glacier as a whole had a slightly positive balance year. This year departs from the negative trend for a second year in a row (see chart to right).
    - Snowfall/winter balance was 110% of average
    - Melt/summer balance was 99% of average.
- The Kahiltna Glacier as a whole also had a slightly positive balance year in 2013. This is a departure from the negative trend on this glacier since 2004 (see chart above).
    - Snowfall/winter balance was 127% of average.
    - Melt/summer balance was 60% of average.
- For more details see the latest report published in 2014: **https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=501088&file=CAKN_GlacierReport_2013_Final.pdf**

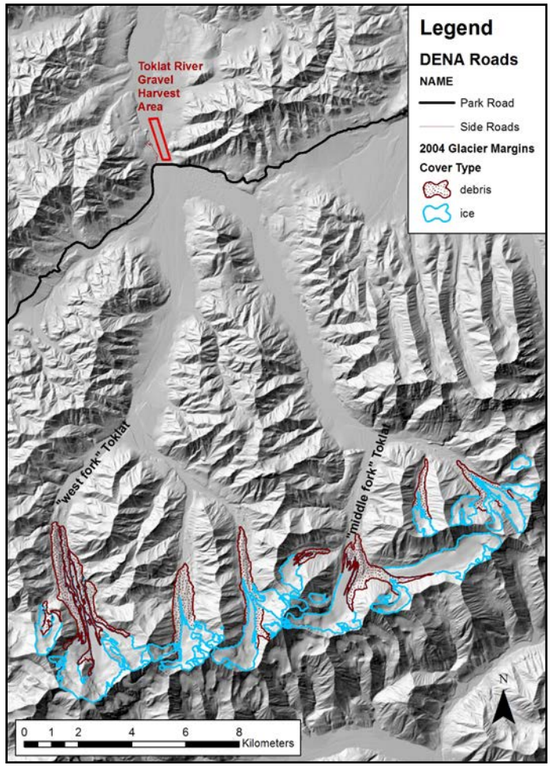


The East Fork Toklat glacier was surveyed with a citizen science seminar in conjunction with Alaska Geographic in August 2014. Six participants helped complete a GPS survey of the glacier terminus and surface elevations of the lower glacier last done in 2010.

Citizen Scientists have been contributing to the knowledge of glacier ice loss rates in the Toklat watershed since 2012. Based on previous data collected in 2002 and a new digital terrain model of the Alaska Range, results show that the area averaged rate of ice loss has increased from -0.7 m/year (between 2002 and 2012) to -1.0 m/year (between 2010 and 2013).

- A video was made by NPS Media Intern Katie Thoreson about the citizen science trip: **https://www.youtube.com/watch?v=zc7jev3ri4c**
- The citizen science expedition will strike out once again July 30 - August 3, 2015. See: **http://www.alaskageographic.org/static/1174/glaciology-backcountry-citizen-science**
- For virtual exploration of some of Denali's glaciers check out these 360 degree panoramas: **http://www.nps.gov/dena/photosmultimedia/vr-panos.htm**
- There is a Fact Sheet available for Denali Glaciers, see here for the digital version: **http://www.nps.gov/dena/naturescience/upload/GlacierMonitoring2012.pdf**
- There is a NEW Fact Sheet for Kids about glaciers, see here for the digital version: **http://www.nps.gov/dena/naturescience/upload/Glaciers_Kids_2014.pdf**

(Above) Participants taking a break during glacier citizen science seminar. (Below) Toklat Glaciers terminus and retreat rates.



Visitor Characteristics and Social Science

Park Visitation

By Britta Schroeder
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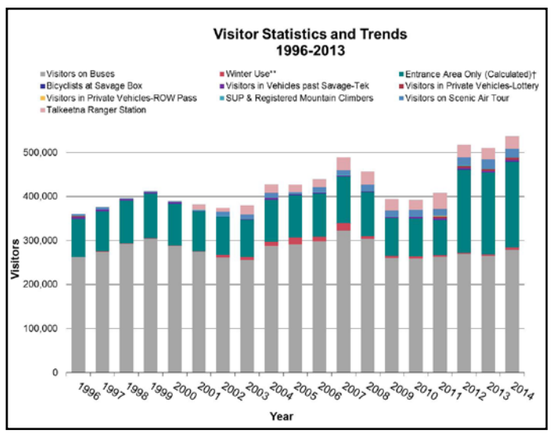
Since the completion of a park visitation study in 2011, a new formula has been applied to subsequent years to calculate park "recreation visits". Previous park visitation statistics were based on formulas derived from 1996 data. The previous formula underestimated visits in the Entrance Area. When the new formula was applied, there was a significant jump in visits with 510,521 occurring in 2013 and 537,434 in 2014. Visitation to the park continues to be on the upward trend as recreation economies recover from the 2008 regression. Bus visits have remained steady with an average of 267,209 visitors over the past five years. Winter use has seen a reasonably large increase in recent years, from 3,133 in 2013 to 5,200 as of January 2014. Entrance area visits (visits going no further than mile 13 on the Park Road) have increased as well.



Visitor Counting at the Denali Visitor Center

By Britta Schroeder
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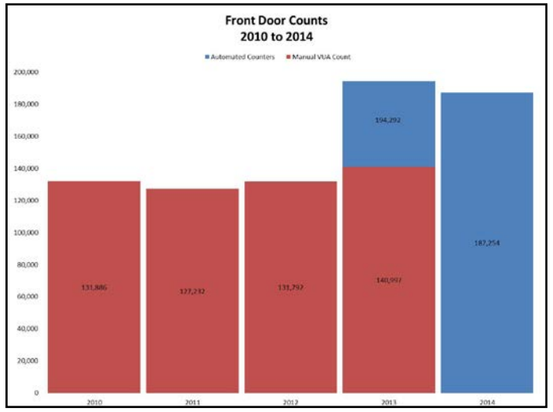
Previous to 2014, visitors entering the Denali Visitor Center were counted manually by Park staff. During the summer of 2013, a pilot study installed automated counters at the Denali Visitor Center (DVC) to count visitors entering and leaving the building. This information was used to calculate total visitation to the DVC during the sampling period as well as calculate the average hourly and daily visitors. Even taking into account error and double counting of visitors leaving the building, automated counts were greater 1.6 times the numbers counted by manual counting.

From May 15 to September 11, 2014, total visitor counts came to 223,353, with about 83% of those visitors entering through the front two doors. Given a 95% confidence interval, the mean hourly count was 186 ± 16, while the mean daily count was 1,861 ± 312. July had the highest visitation rate at 68,268. Automated visitor counts were then compared to visitor counts taken by the NPS employees at the DVC front desk from July 25 through September 12.

	Counting Method	2013	2014
Front Doors	Manual Count	142,321	No Manual Counting
	Automated Calibrated Count	194,292**	187,254
All Doors	Automated Calibrated Count	230,918**	223,353

**estimated from hand counts



Subsistence

Federal Subsistence Registration Permits

Denali staff managed the Federal Registration Permits for subsistence hunting of moose and caribou on park lands in Wildlife Management Unite 13E near Cantwell, and moose hunts on preserve lands in Unit 16B. Permit applications were advanced to the Bureau of land Management in Glennallen and permit data was stored in U. S. Fish and Wildlife Service's database. In GMU 13E Nelchina-Upper Susitna-Cantwell harvest included thirty moose permits were issued and two moose harvested. As of February 15, 67 caribou permits were issued and four caribou harvested.

Subsistence Resource Commission

On August 7, 2014 the Denali Subsistence Resource Commission (SRC) was scheduled to meet in Cantwell at the Cantwell School. Following the SRC meeting a NPS sponsored potluck was held at the Cantwell Community Center. On February 25, 2015 the SRC met again in Fairbanks at the Pike Place Landing.

Subsistence, Stories, and Place Names of the Upper Kuskokwim River Project

The Upper Kuskokwim River lies on the Northwestern side of the Alaska Range. The Athabascan people who live there are called Upper Kuskokwim Athabascans. They have traditionally used lands, now enclosed in the boundaries of the Park, as traditional hunting, trapping and gathering grounds for thousands of years. The language they speak is Dinak'i (Duh-naa-kuh). Their name for Denali is Denaze. Because they are people who have inhabited this land long before there was a National Park here, Denali Park and Preserve has awarded one of the villages, Telida, a two year grant to help them continue an Upper Kuskokwim River regional place names project.

From time immemorial, the native peoples of Alaska have systemically named places, or geomorphic features with names. The names could be descriptions, The Upper Kuskokwim River is named Dichinanek', which means "river of sticks, trees." Lake Minchumina means "lake big lake." They may name a place to remember what happens there, the Trimokish Hills (North Peak) are named Tr'emo K'esh, which means "lonely or sad birch" which may speak of a place where cremations took place. They may explain what is found there, Big River is called, Izdlaghe Zighash No', which means "Sheefish harvest river." They may give direction as to what you do there, Nenots'eshts'ilyash hw, means "where we leave canoes" because the water gets too shallow and you have to proceed on foot.

These names were passed on orally though the ages so that the people of future generations would be able to find their way as they traversed the land, rivers, mountains, hills, portages and lakes. Some names are so old that there is no one living that knows the meaning of the name, but because of oral tradition, they know where the site is located.

Documenting these names is an invaluable part of the Athabascan culture, as the English names are now known more widely while the Dinak'i names are being lost. To date, almost 800 names have been mapped (geo-referenced) almost 800 names. The project team has "discovered" audio recordings of wise Elders who have since passed on, that recorded their travel stories throughout the Upper Kuskokwim River region and into the Alaska Range, as well as trade with the peoples on the southern side of the Alaska range. Some of these travel narratives are so informative that it is possible to retrace their steps. Once the team has collected and translated all that is possible, the Park will compile this information into a book for the Upper Kuskokwim Peoples, as well as create a kiosk in the Park's Visitor Center.

Understanding Change: How Communities Perceive Climate Change at the Local Level

This project elicits observations from subsistence community members about climate change and identifies the challenges that climate change poses for subsistence users. This information will be valuable for understanding the challenges subsistence communities face and providing subsistence opportunities in a changing climate.

Project highlights:

- Common observations of change included warming, vegetation growth, less snow, and drying ponds, while other changes were less frequently mentioned (e.g., rising fern-line, increased erosion), or had greater variation in response (e.g., amount of wind, river level).
- Individuals who interact most closely with the system on a regular basis have more and different observations than those who do not (Table 1). These findings suggest that engaging multiple groups of stakeholders who interact with the park in distinct ways contributes insights about how climate change is impacting park resources and offers a broader foundation for adaptation planning.
- The impacts of climate change that were most consistently mentioned included: distribution of animals (36%), wildlife viewing (28%), and changes in river access (22%). Impacts were primarily negative, although some positive impacts were mentioned (e.g., increased gardening season, easier to warm houses).
- Participants provided five primary suggestions for how NPS could adapt to climate change including education about climate change (25%), maintaining a quality experience (22%), maintaining subsistence (22%), changing Park identity (17%) and continuing current monitoring (12%).
- Participants described how subsistence could be supported within a context of climate change by: listening to subsistence users and taking their insights into account, allowing more regulatory flexibility for hunting and trapping, helping to support income generation for surrounding communities, and thinking creatively about how subsistence will be passed on to the next generation.
- This project demonstrates that non-expert residents have different observations based on their experience with and use of natural resources. This project suggests that there may be benefits of human intimacy with protected landscapes, including memory, diversity, redundancy and information about feedbacks between social and ecological systems.

Conclusions:

- The values associated with living a subsistence lifestyle were positive to the well-being psychologically, emotionally, and physically of the participants. Having a sense of connectedness to the land also brought about a sense of kinship with others not only through the act of teaching, but by sharing within families and between friends.
- While all the communities studied were categorized as subsistence communities, each community was unique culturally, environmentally, geographically, historically, and socially.
- Overall, subsistence hunting was used to supplement income, as both a main food source of moose and as partial income through fur trapping. The costs associated with transporting foods to roadless communities often disrupted individual's abilities to utilize outside resources, resulting in a greater dependence on community sharing and local subsistence.
- It was in the outdoors that individuals felt relaxed, rejuvenated, and connected to a part of a greater system or entity that increased their feelings of wholeness.

Moose Surveys

By Pat Owen
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In 2013, moose surveys were conducted in two areas of the park important to subsistence users.

A full census was conducted in the Cantwell area which means that all survey units in the study area were counted. The Cantwell survey was conducted from November 11 and 12, 2013. Snow conditions were excellent throughout the survey area. A total of 66 units were surveyed which comprised 395 mi2 of study area.

We observed 360 moose. The calf:bull:cow ratio was 15:53:100. Calves, bulls, and cows represented 9%, 31%, and 60% of the population, respectively. Of the total cow moose counted, 85.5% of cows were without calves, 14% of cows had 1 calf, and 0.5% of cows had 2 calves present. Overall moose density was 0.91 moose/mi2).

The Yentna survey was conducted from November 29 and December 2, 2013. High winds resulted in grounding the operation for the days in between the actual survey days. Snow conditions were generally good throughout the survey area. A total of 32 units were surveyed which comprised 197 mi2 (27%) of the total study area.

We observed 111 moose during the survey and estimated 179 + 106 moose for the entire survey area. The calf:bull:cow ratio was 33:52:100. Calves, bulls, and cows represented 18%, 28%, and 54% of the estimated population, respectively. We estimated that 75% of cows were without calves, 17% of cows had 1 calf, and 8% of cows had 2 calves present. Overall estimated moose density was 0.25 moose/mi^2.

Cultural Resources

New Term Park Historian

By Phoebe Gilbert
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In April 2015 Erik Johnson started working as the Park's term Historian. Erik received his master's degree in History from George Mason University in 2014. Since completing his graduate program he has worked as a research historian for a Washington, D.C.-based historic preservation consulting firm and also completed a fellowship with the National Park Service's History Program in the National Capital Region. Erik also completed internships with the Section 106 Officer of the NPS's Washington Support Office and with Glen Echo Park's Oral History Project. Before attending graduate school Erik taught English as a second language in Seoul, Korea for nearly four years. He was born and raised in Colorado and earned his bachelor's degree in International Affairs with a minor in Economics at the University of Colorado in Boulder.

Birch Creek Site Visit

By Phoebe Gilbert
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In 2014 Denali National Park and Preserve began the process of consultation with federally recognized tribes to identify knowledgeable Elders and lineal descendants of families that lived at the Birch Creek Site. Three lineal descendants were contacted during these consultations and invited to conduct a site visit on August 9th, 2014. Two of the descendants were able to attend and flew to the site for a day visit with two NPS staff.

Stanly(left) and Randy Star at the Birch Creek Site. The Star brothers spent much of their childhoods at the site with was incorporated in to the National Park in 1980. This was the first time the two had been back to the site in over 30

During the site visit valuable information identifying the features at the site was gained along with information on how the descendants would like the site managed. The purposes of the site visit and consultation were to; help fulfill the parks obligations under the Native American Graves Protections and Repatriation Act (NAGPRA) that requires Federal agencies to consult with Alaska Native Tribes and lineal descendants on issues concerning Native burial and items subject to NAGPRA that are located on federal lands, and to gain information from these entities regarding the potential stabilization and/or restoration of the site which is being disturbed by erosion and other natural processes. The project resulted in productive consultation with lineal descendants of the site and the potential restoration and/or rehabilitation of the Birch Creek Site. Through this project the Park has gained new information on the history of the site and strengthened tribal relationships through the consultation process. This is an important step in providing for the preservation of cultural identity, interpretation, investigation, and/or restoration of this site with local Native Alaskans at the core of the process.

Site Inventory and Condition Assessments

By Phoebe Gilbert
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In 2014, 300 acres were surveyed for cultural resources. The majority of this survey took place during Section 106 compliance reviews. Seven new archaeological sites were located and recorded during this survey work, and six previously recorded sites in the park underwent site condition assessments. The information gathered during the 2014 field season adds to the growing knowledge of how people have used Denali National Park in the past and furthers the Park's ability to properly manage these resources for future generations.

Archaeology Surveys

By Phoebe Gilbert
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There were two archaeology surveys that were carried out in the park this year. The first was a project investigating the archaeology of the Upper Teklanika River Valley. The objective of the project was to expand upon current knowledge traditional human use of the Teklanika valley which contains archaeology sites that are 12,600 years old. No new sites were recorded during the survey, and one site assessment of a documented site was completed.

The second project investigated the archaeology of the Toklat River. The Toklat river drainage had little to no glaciation during the late Pleistocene and early Holocene (around 10,000 years ago) which may have provided people during these times an advantageous area of occupation for the hunting of ice-age mammals. This area had never been surveyed before. Shovel testing and surface survey were conducted along the river valley with particular emphasis on the areas that were designated as high-potential based on elevation, view shed, and proximity to fresh water sources

Twenty-seven shovel tests (50 cm by 50 cm) were excavated, most of which ended on permafrost approximately 30-40 cm below the surface. No cultural material was found in the shovel tests. Charcoal was collected from what appeared to be a buried natural surface for identification and dating of the landform to try and gain a better understanding of the processes that formed the valley.

Two historic sites were located during this survey. One site is related to construction of the Toklat Bridge and the other appears to be associated with historic mining activities in the area.

Archaeology Culture Camp and Museum Family Day

By Phoebe Gilbert
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In September of 2014 Denali National Park and Preserve, in cooperation with University of Alaska Museum of the North (UAMN), lead a five day Archaeology Culture Camp and Museum Family Day. The archaeology culture camp taught local students about the human history of Denali National Park and Preserve area through an archaeology excavation at the Nenana River Gorge Site. This site is located along the eastern edge of the Park and overlooks the Nenana River. During the camp the students, learned about archaeological ethics, excavated test units, and researched the artifacts that they uncovered. The Museum Family Day allowed the local communities in the Denali area to connect with park and UAMN museum research and collections by asking archaeology and ethnography curators and researcher's questions, participating in hands-on activities, and exploring the collections of artifacts from the Dry Creek and Walker Road Sites located near Healy. The activities included a mock excavation, atl-atl throw, and flint knapping demonstration.

(Above) Culture Camp participants excavate at the Nenena River Gorge Site.

(Left) Overview of the Steep Bluff Historic Site (MMK-197) Which is associated with the construction of the Toklat River Bridge.

Historic American Building Survey (HABS) documentation of historic structures in the Park

By Phoebe Gilbert
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The Heritage Documentation Programs (HDP) assists in the preservation of significant resources by recording historic buildings, structures and landscapes, and transmitting the documentation to an architectural, engineering and landscape archive at the Library of Congress. HDP is comprised of three surveys: the Historic American Buildings Survey (HABS), the Historic American Engineering Record (HAER), and the Historic American Landscapes Survey (HALS); and the Cultural Resources Geographic Information Systems (CRGIS). Documentation by the surveys provides baseline data using measured drawings, large-format photographs, and historical reports that assists in planning efforts for rehabilitation and restoration, and facilitates the interpretation of buildings, structures, and landscapes. HABS, HAER and HALS documentation meets all requirements of the Secretary of the Interior's Standards for Architectural and Engineering Documentation.

In June of 2014 Todd Croteau (Project Leader, HAER, HDP) visited the park and took photos of 21 historic structures for inclusion in the HABS Collection at the Library of Congress. Mr. Croteau prepared photographic views of the structures with large-format (4 x 5) black and white negatives. The majority of the photographs are exterior views but some interior views were also taken. The HDP is currently in the process of organizing, editing, and processing the documentation for deposit in the Library of Congress. Historical data will be included with the photographs. This documentation will provide historical background and graphic data that will aid in the management of the historic resources. Upon completion the photographs and descriptions will be available for public access and use.

HABS photo of Historic Kantishna Roadhouse

HABS photo of the Little Annie Mine

Museum Collection

By Kimberly Arthur, Museum Curator
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This past year the museum collection saw a significant increase in Outgoing Loan Agreements with twelve new loans established. Each loan tracks museum property stored at non-park locations. All park museum property is federal property and is subject to the Annual Inventory Random Sample each year; thus tracking museum property is a vital. The park superintendent approves all loans.

The materials on loan range from specimens and objects collected through research conducted in the park to historic and/or cultural artifacts on exhibit. Collected specimens and objects are used for research, preservation and education. Specimens destroyed through analysis are not accessioned into the museum collection. The steps from collection to research to cataloging can take months to years depending on the collection size and the researcher's purpose. When a loan is established, it can span a series of years or field seasons. Some of the loans renewed expired loans, and this allows the park to receive an update on the condition of the objects and the future intentions of that particular collection.

New loans include:

- University of Alaska Museum of the North Entomology: 911 specimens of bees and flower flies collected during a survey in 2012
- Talkeetna Historical Society: 1 Bradford Washburn Relief Model of Mount McKinley (Denali), on loan since 1988
- Penn State University Vegetation Dynamics Laboratory: 221 white spruce cores and 14 white spruce seeding cross sections
- Ernst-Mortz-Arndt, University Greifswald: 690 tree core samples
- Center for the Study of First Americans, Texas A&M University: 60 archeological artifacts
- Ernst-Mortz-Arndt, University Greifswald: 50 shrub core samples and shrub discs
- University of Alaska Museum of the North Herbarium: 5413 specimens
- University of Alaska Fairbanks Alaska and Polar Regions Collections and Archives: 3 containers, Grant H. Pearson papers;
- University of Alaska Fairbanks Alaska and Polar Regions Collections and Archives: 3 lantern slide collections, totaling 262 slides
- University of Alaska, Climate and Tree-Ring Laboratory: 162 tree cores
- Duke University Herbarium: 77 fungi samples
- University of Alaska Museum of the North Herbarium: 1specimen for graduate student research

The Park currently has thirty-eight active loans with various universities, museums, historical societies and research facilities. This has allowed the park to import new catalog records and maintain the current location and object status for many specimens and objects. The park's museum collection totals 372,954 objects, photos, archives and other museum forms property so outgoing loans are essential as the park collection storage facility houses a small portion of the museum collection. Loan agreements allow for storage and increased access and use of the collection beyond the park boundaries.

This year and the years ahead the park will focus on addressing the archive backlog that has generated with the retirement of some of the park's staff and the growth in central files. These are archives that are not readily being used, so accessioning them into the collection opens them up for research.

Piton, Flat and pointed iron piton with 0.6 CM holes bored in blade. Stamped near the ring are, "Made Switzerland" and "SCH & C(?)ZURICH". DENA 1665

Digitizing the collection continues with roughly 5203 objects, archives or specimens being photographed or scanned. This number continues to grow as it will be an ongoing project. Archives and collections with more than 1 quantity counts, or pages, are not added to the database as it only allows for the first image to show and some collections can have over 100 pages. These pages are stored on a network drive. Like loans, digitization increases access to the collection while also preventing further irreparable disintegration through repeated physical handling and originals can be better preserved future reference. Digitization is significant to preserving the details in important and historic ephemera, especially as time and light naturally age originals.

Objects on exhibit at the Denali Visitor Center during the summer season:

- Pen that President Woodrow Wilson used to sign the park into existence, DENA 4199;
- Adolph Murie's camera, DENA 3108; and
- Spent rifle cartridges, DENA 1640, DENA 1642, DENA 1645.

For paleontology objects on display, please visit the MSLC and the Toklat tent. On display at the tent is an Ichnite trace fossil track (possibly a three-toed dinosaur, a Therapoda or Hadrasaur, DENA 2271.

A park visitor capturing memories of the fossil track located in the Toklat Tent.

The biology collection continues to see yearly growth as researchers study invertebrates, flora, trees, ice, small mammals and other disciplines. Collectively they contribute to the synoptic collection in these areas.

DENA 40291, Bombus melanopygus Nylander on loan to the UAF MUSEUM OF THE NORTH ENTOMOLOGY

As a part of the National Park Service's Centennial Celebration in 2016, the park will be participating in an online virtual exhibit in partnership with Google. Each park, that has a museum collection, was asked to select one iconic image of one object to represent the park's museum collection. Since it will be a cultural exhibit, the object had to represent archeology, art, ethnography, history or archives. With staff and public input, management decided upon homemade crampons from the Sourdough Expedition in 1910 as the crampons represent Denali as North America's highest mountain and mountain climbing, which has become a part of the park's identity and exploring. When the exhibit goes live, it will be shared through social media and on the park webpage.

DENA 405. The homemade crampons were left on Muldrow Glacier by members of the 1910 Sourdough Expedition. They were found and recovered by the Lindley-Like Expedition, 1932.

Murie Science and Learning Center

Murie Science and Learning Center

By Sierra McLane
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Background

The Murie Science and Learning Center (MSLC) promotes science and stewardship on behalf of national parks in northern Alaska. The MSLC is part of a national effort to increase scientific literacy by showcasing research from living laboratories like Denali National Park and Preserve.

Located in Denali, the MSLC is run by the National Park Service in partnership with Alaska Geographic and other organizations. The MSLC has helped disseminate park research to broad audiences and increase the number and quality of research projects since 2005.

The MSLC serves the following national parks across two NPS Inventory & Monitoring Networks:

1. Bering Land Bridge National Preserve
2. Cape Krusenstern National Monument
3. Denali National Park and Preserve
4. Gates of the Arctic National Park and Preserve
5. Kobuk Valley National Park
6. Noatak National Preserve
7. Wrangell-St. Elias National Park and Preserve
8. Yukon-Charley Rivers National Preserve

The area covered by these parks represents more than 50 percent of the lands administered by the National Park Service nationwide.

Additional MSLC partners include Denali Education Center, Doyon- ARAMARK Joint Venture, Denali Borough School District, University of Alaska, Upper Susitna Soil and Water Conservation District, and others.

Programs and Services

- **Day and Evening Programs for Visitors:** Alaska Geographic runs a variety of day and evening programs throughout the summer season, including custom bus tours and dinner presentations featuring current park science, free daily science presentations at noon and multiple evenings per week, and custom science education events.
- **Field Courses for Teachers and Park Enthusiasts:** Alaska Geographic offers up to 24 multi-day field courses each summer. These small-group courses are led by renowned scientists and specialists, including some National Park Service staff. Most courses are based from a field camp on the Teklanika River at Mile 29 of the Park Road.
- **Youth Programs:** Park Service, Alaska Geographic, and Denali Education Center educators offer a variety of programs for youth every summer. These include week-long summer camps for 1st – 12th grade students, multi-day science immersion programs for visiting school groups, distance learning programs for classes throughout the United States, and classroom-based education programs for local schools.
- **Self-guided Activities for Kids and Families:** Park Service education rangers at the MSLC are responsible for overseeing the Junior Ranger and Discover Pack programs for Denali. The Junior Ranger program allows visiting youth to explore Denali through a free activity guide, while Discover Packs are backpacks full of interactive science activities that families can check out at no cost. These programs are largely paid for by Alaska Geographic.
- **Fellowships, Scholarships and Grants:** Alaska Geographic finances the following three programs:
  - **Research Fellowships:** MSLC provides fellowship funding to graduate students and others conducting research in Alaska's northern parks. The purpose of the fellowships is to fill gaps in NPS' ecological and cultural understanding of Alaska's parks. Some funding is also provided by Denali Education Center.
  - **Science Education Microgrants:** Each year the MSLC awards $20,000 in grant funding to individuals or groups wishing to further the Center's goal of promoting science-based education and outreach in Alaska's northern parks. NPS educators and researchers, as well as partners affiliated with the eight MSLC partner parks, are encouraged to apply.
  - **Teacher Scholarships:** The MSLC provides over $10,000 every year in order to allow at least 20 teachers to attend MSLC Field Courses. University credit is available for all courses.

Facilities for Guest Researchers and Visiting Education Groups

The Murie Science and Learning Center has four primary facilities:

- The MSLC Visitor Facility provides a classroom and exhibit area for use by education groups as well as office space for guest researchers. Researchers are encouraged to host educational programs and events in these spaces. Internet access and videoconferencing technology is available for use by visiting educators and researchers.
- The MSLC Dining Hall provides meals for guest researchers and visiting education groups.
- The MSLC Field Camp is located at the Teklanika River (Mile 29) and consists of six tent cabins (24 beds), a yurt, and a food and equipment storage shed. It can be used by researchers as well as paying education groups.
- The MSLC Yurt, located near the MSLC Dining Hall, provides housing for guest researchers and evening speakers.

Alaska Geographic

For more than 50 years, Alaska Geographic has been fostering stewardship for Alaska's public lands through compelling publications, experiential education programs, and bookstores where all proceeds benefit Alaska's public lands.

Contact Information

- Website: http://www.nps.gov/rlc/murie
- Youth camps and K-12 education programs: sierra_mclane@nps.org
- MSLC facility use for NPS functions: sierra_mclane@nps.org
- Field courses and teacher trainings: courses@murieslc.org
- University or professional association group visits: david-tomeo@murieslc.org
- Specialty bus excursions and custom education programs: david-tomeo@murieslc.org

E-Resources

Links to Information

The following links provide more information about Denali's natural and cultural resources and recent research results.

Denali's Nature and Science Webpage

http://www.nps.gov/dena/naturescience/
Access many other useful pages, including the other links listed here.

Current Resource Projects

http://www.nps.gov/dena/naturescience/researchresults.htm
Link to the electronic version of Current Resource Projects 2012 and archives from previous years.

Fact Sheets about Denali Science

http://www.nps.gov/dena/naturescience/factsheets.htm
Access dozens of two-page printable color fact sheets about research at Denali (see pages 63-64).

Alaska Park Science

http://www.nps.gov/dena/naturescience/park-science.htm
View the Denali issue of Alaska Park Science, plus links to other issues with Denali articles.

Climate Data

http://www.wrcc.dri.edu/narratives/alaska/
Data summaries and data analysis tools about Denali's weather and climate.

Fire Information

http://www.nps.gov/akso/nature/fire/index.cfm
Access information about current fires, fire ecology, fire weather and danger, and fire management in Alaska.

Podcasts about Denali Science

http://www.nps.gov/dena/photosmultimedia/dne.htm
Several podcasts are now available in the "Denali: New Expeditions" series.

Central Alaska Network

http://science.nature.nps.gov/im/units/cakn/
Links to resource briefs (for Denali and the other CAKN parks), and the Inventory and Monitoring Program.

Murie Science and Learning Center

http://www.nps.gov/rlc/murie/index.htm
More about the Murie Science and Learning Center and its northern Alaska parks, partners, and programs,

Website for Landscape Photo Pairs

http://www.nps.gov/dena/naturescience/repeat-photos.htm
Link to a site where many photo pairs document landscape change.

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* Unrelated. Coincidentally have the same last name.