National Park Service
U.S. Department of the Interior

Denali National Park and Preserve

Denali National Park and Preserve
Center for Resources, Science, and Learning

Summary of Current Resource Projects 2014

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/naturescience/researchresults.htm

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

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Natural Resources

Integrated Programs and Findings

Road Ecology Program

by Heather McKinney
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Fact sheet on the Road Ecology Program:
http://www.nps.gov/dena/naturescience/upload/RoadEcology2013.pdf

After more than six years of scientific study and four years of planning, analysis, and public input, the Denali Park Road Final Vehicle Management Plan and Environmental Impact Statement (VMP) was approved by the Alaska NPS Regional Director in September 2012. The VMP provides guidance for management of vehicles on the Denali Park Road west of the Savage Check Station (Mile 15) from the Saturday before Memorial Day until the second Thursday after Labor Day or September 15, whichever comes first. The plan was developed to ensure that visitors have a high-quality experience, wildlife and other park resources are protected, and the special character of the park road is maintained. The VMP is expected to provide guidance for the next 15 to 20 years.

Because there is some level of uncertainty and unpredictability in the outcomes of most management actions, park managers will use adaptive management in managing the park road. That is, as traffic volumes and schedules are adjusted to optimize the transportation system, and the results of management actions are monitored and better understood, managers will use the information to adjust further the volumes and schedules to make sure the goals of the VMP are being achieved.

The adaptive management strategy includes four aspects to assure visitor satisfaction and natural resource protection in the face of changes in the transportation system (e.g., scheduling, volume): (1) annual monitoring of indicators to determine if standards for desired conditions are being met, (2) detecting any changes in wildlife sightings from the park road, (3) assessing changes in wildlife populations using data from long-term monitoring programs, and (4) comparing to a control the data gathered before and after the traffic modifications are implemented, in order to determine the impact of the new traffic patterns and volumes (known as the Before-After-Control-Impact or BACI study).

The monitoring program includes seven indicators with quantifiable standards to ensure the indicators are being maintained:

(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 Dall's sheep crossings every hour
(5) Amount of time a hiker waits for an eastbound bus
(6) Hourly nighttime traffic (10:00 PM to 6:00 AM)
(7) Hourly large-vehicle (>80,000 pounds gross weight) traffic

Crowding conditions are monitored at wildlife stops using the ROAR protocol.

How are the indicators monitored?

Data for monitoring the indicators are collected by (1) satellite-based GPS systems installed in vehicles, (2) traffic counters, and (3) staff and volunteer observers.

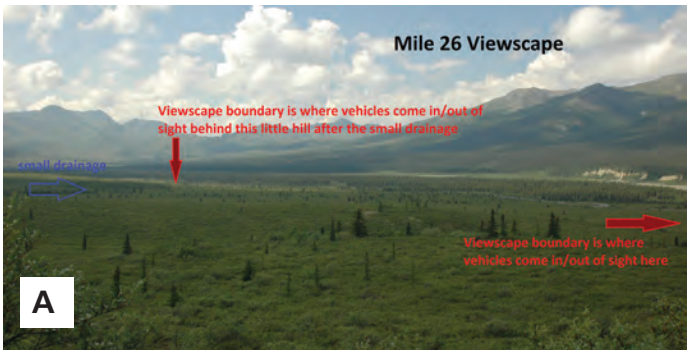
Travelers on the park road during 2013 may have seen a green Ford Escape along the road, at rest stops, and at the Eielson Visitor Center. This vehicle was used by NPS staff who were collecting traffic information and monitoring the number of vehicles stopped at the same wildlife stop.

Staff and volunteers also collect data on crowding conditions at wildlife stops and rest stops while riding concessioner buses as part of the Ride-Observe-And-Record (ROAR) program. These data include the number of each wildlife species observed by age and sex, if possible, the animals location in relation to the road (how far from the road), what the animal(s) is doing at the time of the observation, and the composition of vehicles at the wildlife stop. Bus drivers also record wildlife sighting data by sending a predefined text message (either "wildlife" or the actual species name) at each wildlife stop. The message records the time, day, and location.

There are also seven traffic counters installed along the park road. These supplemental data are used to monitor the condition of the indicators and are also being used to validate the satellite-based GPS tracking system. As of 2013, 100 concessioner-owned buses and 48 NPS vehicles that routinely travel beyond the Savage Check Station have been outfitted with GPS systems. The VMP calls for outfitting with GPS systems all buses that travel the park road beyond Primrose.

Where does monitoring take place?

NPS staff monitor the number of buses and vehicles at three locations as indicators of visitor experience—at the Teklanika and Toklat rest stops and at Eielson Visitor Center. NPS staff also collect data at four viewscapes (A-D, next column) to monitor the number of vehicles visible at one time.



Viewscapes where staff monitor the number of vehicles visible at one time.

The spacing of traffic at five sheep crossing locations (see photos of four of them below) is monitored to ensure that there are hourly ten-minute gaps in traffic. The NPS wants to maintain breaks in traffic throughout the day to enable sheep and other wildlife to move between habitats.

How will the monitoring data 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 for reporting 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 the 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 Winter Road Opening

By Heather McKenny, heather_mckenny@nps.gov

In June 2013, the NPS approved a plan to open the park road to Mountain Vista Rest Area (mile 13) by mid-February each year for a 3-5 year trial beginning in 2014. During the trial period, park staff are collecting data on costs associated with road opening, and monitoring soundscapes, wildlife sightings and behavioral responses, and visitor use levels so park managers can assess the costs and benefits of opening the road in the winter. Wildlife data also enable the park to mitigate any conflicts that might develop between wildlife and vehicles. In 2014, road crews began opening the road on February 1. The road was open to the public starting on February 15.

Wildlife Observations

Wildlife sightings (species, numbers, location) were collected on 29 road trips taken by Law Enforcement rangers and road crew (February 1 through March 15) during normal duties, and by a volunteer on wildlife patrols (February 15 to March 15) during daylight hours. On 10 trips, there were no sightings. Most sightings were of moose and occurred near milepost 12. Moose were in groups ranging from one to seven. Other wildlife included caribou (two

sightings, including a herd of 12), porcupines (two sightings), and lynx (one sighting).

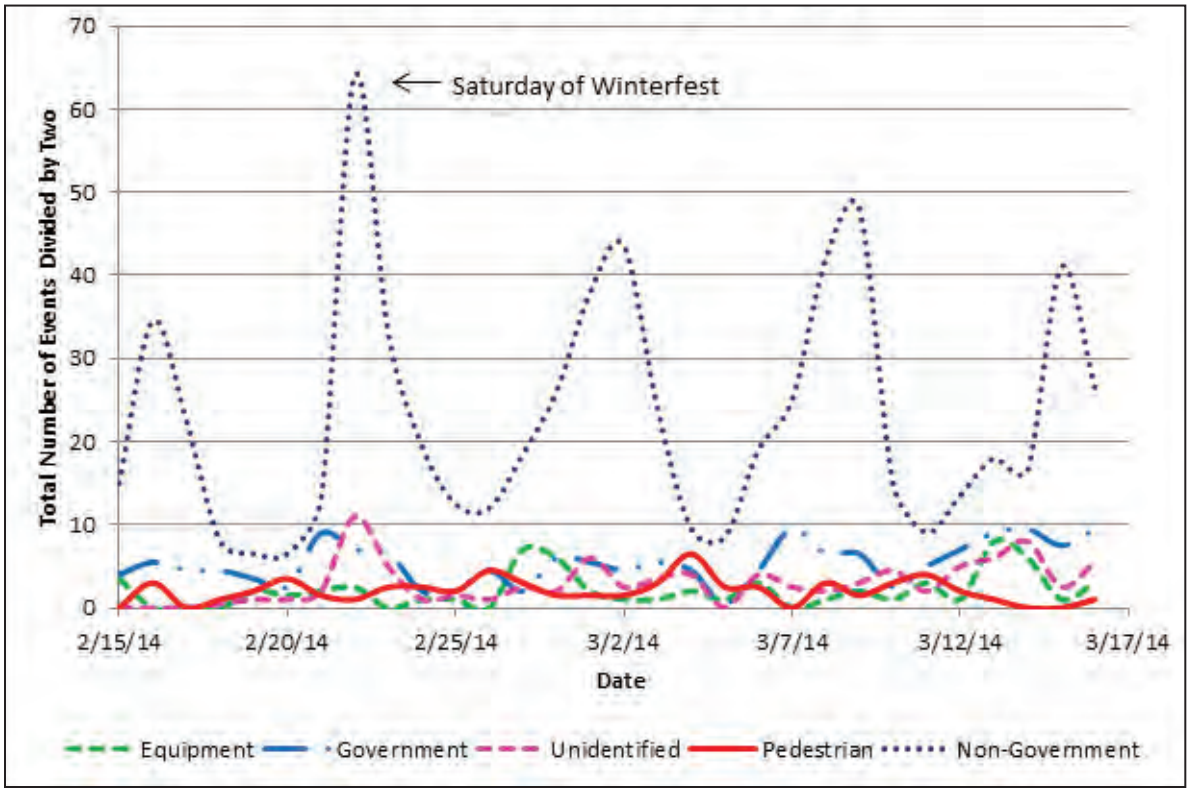
We also conducted 15-minute wildlife behavioral observations on all wildlife observed within 500 meters of the road. Data recorded included species, number present by age and sex, distance from road, activity, and any behavioral responses to stimulus (e.g., vehicle driving past). Of the ten observation periods, there were three documented responses by moose of trotting or running away from vehicles.

Visitor Use Monitoring

We set up a camera west of the Mile 3 Headquarters gate to collect data on road use from February 15 to March 15, 2014. So far, we are not separating data for east- versus west-bound traffic. There were an estimated 973 round trips by vehicles made on the park road (beyond the gate during this time period): 690 trips by private vehicles including one commercial bus, and the remainder by road equipment and other government vehicles. The highest level of vehicle traffic was between 12:00 pm to 3:00 pm and the majority of trips occurred on weekends and holidays. There were approximately 40 trips after dark that were likely people driving the road to view the night sky and the aurora borealis.

Our volunteer also recorded the number of vehicles by type (commercial, government, private) that were parked at the Mountain Vista Rest Area during a 30-minute wait period prior to his return trips east. During the monitoring period he made a total of 165 observations. We observed approximately 227 private vehicles parked at the Mountain Vista Rest Area. The average number of vehicles was 3 (±3.35) and the majority of use was documented on weekends between 1:00 pm and 3:00 pm.

As with the camera data, the maximum number of vehicles was observed during Winterfest on Saturday, February 22, 2014—22 vehicles observed at Mountain Vista.



Use of the Denali Park Road (2/15 to 3/15/14).

Park staff view "events" captured on camera and categorized them as non-government vehicles, government vehicles, road equipment, pedestrians, and unidentified.

The number of events was divided by two to get the number of round trips.

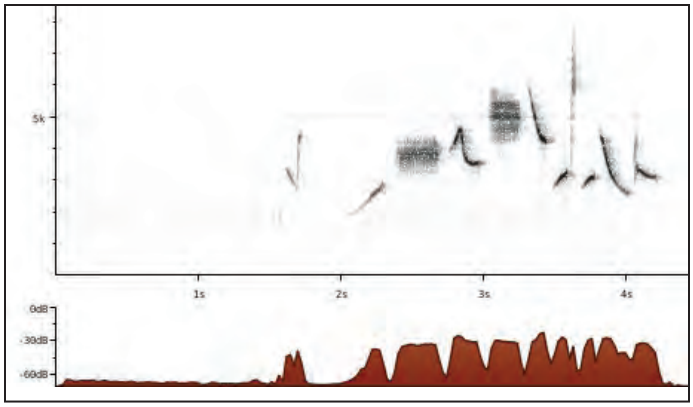
Soundscape Program

By Davyd Betchkal, davyd_betchkal@nps.gov

Soundscape research has been underway at Denali since 2001. Natural and human-generated sounds are being systematically inventoried across the landscape of the park, including popular backpacking areas, Mount 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.

Soundscape Inventory and Monitoring in 2013

In 2013, soundscape staff implemented the seventh season of a revised systematic sampling plan, deploying seven automated sound monitoring stations and rotating them among 15 locations. These locations were: one winter-season site, 7 Central Alaska Network Inventory & Monitoring grid points, 1 location to monitor a voluntary aviation best practice, and 1 location to test noise levels from Hybrid Buses. Over the 10-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 initial inventory nears completion, more time has been devoted to 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 2013, five stations were deployed outside of Denali: four in Noatak National Preserve to monitor aircraft use, and one in Gates of the Arctic National Park 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 – a portion of which would be routed through the preserve.



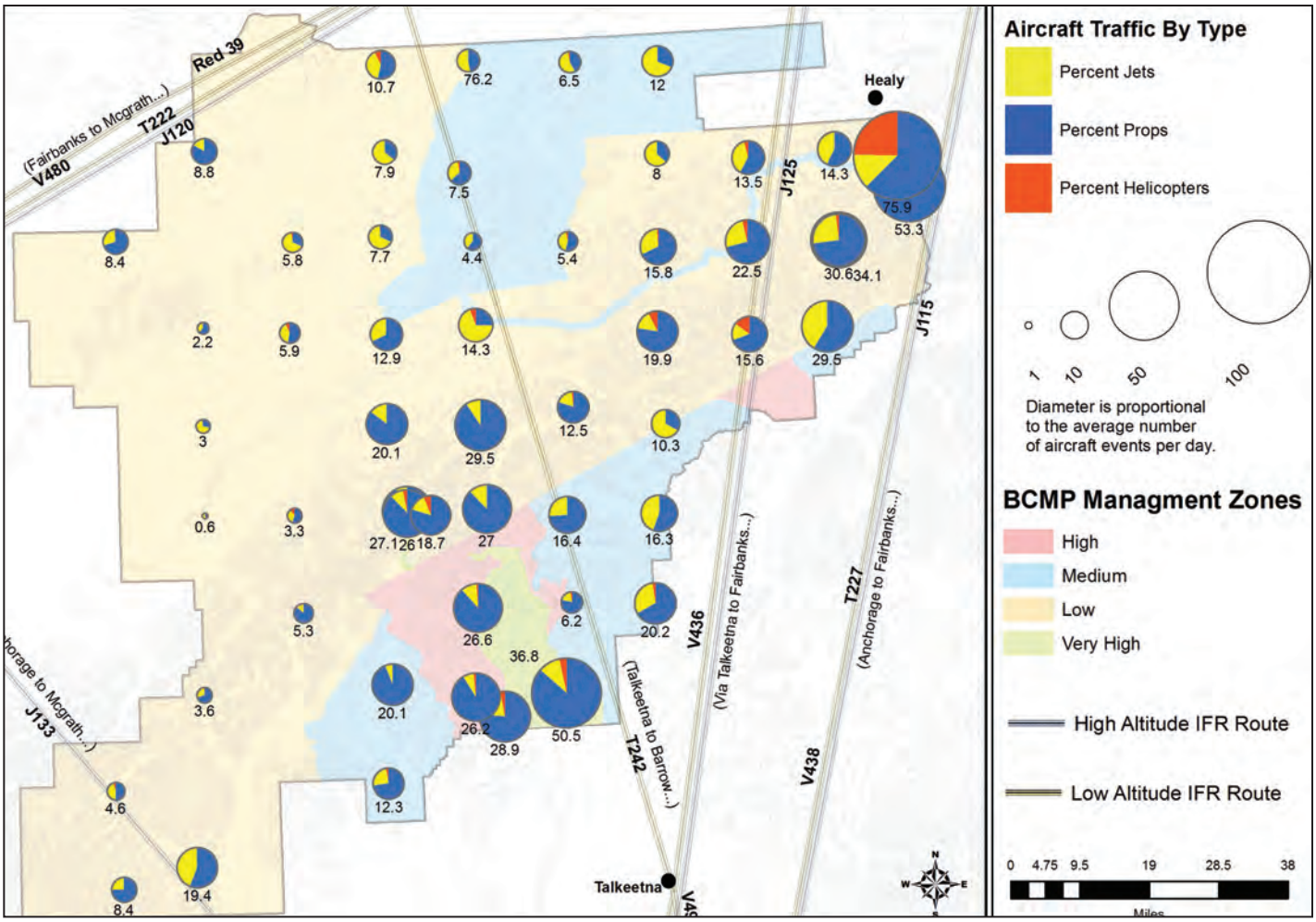
(Upper graph) Spectrogram notation of a Fox Sparrow song recorded at Fourth-of-July Creek. The vertical axis is frequency in Hertz, horizontal axis is time. (Lower graph) Amplitude as a function of time. Xeno-Canto record XC118416.

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 power and distance from nearby water sources, and is consistently as low as 13 – 14 dBA. Overlain on these steady physical sounds are seasonal or daily cycles affected by sunlight or temperature. For instance, both the singing of birds or the flowing of debris down steep-walled valleys follow a predictable daily pattern related to light energy.

Using sound stations to inventory avian populations

In 2012 and 2013, selections of bird song and calls have been 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."

120 recordings from 33 locations across Denali have been contributed to the project so far. These represent 31 species of birds, 25 of which are the northern-most example of the species on Xeno-



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).

Canto. Continuous monitoring has benefitted the detection of species rarely recorded in North America - such as the Golden Eagle (*Aquila chrysaetos*), 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 populations, especially for estimates of occupancy, species richness, or phenology. Because soundscape data have a large spatial extent, they can help extend the management knowledge of traditional passerine surveys over greater areas of the park.

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

Monitoring Impacts from Aircraft Noise

Human-caused noise from aircraft 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, while locations father away from common flightseeing routes rarely exceed 10 overflights per day. This variation in traffic becomes clearer when visualized spatially. The map above 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.

Aircraft noise is dissonant with the scenic, wilderness, and cultural heritage purposes of Denali. Actions to improve conditions of the acoustic environment require information as well as an honest effort. The soundscape inventory exists in

part as a baseline from which to assess government or public-sector actions; both those increasing and those decreasing noise. Modelling and monitoring improve feedback about the effects of a given change, a second major purpose of the program.

Are hybrid buses a quieter choice for the park road?
Over the course of two operating seasons, 2012 and 2013, roadside sound monitoring stations were deployed to document sound pressure levels of the bus fleet along the Denali Park Road. These tests sought to document a baseline of the conventional fleet and then compare hybrid models. At the wilderness boundary (150 feet from the road's center line,) hybrids were found to have a median sound pressure level peak of 57.9 ± 1.9 dBA as they passed. This level was consistent between individual hybrid buses, and did not vary significantly across the season. When compared to the conventional fleet, hybrids were in the 60th percentile of passbys - in other words, they were louder than 60% of the conventional fleet.

In addition to this finding, the study also found clear evidence in support of the physical theory that buses with larger engine volume are quieter than buses with smaller engines on the same road grade. Despite this finding, hybrids were observed to be much louder than predicted for their engine size, on the order of about 2-3 dBA; a clearly noticeable difference to the human ear. The hybrid technology is more efficient than conventional technology, and thus has a smaller engine, but the smaller engine translates to a louder engine.

A third component of the study compared bus noise during idling. These tests sought to simulate the soundscape of a wildlife stop along the road corridor. Ideally, quieter conditions would improve experiences for wildlife and vistor alike - by providing a reprieve for the first and a more intimate sensory experience for the latter. However, tests indicated that hybrids took about 5 minutes to switch off their diesel engine - about the same duration as a typical wildlife stop. Idling levels varied greatly between the two individual hybrids, with 10-minute averages of 49.9 and 53.3 dBA Leq, respectively. (This 3 decibel range made them the third and eighth loudest buses of the eight tested.) Though these idle levels are a substantial 6 dBA lower than levels in transit, it is clear to see that continuing to suggest turning off the bus engine (i.e. not contributing any noise at all) would have a far greater impact than any hybrid technology currently available.

Upcoming Work in 2014
In 2014, sound stations will be placed at six more Inventory & Monitoring grid points. In addition, information collected by a station at Backside Lake will form part of an ensemble of information on private and commercial uses of the area. Also in 2014, a station will be deployed on the park airstrip to document rates of aircraft operation by user type. Two stations will be redeployed in Noatak National Preserve in 2014, and two stations will be installed at new locations in Gates of the Arctic National Park and Preserve.

Detailed soundscape reports can be found at: https://irma.nps.gov/App/Reference/Profile/2204780 or search IRMA website using "Denali AND Acoustic."

Wilderness Stewardship

by Rob Burrows and Dan Abbe
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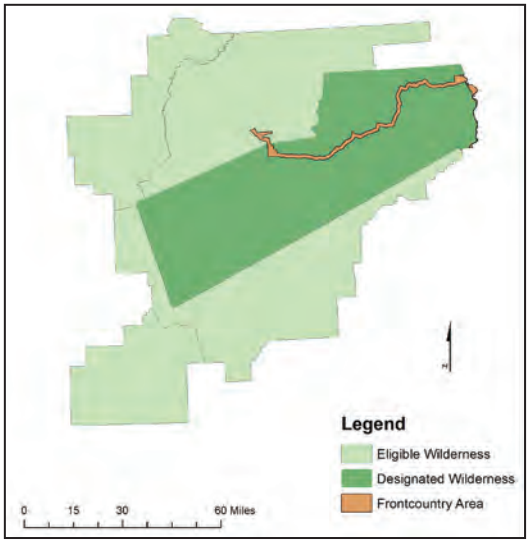
2014 marks the 50th Anniversary of the Wilderness Act. This is a year to celebrate! Look for posted information and announcements about celebration events and activities.

The primary affirmative mandate of the 1964 Wilderness Act is that land management agencies preserve the wilderness character of all areas designated as wilderness. In the last four years a framework for describing just what wilderness character is has emerged, and is proving to be a powerful tool in monitoring, mapping, planning, and clearly communicating wilderness issues.

In the framework, wilderness character is divided into five qualities; (1)natural, (2)untrammeled, (3) undeveloped, (4) outstanding opportunities for solitude or a primitive and unconfined type of recreation, and (5) other features of ecological, geological, scientific, educational, scenic, or historical value (see table on page 10). The definitions of these qualities are standard across all wilderness areas, but what indicators and measures are used to represent each quality is chosen locally and is unique to each area.

In Denali, the vast majority of land is either designated or eligible wilderness. Protecting the wilderness character of these lands is not only a legal mandate, but required by policy as well.

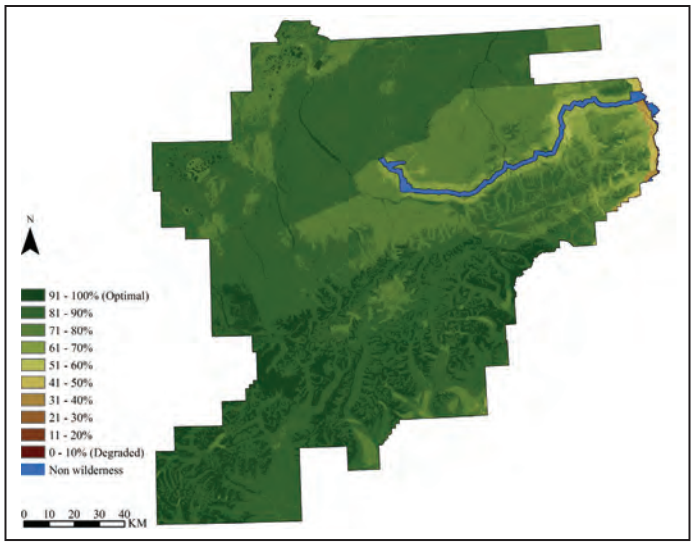
Monitoring certain conditions and indicators using the best available science is an important effort in tracking and preserving wilderness character, protecting Denali's resources, and in providing opportunities for high quality visitor experiences in the backcountry. Efforts are underway to monitor annually 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.



Designated, eligible, and frontcountry areas of Denali. Congress directs the NPS to preserve the wilderness character of the designated Denali Wilderness, while NPS policy directs Denali to preserve the wilderness character of eligible wilderness lands.

• *State of the Backcountry Report* will be released in 2014. It provides, for the first time, a report documenting the current state of Denali's wilderness character.

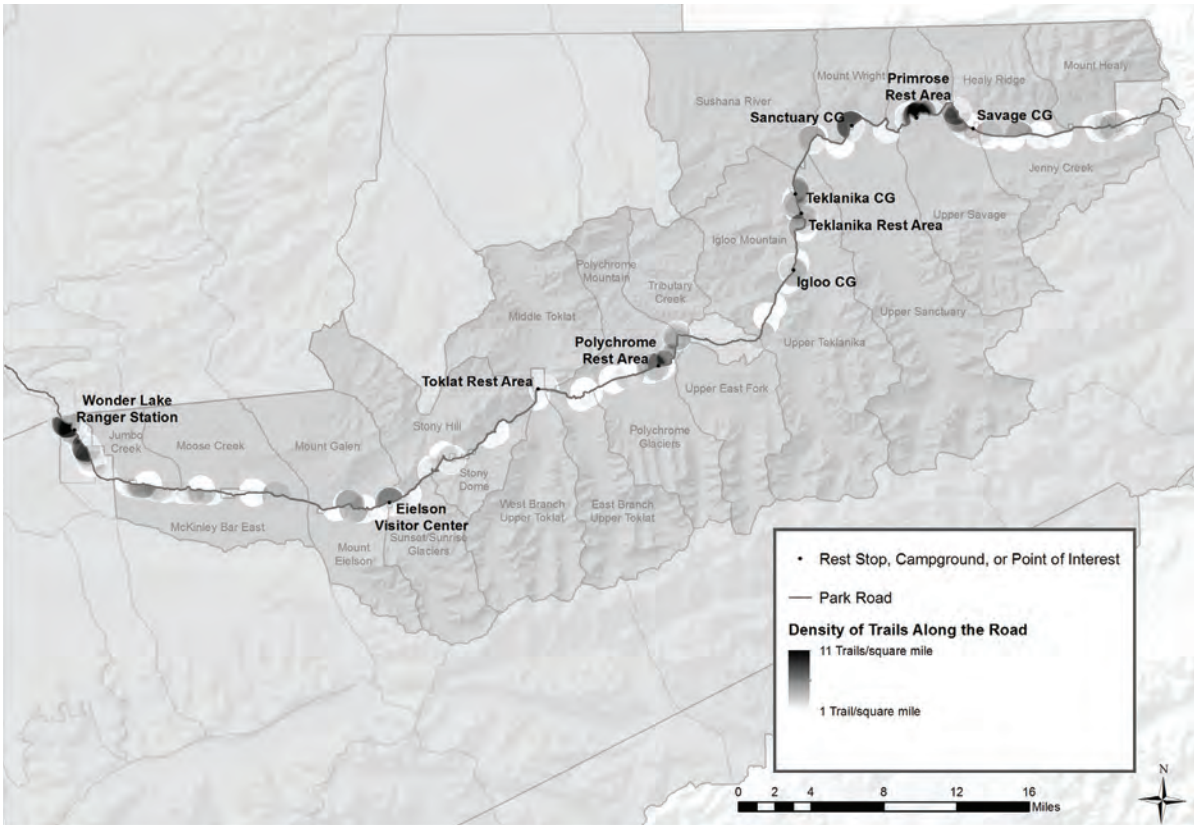
• *Wilderness Character Map.* In conjunction with Peter Landres and James Tricker of the Aldo Leopold Wilderness Research Institute, park staff have completed a wilderness character spatial model. Using the wilderness character framework, this model uses various digital spatial (GIS) datasets that represent degradation to the 5 wilderness character qualities.



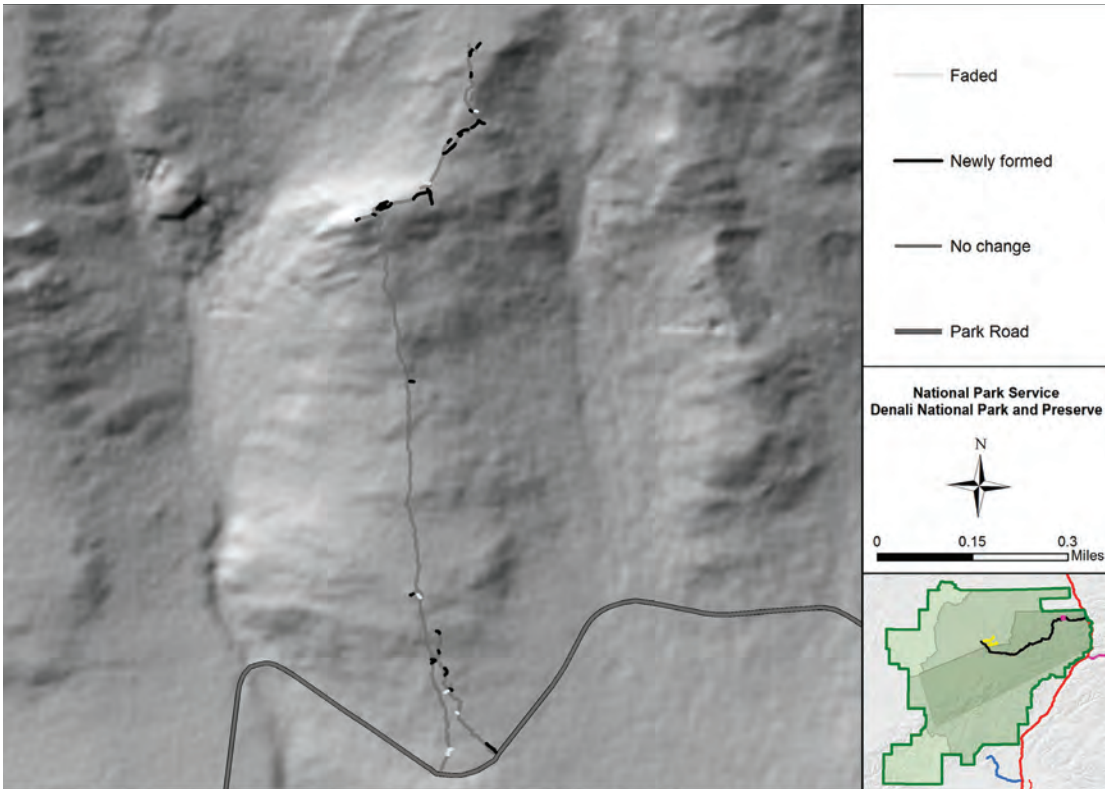
Wilderness character map of Denali's backcountry

• *Informal (social) Trail Status Report.* Most of the Denali backcountry has a "no formal trails" policy 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. A report will be released this year summarizing informal trail monitoring efforts to date. The focus of this effort has been along the park road where a total of 323 informal trails were identified (see upper map next page).

More extensive trail networks have been documented in 14 backcountry units. The map of the Primrose Ridge area is one example (see lower map next page).



The density per mile of informal trails leaving the park road as inventoried in 2012-2013 (darker color indicates higher density)



The extent of trail change at Primrose Ridge area (heavy line means newly formed, faint line means decreased use, light line means no change)

SUMMARY OF QUALITIES, INDICATORS, AND MEASURES OF WILDERNESS CHARACTER

NATURAL

Wilderness "...is protected and managed so as to preserve its natural conditions"

Wilderness ecological systems are substantially free from the <u>effects</u> of modern civilization

Indicators are:

- Plant and animal species and communities
- Physical resources
- Biophysical processes

Measures could include:

- abundance/distribution for species of concern
- non-native species
- grazing allotments
- visibility, ozone, chemical deposition
- departure from natural fire regimes
- loss of connectivity
- measures related to climate change

UNTRAMMELED

Wilderness is "...an area where the earth and its community of life are untrammeled by man..." and "...generally appears to have been affected primarily by the forces of nature"

Wilderness is essentially unhindered and free from the <u>actions</u> of modern human control or manipulation

Indicators are:

- Actions authorized by the Federal land manager that manipulate the biophysical environment
- Actions <u>not</u> authorized by the Federal manager that manipulate the biophysical environment

Measures could include:

- spraying weeds
- suppressing or lighting fire
- introducing non-native species
- unauthorized actions such as predator control

UNDEVELOPED

Wilderness is "...an area of undeveloped Federal land...without permanent improvement or human habitation" and "...where man himself is a visitor who does not remain"

Wilderness retains its primeval character and influence, and is essentially without permanent improvement or modern human occupation

Indicators are:

- Non-recreational structures, installations, developments
- Inholdings
- Use of motor vehicles, motorized equipment, or mechanical transport

Measures could include:

- authorized installations and developments such as scientific equipment, radio repeaters, fish barriers
- unauthorized installations and developments
- inholdings
- administrative and emergency uses of motor vehicles, motorized equipment, or mechanical transport
- unauthorized uses of motor vehicles, motorized equipment, or mechanical transport

SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION

Wilderness "…has outstanding opportunities for solitude or a primitive and unconfined type of recreation"

Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation

Indicators are:

- Remoteness from sights and sounds of people inside the wilderness
- Remoteness from occupied and modified areas outside the wilderness
- Facilities that decrease self-reliant recreation
- Management restrictions on visitor behavior

Measures could include:

- visitor use
- area affected by travel routes
- night sky visibility
- impacts to soundscape
- authorized recreation facilities such as trails, toilets, bridges, shelters
- unauthorized recreation facilities such as user-created campsites, illegal motorcycle/ATV trails
- visitor management restrictions

OTHER FEATURES

Wilderness "…may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

Wilderness preserves other tangible features that are of scientific, educational, scenic, or historical value

Indicators and measures of other features must be identified separately for each wilderness, and not readily fit within one of the other qualities. Examples include cultural and historic sites, and paleontological features.

Modified from -- *Keeping it Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System. 2008. USDA Forest Service RMRS-GTR-212. Fort Collins, CO.*

Plants and Vegetation

Vegetation Succession near the Muldrow Glacier

By Sarah Stehn
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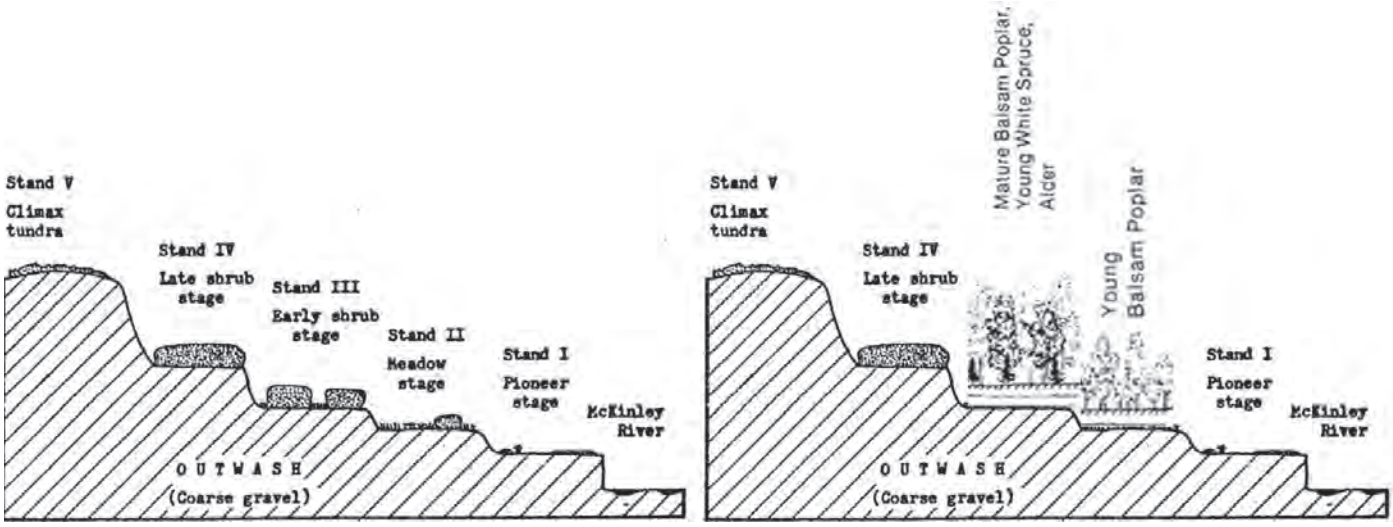
During 2013, Denali botanists continued analysis on data collected at the historic vegetation plots located just west of the Muldrow Glacier terminal moraine in outwash of the McKinley River. With data sets spanning from 1958 to 2012, the goal was to compare plant and soil succession on terraces of the river across time and space.

Dr. Leslie Viereck, one of Alaska's pre-eminent botanists, established the permanent plots on terraces near the Muldrow in 1958. The terraces or steps represent stages of vegetation development (see figure below) - early pioneer (MR00), pioneer (MR01), meadow (MR02), early shrub (MR03), late shrub (MR04), and climax tundra (MR05). The age of these steps ranges from 25-30 years old (pioneer stage) to 200-300 years old in the late shrub stage, and range in elevation from 748 m at the early pioneer stage to 779 m at the climax tundra stage. In 1975, Dave and Roseann Densmore re-read the Viereck plots and installed additional ones along newly-created transects intended to sample each stage of succession. In 2000, staff established a new transect to represent an early pioneer stage. In 2012, all known plots and transects were visited and remeasured according to their original protocols. Additionally, because researchers suspected an increase in tall woody shrubs through the study area, they sampled an additional 90 locations for tree and shrub cover.

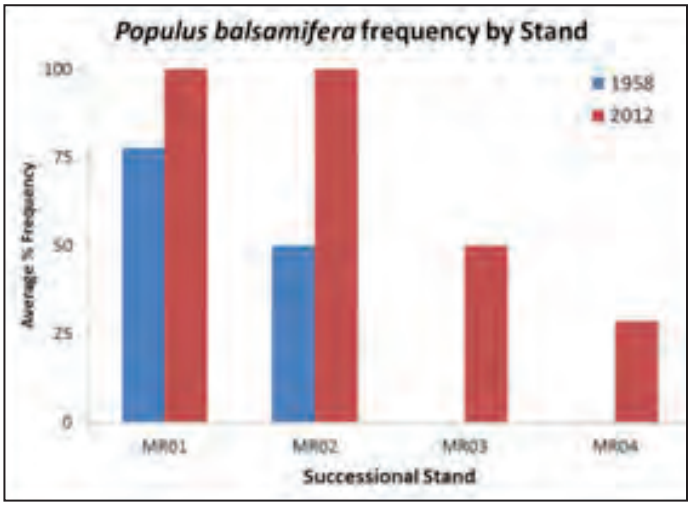
Comparison of vegetative conditions at plots on the Muldrow terraces in 1958, 1975, 2000, and 2012 has revealed much about the trajectory of plant succession in that area. Results suggest that succession has progressed along the trajectory outlined by Dr. Viereck (left diagram, below) but that abundance of particular species has changed in somewhat unexpected ways.

The presence of balsam poplar (*Populus balsamifera*), in particular, has greatly increased across all stands (see bar graphs and photos on next page). The additional of balsam poplar to the landscape is significant because its tree growth form allows it to overtop other plants, its clonal growth gives it "strength in numbers" against brutal winter winds, and its deciduous litter has the capacity to severely inhibit moss-mat formation. Data collected from poplar-dominated plots also exhibited higher soil temperatures than plots not dominated by poplar.



Schematic of succession along the terraces of the Muldrow: (left) Dr. Viereck's proposed successional sequence. (right) Same schematic with a potential alternate trajectory suggested based on 2012 findings.

A photo series of a Stand 1 (MR01) transect exhibiting a large increase in balsam poplar. The mineral soils visible in the 1975 photo were colonized by poplars, which then expanded into nearby areas.



Frequency of balsam poplar across the study area in 1958 and 2012.

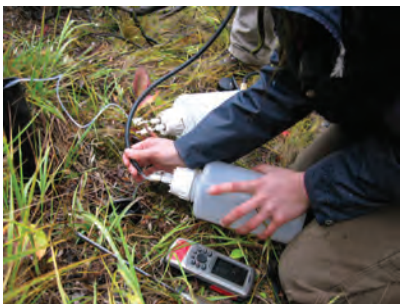
The increase in frequency and abundance of balsam poplar highlights how the distribution of one species can affect an entire ecosystem. Data collected in 2012 suggest that an alternate successional trajectory (right hand diagram on previous page) may have developed in the 54 years since Dr. Viereck first studied vegetation on the Muldrow terraces. Denali researchers will continue monitoring vegetation change in this area, and will consider this detailed analysis when forming hypotheses of changes that may be occurring park-wide. The preservation of Dr. Viereck's original research plots, and the ability to resample them, is a testament to the importance of conservation areas to long-term ecological research.

Monitoring Dust Palliative Use along the Park Road

by Carl Roland
carl_roland@nps.gov

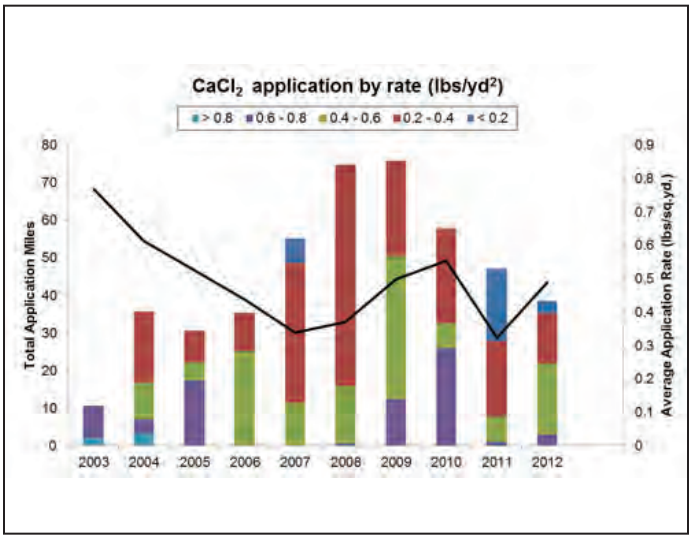
To reduce road dust created by road traffic, park maintenance crews apply an aqueous solution of calcium chloride ($CaCl_2$) to the surface of the park road. The application reduces dust and the need to replace fine materials lost from the road as dust, but also has the potential to adversely affect ecosystems adjacent to the road. The addition of $CaCl_2$ 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 NPS has developed a monitoring plan to assess and monitor the possible effects of applying $CaCl_2$ 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 10 meters away in native soil. Botany program staff collect water samples each summer from the lysimeters and nearby water bodies to test for chloride concentration.

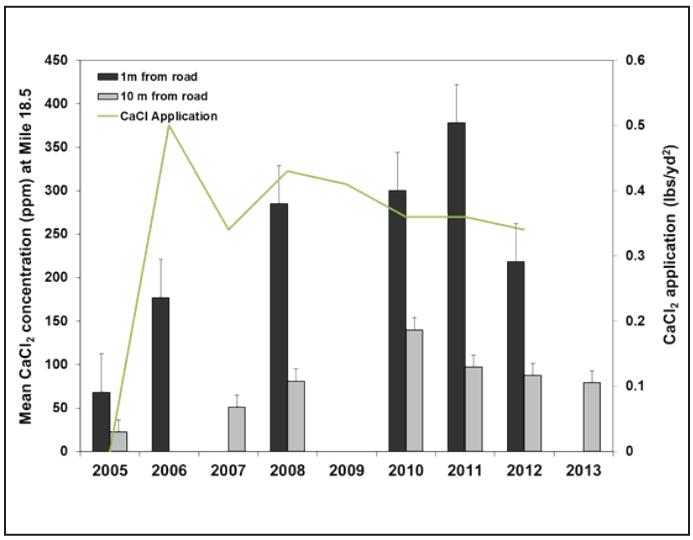


Sampling water at lysimeter

2013 was a relatively dry and hot year, and an above average level of $CaCl_2$ was applied to the park road. Overall, application of $CaCl_2$, both in terms of total mileage and application concentration, has decreased over time, as park maintenance personnel learn the most effective times and concentrations to apply the compound (see figures above).
However, because it is the cumulative effects of these applications that may have an impact on the roadside ecosystem, monitoring will always be necessary. Staff will continue to monitor these stations in 2014.



Application of $CaCl_2$ across years. Bars show total miles affected by application and the proportion of those miles receiving different concentrations of $CaCl_2$. Line shows the average application rate per year across all miles in which $CaCl_2$ was applied.



Application of $CaCl_2$ by year at Milepost 18.5. Bars show the measured concentration of $CaCl_2$ in the soil water matrix, both near and farther from the road. The line shows the application rate of $CaCl_2$ for that stretch of road in each year (read y axis on right side).

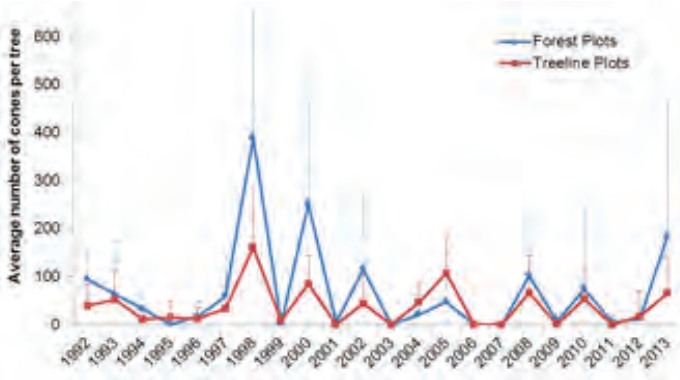
White Spruce Cone Production and Seed Viability Monitoring

by Carl Roland, carl_roland@nps.gov

Botany program staff monitors permanent plots installed in 1992 within the Rock Creek drainage near Park Headquarters. In these set of plots, located at treeline and in the forest, staff document annually tree diameter growth, cone and seed production, and seed viability of white spruce (*Picea glauca*).

Monitoring will continue in 2014, adding to one of the longest-term records of white spruce seed production and viability in Alaska. The results of this long term study will soon be published as an article in the international ecological journal Oecologia: *Climate sensitivity of reproduction in a mast-seeding boreal conifer across its distributional range from lowland to treeline forests*.

Seed production in white spruce is a two-year process in which cones are initiated one year, and are pollinated and come to maturity in the second year of the reproductive cycle. Denali results suggest that an optimal seed production year will occur after two wet, cool summers (in which reserves for reproduction are stored), followed by a warm and dry early summer (which is a cue for cone initiation), and capped with a wet, warm summer helping seeds to grow and mature before seed dispersal (when cone maturation is complete).



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 among trees.

2013 was one of the higher cone production years recorded in the Rock Creek drainage since 1992 (see figure above). 1998 and 2000 remain the highest production years of those measured, with 2013 approaching the magnitude of 2000 only in the Forest plots.

However, data collected in Rock Creek has allowed a better understanding that cone production does not necessarily equate to viable seed production. Different factors control seed viability than influence production. Thus, a large number of cones do not necessarily contain a high percentage of viable seed to produce new trees (see table below).

Site	Year	Seeds/ m^2	Germination (%)	Estimated number of viable seeds/m^2
Forest	1998	1884	6.0	114
	2010	1158	11.4	133
Treeline	1998	63	0	0
	2010	41	3.5	1

While 1998 was a year of very high cone production and 2010 was a year when fewer cones were produced (compare years on graph above), in 2010 spruce on average had similar seedfall, and greater germination and viability rates.

CAKN Aspen Phenology Monitoring

by Carl Roland, carl_roland@nps.gov

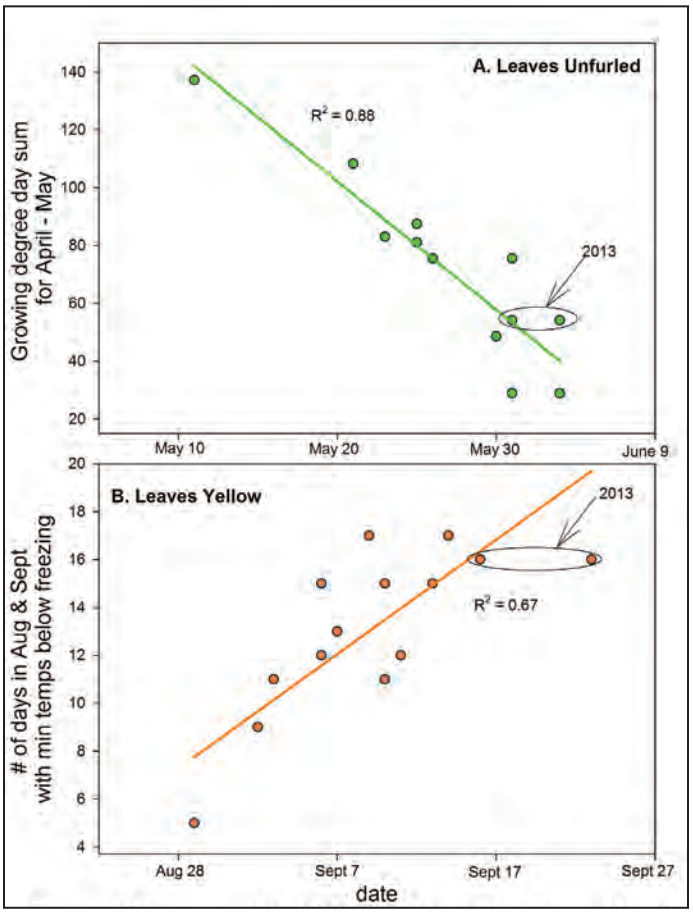
Purpose: The Central Alaska Network (CAKN) monitors phenology because there is considerable evidence from studies around the world that climate change is advancing the timing of flowering and leaf-out and extending the growing season of plants in northern latitudes and high elevations. A longer growing 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 (phenology) in aspen (Populus tremuloides) in Denali in 2005, and have included other areas of interior Alaska in the study more recently. Aspen was chosen because it is a widely distributed species studied by phenology monitoring programs across the continent.

Results: Initial findings show leaf-out in aspen is strongly correlated with spring temperatures: leaf-

out occurred up to 20 days earlier when the sum of growing degree days accumulated 100 more degrees during the months of April and May (Fig 1A). The warmer it is in April and May, the earlier the leaves come out. The data also show a strong correlation between senescence (leaves turning yellow) and the number of days with freezing minimum temperatures in August and September, that is, leaves turned yellow later with more freezing nights in late summer (Fig. 1B). This result is exactly the opposite of what one would expect! Can you think of a reason why this would be? This result may be an artifact of small sample size, but we must be careful not to throw out results just because they do not conform to our preconceptions! We also found growing season length varied from year to year—for example, the longest growing period observed was 114 days in 2005 and the shortest was 90 days in 2006, representing a possible 22% variability in growing season length. This is a considerable difference in time available for growth and development among years.

Conclusion: These observations suggest warmer springs may lead to earlier green-up and longer growing seasons. The results from the fall observations remind us 1) we are dealing with correlation, not causation (a lack of cold nights likely probably does not cause leaves to turn yellow!) 2) we need to keep collecting data to increase our sample size and 3) there is a lot for us to learn about the way our world works--and how it works is probably different than what we expect!



Upper graph: Date leaves unfurled (fully opened) in relation to the sum of growing degree days (sum of temps above 5 C) in April and May.

Lower graph: Date leaves turned yellow (at least 50% of leaves on all trees in plots were yellow) in relation to the number of days with freezing temperatures in August and September. Points are for each year of observations (2005-2013) for each plot in Denali.

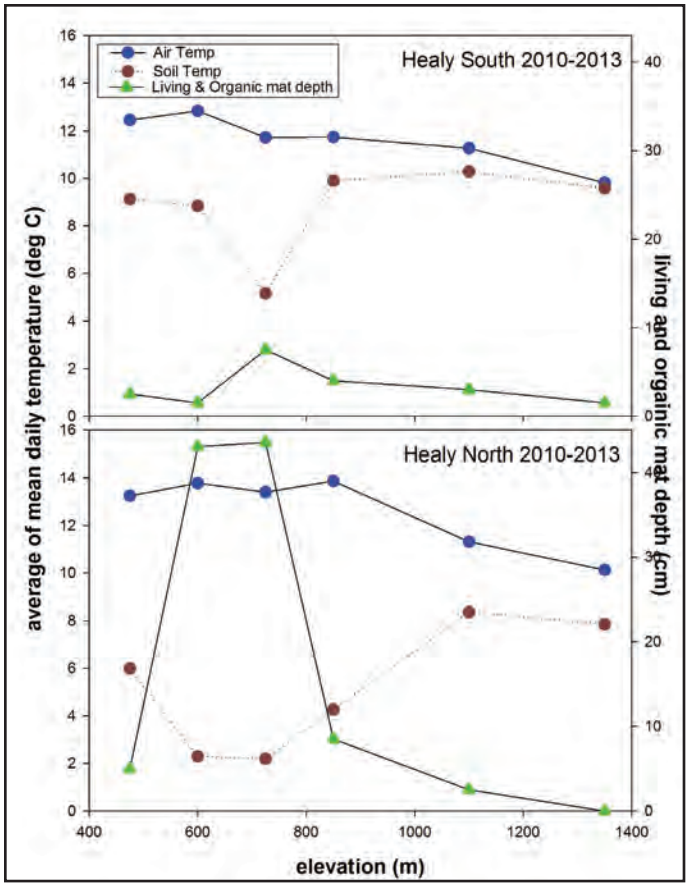
CAKN Surface Temperature along an Elevation Gradient

by Carl Roland, carl_roland@nps.gov

Purpose: The impetus for this project came from the following observation: treeline, shrubline, and tundra-line are about 200 to 400 meters higher in Wrangell-St. Elias (WRST) and Yukon-Charley Rivers relative to Denali. We suspect this difference in vegetation line may be due (at least in part) 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 (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 north and south transects in YUCH in the Ogilvie Mountains near the border with Canada. When we installed the temperature sensors, we also 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). So far we have growing season air and soil temperatures for Mt Healy from 2010 to 2013. In 2014, we will get the first over winter data and the first growing season data from YUCH.

Results: Results comparing temperatures from Yukon-Charley in the eastern part of the state to Denali will have to wait until this summer when we collect the data from the sensors currently recording temperatures from Yukon-Charley. In the meantime, we can gather information about temperature along north and south-facing elevation gradients in Denali. In general the growing season air temperatures are similar on the north and south side of Mt. Healy, but the soil temperature is colder on the north side compared to the south side (see both panels in figure at right). Air temperature decreases with increasing elevation, as you would expect. Soil temperatures, on the other hand, generally increase with increasing elevation and are colder on the north side of the mountain. The depth of this living and organic mat shows the exact opposite pattern as soil temperature: the two are strongly inversely correlated. 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, which creates extreme growing conditions for plants. On the north slopes with thick living and organic mats, plant roots experience near-freezing conditions, while their branches exist in much warmer conditions.



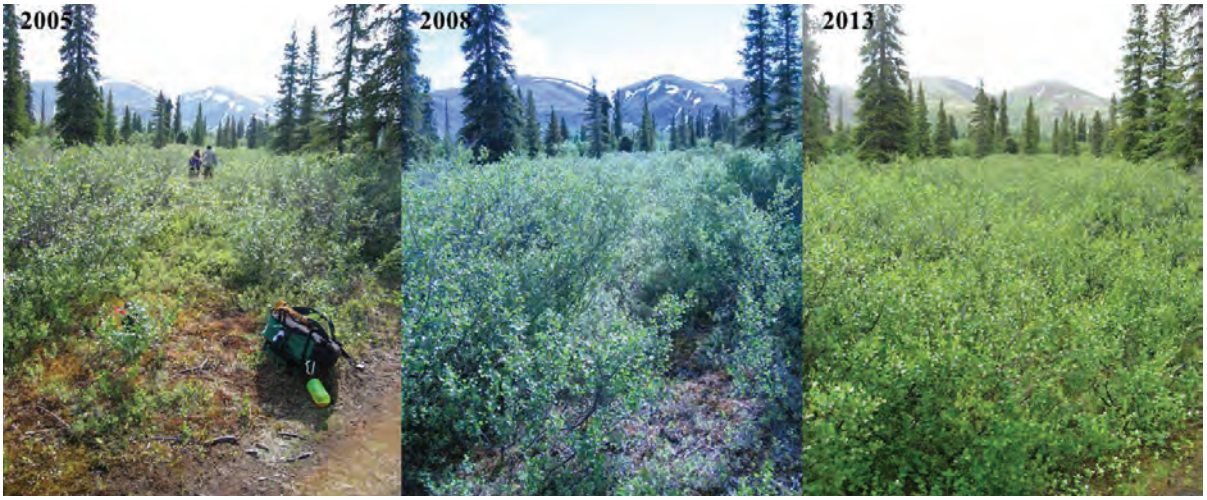
Average of mean daily temperature between June 1 and August 31 for 2010-2013 as well as the depth of living mat and organic material for six elevations on Mount Healy (north=lower panel, south=upper panel).

Off-Road Vehicle (ORV) Impacts

by Sarah Stehn, sarah_stehn@nps.gov

In the Cantwell Traditional Use Area, the NPS allows subsistence users to operate off-road vehicles (ORV) for subsistence hunting purposes on a set of designated trails and routes. 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, resource staff has conducted annual monitoring to document trail use, extent, and condition—including any impacts or incursions beyond established trails. Overall, trail use remains fairly stable across the area.



Recovery of native shrubs during (2009-2013) off the Windy Creek Trail. Further illegal use of this side route is unlikely.

It is likely that the same users are using the trails in the same way each year to fulfil their subsistence hunting needs. Trail conditions vary among the different trails, but, in general, increased signage and marking of routes and boundaries appear to have concentrated ORV impacts within a smaller area. Areas of past ORV incursion are showing signs of recovery (see photo sequence above), indicating that further incursions have been avoided.

Annual monitoring of trail use and impacts beyond established ORV trails.

Eradication of Invasive Plant Species

by Wendy Mahovlic, wendy_mahovlic@nps.gov

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 1417 lbs of invasive plant species in 2013 (see table on next page). Volunteers and the SCA intern invested 1084 hours in eradication efforts. Three species that were pulled in 2012 were not seen in 2013.

Native Seed Collections

by Wendy Mahovlic, wendy_mahovlic@nps.gov

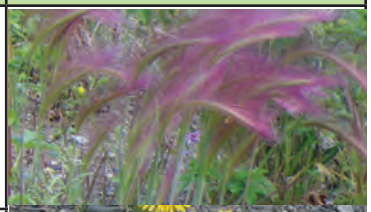
Wendy Mahovlic, along with an Student Conservation Association (SCA) intern, SAGA (Southeast Alaska Guidance Association) volunteers, and other volunteers also collected a total of 65 lbs (uncleaned weight) of native seeds for revegetation projects. Volunteers invested 396 hours in "need for seed" program.

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

East End:
Oxytropis campestris: 20 lbs
Hedysarum alpinum: 11 lbs
Leymus innovatus: 1 lb
Elymus sp: 7 lbs
Hedysarum mackenzii: 5 lbs
TOTAL = 44 lbs

West End:
Hedysarum alpinum: 4 lbs
Elymus sp: *6 lbs*
Leymus innovatus: 2 lbs
Oxytropis campestris: 8 lb
Arnica lessingii: 1lb
TOTAL = 21 lbs

Hundreds of pounds of invasive plant species were pulled in 2013 (listed here in order of pounds pulled). If you think you see one of these plants at a location other than the ones listed in the table below, please contact Wendy Mahovlic at 907-683-6246.

Plant Species Removed	Common Name	Pounds Removed	Location Where Removed	Photograph
Hordeum jubatum	Foxtail Barley	745 lbs	Miles 237.25 and 238 Parks Hwy; scattered Mile 1-2 park road, Shaffer Bldg, CLA Bldg., Kennels Road	
Taraxacum officinale	Dandelion	528 lbs	Mile 1 - 43, Mile 72 - 92 of the park road	
Plantago major	Plantain	35 lbs	Shaffer Bldg, Mile 237.25 Parks Hwy, CLA Bldg., Kennels Road	
Melilotus alba	White Sweet Clover	20 lbs	Mile 232.5 and Mile 238 Parks Highway	
Crepis tectorum	Narrowleaf Hawk's-Beard	21 lbs	Sewage Lagoon, Mile 1 of the park road, Bus parking lot	
Vicia cracca	Bird Vetch	17 lbs (some dirt)	1 population of the 5 sprayed in 2012 re-emerged at Mile 1, park road; Mile 231.7 Parks Hwy, Denali Ed. Center	
Galeopsis bifida	Hempnettle	20 stems	Kantishna Horse Corral	
Linaria vulgaris	Yellow Toadflax	1 lbs	Railroad tracks, Denali Depot	
Hieracium umbellatum	Narrowleaf Hawkweed	1 lbs	Mile 231.75 Parks Highway	
Trifolium hybridum	Alsike Clover	0 lbs	2012 in Kantishna Horse Corral	
Tripleurospermum perforata	Scentless False Mayweed	0 lbs	2012 at Denali Depot and Shaffer Bldg	
Silene noctiflora	Night-blooming Cockle	0 lbs	Kantishna Horse Corral	

NOTHING TO PULL—SUCCESS!

Wildland Fire

Contact:

Larry Weddle, Fire Management Officer
larry_weddle@nsp.gov (907) 683-9548

Fire Highlights for 2013

There were fourteen wildfires in Denali in 2013. Thirteen wildfires burned on NPS-administered lands.

The North Swift Fork fire was the first fire discovered (May 31st), soon after the delayed "snow free" date. The last fire to be declared out (October 1st) was the Sandless Lake and Beaver Log Lakes fires. Fire sizes ranged from 0.1 acres (Wyoming Hills fire) to 64,416 acres (Beaver Log Lakes Fire).

The fire season in 2013 set two records of note:
(1) A total of 220,254.6 acres burned from wildfires that either ignited within Denali or burned onto NPS lands from other landowners.
(2) There were more large fires (4 wildfires > 10,000 acres) within Denali.

Photo credit: BLM Alaska Fire Service, Will Hutto

North Swift Fork Fire one day after discovery (June 1, 2013)

Photo credit: NPS volunteer, Yasunori Matsui

Toklat River East Fire six days after discovery (July 2, 2013)

There were 14 wildland fires in Denali in 2013—all ignited by lightning.

Fire Name	Burn Period	Acres	NPS Acres	Fire Type	Comments
Bear Creek	6/21/13 - 9/4/13	3,530	3,530	Wildfire	Resource objectives
Moving River	6/22/13 - 9/4/13	34,176	34,083	Wildfire	Resource and Protection objectives
Beaver Log Lakes	6/22/13 - 10/1/13	64,416	18,085	Wildfire	Resource and Protection objectives
Dead Fish Lake	6/24/13 - 9/4/13	6,107	0	Wildfire	Resource objectives
Sandless Lake	6/25/13 - 10/1/13	59,869	9,702	Wildfire	Resource objectives
Brooker Mountain	6/25/13 - 6/30/13	0.5	0.5	Wildfire	Protection objectives
Xerces	6/25/13 - 6/28/13	3	3	Wildfire	Protection objectives
Toklat River East	6/26/13 - 9/4/13	33,279	33,279	Wildfire	Resource and Protection objectives
Wigand Creek	6/26/13 - 7/24/13	704	704	Wildfire	Resource and Protection objectives
Wyoming Hills	6/26/13 - 7/1/13	0.1	0.1	Wildfire	Resource objectives
McKinley River East	6/28/13 - 9/4/13	4,442	4,442	Wildfire	Resource objectives
Chilchikabena Lake	6/29/13 - 7/4/13	n/a	merged with Moving River Fire	Wildfire	Resource and Protection objectives
Castle Rocks	7/6/13 - 9/4/13	12,934	12,934	Wildfire	Resource and Protection objectives

There were 3 prescribed fires in Denali in 2013.

Fire Name	Burn Period	Acres	Fire Type	Comments
FY2013 Admin Road 1	10/23/12 - 11/7/12	6	Prescribed Fire[1]	Burning of biomass debris from roadside maintenance projects and hazard fuels treatment projects
Parker Cabin	2/21/13 - 2/23/13	1	Prescribed Fire[1]	Burning of biomass debris from hazard fuels treatment projects
Toklat Pile	5/22/13 - 6/11/13	2	Prescribed Fire[1]	Burning of biomass debris from roadside maintenance projects and hazard fuels treatment projects

[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.

All wildfires were ignited by lightning. Most of the fires were managed to maintain wildfire as a natural process while protecting sensitive features as necessary. Due to the abnormally high fire-danger conditions during portions of summer, two fires were suppressed near Kantishna (Xerxes and Brooker Mountain fires). Under normal fire danger conditions, these two fires would have been considered for management as a natural process while protecting sensitive features as warranted. In addition, four wildfires did require specific site protection measures to protect homes and outbuildings near Lake Minchumina (Beaver Log Lakes fire), historical sites (Moving River and Toklat River East fires), and administrative sites (Castle Rocks fire).

On numerous occasions in 2013, the Western Area Fire Management staff at Denali cooperated with the Alaska Fire Service (BLM) and the State of Alaska's Division of Forestry. Managing fires, inside and outside of the park, was accomplished by implementing the "Closest Forces" concept: NPS personnel monitored wildfires in Denali and 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 Sushana River fire in Wrangell - St. Elias, supporting the State of Alaska's Division of Forestry, Tok Area.

Denali's staff detailed to the Alaska Interagency Coordination Center Type 2 helicopter module for support of multiple fires in the lower 48. The Type 6 engine was assigned to the Stuart Creek 2 fire on Fort Wainwright and other overhead and fire crew positions were filled by NPS Staff.

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 have grown up between the 1940s and 2013 at the Park Headquarters; 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.

In 2013, fire management staff improved the defensible space (about 11.2 acres) at Park Kennels, CCamp, and Toklat by trimming branches to varying heights from the ground to give a natural appearance. In addition, fire staff completed maintenance treatments to the Lower Toklat Patrol Cabin and Roosevelt Cabin in response to nearby wildfires.

During 2014, fire staff plan to create defensible space around the Moose Creek and Busia Cabins. This will be the initial treatment at these sites and they will then enter a maintenance cycle after this. Limbing and some cutting/thinning is planned in the Headquarters Residential Area, CCamp, Toklat and Stampede Mine 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:
www.nps.gov/fire/wildland-fire/connect/fire-stories/2013-parks.cfm

Defensible space projects planned for 2014

Project Name	Date	Acres	Treatment	Comments
Headquarters Residential (Unit 10)	5/13 - 9/26	2	Maintain	Maintain defensible space
CCamp (Unit 5)	5/13 - 9/26	2	Initial and maintain	Create/improve defensible space
Toklat Road Camp (Unit 5)	5/13 - 9/26	2	Initial and maintain	Create/improve defensible space
Moose Creek Cabin	5/13 - 9/26	0.4	Initial and maintain	Create/improve defensible space
Busia Cabin	5/13 - 9/26	0.7	Initial	Create defensible space
Stampede Mine	5/13 - 9/26	1	Maintain	Maintain defensible space
Gallup Cabin	5/13 - 9/26	0.7	Maintain	Maintain defensible space
Sushana Patrol Cabin	5/13 - 9/26	n/a	Evaluate	Evaluate need for defensible space
Lower Savage Patrol Cabin	5/13 - 9/26	n/a	Evaluate	Evaluate need for defensible space

Prescribed Fires Planned for 2014

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 2014, staff plan to will burn debris from past hazard fuels projects at the Headquarters, CCamp, Toklat and Kantishna.

Fire Name	Burn Date	Acres	Fire Type	Comments
Admin Road 1 (FY 2014)	12/9/13 - 12/14/13	7.2	Prescribed Fire	Burn biomass debris from roadside maintenance projects and hazard fuels treatment projects
Kantishna	2014	2.0	Prescribed Fire	Burn biomass debris from roadside maintenance projects
Toklat Pile	2014	1.9	Prescribed Fire	Burn biomass debris from roadside maintenance projects and hazard fuels treatment projects

Denali Fire Management and Fire Ecology Program

To maintain and understand 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

Below are descriptions of fire ecology projects that were accomplished in 2013 and plans for 2014 in Denali.

How dry is it?
Fuel Moisture Sampling in Denali
The amount of moisture in various types of vegetation (fuel for fires) 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.

Denali Western Area Fire Management staff collect fuel moisture samples at the RAWS site near the Denali Visitor Center.

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 Alaska. The Alaska NPS Fire Ecology Program established sampling sites in Denali near the Remote Automated Weather Station (RAWS) at the Denali Visitor Center.

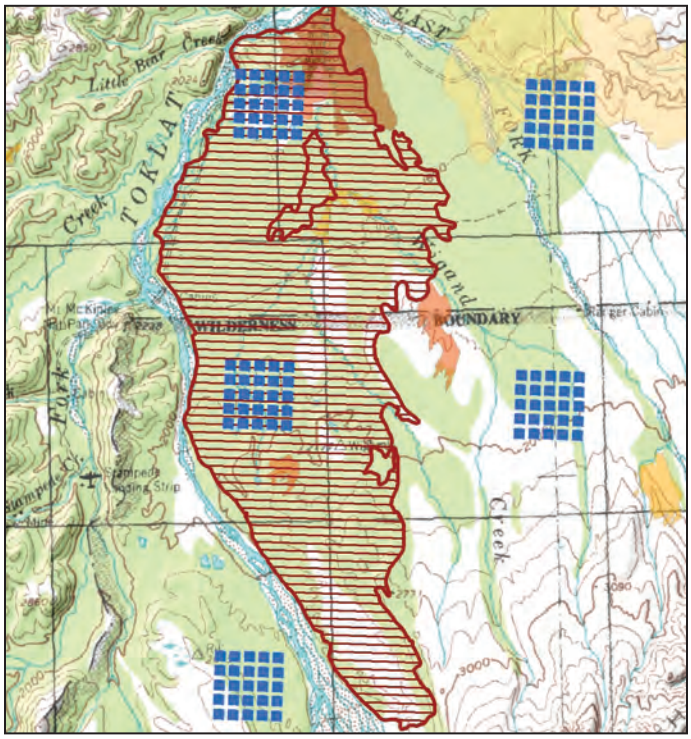
The data for all the sites in Alaska have been entered in the National Fuel Moisture Database. This information has been used for fire behavior modeling and to compare duff moisture to the Canadian Forest Fire Danger Rating System (CFFDRS) fire danger indices. Prior to this project, only minimal sampling of live fuel moisture has been done in Alaska.

Staff plan to continue sampling in 2014. Learn more about fuel moisture sampling here: http://www.frames.gov/partner-sites/afsc/events/previous-events/workshops/2013-fuel-moisture-sampling-workshop/

Long-Term Plots for Monitoring Vegetation Burn in 2013

In 2013, a total of 34 wildfires burned 284,467 acres within or partially within the administrative boundaries of six National Park Service units in Alaska. It was the second largest fire season on record for Alaska park units (WFMI data 1950-2012). Nationally, sixty-four percent of the area that burned by wildfires was on NPS lands.

In Denali, numerous large fires occurred. Based on fire perimeters, more than 75 previously-established vegetation plots were burned in the 2013 fire season. The Central Alaska Network (CAKN) Inventory & Monitoring vegetation monitoring program has established a network of vegetation monitoring plots within Denali (see map at right for 5 grids of plots). What happens after the fire will depend strongly on the burn severity of the fire. Burn severity can impact the types of plants that return and (potentially) the permafrost in the area. In 2014, the fire management program plans to measure the 1-year post-fire effects on up to 50 of the vegetation plots that burned in 2013. The purpose of monitoring these plots are to verify remotely-sensed burn severity maps, provide plot level burn severity, repeat photos and provide other site information for the CAKN Denali vegetation monitoring plots.



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

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 promote the revised Alaska FIREWISE concept in 2014 and assist with Firewise workshops (teach community members how to reduce combustible material near their homes to reduce wildland fire risk).

Each year Fire Management staff provides updated information about fire danger and maps about fires in and outside of the park.

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*. These fact sheets are downloadable as pdfs at: www.nps.gov/akso/nature/fire/documents/FireEcology2011.pdf

Wildlife

Wildlife Observations along the Park Road

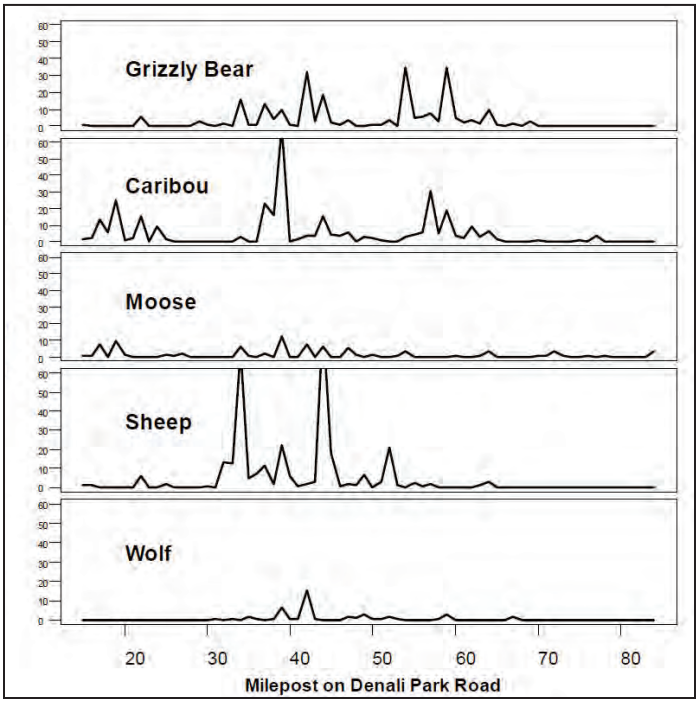
by Bridget Borg, bridget_borg@np.gov

Wildlife sighting data recorded by bus drivers and trained observers constitutes a valuable long-term data set. This dataset is useful in monitoring wildlife populations along the road, and also the quality of visitor experience in Denali (because visitors want to see wildlife), which managers are tasked to maintain.

Since 1996, bus drivers and park staff have recorded the numbers of bears, moose, sheep, caribou, and wolves they see on trips along the park road. 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 data at wildlife stops.

Current data collection via the MDT focuses on classifying wildlife stops by species. Additionally, trained observers collect more detailed information

Data from 2011 were used to make these graphs that give some idea of where the odds are highest of seeing wildlife.



on 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 80 trips in 2013, recording detailed information on 1069 wildlife stops along the park road. Based on the ROAR data, the chances of seeing wildlife are as follows...

The percentage of trips in 2013 (average for 1999-2013 in parentheses) on which at least one individual of each of the "big five" species was seen on a bus trip going at least as far as Eielson Visitor Center:

70% for grizzly bears (83%)
80% for caribou (89%)
63% for Dall's sheep (78%)
48% for moose (42%)
4% for wolves (17%)

From data collected 1997-2013, the probabilities of seeing a bear or Dall's sheep were the lowest in 2013 (70% and 64% of trips saw a bear or sheep respectively). The highest probability of seeing a bear was in 2001 (93% of trips) and the highest probability of seeing a sheep occurred in 1997 (94% of trips). The probability of seeing a wolf in 2013 (4% of trips saw a wolf) was the lowest since 1997 when 3% of trips saw a wolf.

Keep Wildlife Wild

by Pat Owen, pat_owen@nps.gov

Denali's resource staff continues to educate people with the basic message:

Keep wildlife wild -
do not approach or feed wildlife

Anecdotal observations continue to indicate that the program is successful. Fewer reports of human-wildlife conflict due to food conditioning have been reported each year the program has been in effect. The program includes bookmarks, brochures, and signs bearing a universal symbol "Do not feed the animals" with text explaining why this is important. Again in 2013, staff distributed these materials around the park and will do so in 2014. Signs appear on trash cans, picnic tables, and toilet stall doors. The message has also become part of every interpretive program.

The Keep Wildlife Wild program serves as a model for other parks. Wildlife staff encourages everyone working at the park to take every opportunity to discourage the feeding and subsequent habituation of wildlife.

Bear Monitoring

by Pat Owen, pat_owen@nps.gov

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 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 predator control efforts by the State of Alaska.

Bear capture was conducted on May 21-23, 2013 from a helicopter, with fixed-wing aircraft support. A total of six bears (five females and one male), including one female black bear were all captured for the first time and fitted with GPS radio collars. Bears were radio tracked through September. There are currently 11 bears wearing GPS and 3 wearing VHF collars in the study.

Plans for 2014 are to continue analyzing GPS radio collar data. In May, staff will try to capture six additional bears near the north park boundary. All bears will be radio tracked 1-2 x per month.

Bear Management

by Pat Owen, pat_owen@nps.gov

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 of the Denali campgrounds was in 1994. Since 1983, only five bears have been destroyed, one sent to a wildlife park, and two relocated by the National Park Service.

Between May 30, 2013 and September 15, 2013, 40 bear-human interactions were documented: 1 observation, 34 encounters, and 6 incidents (see table). The total of 41 BIMS in 2013 marks a 42 percent decrease from the 2012 total of 69. Of those interactions rated as encounters, 10 occurred in the frontcountry and 24 occurred in the backcountry. Of the 6 interactions classified as incidents this season, 3 occurred in the front country while the other 3 occurred in backcountry.

Backcountry: Backcountry interactions between humans and bears decreased from 33 in 2012 to 26 in 2013, a decrease of 22 percent. Of these backcountry interactions, three were considered incidents. Of the two incidents, one 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 m. Because 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 and incidents decreased since 2012, including a decrease in the number of incidents involving bears causing property damage.

Bear resistant food container

Frontcountry: The reported frontcountry interactions in 2013 decreased 58 percent from 2012. There were 33 interactions in frontcountry areas in 2012 and 14 in 2013. Of all the interactions, 3 were considered incidents. One was a general incident with the other two being property damage.

Interactions	Front country	Back country	Total
Observation	0	0	0
Encounter (when bear is aware of human and thus bear's behavior is altered)	10	24	34
Incident (when bear is involved in close charge, actual contact, or damage to human or property	3	3	6
Control Action	0	0	0
Total	14	27	41

Bear-human interactions in Denali that were documented in 2013 in the Bear Incident Management System (BIMS) database

Moose

by Pat Owen, pat_owen@nps.gov

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 is 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.

Dall's Sheep

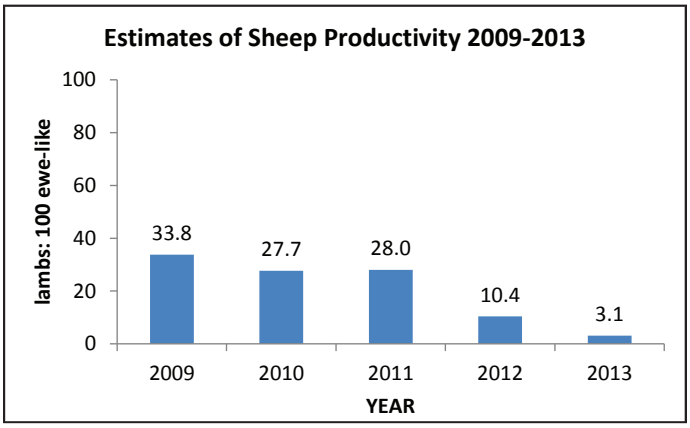
Aerial Survey

No aerial surveys were conducted in Denali in 2013 and none are planned for 2014.

Ground-based Surveys

From 2008 to 2013, park staff have conducted annual ground-based Dall's sheep surveys. Ground surveys allow closer and more careful observation of sheep and provide more detailed and accurate composition data, but the areas that can be surveyed on foot are very limited. Staff reinstituted ground surveys in 2008.

Denali staff conducted ground-based Dall's sheep surveys June 11-18, 2013. These surveys classified sheep. The lamb productivity estimate was 3.1 lambs per 100 ewes, based on limited ground surveys, which is below the previous year's estimate of 10 lambs per 100 ewes. The range of productivity from 2009-2012 is 10-34 lambs per 100 ewes (see bar graph below).



Caribou

by Layne Adams, ladams@usgs.gov

Background and Historical Overview

Population dynamics of the Denali Caribou Herd have been investigated continuously at Denali National Park and Preserve since 1984. Denali National Park, totaling 18,800 km2, encompasses nearly the entire range of the Denali Herd, providing a unique opportunity to investigate caribou population dynamics where ungulate populations (caribou, moose, and Dall's sheep) and the large carnivores that prey on them (wolves, grizzly bears, and black bears) are driven primarily by natural processes.

Research on Denali's large carnivore/ungulate system serves as an important naturally-functioning benchmark for comparison to manipulated systems. This caribou research is also a component of Denali's large mammal monitoring program, providing data about long-term trends of park wildlife populations and the causes of population changes.

To date, much has been learned about the interactions between predation and weather that drive the dynamics of the Denali Caribou Herd.

Objectives

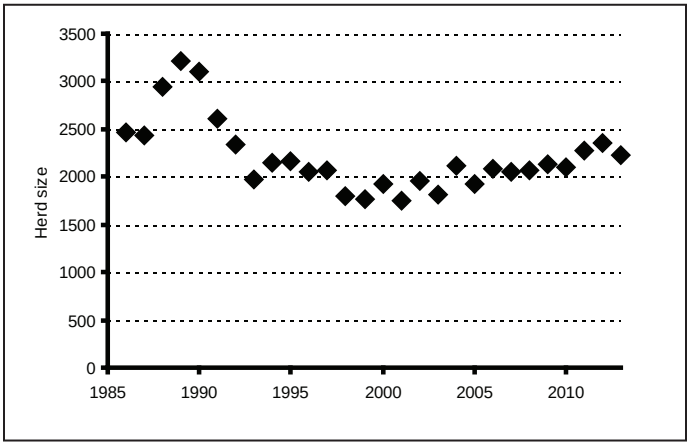
The current goals of this research are
(1) to document population trends, primary vital rates (calf production, calf recruitment, adult female survival), and other important population characteristics (female age structure, adult sex ratios)

that determine the status of the Denali Caribou Herd (2) to evaluate growth, survival, and seasonal distribution of adult males of the Denali Caribou. (3) Relate caribou population status, trends, and vital rates to climatic variables and predator population characteristics.

The data presented here represent information gathered during October 2012-September 2013.

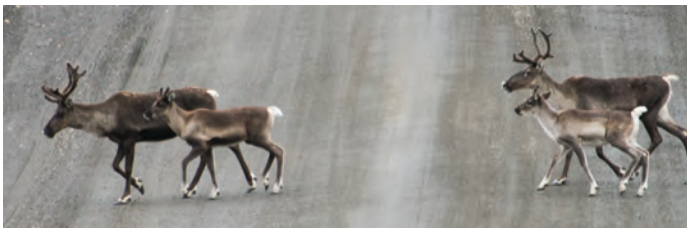
Herd Size

I derived a preliminary herd size estimate of 2,230 caribou for September 2013; that number will be adjusted based on results of the 2014 census. This population estimate is consistent with continued slow growth of the Denali Herd at about 2% per year since 2003.



Adult Sex Ratios

Our efforts to conduct an adequate late September composition survey were hampered by inclement weather on the north side of the Alaska Range and the government shutdown starting October 1, 2013. We classified 295 caribou on ranges south of the Alaska Range on 28 September 2013, but did not get workable weather conditions to the north on the 3 remaining days of the month. Our annual goal has been to classify > 1,000 caribou and has been met in all but 4 years since 1984 (713, 670, 997, and 295 in 1984, 2002, 2007, and this year, respectively).



I estimated an adult sex ratio of 42 bulls:100 cows, similar to the last 3 years. 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 limited recruitment of male calves. Bull:cow ratios have increased slowly since 1998 but are a still well below levels at the beginning of the study. 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 80% in mid-May 2013, based on 66 radiocollared females in the age-structured sample. Of the 13 non-parturient females in the sample, 11 were ≤ 2

When this study began in the mid-1980s, the Denali Herd was increasing at about 7 percent per year during a period of relatively mild winters. Survival of caribou cows was high (96% per year) and about 50% of the calves produced were recruited. With the onset of a period of severe winters in 1988, caribou numbers leveled off at 3,200 in fall 1989, then declined by one-third over two years to approximately 2,300 caribou by fall 1992. During the period of decline, adult cow survival dropped substantially, to an average of 85%/year, and calf recruitment dropped to just 10 percent.

During 1993-2003, with a return to moderate winter snowfall, the caribou herd continued to decline, but a much slower rate of about 2 percent annually. Adult cow survival was comparable to the period of herd growth in the mid-1980s, but calf recruitment to fall continued to be very low (mean = 15 percent). With low calf recruitment during 1990-2003, the female age structure became heavily weighted towards older females, a harbinger of impending population declines regardless of winter snowfall patterns. In May 2002, an estimated 24% of the females in the herd were >13 years old. As a result of these old females dying, adult female survival was low in the 2002-03 and 2003-04 winters (average = 83%) even though winter snowfalls were substantially below average. These survival rates are comparable to rates measured during the extreme winters of 1990-93.

During the last 10 years (2004-2013), calf survivorship until fall has improved to an average of 27 percent allowing for limited froth of the herd at about 2 percent per year.

years-old (8 yearlings, 3 2-year-olds); the remaining 2 females were 4 and 15 years old. The herd natality rate has varied from 59% in 1990 to 92% in 1994 and is primarily influenced by the proportion of the population consisting of yearlings and the variable productivity of the 2-year-old cohort.

During the mid-June 2013 postcalving composition survey, we noted 33 calves:100 cows. By the late September composition count, that ratio had declined to 18:100, again based on a relatively low sample size of caribou in 2013 compared to other years. Based on these ratios and accounting for adult female mortality between mid-May and late September, I estimated 21% survival to fall for the 2013 cohort. Calf survival has averaged 27% over the last 10 years, compared to 42% and 15% during 1987-1990 and 1991-2003, respectively.

Female Survival and Age Structure

During October 2012 – September 2013, 8 females from the age-structured sampled died for an annual mortality rate of 12%, equal to the long-term study average (range of annual values = 2-23%). The female age structure in May 2013 exhibited the effects of improved recruitment over the last 9 cohorts, although the proportion of females that were ≥ 13 years old remained high. With continued moderate recruitment, the proportion consisting of older females will likely decline over the next few years because of the paucity of females 10-12 years old, representing the 2001-2003 cohorts that are the last from the period of low recruitment.

The adult female mortality rate has varied from an average of 7% during 1986-89 when the herd was growing at 8%/year to 19% on average during 1989-93, the period of severe winters and marked herd decline of 10%/year. Since about 2000, mortality rates for adult females have averaged 12% in spite of mild to average winter conditions. This higher mortality in the last decade has in part been due to an age structure skewed toward older females and the losses of those females. Given the current age structure, annual mortality rates will likely decline from current levels as the cows ≥ 13 years old die off, and those age classes are replaced by the weak 2001-2003 cohorts.

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.

Adult Bull Survival

During September 2007- September 2013, we radiocollared and monitored 198 male caribou, including 137 captured as adults (≥ 1 year old) in mid-September, and 61 captured as 10-month-old calves (12-13 each March 2008-2012). We have experienced some difficulties with premature failure of radiocollars (n = 18) or loss of radiocollars (n = 21). In Fall 2010, we began deploying transmitters that were fully cast in urethane resin that protects the electronic components from shock during rutting fights. That appears to have taken care of the failure

issue, although we continue to experience occasional failures with radiotransmitters deployed prior to September 2010. Many of the dropped collars (n = 13 of 21) also resulted from the rut in that they were torn off during rutting fights; the remainder (n = 8) were due to premature failure of the elastic expansion sections in the collars. In addition to 4 capture-related deaths, we have noted 76 deaths to date attributed to the following causes, including wolves (36), bear (13), accidents (2), unknown large predator (8), unknown (16), and unknown, but not predation (1).

Age-specific survival rates of males were high and possibly increasing through 4 years of age. Survival then declined as individuals become active in the rut

through 7 years of age, and dropped off markedly for males > 7 years old. Very few caribou bulls survive to 10 years of age; the oldest bull we monitored died in May as he turned an estimated 13 years old and is the only collared bull to survive beyond an estimated 11 years of age. Bulls ≥ 3 years old died predominantly during July – November (82% of annual mortality). Of this mortality, over half (43% of annual mortality), occurred prior to the onset of the rut around mid-September.

Bull Growth Patterns

In September 2007-2013, we weighed 158 bulls ≥ 1 year old, at their initial captures and recaptures

to replace radiocollars prior to battery exhaustion. In mid-September bull caribou should be at their maximum body for the year in preparation for the rut and ensuing winter. Overall, body masses of these males ranged from 93 to 278 kg. Body masses increased markedly with age from 1 to 6 years of age, gaining an average of 24.5 kg each year, and plateaued at 231.4 kg on average for bulls ≥ 6 years of age. Antler size was strongly correlated with body mass ($r2 = 0.90$, $F1,155 = 1377.61$, $P < 0.001$), thus mean antler length showed a similar pattern to body mass, increasing by 14.3 cm/year for bulls 1 – 6 years of age, and averaging 123.5 cm for bulls ≥ 6 years of age.

Planned Activities (Oct 2013-Sept 2014)

In the upcoming year, we plan to continue efforts to assess population dynamics of the DCH and begin bringing studies of survival, growth, and seasonal distribution of bulls to completion. Specifically, objectives for the year include:

1. Capture and radiocollar caribou females as needed to maintain an age-structured sample of approximately 60 individuals for estimation of calf production, age structure, survival patterns and seasonal distribution, and to aid in population monitoring.
2. Capture and remove radiocollars from approximately half of the instrumented bull in the herd in mid-September 2014; all individuals will be fully processed during capture to add to datasets on growth patterns of males. Remaining bulls will be captured for collar removal in September 2015.
3. Locate all instrumented caribou in late November, late January, mid-March, late April, mid-May, early June, late July, and late September, or as needed to meet study objectives.
4. Conduct the post-calving census/composition survey and the fall composition survey to determine herd size, calf recruitment, and adult sex ratio.

Wolves and Coyotes

by Steve Arthur, stephen_arthur@nps.gov

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. Intensive research was concluded in 1993, but research and monitoring efforts continue. The current study 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. In recent years, the use of GPS/ARGOS collars that upload locations daily or even more often has greatly increased the number of locations available for most collared wolf packs.

Telemetry locations acquired over one year are used to determine the area of each pack territory. Areas of the combined pack territories and pack counts are used to estimate abundance and density of wolves. In addition, monitoring data have been used to determine wolf movements, den locations, mortality factors, behavior, and population dynamics.

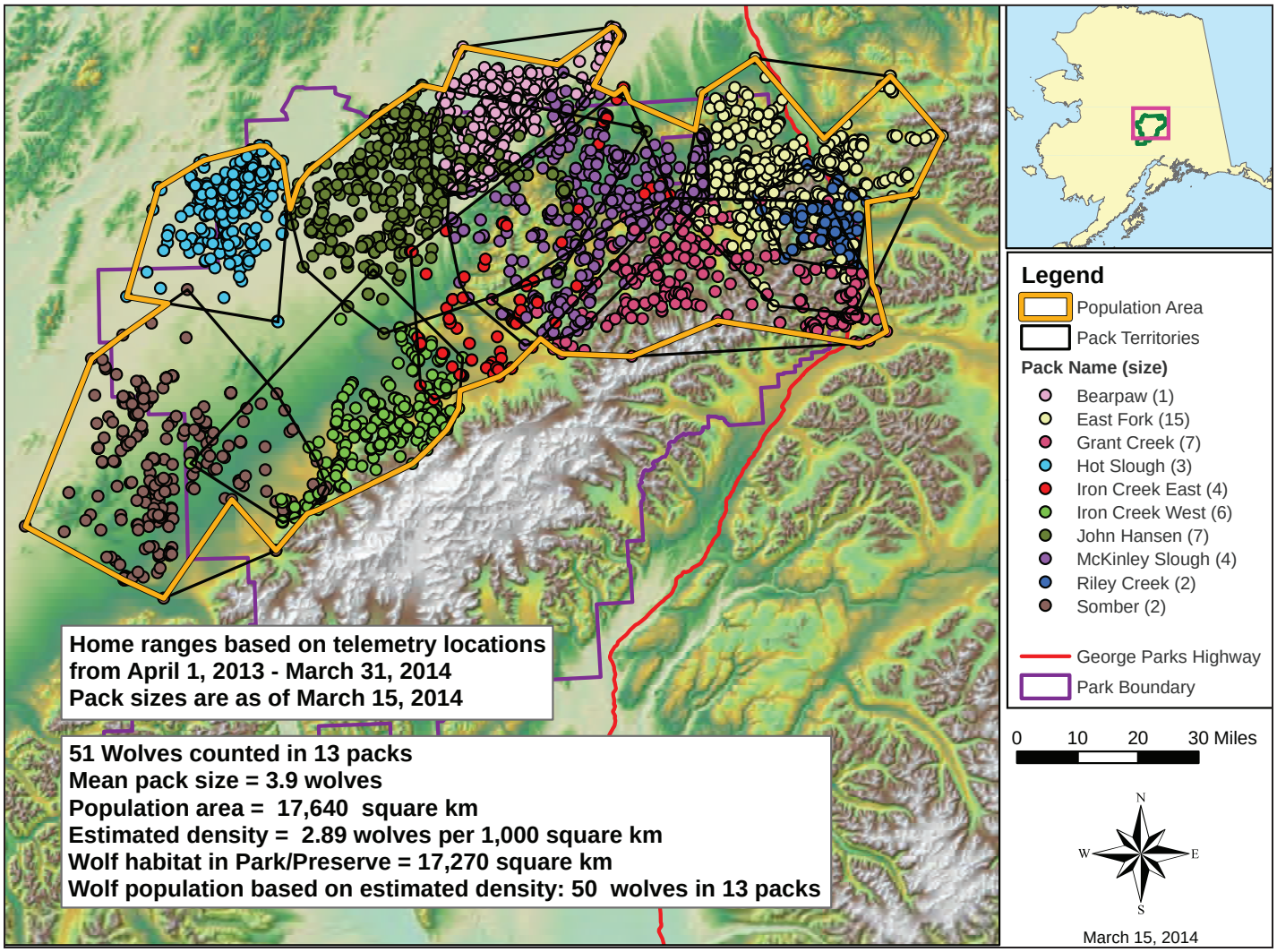
Wolf pack territories and radiocollared wolves
As of March 15, 2014, there were 13 wolf packs in Denali with collared wolves in them. Two types of collars were used. Four wolves wore conventional, VHF radio collars that are located from antennae-equipped aircraft. Another 15 wolves carried GPS collars that determine the animal's location *once or more times per day*, store the data, and upload it through the ARGOS satellite system.

Estimated Density of Wolves in Denali, 1986-2014
In April 2014, there were 51 wolves in the packs being monitored by park biologists. The estimated density of wolves in Denali (about 7.5 wolves per 1,000 square miles or 2.9 wolves per 1,000 square kilometers) was slightly less than last year's estimate of 8.2 wolves per 1,000 square miles or 3.2 wolves per 1,000 square kilometers.

Coyote Study in Denali
In the last year, the park established an Memorandum of Understanding with the University of Alaska Fairbanks. This M.O.U. formalizes and expresses park support for the research project on coyotes being conducted in and near Denali during 2012-2015 by Kelly Sivy, a graduate student of Laura Prugh in the Department of Biology and Wildlife. Sivy's research investigates mesocarnivores (coyotes, foxes, lynx) and their response to wolf presence, prey availability, and snowpack in two locations. Of the two locations, Denali area (including the Stampede Corridor) is the one that includes wilderness.

During wolf capture for radio collaring in December 2013 and March 2014 (1 and 6 wolves radio collared, respectively), three coyotes were fitted with radio collars. The data from radio-collared coyotes will aid in Sivy's research and ultimately benefit the park.

Wolf population estimates for Denali in spring 2014.



Wolf Viewing Project

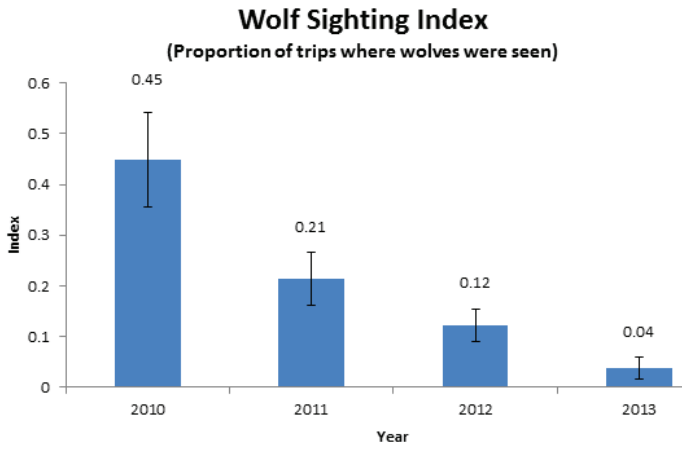
By Bridget Borg bridget_borg@nps.gov

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

As part of this study, we developed a 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. To maintain consistency across years, we limited this index to consider only trips by experienced observers (park employees and buses with data-logging computers). 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 to create an index of annual wolf sightings for the park 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 review are slated for 2014.

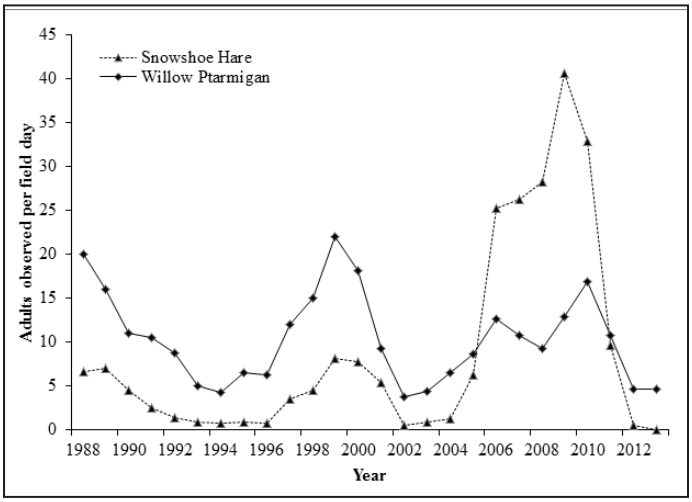
Snowshoe Hare (and Willow Ptarmigan)

by Carol McIntyre, carol_mcintyre@nps.gov

NPS biologists in Denali calculate annual indices of abundance for snowshoe hare and willow ptarmigan by recording the number of adults of each species observed during routine field activities from late April through June. These data allow biologists to identify the frequency and magnitude of the population cycles of each species over time. The number of snowshoe hare detected per field day decreased substantially in 2012 and remained low during 2013, indicating that the species was in the low phase of its cycle (see graph below).
Detections of willow ptarmigan also decreased in 2012 and remained low in 2013, in synchrony with snowshoe hares. Data collect in Denali were used in the publication:

Krebs, C.J., K. Kielland, J. Bryant, M. O'Donoghue, F. Doyle, C. McIntyre, D. DiFolco, N. Berg, S. Carrier, R. Boonstra, S. Boutin, A.J. Kenney, K. Bodony, J. Putera, and T. Burke. 2013. Synchrony in the snowshoe hare cycle in Northwestern North America, 1970-2012. Canadian Journal of Zoology 91: 562-572.

Counts of snowshoe hare and willow ptarmigan will continue in 2014. Additionally, starting in May 2014, the Alaska Department of Fish and Game will include a study area in Denali as part of their statewide springtime abundance surveys. These surveys are the means through which the Alaska Department of Fish and Game (ADF&G) monitors willow and rock ptarmigan populations statewide.



Annual abundance indices for snowshoe hare (dashed line with solid triangles) and willow ptarmigan (solid line with solid diamonds) from 1988 to 2013, Denali.

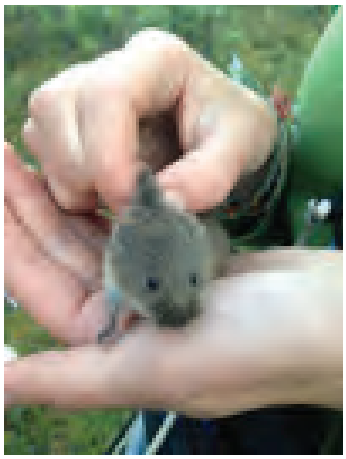
Small Mammals

by Melanie Flamme, melanie_flamme@nps.gov

Purpose: The Central Alaska Network (CAKN) has monitored small mammal populations in Denali National Park and Preserve since 1992 (22 years) as part of its Vital Signs Long-term Monitoring program to assess the status of this park resource. Small mammal species represent a low trophic level in the ecosystem in Denali. Voles consume seeds, berries, plants, fungi and invertebrates, and are an important prey source for raptors and carnivorous mammals. Our objectives are to monitor changes in the density and abundance of small mammal populations in the Rock Creek drainage in Denali over time.

Implementation: We monitor three species of voles in the park: northern red-backed vole (Myodes rutilus), tundra vole (Microtus oeconomus) and singing vole (Microtus miurus). Monitoring of these small mammal species occurs on four study plots along the Rock Creek drainage using live-trapping and mark-recapture techniques. We sample the small mammal population in late August, near the end of the breeding season when the population numbers are close to the peak before winter. Live traps are baited with irradiated sunflower seeds, stuffed with bedding, and checked 3 times daily (6am, 1pm and 8pm). Animals are live-trapped, weighed, identified by sex and species, implanted with an identification tag and released. Every individual can then be identified with a "reader" for capture/recapture estimates of population size.

Results: Our findings show small mammal populations fluctuate over the years and may be influenced by abiotic factors such as the timing of the onset of spring and the warmth of the summer. The warmer it is in the spring, the earlier the snow melts and plants emerge as available food. Further, an earlier spring provides a longer breeding season for small mammals that survived the winter, offering the opportunity to produce multiple litters during summer. If the summer is long enough, generations of small mammals (the offspring of the offspring of the overwinter survivors) may breed to produce litters and increase the population size. We are currently analyzing data that supports the importance of small mammals in the ecosystem and examines their population fluctuations. We plan to publish this data soon and will reveal these interesting findings.



Conclusion: These observations suggest earlier springs and warmer, longer summers may lead to earlier green-up, longer plant growing seasons and thus, longer breeding seasons for small mammals. From this and other studies we know that populations of voles vary across the landscape

and over years but pinpointing the causes of the population fluctuations has been challenging. Long-term data sets, such as this one, will help us to better understand these fluctuations and the role of small mammals in the ecosystem.

Birds

by Carol McIntyre, carol_mcintyre@nps.gov

Abundance and distribution of passerines

Passerine (perching) bird monitoring programs started in Denali in 1992. Denali was one of four prototype parks selected for the NPS Long-term Ecological Monitoring Program. This program evolved into the NPS Vital Signs Inventory and Monitoring program in 2001 and Denali joined two other parks, Wrangell-St. Elias National Park and Preserve and Yukon-Charley Rivers National Preserve, to form the Central Alaska Monitoring Network (CAKN).

Monitoring passerine birds is one of the Vital Signs of the CAKN. The Order Passeriformes (passerines or perching birds) is the single largest order of birds in the world, comprising over 50 percent of avian species diversity on our planet. Of the 169 species of birds documented in Denali, 65 (38%) are in the order Passeriformes.

One of the major objectives of the CAKN passerine monitoring program is to detect changes and trends in abundance for the most common species of passerine birds. Our goal is to identify population trends quickly, efficiently, and accurately to inform timely conservation decisions. To achieve this goal, NPS biologists conduct a series of standardized point counts at sampling points along the Denali park road in Denali, the Nabesna and McCarthy Roads in Wrangell-St. Elias, the upper Yukon River in Yukon-Charley, and on sampling plots within walking distances of these roads and the river in all three NPS areas.

Roadside surveys. NPS field biologists conducted the standardized surveys from late April through June 2013 along three roadside survey routes in Denali (see table below). Route 1 starts at the junction of State Highway 3 and the Denali Park Road. Route 2 starts at mile 25 of the Denali Park Road. Route 3 starts at mile 50 of the Denali Park Road. Each survey route contained 50 sampling points spaced approximately 800 meters apart and is approximately 39.4 kilometers long. At each survey point, biologists conducted standardized 3-minute surveys and recorded all bird heard and all bird seen within 400 meters of the point. The surveys start ½ hour before sunrise and end about five hours later.

Early spring weather conditions from late April through May were challenging for both birds and bird surveyors. April 2013 was the coldest April on record in Denali, with temperatures 14.3°F colder than normal. There was also nearly 9” more snow than normal in April, including 7.8” of snow on 25 April (Sousanes and Hill 2013). Temperatures remained cold through the first three weeks of May and May 2013 was the 4th coldest on record with five new record temperatures set between 7 and 18 May (Sousanes and Hill 2013). Total snowfall for March, April and May was 34.8”, 232% of normal levels. Adding to the challenging spring conditions were several large snowstorms during spring migration. A large snowstorm moved through eastern Alaska in the upper Tanana River Valley from May 12 to 14, 2013. According to FWS biologists in Tok, the storm resulted in enormous fallouts of migratory passerines including unprecedented numbers of flycatchers, warblers and sparrows. FWS biologists estimated that there were over 100,000 sparrows on the ground in and near Tok during the snowstorm. Another large snowstorm on May 17 resulted in another large fall out of migratory birds south of Denali where local residents observed thousands of Lapland Longspurs, among other species, along roadsides.

The harsh spring weather conditions appeared to influence the results of our 2013 passerine surveys in at least two ways. First, the date of first detection for the earliest arriving migratory passerines in Denali were from 5 to 20 days later in 2013 than in the past three years (see table above).

Second, the number of survey points where at least one species was detected from late April through

	Date of First Detection on Roadside Bird Survey Route 1			
	American Robin	Varied Thrush	American Tree Sparrow	Dark-Eyed Junco
2010	April 22	May 5	April 22	April 22
2011	May 4	May 5	May 4	April 21
2012	May 1	May 1	May 1	May 1
2013	May 15	May 15	May 15	May 15

mid-May was far less in 2013 than in the previous three years (see table below). It wasn't until late May that detections were made on most points, a pattern that suggests that the activity of both resident and migratory passerines was affected by the cold and snowy spring weather conditions.

NPS biologists are currently analyzing data collected along the roadside survey routes to estimate abundance and trends. Results of these analyses will be available in 2015.

Results from part of this study were recently published in Biological Conservation:

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.

In addition, an overview of the project is available as a new Denali Fact Sheet: Monitoring Passerine Birds.

In early 2014, NPS staff decided to combine the passerine monitoring efforts in the Central Alaska Monitoring Network (CAKN) and the Arctic Monitoring Network (ARCN). Our combined efforts will increase our survey efficacy and provide unique opportunities for detecting trends in passerine birds across these large monitoring networks. As part of the combined efforts, NPS biologists will travel to Gates of the Arctic National Park and Preserve to conduct passerine surveys on the North Fork of the Koyukuk River and will also continue to conduct the roadside bird surveys in Denali and Wrangell-St. Elias National Park and Preserve.

Breeding Bird Survey (BBS)

The North American Breeding Bird Survey (BBS) is a large-scale survey of North American birds. Nearly 4,100 BBS routes are located in the U.S. and Canada and about 2,900 routes are surveyed annually. The BBS has accumulated over 40 years of data on the abundance, distribution, and population trends of more than 420 species. These data are useful for assessing if changes of a species in certain states are related to a continental decline or merely represent population shifts within their breeding range. Park biologists usually survey two BBS routes in Denali in June each year: the Savage BBS and the Toklat BBS. Each route contains 50 sampling points located 800-m apart. At each point, the observer conducts a three-minute count and records all birds detected within 400-m of the sampling point. Two BBS routes were conducted in Denali in 2013. Results of the two Denali BBS routes are available on the North American Breeding Bird Survey website (https://www.pwrc.usgs.gov/bbs/RawData/Choose-Method.cfm). Two BBS routes will be conducted in Denali in June 2014. These surveys are conducted collaboratively with the Central Alaska Monitoring Network's passerine monitoring program.

	Number of Points of roadside Bird Survey Route 1 where at least one species was detected			
Year	April 18-21	April 30-May 4	May 7-11	May 15-21
2010	35	50	45	50
2011	27	40	49	50
2012	41	36	49	50
2013	28	28	22	48

Route	Number of repeat surveys	First and last survey dates	Number of bird species detected (seen or heard) for all surveys	Ten most frequently seen species)in taxonomic order)
1 (Mile 0 - Mile 24.5)	10	April 18 - June 23	48	Willow Ptarmigan, American Robin, Orange-crowned Warbler, Yellow-rumped Warbler, Wilson's Warbler, American Tree Sparrow, Fox Sparrow, White-crowned Sparrow, Dark-eyed Junco, Redpoll sp.
2 (Mile 25- Mile 49.5)	8	May 1 - June 24	51	Willow Ptarmigan, Black-billed Magpie, American Robin, Orange-crowned Warbler, Yellow-rumped Warbler, American Tree Sparrow, Savannah Sparrow, Fox Sparrow, White-crowned Sparrow, Dark-eyed Junco
3 (Mile 50- Mile 74.5)	4	May 31 - June 25	47	Willow Ptarmigan, Arctic Warbler, Orange-crowned Warbler, Wilson's Warbler, American Tree Sparrow, Savannah Sparrow, Fox Sparrow, White-crowned Sparrow, Golden-crowned Sparrow and Redpoll sp.

Summary of survey effort and most frequently detected species on the three Denali roadside bird survey routes in 2013.

Monitoring territory occupancy and reproductive success of Golden Eagles and Gyrfalcons

Denali contains one of the highest reported nesting densities of Golden Eagles in North America, with over 80 territorial pairs living in the northern foothills of the Alaska Range. The National Audubon Society designated this region in DENA as an Important Bird Area because it supports an unparalleled nesting population of Golden Eagles. The area also contains a relatively large number of nesting Gyrfalcons, a species that nests in the same habitat as Golden Eagles in much of interior and northern Alaska. NPS biologists started the Denali Golden Eagle study in 1987 and it has evolved into the longest running ecological study of a migratory population of Golden Eagles in the world. Data from this project are becoming more important as increased concerns about the conservation of Golden Eagles increases due to the rapid spread of human activities across their range.

Monitoring the territory occupancy and reproductive success of Golden Eagles is a priority of Denali's Resource Stewardship Strategy and a Vital Sign of the Central Alaska Monitoring Network (CAKN). In 2013, NPS biologists monitored the occupancy of nesting territories and reproductive success of Golden Eagles and Gyrfalcons in the northeast region of Denali, marking the 26th consecutive year of this study. Park biologists collected data using two standardized aerial surveys conducted from a small lightweight helicopter, and additional ground observations and foot surveys. NPS biologists completed surveys to document occupancy and breeding activities in late April nesting success and fledgling production in mid-July.

Golden Eagle surveys in 2014 -- the Perfect Storm. The combination of heavy snow cover in April and low numbers of snowshoe hare and willow ptarmigan created the Perfect Storm for documenting territory occupancy and reproductive activities of Golden Eagles in Denali in 2013. During their standardized aerial surveys, NPS scientists rely on several clues to document territory occupancy and breeding activities of Golden Eagles in Denali. Many of these clues including observations of an incubating eagle and nest refurbishment and construction, are easily detected during an aerial surveys. But others, including territorial behavior, require additional observations made from vantage points on the ground. Many long-lived raptors, including Golden Eagles, do not lay eggs when prey abundance is low. In Denali, nesting rates of Golden Eagles are closely tied to the abundance of snowshoe hare and willow ptarmigan (see McIntyre and Schmidt 2013 for details). In years when eagles do not lay eggs, NPS biologists rely on other clues to document territory

occupancy including refurbishing of nests and territorial behavior (such as observation of territorial defense and courtship). In 2013, the abundance of snowshoe hare and willow ptarmigan was the lowest recorded in the study area since the Golden Eagle study started in 1988. This resulted in very few females laying eggs. The snow storms before and during the eagle surveys in late April 2013 resulted in a beautiful snow-covered landscape.

These snows covered up many Golden Eagle nests in the study area and also covered up any evidence of nest refurbishment. These conditions created difficult survey condition in late April and NPS scientists had to rely primarily on observations of territorial behavior to document territory occupancy. Because many different types of territorial behavior are difficult to document from aerial surveys, NPS scientists had to change their survey strategies and spend much more time making observations from the ground to document territory occupancy. As a result, NPS scientists had to reduce their survey coverage in the study area and only monitored 48, rather than nearly 80, Golden Eagle nesting territories in Denali in 2013.

Forty-six of the 48 territories monitored in 2013 were occupied, but only 2 contained nesting pairs (e.g., a female that laid eggs) and only 1 of these pairs successfully raised young. Only 1 fledgling was produced in the Denali study area in 2013.

NPS biologists expected low reproductive success because of the low abundance of snowshoe hare and willow ptarmigan, but were surprised at the extremely low numbers of nesting eagles and fledglings. Nesting success and production has been low in other years when hare and ptarmigan were in the low phase of their cycle in the study area, but 2013 marks the first year when reproductive activity and success remained very low for two consecutive years.

The long-term studies in Denali suggest that territory occupancy remained stable since 1988. But during that same time period, NPS scientists documented substantial decreases in the rates of Golden Eagle egg-laying and fledgling production (McIntyre and Schmidt 2012). Research in Denali indicated that the declines were not related to conditions on the breeding grounds including food supply, weather and habitat. This suggests that other factors in Denali such as age structure of the population and factors on migration corridors and wintering grounds are causing the decline (McIntyre and Schmidt 2012). NPS scientists are collaborating with others (see below) to identify the factors driving the population trends of Denali's Golden Eagles.

Gyrfalcons. In 2013, NPS biologists monitored 7 Gyrfalcon nesting territories in Denali, about 50% fewer than in most other years since 1988. Occupancy of territories was high, but all measures of reproductive success were less than average.

Collaborating on a landscape scale. To protect the migratory birds that nest in Denali, the NPS must engage in conservation efforts that reach far beyond park boundaries and identify the factors that influence the survival of these birds. Golden Eagles that nest in Denali are migratory and their winter ranges span from central Alberta to northern Mexico. Habitat across this vast region of western North America is rapidly changing due to a wide variety of human activities. NPS biologists are collaborating with US Fish and Wildlife Service, US Geological Survey, Alaska Department of Fish and Game, and West Virginia University on several studies to identify the factors driving the population trends of Denali's Golden Eagles. This includes studies of habitat condition, the influence of lead poisoning, the risk of electrocution and collision with wind turbines, and many other factors.
The collaborative studies are providing essential information for conserving Denali's Golden Eagles by identifying the mechanisms that regulate its population, including documenting where specific individuals breed, migrate, and overwinter and how the conditions of these areas influence their survival and reproduction. Further, NPS scientists are working with the US Fish and Wildlife Service to develop and implement effective conservation programs for this species and its habitats across western North America in the US, Canada, and Mexico.

Year	Occupancy (%)	Nesting Pairs (%)	Nesting Success (%)	Fledglings per successful pair	Fledglings per nesting pair	Fledglings per territorial pair
1988	88	72	81	1.40	1.14	0.82
1989	85	88	84	1.63	1.37	1.21
1990	81	83	71	1.56	1.10	0.91
1991	83	71	84	1.49	1.25	0.89
1992	84	57	46	1.39	0.64	0.36
1993	83	46	61	1.95	1.18	0.54
1994	85	36	45	1.22	0.55	0.20
1995	84	48	70	1.26	0.89	0.43
1996	90	43	88	1.22	1.08	0.46
1997	83	70	73	1.66	1.21	0.84
1998	80	52	65	1.50	0.97	0.50
1999	89	72	81	1.64	1.33	0.96
2000	85	76	64	1.50	0.96	0.73
2001	84	65	52	1.35	0.70	0.46
2002	89	14	40	1.00	0.40	0.05
2003	86	35	52	1.46	0.76	0.27
2004	89	44	50	1.25	0.63	0.27
2005	88	54	68	1.36	0.93	0.50
2006	91	79	81	1.49	1.21	0.95
2007	91	74	77	1.59	1.22	0.90
2008	87	68	67	1.53	1.02	0.69
2009	93	82	69	1.60	1.10	0.91
2010	94	68	71	1.36	0.96	0.65
2011	94	53	49	1.25	0.61	0.32
2012	93	25	35	1.00	0.35	0.09
2013	96	4	50	1.00	0.20	0.02

Summary of the rates of nesting territory occupancy, nesting (egg laying), nesting success, mean brood size, and overall population productivity for Golden Eagles in Denali, 1988 to 2013.

NPS scientists are also collaborating with the newly formed Tundra Conservation Network. The Tundra Conservation Network consists of over 30 scientists who are studying how Arctic nesting raptors including Rough-legged Hawks, Golden Eagles, Gyrfalcons and Snowy Owls are responding to a changing climate.

Protecting nesting eagles from disturbance

Eagle-eye observers may notice something a bit odd in a well-known Golden Eagle nest just west of Eielson Visitor Center in 2014. The nest is located on a large isolated rock outcrop right next to the Denali Park Road, where the road passes over stream on a very steep mountain side. This historical nest is part of a nesting territory that contains at least three other nests and has been used by both Golden

Eagles and Gyrfalcons for decades. Known locally as "Eagle's Nest Corner", here the stream flows under the Denali Park Road through two culverts and exits through a crib wall. The crib wall lumber is rotting and the wall is leaning outward. The culverts have rusted through on the bottom and water is leaking into the road fill behind the cribbing which contributes to the outward wall lean and lumber rot, creating a hazardous condition at this section of the Denali Park Road. This safety hazard will be eliminated by a construction project in summer 2014 that will install new culverts and reconstruct the cribbing wall. NPS staff determined that the level of human activities associated with this construction project could disturb Golden Eagles that are using this nest. To eliminate the risk of disturbance, the NPS obtained a permit from the US Fish and Wildlife Service (FWS) to install a nest deterrent to keep Golden Eagles (and Gyrfalcons) from using this nest during 2014. Using the NPS long-term data set

Looking south to the upper Savage River during Golden Eagle surveys in late April.

on Golden Eagle nesting territory occupancy and reproductive success, FWS biologists determined that the temporary loss of this particular nest for one season would not cause any significant loss of Golden Eagle productivity. The NPS long-term data set was key to obtaining this permit – it allowed FWS biologists to assess if the loss of this specific nest for one breeding season would have any detrimental effects on the population. By keeping Golden Eagles (and Gyrfalcons) from using this nest, the construction project can proceed without any risk of disturbing the nesting raptors. The nest deterrent is temporary and will be removed immediately after the construction project is completed. The territory, including occupancy of the nests, will be monitored during and at least three years after the construction project. This is a good example of how NPS staff are working together to protect critical park resources while maintaining safety standards along the Denali Park Road.

Bird Species of Conservation Concern

In 2013, staff from Camp Denali and North Face Lodge continued to document the distribution and occurrence of a suite of 34 bird species of conservation concern. Target species included in this project are those with documented population declines such as Olive-sided Flycatcher and Rusty Blackbird and those that respond quickly to changes in their habitat such as Gray-cheeked Thrush and Golden-crowned Sparrow. From early June through early September, observers recorded their detections of target species on a pocket-sized target bird checklist during their routine daily activities in two different observation areas.

Area	Most commonly detected species
Toklat west to Grassy Pass	Long-tailed Jaeger, Arctic Warbler, Northern Wheatear, and Golden-crowned Sparrow
Grassy Pass west to Kantishna	Scaup sp., Black Scoter, Long-tailed Duck, Horned Grebe, Lesser Yellowlegs, and Gray-cheeked Thrush

Summary of the most commonly detected species on the bird species of conservation concern project, 2009 to 2013.

Denali scientists are using data collected by this project to help assess changes in bird presence and distribution over time. This project is also helping naturalists and rangers provide park visitors with current information about contemporary conservation issues of Denali's birds. This project will continue in 2014.

Citizen-based Bird Counts in the Local Area: Christmas Bird Count

The Christmas Bird Count (CBC) is the longest running Citizen Science project in the world. Beginning on Christmas Day 1900, ornithologist Frank Chapman, an early officer in the then budding Audubon Society, proposed a new holiday tradition - a "Christmas Bird Census" - that would count birds in the holidays rather than hunt them. Since then, the CBC has been conducted as an early-winter bird count, where thousands of volunteers across the US, Canada and 19 countries in the Western Hemisphere, go out over a 24-hour period to count birds through a designated 15-mile (24-km) diameter circle, counting every bird they see or hear all day. The results of their efforts are compiled into the longest running database in ornithology, representing over a century of unbroken data on trends of early-winter bird populations across the Americas. When CBC data are combined with data from other surveys such as the North American Breeding Bird Survey, scientists begin to see a clearer picture of how the continent's bird populations have changed in time and space over the past hundred years.

The Denali CBC was originally started in 1966 but was only conducted for three years. Local naturalist Nan Eagleson restarted the Denali CBC and has organized and compiled the results of count since 1992. Local birder Jill Boelsma started the Cantwell CBC in 2008 and continues to organize and compile the results of the count. To see results of the Christmas Bird Count, visit this web site: http://birds.audubon.org/christmas-bird-count

Summary of the Cantwell CBC in 2013

Date	12/22/2013
Participants	5
Party Hours	11
# Species Detected	14
Temperature Range	6 to 18 °F
Morning Weather	cloudy with light snow
Afternoon Weather	cloudy with light snow
Species Detected	Ptarmigan spp., Downy Woodpecker, American Three-toed Woodpecker, Gray Jay, Black-billed Magpie, Common Raven, Black-capped Chickadee, Boreal Chickadee, Red-breasted Nuthatch, American Dipper, Pine Grosbeak, White-winged Crossbill, Common Redpoll and Pine Siskin.
Most Frequently Detected Species	Ptarmigan spp., Pine Grosbeak

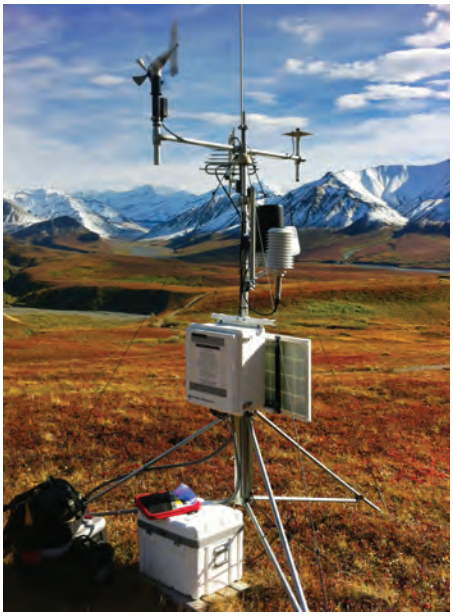
Physical Resources

Parkwide Climate Monitoring

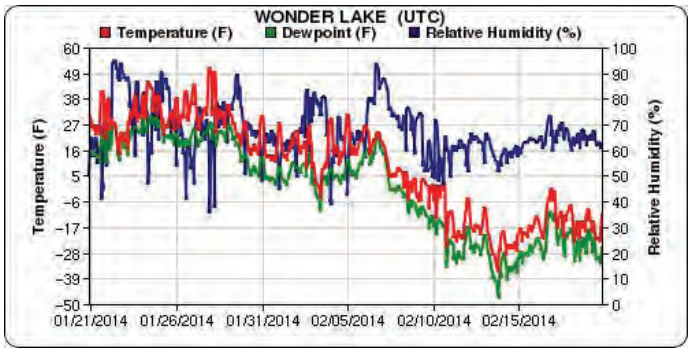
by Pam Sousanes, pam sousanes@nps.gov

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.

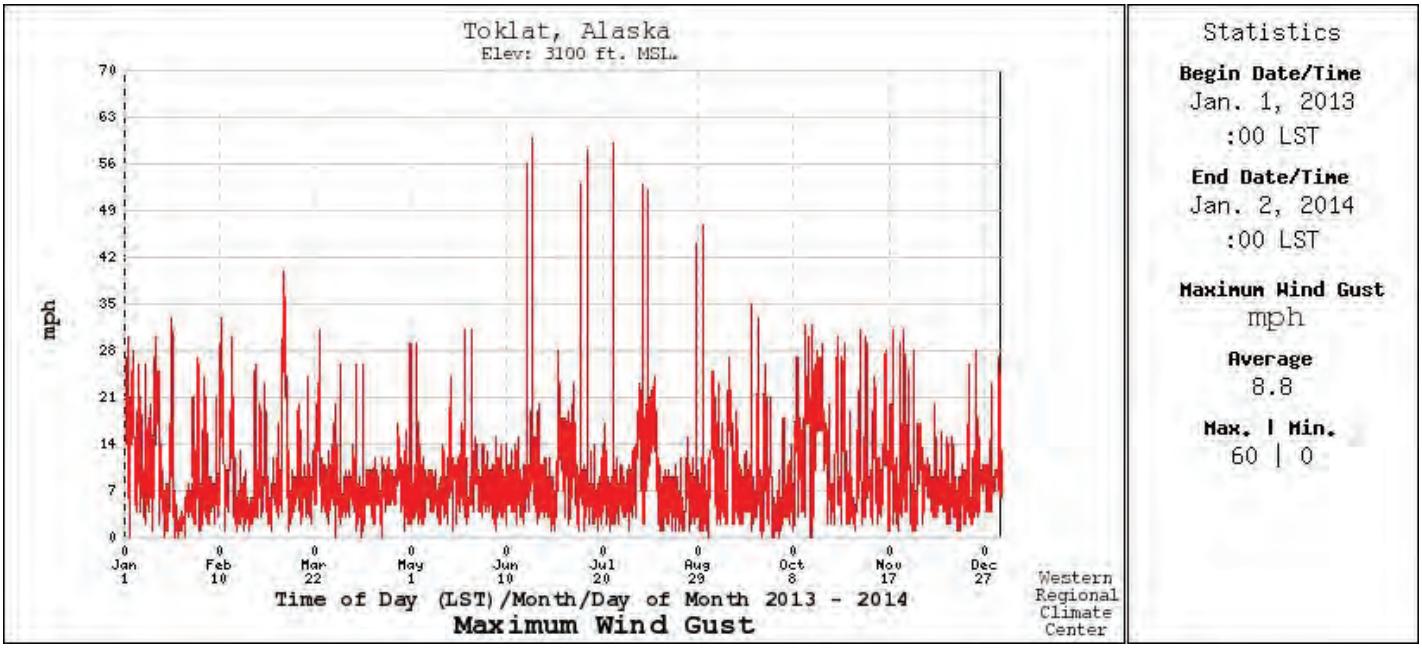


Climate station at Eielson Visitor Center



Wonder Lake data from the Mesowest website

Maximum wind gusts at Toklat for 2013 from WRCC



Weather Monitoring at Park Headquarters

by Pam Sousanes, pam sousanes@nps.gov

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.

2013 Weather Summary: It was a very interesting year for weather. The average annual air temperature of 27.8° F was right at normal. The total precipitation for the year was 14.7 inches, which is only 0.3 inches below normal. According to the annual statistics 2013 was a normal year, except that it wasn't average and it was full of extremes.

The temperatures started out above normal in January and February, but fell below normal for most of the spring. April ended up being the coldest April on record and the melt out date for the winter snowpack on May 25 was one of the latest spring melt outs on record as the snow continued to fall throughout May. There was a dramatic change in temperatures during the last week of May and the long cold spring was over, the cold spring was followed by the second warmest June on record and a very warm and dry summer overall. September was cool and wet, but was followed by the third warmest October on record. November was relatively warm and snowy; it was the seventh wettest November on record. In December the temperature and moisture pattern changed again and the year ended up on the cool and dry side.

In the next column are summaries of the 2013 climate data for temperature and precipitation collected at Park Headquarters. On the next page, temperature and precipitation are compared with the 1981-2010 normal period.

2013

Temperature

- Maximum temperature 88° F recorded on June 26
- Minimum temperature -36°F on January 28
- Mean annual air temperature 27.8°F (1981-2010 normal is 27.8°F)

Precipitation

- Total Precipitation 14.73 inches
- Departure from Normal -0.33 inches
- Max. 24 hr precipitation 0.72 inches on Oct 29
- Total Snowfall 79.9 in. (7/1 to 6/30)
- Departure from normal -3.2 inches
- Maximum 24 hr snowfall 7.8 inches on April 25

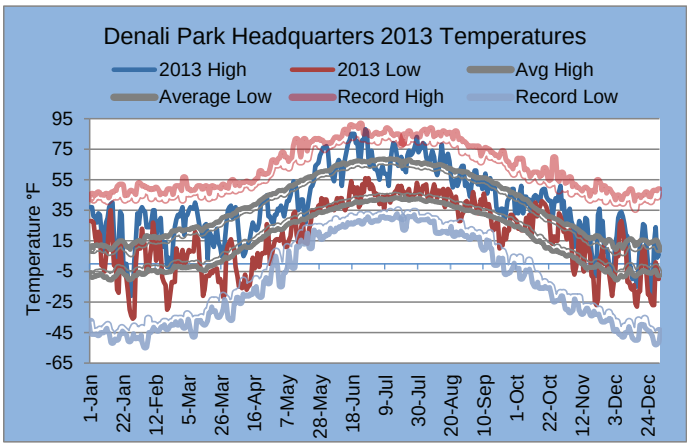
2013 Denali Headquarters Average Monthly *Temperature*

	2013	1981-2010 Average
January	9.7	3.1
February	11.8	7.6
March	11.1	13.4
April	13.6	27.9
May	36.0	42.8
June	57.8	52.8
July	56.2	55.6
August	53.4	50.6
September	38.5	40.4
October	34.7	22.9
November	10.3	8.9
December	1.0	6.9
Yearly Average	**27.8**	**27.8**

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

2013 Denali Headquarters Average Monthly *Precipitation*		
	2013	1981-2010 Average
January	0.60	0.60
February	0.35	0.54
March	0.97	0.39
April	0.82	0.40
May	0.33	0.87
June	0.79	2.15
July	1.91	3.22
August	2.57	2.71
September	2.15	1.70
October	1.79	0.78
November	2.03	0.75
December	0.42	0.92
Yearly Total	**14.73**	**15.06**

Blue shading = wetter than normal; tan shading = drier than normal



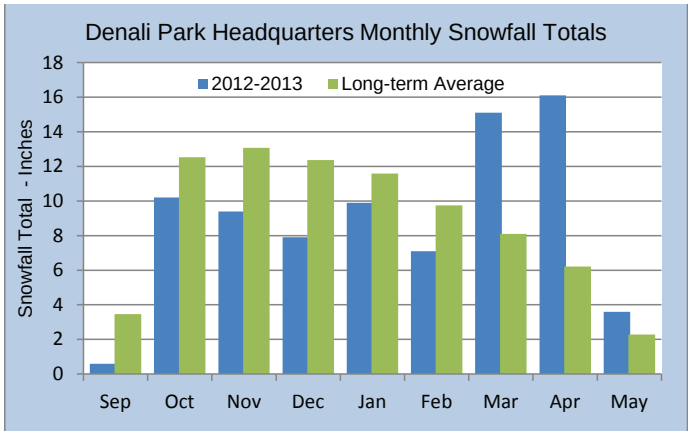
Snow Surveys

by Pam Sousanes, pam_sousanes@nps.gov

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 2012-2013, 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 2012-2013 season:

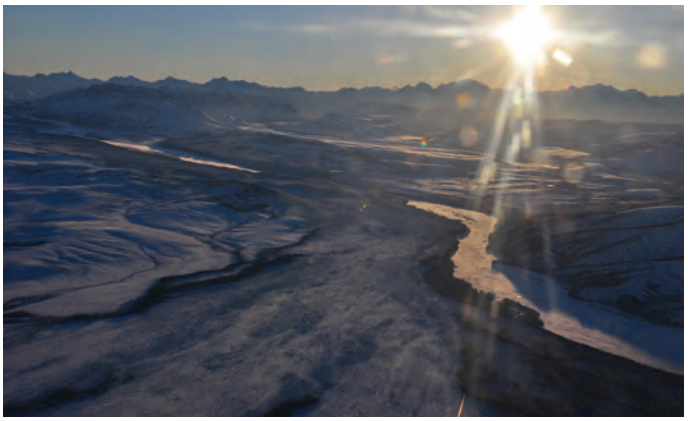
The first persistent snow came in mid-October as expected. A total of 10.2 inches of snow fell during the month at park headquarters, which is just above normal. November and December were cold, and total snowfall was below normal. On December 1, there was 7 inches of snow at park headquarters,



the long term average is 10 inches. Out in Kantishna there was 9 inches of snow for the December 1 survey. By January 1st a total of 28.1 inches of snow had fallen at park headquarters, normally 45.4 inches would have fallen during the early season.

By February 1 the snowpack in the western portion of the park was just about normal; Kantishna had 20 inches of snow with a water equivalent of 3.5 inches. At park headquarters 7.1 inches of snow fell during the month of February, which is 1.3 inches less snowfall than normal for February and about 65% of normal water content. Bad weather hampered the snow survey flights to the south side of the Alaska Range for January and February, but the automated site at Tokositna Valley continued to run through the season providing a glimpse of the conditions on the south side of the Alaska Range. On the first of February, there was 38 inches of snow with 8.6 inches of water content, which was just about normal.

The snow conditions on March 1st were just about normal for the south side markers with snow



Lake Minchumina snow survey flight (upper photo, year unknown) and Toklat River during December snow survey (lower photo, year unknown)

depths ranging from 49 to 72 inches, and water contents between 96 and 125% of normal. At park headquarters it finally started snowing in March. The total snowfall for March was 15.1 inches, which is 220% of normal. April was also snowy with 16.1 inches falling for the month, normal is 5.9 inches. Normally in April, the snowpack starts to decrease with increasing temperatures; this year it continued to increase through April and the beginning of May. For the last snow survey of the season (on May 1st) the snow depths were more like March measurements. Kantishna still had 30 inches of snow on the ground (normal is 9 inches), and park headquarters had 24 inches of snow (normal is 14).

The Kantishna SNOTEL site recorded 6.7 inches of total winter precipitation (snow water equivalent) from October 1, 2012 through May 1, 2013, which is 108% of average. The total annual precipitation for the site was 20.0 inches; normal is 20.7 inches. The winter snow accounted for 34% of the total annual precipitation. Snow-on date was October 8, 2012 and the snow-off date was May 26, 2013. The precipitation gage at Tokositna Valley recorded 19.0 inches of precipitation from October 1, 2012 through May 1, 2013. This is 39% of the total annual precipitation of 48.6 inches for the 2013 water year. Thanks to the late season snow, the park headquarters site ended up with a total of 79.9 inches for the snow season, which is about 104% of normal. Snow on date was October 15 and the melt-out date was May 26, 2013, the second latest on record.

Air Quality Monitoring

by Andrea Blakesley, andrea_blakesley@nps.gov

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/.

Visibility Webcam

by Andrea Blakesley, andrea_blakesley@nps.gov

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.

Mercury Monitoring

by Andrea Blakesley, andrea_blakesley@nps.gov

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).

Sampling dragonfly larvae

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 contained relatively low amounts of mercury in comparison to most other parks sampled that year. This project will continue in 2014.

2013 Igloo Debris Slide

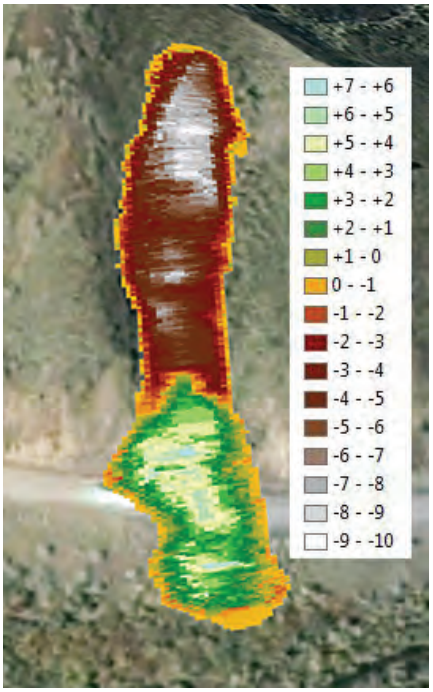
by Denny Capps, denny_capps@nps.gov

On October 23rd, road maintenance staff discovered that a 600'-long, 110'-wide debris slide had blocked the park road near Mile 38.

Igloo Creek Debris Slide looking east to west across the park road. Note two staff members collecting measurements near the upper left corner of the slide for scale.

Blocks of permafrost-frozen, unconsolidated debris as thick as 15' and the size of a small cabin had slid on a slippery, unfrozen clay that acted as the failure plane. With winter snows held off by unseasonably warm weather, the Denali road crew managed to clear the road of debris after considerable effort.

The trigger for the slide remains unknown. Ground, aerial, and satellite imagery of the site in the years and months before to the event indicate that a small slide had previously occurred here, groundwater seeped from the area, and the ground was beginning to move slightly (see additional imagery at http://www.nps.gov/dena/naturescience/landslides.htm).



Approximate ground surface elevation change caused by Igloo Debris Slide in meters based on GPS measurements.

In the days preceding discovery of the slide, the area was experiencing temperatures that fluctuated near the freezing point. Therefore, the forces associated with the expansion of ice during the repeated freezing and thawing of water near the surface may have triggered the slide. Alternatively, we also know that a thick layer of permafrost slid on an unfrozen layer of clay.

GeoCorps geologist Amy Atwater sizes up one large block of permafrost-frozen debris while standing on the slippery failure plane of clay.

Regionally, permafrost is thawing; while the local trend is presently unknown, thaw in the area would be consistent with regional trends. Therefore, it is possible that the permafrost thinned through the clay layer, which triggered the slide. Many other triggers are also possible and are being examined.

The exact timing of the slide also remains under investigation. The last confirmed passage through the area before discovery of the slide occurred on October 12. The Alaska Earthquake Information Center also attempted to determine the timing of the slide; however, due to its relatively small size and apparent slow movement, it is possible that the slide did not create a distinctive seismic signal like larger, faster events.

The future hazard to the Denali Park Road to debris slides and other mass movements is under active investigation. During periods of warmer temperatures and high rainfall, when the ground thaws and the debris becomes saturated, additional activity at the Igloo Debris Slide can be expected. A ditch to capture these materials has been excavated. If deemed necessary, Denali National Park staff will institute additional protective measures with the assistance of the Federal Highways Administration, NPS Geologic Resources Division, and the Alaska Department of Transportation. Denali staff has already begun the process of analyzing other sections of the Park Road for similar problems so that potential hazards can be mitigated.

Paleontological Survey of the Cantwell Formation

by Denny Capps, Amy Atwater, and Montana Hodges
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A student on a field trip found the first dinosaur track in the park in 2005. Since then, several thousand tracks of many different types of dinosaurs have been found in the (lower) Cantwell formation, a late-Cretaceous sedimentary unit consisting of shale, sandstone, and conglomerate. Recent radiometric dating of tephras (volcanic ash) in the Cantwell formation indicates that the rocks are approximately 70 million years old. In addition to tracks, the Cantwell formation also preserves many forms of plant and invertebrate trace fossils.

Paleontological Survey

The 2013 season resulted in exciting new discoveries and focused on three main topics: 1) paleontological resources inventory in the field as in past years, 2) development of dinosaur track site prediction model, and 3) development of a paleontology management and monitoring report.

Most work was conducted by two GeoCorps America interns, Montana Hodges and Amy Atwater, with additional work and supervision provided by Physical Science Technicians, Maisie Richards and Nadine Reitman, and Park Geologist, Denny Capps.

Park, museum, and university staff (including Interpretation staff member Dan Leifheit, and paleontologist Dr. Tony Fiorillo) hiked many kilometers searching for and documenting fossils within the Cantwell Formation. New explorations were conducted in several areas of the park. The team added 30 new localities to our paleontology database, which now contains 235 sites and over 480 specimens. These specimens included a new dinosaur genus for Denali - *Edmontonia*, an armored, herbivorous dinosaur (see track in photo below). Other exciting finds included many new tracks of *Magnoavipes denaliensis*, a large wading bird thus far only found in Denali, and of therizinosaur, a four-toed, herbivorous theropod dinosaur. The only known tracks of therizinosaur in the state are located here in Denali.

Edmontonia (armored, herbivorous dinosaur) track found in Cantwell Formation in 2013 by Dan Leifheit from the Interpretation Division.

Amy Atwater utilized the above paleontology database to create a prediction model for fossil sites within the Cantwell Formation using a suitability analysis. The area that contains the dinosaur fossils is both large and difficult to access. This creates a need for a technique to assess the likelihood of finding fossils in a given area before sending researchers into the field. Fossil locality discovery has traditionally resulted from guesswork and from extensive field surveys. The recent increase in the availability of remotely-sensed imagery, utility of geographic information systems (GIS), and expansion of the park's paleontological database enabled us to address the challenge of fossil site identification within Denali. Geospatial factors that are regarded as useful for finding fossils within the Cantwell Formation were analyzed and ranked on a scale from 1 to 4, with 4 representing the best score. We identified the 4 most significant geospatial factors in fossil sites within the Cantwell Formation to be vegetation coverage, slope, aspect and proximity to landslides. These different factors were then weighted and used to create a suitability layer for the Cantwell Formation. Initial field testing indicates that the model accurately predicts fossil sites, though defining areas of high, medium, and low site density requires additional testing and data collecting by future GeoCorps participants. Continued field testing will allow us to refine the model. This suitability analysis will save government resources and reduce the exposure of researchers to the many hazards associated with the Denali backcountry.

Montana Hodges' paleontology management and monitoring report established protocols for long-term monitoring of natural and anthropogenic impacts to fossils to maximize paleontological study. Management of the fossils for both research and public interest represents a unique case study due to the access restrictions and wilderness philosophies of the park. Human threats to the resource include damage by touch, vandalism, and removal of the loose casts. Natural erosion also threatens the fossils, specifically freeze-thaw cracking and shatter. Denali National Park's mission is directed toward

wilderness preservation not collection of resources. This project created analytic methods and models for the annual monitoring of conditions at fossil sites. The analysis and results of this report provide new information useful for maintenance of current infrastructure and planning for future discoveries of fossil resources on federally protected land, particularly within the park system. The report presented an analysis of effective management plans for specific human-related resource issues and impacts. Emphasis was given to science-based information for use by the park staff to quantify both public interest and paleontological value.

Toklat River Dynamics and Gravel Acquisition

by Denny Capps, denny_capps@nps.gov

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. This method allows for minimum impact on the river system while providing a long-term, sustainable gravel yield. Harvesting gravel locally minimizes traffic on the park road, use of fossil fuels, and the potential for introducing invasive plants from external gravel sources.

Every year the park monitors natural and human-induced floodplain changes and a new two-year study with university partners will begin in 2014. Park staff plan to implement new monitoring equipment at the site such as a stage (river level) gauges and a time-lapse camera. The university study will utilize emerging technologies such as terrestrial LiDAR to carefully map changes in the elevation and form of the Toklat floodplain before and after the gravel excavations.

Precision Elevation Change Detection

by Denny Capps and Nadine Reitman
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Changes in the land surface through time are caused by landslides, thermokarst, glaciers, park infrastructure, and many other physical, biological, and anthropogenic processes. For example, a landslide in 2013 blocked the Denali Park Road, thermokarst features (e.g. lakes and slumps created by permafrost thaw) are developing on the north side of the park, most glaciers are shrinking, and new facilities and trails are being built. Historically, these changes were detected using either less efficient methods such as extensive fieldwork or more expensive techniques such as LiDAR.

These technologies required extensive resources and were often slow to deploy. However, new technology promises to allow Denali faster, more comprehensive images at relatively low costs. The most promising new technology is called Structure from Motion (SfM). SfM software and techniques have the ability to detect and quantify even small horizontal and vertical changes (few inches or cm) in the land surface through time. It does this by creating three-dimensional scenes or models of an object or landscape from many photos taken using a normal digital camera. It is useful for combining photos taken from the ground or air and generating a digital elevation model (DEM) of a particular area.

Combined with locational data from a GPS, SfM scenes can be tied into a precise location, allowing repeat photography and monitoring. Denali National Park and Preserve began implementation of SfM in 2013 and plans to instigate the first full program in the NPS in 2014. It will be used for monitoring slope stability and predicting landslides along the park road, tracking thermokarst development and therefore permafrost thaw, glacier change, infrastructure development or reclamation, and many other processes. Therefore, the public and park will benefit—public safety will be improved because of the enhanced ability of park science staff to identify hazards; increased knowledge of the landscape will assist with innumerable science projects and maintenance of infrastructure; and many existing studies that require either extensive fieldwork, periodic LiDAR, or other surveys will now be conducted with this technique, which will result in substantial economic savings.

Glaciers

by Rob Burrows, rob_burrows@nps.gov

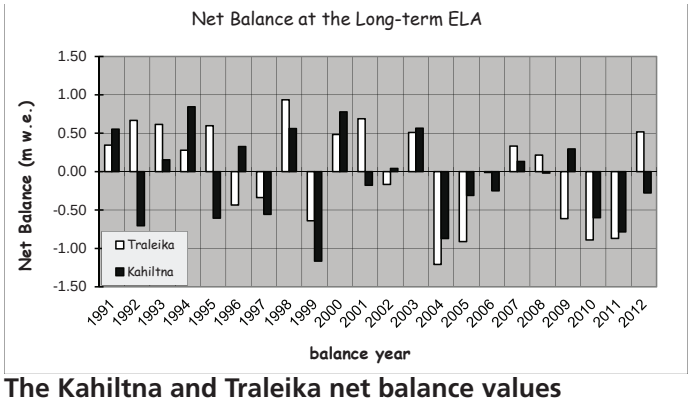
Glaciers are the enigmatic sculptors of the mountains. They are a sensitive indicator and powerful symbol of climate change. Almost all glaciers across the globe are thinning and retreating in unison from the warming climate. Denali's glaciers are no exception, however the highest elevation glaciers 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.

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 habitat. 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, as well as work by outside researchers.

Index Site Monitoring

In 2013 the Kahiltna and Traleika glaciers were monitored for mass balance at index sites for the 22nd year.

- Thanks to the assistance of Denali backcountry rangers in fall 2012 and 2013, the Traleika index stake was accessed on foot for the second year in a row of the monitoring program
- The Traleika glacier as a whole had a neutral to slightly positive balance year in 2012. This year represents a hiatus from the negative trend the glacier has experienced since 2004.
  - Snowfall/winter balance was 115% of average
  - Melt/summer balance was 63% of average
- The Kahiltna Glacier as a whole had a neutral to slightly negative balance year. This adds to the negative trend on this glacier since 2004.
  - Snowfall/winter balance was 71% of average
  - Melt/summer balance was 85% of average



The Kahiltna and Traleika net balance values

Glacier Photo Panoramas

For virtual exploration of some of Denali's glaciers check out these 360 degree panoramas: http://www.nps.gov/dena/photosmultimedia/vr-panos.htm

Glacier Fact Sheets

There are two Fact Sheets available for Denali Glaciers. Check out the digital versions:

Glacier Monitoring: www.nps.gov/dena/naturescience/upload/GlacierMonitoring2012.pdf

A NEW Fact Sheet for Kids about Glaciers: www.nps.gov/dena/naturescience/upload/Glaciers_Kids_2014.pdf

Glacier Citizen Science:
The West Fork Toklat glacier was surveyed with a citizen science seminar in conjunction with the MSLC in August 2013. Six participants helped complete a GPS survey of the terminus last done in 2002 and of surface elevation of the lower glacier last done in 2002. The expedition will strike out once again August 7-11, 2014.
See: http://www.alaskageographic.org/static/1174/glaciology-backcountry-citizen-science

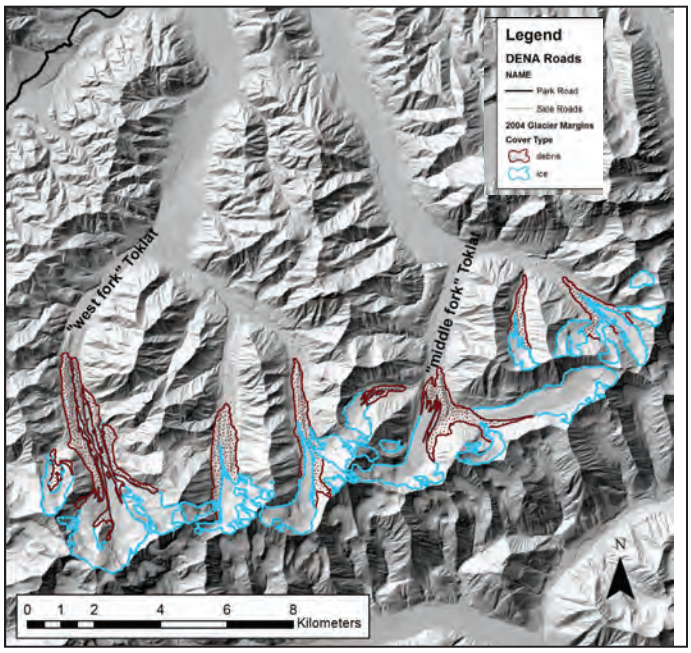
The glacier field workshop

Glacier Inventory
With funding from the NPS, researchers from University of Alaska Fairbanks and Alaska Pacific University have completed an inventory of all glaciers in Denali from 2010 satellite imagery. In addition they have compiled surface elevation change data from select glaciers. The changes in ice volume calculated from repeat airplane borne laser altimetry surveys reveal the following results:

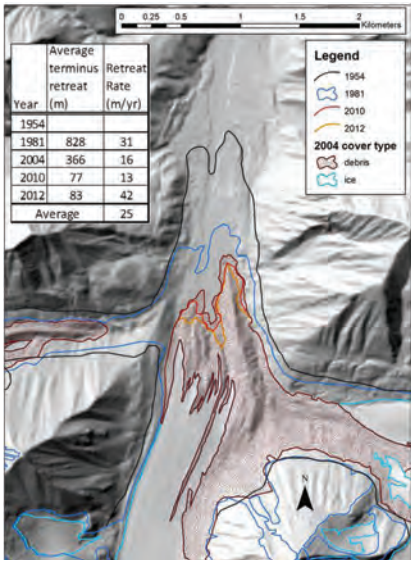
- The area of Denali glaciers decreased by 8 percent between 1952 and 2010, with most of this loss occurring on small to medium size glaciers at mid elevations (1400-1800 meters elevation). A few glaciers increased in area, but this was due to surging, most notably Muldrow and Peters glaciers.

- Of the glaciers measured by repeat laser altimetry in Denali, two had positive glacier-wide mass balance rates for some portion of the measured 1994-2010 period Muldrow had an overall negative mass balance rate.

- All other glaciers and intervals in Denali had negative mass balance rates (overall thinning) ranging from -0.7 to -2.2 m water equivalent per year. The lowest measured balance rate was on Middle Fork Toklat Glacier from 2008-2010. Kahiltna and middle fork Toklat thinning rates appear to have increased during the 2008 to 2010 period. Results from GPS surveys conducted during the citizen science courses indicate continued ice loss in middle fork and west fork Toklat Glaciers between 2010 and 2013.



Toklat Glaciers (above) and ampped glacier terminus and retreat rates for Middle Fork Toklat (below)



Year	Average terminus retreat (m)	Retreat Rate (m/yr)
1954		
1981	828	31
2004	366	16
2010	77	13
2012	83	42
Average		25

Research
This year researchers from several universities will continue their project to better understand the climate of the last 1,000 years in the Alaska Range. Last year they successfully drilled two ice cores that are just over 200 meters long (deep) on the Mt. Hunter summit plateau and installed a weather station there. This year they will maintain the weather station; in 2015, they hope to date moraines of some of the large glaciers to the south of the Alaska Range crest such as the Kahiltna.

For a teacher's eye view of part of the 2013 expedition see this PolarTrec blog: http://www.polartrec.com/expeditions/reconstructing-the-past-climate-of-central-alaska

Restoration at Eldorado Creek

by Dave Schirokauer
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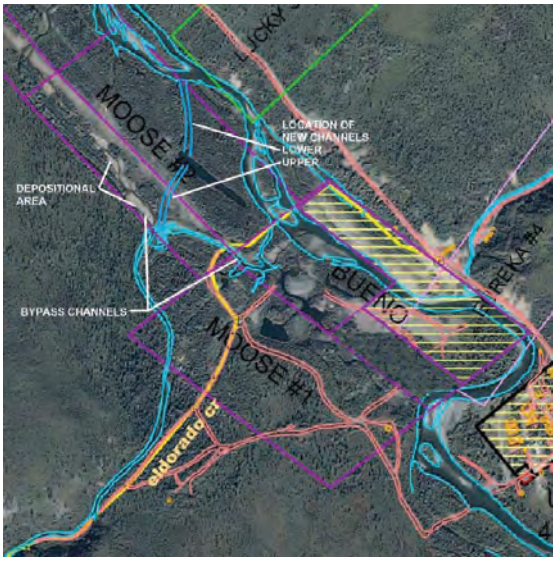
Eldorado Creek is being returned to its natural channel. The park will initiate restoration of 750 feet of critical riparian and aquatic habitat on lower Eldorado Creek in Kantishna. The design goals include the creation and protection of aquatic habitat, as well as protection of private properties in the floodplain downstream from the project reach. The work also serves to progress wetlands mitigation agreements required under the Clean Water Act. The work is funded by mitigation money from the projects to replace the Rock Creek Bridge and to stabilize the slopes at the Sanctuary Saddle and at MP 4.5.

During the mining era Eldorado Creek was diverted to facility mining operations in the Moose and Eldorado Creeks floodplain. Bypass channels were constructed that have been in place since the last 1970's. This project will reclaim the original channels of Eldorado Creek and fill the bypass channels with native vegetation. Project layout will occur in July and dirt work will begin on August 1 after the migratory bird nesting season. It will take several years of succession for the stream and adjacent riparian habitat to fully resume natural ecological functions which will be closely monitored.



Permafrost

by Dave Schirokauer
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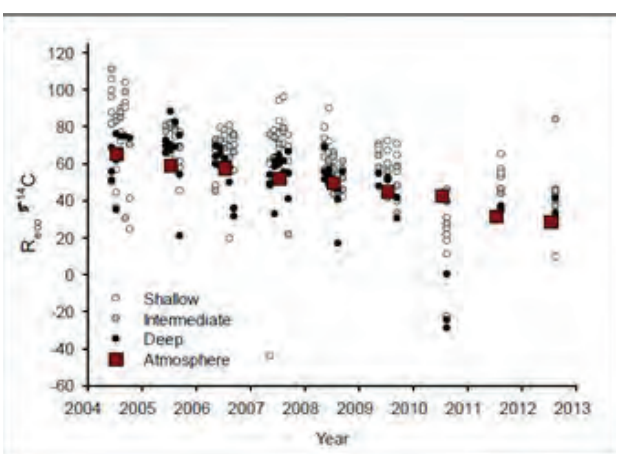
Denali lies near the southern limit of permafrost, or ground that remains frozen for 2 or more years. If the region's climate warms over the next several decades as predicted by global circulation models, permafrost controlled landscapes in Denali will change significantly. Changes in the size, shape, and juxtaposition of permafrost patches is going to be an increasingly important driver of changes in landscape patterns of vegetation, wetlands, wildlife habitat, fire regime, and water quality. The Central Alaska Inventory and Monitoring Network, academic researchers, and Denali staff are testing and implementing a multi-scale permafrost

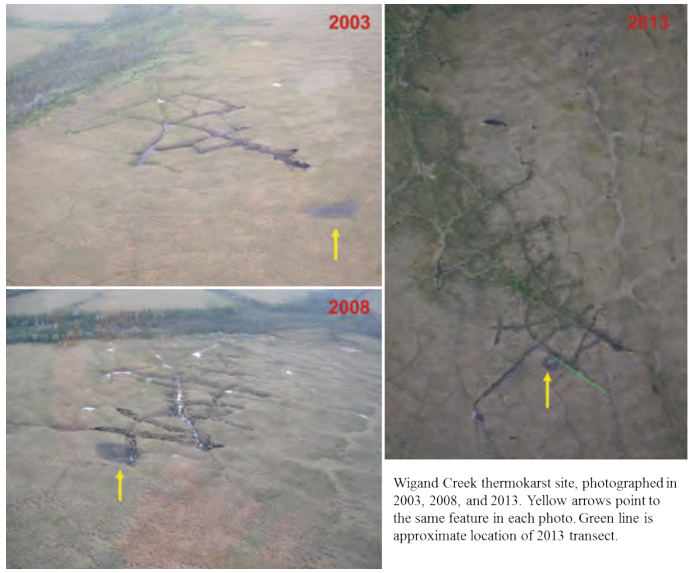
monitoring program, which will focus portions of the Denali, Yukon-Charley Rivers National Preserve, and Wrangell-St. Elias National Park and Preserve.

At the finest scale, index monitoring sites (areas with interesting and rapidly changes permafrost features) will be identified, characterized, and revisited every 5-10 years. In August of 2013, science staff revisited the Wigand Creek thermokarst and documented significant thermokarst expansion (see photos at right). Boreholes designed for temperature profile measurements are located near Denali (at Eight Mile Lake) and near the other two parks. These are monitored annually. At broader scales, satellite imagery is being used to detect changes in permafrost at decadal time scales.

The emission of sequestered carbon from thawing permafrost into the atmosphere and into aquatic systems has been monitored at the research site at Eight Mile Lake since 2004. As the processes of chemical and physical carbon release from thawing permafrost are better understood, results will be applied through models to broader landscapes and global atmospheric CO_2 projections. It has been hypothesized that thawing permafrost will be a significant contributor to atmospheric CO_2 over the next century.

Radiocarbon is measured in ecosystem respiration (CO_2) periodically during the growing season across the permafrost thaw gradient. Data are grouped here in three bins according to the active layer depth of each particular respiration sampling location. Radiocarbon of the atmosphere is shown as a reference; it is currently declining as radiocarbon-

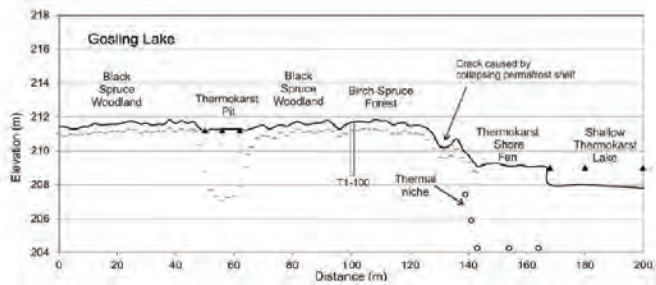




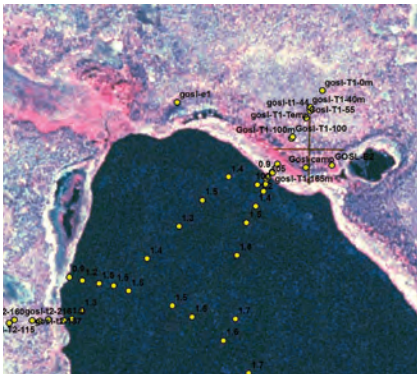
Wigand Creek thermokarst site, photographed in 2003, 2008, and 2013. Yellow arrows point to the same feature in each photo. Green line is approximate location of 2013 transect.

free fossil fuel carbon is accumulating in the atmosphere. Respiration radiocarbon values below the atmosphere show the strong imprint of old carbon that has negative radiocarbon values. Consult the paper by Schuur and Bracho 2013 for more info.

In August 2014, we plan to re-start permafrost monitoring at Gosling Lake in the remote northwest portions of the park. This permafrost-controlled lake is an ideal location to study coupled permafrost - lake dynamics. The transects on the aerial image were established in 2005 and will be repeated in 2014.



Gosling Lake transects



Long-term Stream Monitoring

by Trey Simmons, trey_simmons@nps.gov

Ecologist Trey Simmons began collecting data from Denali streams in 2007 as part of the Central Alaska Network (CAKN) long-term stream monitoring program. The CAKN program collects a variety of types of information about streams and rivers in all three network parks (Denali, Wrangell-St. Elias National Park and Preserve and Yukon-Charley Rivers National Preserve), including data about fish, aquatic insects, diatoms, water chemistry, temperature, stream flow and habitat. This information will be used to detect and quantify changes in the condition of Denali's stream and river ecosystems as they respond to climate warming or other human-caused impacts.

Aquatic insects and diatoms are especially useful in helping to assess the status of stream ecosystems. Although fish are the most obvious organisms in some streams because of their size, aquatic insects are ubiquitous, occur at high densities, are diverse (20-40 species in most streams) and play a variety of critical roles in the ecosystem. Because they also tend to be sensitive to environmental conditions (things like water temperature, pH, nutrients, channel stability, and streamflow patterns), aquatic insects can be extremely valuable as biological indicators of ecosystem condition and water quality. This is important, because we can't always measure easily the many ways in which the physical and chemical aspects of streams are changing. Diatoms, a type of algae, are also important biological indicators for streams. Not only do they represent the base of the food chain, but they are also present in very high densities, exhibit remarkable diversity (30-50 species in most streams), and are also sensitive to changing environmental conditions.

We know that fish are important to park ecosystems, both aquatic and terrestrial, but collecting data about the distribution of fish is time consuming and expensive. Working with scientists at the U.S. Geological Survey, Simmons is developing methods to use DNA to detect the presence of fish species in streams and lakes. So-called "environmental DNA" can be isolated from water samples, and using modern technology, it is possible to use this DNA to identify the species that are present in the lake or stream from which the sample was collected. This approach will make it straightforward and inexpensive to collect extensive data on the distribution of fish species in Denali.

Simmons is also using small inexpensive data recorders to continuously monitor the temperature of streams and rivers along the park road. Increased water temperatures are one predicted effect of global warming on Denali's streams, although streams that are influenced by glacial runoff may paradoxically get colder in the short run due to increased glacial melting.

Another predicted effect of global warming is the change in stream and river flow patterns; this type of change could have dramatic effects on both aquatic and terrestrial habitats and the wildlife that depend on them. Although collecting continuous quantitative data about flow using stream gages is too expensive to implement in Denali, we can get a pretty good idea about how stream and river flows are changing from day-to-day and from year-to-year by using inexpensive time-lapse cameras. These cameras, which record a picture of river conditions several times a day year round, will also provide information about possible changes in the timing of river ice breakup and freezeup, and, if approved, will be installed on bridges along the park road this spring and summer.

Since 2006, 52 streams and rivers in Denali have been sampled, mostly on the north side of the Alaska Range near the park road. Ten of these sites are being sampled every year, which increases our ability to detect changes in their condition, and a number of others are sampled once every 2 to 3 years. However, because these "sentinel" sites were not selected randomly, they can't be used to tell us what's going on in other areas of Denali. Therefore, 60 other randomly-selected sites in the park are also being sampled as part of the monitoring program. Data collected at these sites will help provide inference to the condition of stream ecosystems across the entire park. However, because most of these random sites are very remote and require the use of helicopters,

they are very expensive to sample, and so only a few are visited each year. Because of this limitation, these remote sites will only be sampled about once every 10 years.

Combining information gathered at the two types of sites will maximize our ability to accurately monitor changing conditions in all of Denali's streams. In 2014, Simmons will be collecting data from streams all along the park road, from Rock Creek near park headquarters to Moose Creek in Kantishna, as well as visiting some remote sites on the south side of the Alaska Range and in the far western part of the park.

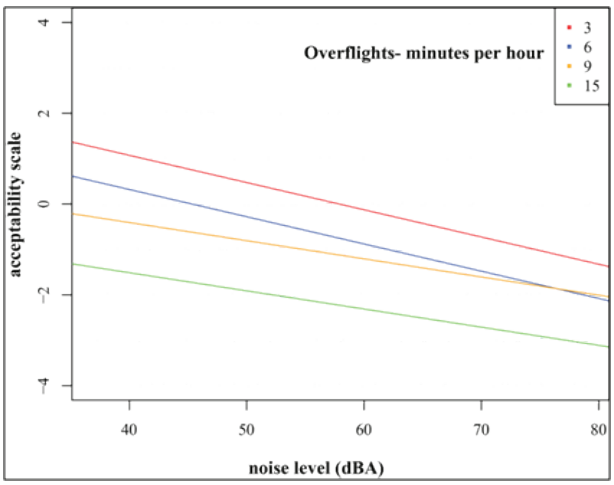
Trey Simmons samples the East Fork Toklat River

Visitor Characteristics and Social Science

Social Norms about Soundscapes

by Dave Schirokauer
dave_schirokauer@nps.gov

Understudying Denali unique natural soundscapes and how this resource contributes to positive visitor experiences has been the subject of a multi-year social science investigation. Park visitors were queried on the McKinley Bar Trail, Triple Lakes Trail, at the Backcountry Information Center and in Talkeetna. Investigators have learned a lot about how natural soundscape and motorized noise contribute to the visitor experience in Denali's backcountry. This will be the topic of an upcoming journal publication: *Denali National Park and Preserve visitor perceptions of aircraft sounds: Innovative methodologies for informing soundscape management*.



Predicted acceptability models by number of overflights (3, 6, 9 or 15 minutes per hour). Solid lines represent the predicted relationship between acceptability (on a scale from -4, very unacceptable, to +4, very acceptable) and noise level based on data from Denali National Park and Preserve visitors.

Monitoring Resource Conditions and Visitor Use Levels at Backside Lake

by Dave Schirokauer
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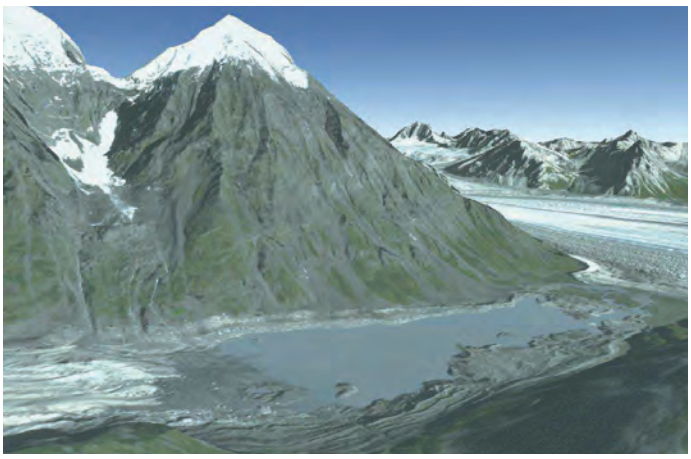
Backside Lake is an alpine lake, located in the park at approximately 2,600' in elevation on the south side of the Alaska Range, west of the Ruth Glacier and south of Mount Church. Currently, Backside is the only lake within the park that is being utilized for commercial float plane landings. Commercial landings are authorized there through the authority of Type III Concession Contracts and Alpine Adventures (AAA) is offering guided day hiking and guided overnight hiking in the Backside Lake area.

This season Denali staff will be monitoring resource conditions and visitor use levels at Backside Lake in accordance with the park's Backcountry Management Plan and the indicators and standards prescribed for this area. Plans for Backside Lake include social trail monitoring, time-lapse cameras to monitor use patterns, and acoustic data collection.



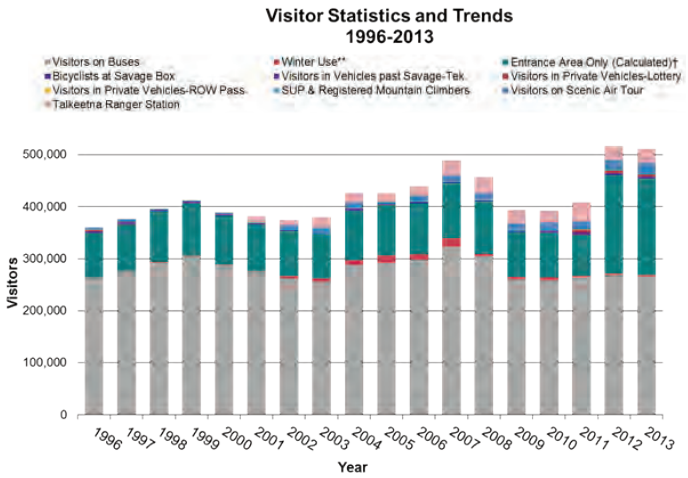
Backside Lake

Park Visitation

Britta Schroeder, britta_schroeder@nps.gov

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 visit in only the Entrance Area. When the new formula was applied, there was a

jump in visits with 516,906 in 2012 and 510,521 in 2013. Visitation to the park continues to be on the upward trend as recreation economies recover from the 2008 regression. Bicyclists and winter use has seen a reasonably large increase in recent years, while bus visits hold steady since about 2009. 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

Britta Schroeder, britta_schroeder@nps.gov

Currently, visitors entering the Denali Visitor Center are counted by hand by Park staff, who are often consumed with multiple other duties during this time. Automating visitor counts allows park staff to dedicate their full attention to visitor questions and safety. During the summer of 2013, automated counters were installed 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 (July 25-September 12) as well as calculate the average hourly and daily visitors. The automated counts were compared to counts done by DVC front desk employees to establish a relationship which estimated the data previous to the sampling period (May 15-July24).

To assess the accuracy of the automated counters, random samples of hours were selected for calibration. Calibration consisted of counting the visitors with hand counters and then comparing hand visitor counts with the automated counts for that same time period. This resulted in a correction factor that was applied to the automated visitor counts to obtain the estimated final visitor counts From July 25 through September 12, total visitor counts came to 101,445, with about 80% of those visitors entering through the front two doors. Given a 95% confidence interval, the mean hourly count was 198 ± 16, while the mean daily count was 1,978 ± 329. Monthly means were not calculated since May, June, and July datasets were incomplete or missing all together.

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. Because the automated counters were not operational until July 25, another regression coefficient was calculated based on the calibrated automated counts compared to the front desk counts. This regression coefficient was used to estimate the automated visitor numbers from May 15 to July 24. Even after calibration and division, automated counters registered over 1.6 times the number of visitors counted by front desk employees.

Data	2013 (July 25-Sept 12)	2013 (Estimate for Entire Summer)
Front doors - hand tally	61,390	142,321
Front doors - automated counts	85,042	194,292*
All doors - automated counts	101,445	230,918*

* estimates from hand counts

Subsistence

by Amy Craver, amy_craver@nps.gov

Federal Subsistence Registration Permits

Denali staff managed the Federal Registration Permits for subsistence hunting of moose and caribou on park lands in Wildlife Management Unit 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.

Subsistence Resource Commission

On October 5, 2013 the Denali Subsistence Resource Commission (SRC) was scheduled to meet in Cantwell at the Cantwell Community Center. Due to the Government shutdown the meeting had to be cancelled. The next SRC meeting is scheduled for August 6, 2014 in Cantwell at the Cantwell Community Center.

Furbearer Study

The Denali Subsistence Advisory Commission has requested that the National Park Service begin a study of furbearer numbers and distribution in the park and preserve, and ground-based track surveys show the greatest promise of collecting meaningful data at a reasonable cost. This project has been funded and will establish a set of standard travel routes, to include historic and current trapline trails and suitable waterways that could be surveyed in winter to obtain an index of furbearer numbers in the ANILCA additions to Denali. In order to increase the usefulness of the data, an NPS statistician will investigate the use of patch occupancy modeling of winter track data. A detailed monitoring protocol will be written, in order to ensure consistent gathering and analysis of winter track data. This project is slated to receive funding in the near future.

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

In partnership with Telida Village Council, this project is documenting the historical use of the land and waters for subsistence, and describe how and where people traveled and what resources were harvested in specific places.The goal of this project will be to complete the ongoing Upper Kuskokwim Place Names Project through a comprehensive interview and research process. This project will interview Elders who possess the knowledge, technology and expertise needed to annotate our place names. Information gathered will be used to further Telida Village's language, historical and cultural preservation and revitalization project.

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

This project seeks to understand why subsistence users utilize park resources, how subsistence users perceive the ecosystems they rely on, their observation of changes brought about with global warming, and the types of information they need to make decisions regarding adaptation to climate change. This study will pave the way for community and Park adaptation planning by providing information about observed changes, perceptions of system function and by identifying indicators that communities are, or would be, interested in monitoring in order to make adaptation planning decisions.

Denali Community Subsistence Ethnography—Cantwell, Telida, Nikolai, and Lake Minchumina

This study uses qualitative and ethnographic analysis to explore what it means to be subsistence user in modern Alaska, what difficulties are faced by present generations, and the ways in which subsistence practices are important to the user. This exploration will yield a broader understanding of the term subsistence while providing a stronger web of discourse between management, subsistence communities, and the public in general.

Updating and Redesigning Subsistence Management Plans for Alaska's National Parks: Denali, Wrangell-St. Elias, and Gates of the Artic

The goal of this project was to develop and implement an improved format/design for park subsistence management plans(easy to update, searchable (electronically), printable, postable on the park's website). SAC members have identified redesigning the park subsistence management plans as a high priority. These plans include valuable information about important issues for subsistence in a given park unit along with a chronology of work on each issue. The goal of this project was to develop and then implement an improved format/design for the park subsistence plans. The redesign was a two stage process. In the first stage, a design template for the revised plans was developed using the Denali material. In the second phase, WRST and GAAR drew upon the DENA template to revise the individual plans for those parks.

Nikolai Fish Wheel Video

In June 2013 elders from Nikolai came together and taught their youth how to build a fishwheel, which is a device Athabaskans have used for centuries to catch fish. Photojournalist intern, Charlotte Bodak documented the Fishwheel project on video, which is posted on the park website.

Moose Surveys

by Pat Owen, pat_owen@nps.gov

Denali received funding by the Subsistence Advisory Council in 2013 to conduct moose surveys in two important subsistence use areas on the south side of the park. Surveys for the Cantwell and Yentna areas were conducted in late early winter 2014.

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 November 11 and 12, 2013. Snow conditions were excellent throughout the survey area. A total of 66 units were surveyed which comprised 395 mi^2 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/mi^2).

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 mi^2 (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

Park Historian Jane Bryant Retires

by Amy Craver, amy_craver@nps.gov

The final day of 2012 heralded the end of an era at Denali, as Jane Bryant shut down her computer and turned off her office light for the last time. She started working for the park in 1976, making her one of the park's longest tenured employees. Her jobs at the park included ranger-naturalist, Superintendent's secretary, payroll clerk, procurement clerk, campground cleaner, and cultural resources technician. She's also driven buses, baked, taught school, and hauled freight with sled dog teams. Her final position as the park's cultural anthropologist allowed her to follow her passion of researching and documenting the history of this park from the gold rush days of Kantishna to the present.

Survey of Ancient Lake Minchumina Shoreline

by Phoebe Gilbert, phoebe_gilbert@nps.gov

This three year project to investigate, map and create a chronology for the relic shorelines of ancient Lake Minchumina, through the identification of archaeological sites and environmental/ geographical features associated with the fossil lakeshore. The study too place in the Northwestern corner of Denali and began in 2011. The study area includes drainages of the Muddy River, Birch Creek, and Foraker River.

Fieldwork for the project took place in 2011 (Phase I) and 2012 (Phase II); project work in 2013 (Phase III of the project) consisted of lab work and writing of the final report.This project has resulted in new data to help understand the cultural resource potential of the northern preserve, as well as a beginning to meet the challenges to map, develop a chronology, and interpret the depositional history for ancient Lake Minchumina.

Geomorphic testing was carried out in the Beaverlog Lakes area, along the Muddy River, at Sevenmile Hill, and at Lake Minchumina. Fossil beach ridges were mapped, a fossil spit identified, and a raised beach with lake sediments was recorded around Lake Minchumina. Geological survey identified significant stratified sediments along the Muddy River in the Beaverlog Lakes area that are associated with the ancient lake. Erosion cut banks with exposed laminated sand deposits were mapped and one erosion face with complex layers of alternating sand, silt, and mud was sampled and tested for pollen. The raised beach deposit at Lake Minchumina was sampled with the same purpose in mind and a radiocarbon date of 34,000 years ago was obtained from the sediment profile. The sediment study from both sites, although incomplete at this time, shows that pollen and diatoms, in various quantities and preservation, are present at both localities. Two Holocene age radiocarbon dates were obtained from a stratified cut bank along the Muddy River.

Two sets of beach ridges were identified and mapped at Lake Minchumina, one set is at the northeast side of the lake and the other is location almost two kilometers across the bay on the northwest side. The beach ridges are correlated and show a larger lake existed that was up to five meters above the modern lake level recorded in 2012. Geologic testing in the Sevenmile Hill area was not completed due to frozen ground, however; low lying linear features in the vicinity were tested and appear to be dunes.

Seven new cultural resource sites were added to the inventory. Prehistoric sites were located west of Beaverlog Lakes (MMK-0183) and at Sevenmile Hill (MMK-0186). A multicomponent, historic and prehistoric, site (MMK-0184) was identified south of Beaverlog Lakes and a historic cabin ruin (MMK-0182) was found at the head of Spencer Creek. Three new archaeological sites (MMK-0179, MMK-0180, and MMK-0181) and the locations of two previously reported sites, MMK-005 (Birches site) and MMK-006, were verified at Lake Minchumina. Radiocarbon dates were obtained on two sites: at MMK-0179 (Carey site), a house pit was dated to circa A.D. 1880 and had an older component dating to A.D. 1000; and another house pit site, MMK-0181, was dated to A.D. 700 was associated with another house site.

Testing at Sevenmile Hill produced prehistoric lithic cultural material in three test pits and helped delineate a new archaeological site, MMK-0186. Additional survey and testing conducted in the Beaverlog Lakes area identified a prehistoric component at MMK-0184 and showed that the associated pit features at the site were not likely produced by natural causes. Archaeological work at MMK-0179, the Carey site, consisted of three 1 x 1m units excavated within the suspected house feature and incorporated the .5 x .5m test pit dug in 2011. The site has both historic and prehistoric components. The upper deposit is a highly mixed matrix with fauna, some fire-broken rock, and historic artifacts. Beneath the historic zone is the floor of a prehistoric house that could be traced horizontally to undisturbed sediment indicating where the house pit was originally constructed. Lithic artifacts of obsidian and chert were associated with the floor, as well as some bone and burned wood fragments. Obsidian artifacts from both Carey-1 and Rock Point were traced to the Batza Téna source off the Koyukuk River.

Section 106 Compliance and Site Condition Assessments

by Phoebe Gilbert, phoebe_gilbert@nps.gov

Four hundred acres were surveyed for archaeological sites in 2013. The majority of this survey took place during Section 106 compliance reviews . Twenty six new archaeological sites were located and recorded during this survey work, and 10% (32 of 296) of the known sites in the park underwent site condition assessments. While the survey work conducted this summer increased the number of known sites in the park by almost 9%, this is likely only a small fraction of the number of actual sites in the park. To date, less than 1% of the park has been surveyed for archeological resources. The information gathered during the 2013 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.

Denali-Susitna Exploration Camp: Historic Archaeology of Talkeetna

by Phoebe Gilbert, phoebe_gilbert@nps.gov

Denali, in conjunction with the Murie Science and Learning Center (MSLC) and the Upper Susitna Soil and Water Conservation District (USSWCD), ran a five day field school from July 15-19th 2013 at a historic archaeology site in Talkeetna, Alaska. The site is located on a lot owned by the NPS in the town of Talkeetna and is not in the boundaries of Denali National Park and Preserve.

During the field school local high-school students from the Matanuska-Susitna Borough learned about cultural resources, basic archaeological excavation techniques, and the history of the area. The purpose of the field school was to further document and investigate the history of the site and its significance for listing on the National Register of Historic

Places, educate area high school students about the history of their town, and engage the public in archaeological research.

During the field school the students (see photos at right) learned about archaeological ethics, excavated test units, and researched the artifacts that they uncovered. The week culminated with a public presentation where the students presented what they learned and displayed the artifacts that they recovered from the dig to the community. The presentation took place at the Sheldon Community Arts Hanger, Talkeetna Alaska.

Over the course of the project several hundred artifacts were recovered from nine 50 x 50 cm test units; many of which are diagnostic. One of the most interesting artifacts recovered is a carbide miner's lamp. The brass lamp was made in 1925. Other interesting artifacts were several whole glass bottles, two glass beads, moose bones, and an enamel bowl-all of which date to the 1920's and 1930's.

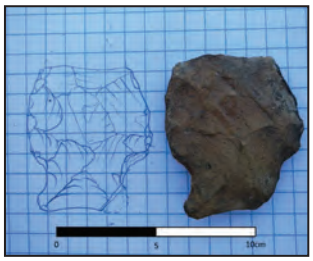
Based on their observations and the artifacts recovered, the students thought that the site was inhabited from 1925 to 1938, that it was likely associated with mining, and that the site inhabitants enjoyed beer and may have been anemic. The students tested the site, researched and presented their findings in a scientific and clear manner.

Archaeology Citizen Science

by Phoebe Gilbert, phoebe_gilbert@nps.gov

Denali, in conjunction with the Murie Science and Learning Center (MSLC) also ran a field school from July 29 - August 2, 2013. It was designed to introduce students to sub-arctic Alaska prehistory and archaeological field methods. The course took place in both a classroom and field setting. Students received training in archaeology ethics, field methods (see photo at right), and the cultural chronology of Interior Alaska. The project took place in the Savage River watershed south of the Park Road and at the MSLC Field Camp near Teklanika Campground.

Six students participated in the course, five of whom are elementary school teachers. By the end of the course, the students had developed a firm understanding of archaeological ethics and the field recording techniques covered in the course. All five educators produced lesson plans for an archaeology-themed exercise. Nine previously unrecorded prehistoric sites were located during the project and four condition assessments of previously recorded sites were completed. The information on the new sites informs our understanding of Denali's human history and will contribute to the protection of the park's cultural resources.



Museum Collection

By Kimberly Arthur, Kim_Arthur@nps.gov

The museum collections program continues to work with the multiple divisions (Interpretation and Maintenance) to increase access, public awareness, and research use of the park's museum collection.

This past year, mountaineering was highlighted as the centennial of the first ascent of Denali (Mount McKinley), June 7, 1913, was celebrated. Exhibits were at Eielson Visitor Center and the University of Alaska Museum of the North with each showcasing objects from the parks collection.

Both have since closed, but visitors may still read about the story and see related images at The American Alpine Club's Explore Special and Digital Collections website. Here, a digital exhibit of the ascent is showcased: "Denali Centennial: Commemorating Our Pioneers" by Jonathan Waterman. In particular, an axe and crampons used by the Sourdough Expedition (DENA 1636 and DENA 405) is highlighted along with the Hudson Stuck thermometer (DENA 388) shown below.

To see the online exhibit, please visit: http://explore.americanalpineclub.org/ and click on "Denali '13."

Last year, the museum collection was enhanced with 1020 slides of flora, fauna and scenery taken by Adolph Murie. Along with this were five field binders of flora specimens personally collected by Adolph and Louise Murie. Winter volunteer and summer Interpretation Ranger, Daniel Leifheit, photographed the five binders to create this multimedia project. With the array of technology devices, this format will help visitors to access special collection, learn more about park history and science, and provide an alternative learning format. This summer there is hope that an eBook/iBook will be launched showing the Murie flora specimens. Updates will be known and given as the project nears completion.

Other ongoing projects include updating archives backlog, fixing errors in collection records, and increasing access to the collection. With a growing collection, much work is being done to increase digitization of the collection which will increase collection access for researchers, the public, staff, education and outreach. Digitization also helps prevent further irreparable disintegration of photos and objects through repeated physical handling, and preserve the original materials for future reference. Digitization is significant to preserving the details in important and historic ephemera, especially as time and light naturally age originals. Whether through scanning, photography, or audio recordings, the museum is still in the beginning stages of a standard operating procedure that will assist future museum personnel in further digitization and bringing online part of the collection. The collection has received help with digitizing from the media team and volunteers.

As the summer season opens to visitors, it is a prime season for researching in Denali. The park's biology collection continues to see yearly growth as researchers study species from bees to flora and small mammals. Each project will better aide future research, provide baseline data where there was none or few, and enhance the synoptic collection in these areas.

This summer season the museum staff, along with an interpretation park ranger, will continue to increase access to the museum collection through informal interpretive programs and providing digital copies of various historic photographs.

Research Support

Geographic Information System

A Geographic Information System (GIS) is a digital database system for storing, analyzing, and displaying spatial information. Anything that can be depicted on a map can be incorporated into a GIS.

Denali's GIS is used by all functions in the park for analysis of park resources, including preparing maps for planning, public displays, drawings for construction, mining site rehabilitation, and design work. Denali's GIS includes several hundred layers or themes of information (hydrology, elevations, buildings, roads, etc.) that can be overlain by the computer to form composite maps. In addition to producing maps and other visual products, the associated databases can be queried in an unlimited variety of ways to analyze the features appearing in the maps. The system is managed on a central workstation and used by park staff on their desktop computers, laptops and other mobile devices. Efforts are on-going to make the technology and/or products more useful and available. A simplified interface called ArcReader requires no GIS background and makes much of the information available to casual users. Applications such as Google Earth have brought GIS technology to anyone with an internet connection. Increasingly, viewing the data and analyzing the information can be accomplished in a web browser, a capability that promises to make the technology available to a much wider audience.

The park's GIS program is involved in an on-going project begun in 2005 to collect high-resolution (1 meter) satellite imagery of the park. Most of the park has imagery although significant portions are cloud-obscured. It is hoped that eventually the entire park will be collected as clear (cloudless) images become available resulting in a base map far more accurate than the existing USGS Topo Quads. A statewide initiative is currently working to obtain 5-meter satellite imagery and elevation data for the entire state by 2014. This base data will serve as an extremely accurate basemap. Data for almost all of Denali has been collected and is currently being processed. The USGS will be using this information to produce a new set of 1:24,000 scale topographic quads that will replace the existing 1:63,360 scale maps, some of which are almost 60 years old.

The park maintains a copy of the entire NPS GIS dataset for the state of Alaska locally (over 2.0tb of data and over 18,000 coverages). Many additional layers of information have been added. The dataset is kept current through updates that are conducted nightly over the internet. Major infrastructure layers are updated to reflect changes as a result of work accomplished in the summer season.

One especially exciting dataset comprises LIDAR (Light Detection and Ranging) data that covers the entrance area, headquarters and the Hines Creek Fault as far as Sanctuary. This elevation data is at a 2-meter resolution and is so clear trails can be seen.

A select set of GIS layers are available for easy public viewing (trails, backcountry units, animal movements) using freely available software such as Google Earth. The data files can be downloaded from the park's website (www.nps.gov/dena/planyourvisit/gis_gps_data.htm). Recently, the high resolution satellite imagery viewable in Google Earth has been upgraded to include much of the eastern half of the park.

GPS (Global Positioning System) has become a valuable tool for park managers in all disciplines. The latest high-end handheld GPS collects positions as precise as 8 inches. The park glaciologist uses Survey-Grade GPS to measure movements of glaciers within 0.1 meter. Biologists use GPS to document sample site and observation locations within 2 to 5 meters. The backcountry staff uses small, recreation-grade GPSs to document patrol routes, campsite locations and for search and rescue. The maintenance Division uses GPS to document infrastructure such as culvert locations and for laying out construction projects. In the future this tool will increasingly be useful for precisely locating park infrastructure and documenting management activities.

Research and Resource Communications

by Lucy Tyrrell, lucy_tyrrell@nps.gov

Fact Sheets about Park Resources and Research (as of 5/1/2014)

New fact sheets were created with researchers in 2013 and early 2014, bringing the total number of fact sheets to . In addition, there are now a total of three fact sheet designed for kids.

DENA-FS-001-2006 2006 Alaska Science Symposium: Park Science in Central Alaska…
DENA-FS-002-2006 Central Alaska Network Inventory & Monitoring Program
DENA-FS-003-2006 Monitoring Climate Change (update in 2007)
DENA-FS-004-2006 Dinosaur Track Found in Denali
DENA-FS-005-2006 Denali's Resource Stewardship Strategy: Developing a document, planning for the future (updates in 2006, 2007 (2 updates), 2008)
DENA-FS-006-2006 An Integrated Study of Park Road Capacity 2006
DENA-FS-007-2006 Large Mammals…How many are there? (updates in 2007, 2008, 2009, 2010)
DENA-FS-008-2006 Moose Surveys (2010)
DENA-FS-009-2006 Permafrost Landscapes
DENA-FS-010-2006 Rivers and Streams (4-pages)
DENA-FS-011-2006 Soil Survey and Ecological Classification
DENA-FS-012-2006 Soundscapes
DENA-FS-013-2007 Wildland Fire Risk and Response: Why are you cutting those trees? (update in 2010)
DENA-FS-014-2007 Sharing Research (not printed)
DENA-FS-003-2007 Monitoring Climate Change
DENA-FS-015-2007 An Integrated Study of Park Road Capacity Summer 2007
DENA-FS-007-2007 Large Mammals…How many are there?
DENA-FS-016-2008 Climate-related Vegetation Changes
DENA-FS-017-2008 Population Biology of the Wood Frog
DENA-FS-018-2008 Reconstructing Ecosystems of the Lower Cantwell: Plants in the Age of Dinosaurs
DENA-FS-007-2008 Large Mammals…How many are there?
DENA-FS-019-2008 An Integrated Study of Park Road Capacity Summer 2008
DENA-FS-020-2008 Painted Fossil Bison Skull: When, how, and why was it painted?
DENA-FS-021-2008 Ecology of Upwelling Areas in the Toklat River
DENA-FS-022-2008 Paleoecology of Denali's Dinosaurs
DENA-FS-023-2008 Stampede Creek and the Legacy of Mining: Antimony Movement in Stream Water and Sediment
DENA-FS-024-2008 How old are these spruce? (not printed)
DENA-FS-025-2009 Wolf Monitoring 1986 – 2009 (update in 2010)
DENA-FS-026-2009 Large Lakes and Landscape Limnology
DENA-FS-027-2009 Beavers Across Denali's Hydrologic Landscape
DENA-FS-028-2009 Surveying Dall's Sheep Populations
DENA-FS-029-2009 Treeline Shifts in Denali: Influences of Climate Change and Local Site Conditions
DENA-FS-030-2009 Air Quality Monitoring
DENA-FS-031-2009 Permafrost Thaw and Carbon Balance
DENA-FS-007-2009 Large Mammals…How many are there?
DENA-FS-032-2009 Long-term Monitoring after Restoration of Kantishna's Placer-Mined Streams
DENA-FS-005-2009 Implementing Denali's Resource Stewardship Strategy: Achieving desired conditions for park resources (updated with revised title)
DENA-FS-033-2010 Restoration of Mined Lands in Kantishna
DENA-FS-034-2010 Preservation of Cultural Resources
DENA-FS-035-2010 Ice Patch Archeology
DENA-FS-036-2010 Natural Resource Condition Assessment
DENA-FS-037-2010 Museum Collections: Preserving Denali's Stories
DENA-FS-038-2010 Understanding Park Visitor Characteristics

DENA-FS-039-2010 Integrated Study of Park Road Capacity Summer 2010
DENA-FS-007-2010 Large Mammals…How many are there?
DENA-FS-025-2010 Wolf Monitoring 1986 – 2010 (update)
DENA-FS-040-2010 Moose Rut
DENA-FS-008-2010 Moose Surveys
DENA-FS-041-2010 Subsistence
DENA-FS-042-2010 Prehistoric Upland Hunting Site
DENA-FS-043-2010 Measuring Movements along the Denali Fault
DENA-FS-013-2010 Wildland Fire Risk and Response: Why are you cutting those trees?
DENA-FS-012-2010 Soundscapes
DENA-FS-044-2010 Are Wolf Viewing Opportunities at Risk?
DENA-FS-045-2010 How Are Permafrost Landscapes Changing?
DENA-FS-046-2010 Monitoring Contaminants
DENA-FS-047-2010 Ecology of Golden Eagles
DENA-FS-048-2011 Ancient Hunters near the Teklanika River
DENA-FS-007-2011 Large Mammals…How many are there?
DENA-FS-049-2011 Where is all that smoke coming from?
DENA-FS-050-2011 Melting Glaciers in the Kichatna Mountains
DENA-FS-051-2011 The Status of Resource Stewardship in 2010: A Scorecard Approach to Reporting
DENA-FS-052-2011 Tracking Crevassed Human Waste on Denali
DENA-FS-053-2011 Mountain Building in the Alaska Range
DENA-FS-054-2011 Learning about Climate Change from Ice Cores
DENA-FS-055-2011 Wildland Fire Ecology
DENA-FSK-01-2011 Dancing with Dinosaurs
DENA-FS-025-2011 Wolf Monitoring 1986-2011 (update)
DENA_FS-056-2012 Understanding and Managing Soundscapes
DENA-FS-057-2012 Fossil Bird Diversity
DENA-FS-058-2012 Earthquake Monitoring
DENA-FS-059-2012 Managing Invasive Plants
DENA-FS-060-2012 Studying the Active Boundary of Tectonic Plates
DENA-FS-061-2012 Permafrost Thaw and the Nitrogen Cycle
DENA-FS-062-2012 Young Scientists Measure Lake Ice and Snow at Horseshoe Lake
DENA-FS-063-2012 Estimating Park Visitation
DENA-FS-064-2012 Glacier Monitoring
DENA-FS-065-2012 Visitor Spending and the Local Economy
DENA_FS-066-2012 Aircraft Overflights Advisory Council

NEW in 2013, 2014

DENA FS-067-2013 Monitoring Songbird Populations
DENA-FS-007-2013 Large Mammals…How many are there?
DENA-FS-063-2013 Estimating Park Visitation (reprint with corrections, edits)
DENA-FS-004-2013 Discovery of Denali's First Dinosaur Track (reprint, revision)
DENA-FS-068-2013 Protecting Wildlife and Visitor Experience along the Denali Park Road
DENA-FS-069-2014 Surveying Denali's Pollinators: Bees and Flower Flies
DENA-FSK-02-2014 Giant Gliding Glaciers (For Kids)
DENA-FSK-03-2014 Grizzlies: Big, Brown, Berry-eating Bears (For Kids)
DENA-FS-007-2014 Large Mammals...How many are there?


Denali

National Park Service
U.S. Department of the Interior

Denali National Park and Preserve

Giant Gliding Glaciers

FOR KIDS

Glaciers, like the Traleika Glacier in this photo, are important because they shape the landscape, hold large amounts of frozen water, and record in ice the story of the Earth's climate.

Glaciers are masses of ice on the move. For any place to have glaciers, there must be more snow falling in winter than snow and ice melting in summer.

Denali National Park and Preserve has many glaciers (they cover about 15 percent of the park's area). Some of the park's glaciers are like huge lumps of vanilla ice cream sliding down the scooped-out bowls (*cirques*) of the Alaska Range. Other glaciers are giant rivers of ice that flow and glide slowly downhill in the mountain valleys.

As glaciers move, the sides and bottom of the ice pluck large boulders, gravel, rocks, and dirt, and drag this material along—in the ice, under the ice, or on the ice. The flowing ice, and rocks frozen into the bottom of the glacier, carve wide U-shaped valleys, scrape grooves in the bedrock, or polish rocks into dust. The glacier surface often breaks forming cracks called *crevasses*.

Read below how glaciers form, then turn the page to explore (1) what glaciologists learn from glaciers, (2) how climate change affects glaciers, and (3) which glaciers and glacial features you might see in Denali.

WHAT IS NEEDED TO MAKE A GLACIER?

Snow: Lots of snow falls in a mountain valley and builds up new snow layers each year.

Cold: Even summer heat does not melt the new layers, so they bury and compress old layers.

Time: Over a few years, the added snow weight melts and refreezes flakes into ice called *firn*.

Pressure: As pressure builds with more layers, firn grains fuse to become glacial ice.

Gravity: When the ice flows under its own weight, it is a glacier!

Snowflake diagram courtesy Bob Corby, Department of Geology and Physics, Georgia Southwestern State University

Research Administration

by Lucy Tyrrell, lucy_tyrrell@nps.gov

Research by the numbers

As of April 15, 2014, 881 study numbers have been assigned to scientific and scholarly studies (some completed, some continuing). Each year there are approximately 50-75 studies that are ongoing or recently completed.

These projects are either conducted by Denali staff (described at length in this document) and park cooperators (e.g., U.S. Geological Survey, the Alaska State Department of Fish and Game), or by other investigators (e.g., from universities and other agencies and institutions). Appropriate research gathers information while making minimal impacts to park resources. Scientific research on arctic and subarctic ecosystems has been integral to the understanding, management, and protection of resources at Denali National Park and Preserve since the early 1900s.

Conducting Research

Scientists wanting to conduct research must submit a study proposal and fill out an application. To expedite this process, the National Park Service developed a Research Permit and Reporting System (RPRS). Scientists file an application using the new RPRS website: https:/irma.nps.gov/rprs/

Information for researchers is posted on the park's website (access the Information for Researchers page via the Nature and Science page) www.nps.gov/dena/naturescience/research.htm

Denali Park staff review the application and study plan for any administrative, scientific, or compliance concerns, assess how the proposed project fits in with the overall science goals of the park, and set the conditions of the research permit, if approved and issued. Collecting permits may be granted for limited collecting of objects, whole organisms, or parts of organisms (e.g., leaves). Some samples may be destroyed while being analyzed. Some animals may be collected and released after they have been measured or tagged.

Each researcher reports his/her results in an Investigator Annual Report (IAR). Each researcher at Denali is expected and encouraged to include an educational component to their project, in addition to filing an IAR.

Study files about each research project are kept electronically and hardcopies filed in fireproof file cabinets in the resources building until they are archived. Reports, dissertations, and publications resulting from scientific studies become part of Denali's resources technical library (hardcopy and digital). Arrangements can be made to use these materials by contacting the Lucy Tyrrell, research administrator at (907) 683-6352.

Revised Access Database about Research

During 2011 and 2012, through a cooperative agreement with St. Mary's University of Minnesota, St. Mary's staff worked with Denali's research administrator to revise the Access database that Denali uses to supplement the Research Permit and Reporting System (RPRS) database. The revised Access database includes new information (e.g., to help with researcher logistics), deletes obsolete information, and reformats the input fields into screens that are user-friendly. The Access database can produce reports by year or by other sorting factors.

In 2013 and continuing in 2014, data from 2011 and 2012 are being entered into the revised database and then will be available to multiple users.

Researchers in Denali (2013)

by Lucy Tyrrell, lucy_tyrrell@nps.gov

The following researchers (non-Denali staff, listed alphabetically) held research permits in 2013.

Results of research is report annually in Investigator Annual Reports (IARs) on the Research Permit and Reporting website: https://irma.nps.gov/rprs/
If you access the RPRS, you will have two menu options (regardless of who you are, no account needed). The menu options are IARs and Parks. The IAR search option allows users to search the IAR record.

Research results may also reported elsewhere in Current Resource Projects 2014 and some research has been incorporated into one or more fact sheets.

Layne Adams
UGSG, Anchorage
Dynamics of the Denali Caribou Herd

Sean Bemis and Jeff Benowitz
University of Kentucky and UAF
A late Cenozoic record of restraining bend initiation and evolution along the Denali fault

Jeff Benowitz
University of Alaska Fairbanks, Geophysical Institute
Geochronological framework for the Cantwell Formation: Denali

Matt Brownlee
University of Utah
Prioritizing conservation actions for North American grizzly bears by testing their efficacy as a flagship species

Kyle Bohnenstiehl
UNAVCO Inc
Plate Boundary Observatory (PBO) stations in Denali monitors tectonic and magmatic process using high precision Global Positioning Systems (GPS)

Anthony Fiorillo
Perot Museum of Nature and Science, Dallas
A detailed study of an ancient high latitude terrestrial ecosystem and its implications for understanding climate change: the dinosaurs and their ecosystems within the Lower Cantwell Formation in Denali National Park

Jeffrey Freymueller
University of Alaska Fairbanks, Geophysical Institute
Repeated Global Positioning System (GPS) and Absolute Gravity Measurements to Measure Active Crustal Deformation in Southern Alaska

Michael Grocott
University of Birmingham, UK
The hydrology of biological hotspots in a glacierized catchment: an integrated tracing and modeling study

Roger Hansen
Alaska Earthquake Information Center
Denali seismic monitoring sites

Chuck Holmes
Holmes Cultural Resource Consulting
The archeology and geomorphology of ancient Lake Minchumina, Central Alaska

Ron Karpilo
Colorado State University, Department of Geosciences
Photographic monitoring of the natural viewshed of Denali

Christina Leshko
Michigan State University (Ph.D. student)
Exploring attitudes and values in visitor discourses of wolves at Denali

Michael Loso
Alaska Pacific University
A field assessment of Focus Glaciers for the "Alaska NPS Glacier Inventory and Change Assessment" project

Julia Lushing, David Zald
Vanderbilt University
Altitude induced hypoxia effects on cognitive and emotional processing

Maggie MacCluskie, Melanie Flamme
Central Alaska Network, NPS
Monitoring of Small Mammal Populations in Denali National Park and Preserve

Alexander Milner
Birmingham University, UK
Long term ecological monitoring of streams
Link Olson
UA Museum of the North
The effects of a century of climate change on Denali's small mammal fauna

Erich Osterberg
University of Maine/New Hampshire
Central Alaska climate and glacier response over the past 1,000 years

Roger Robinson
Vermicomposting human waste in outside environment at latitude 62 degrees N

Jessica Rykken
Museum of Comparative Zoology, Harvard University
A survey of bees and flower flies in Denali National Park and Preserve and a multiregional evlaution of pollinator response to climate change in critical habitats service-wide

Ricardo Santos (postponed to 2014)
Instituto Superior Tecnico, Portugal
Giardia and Cryptosporidium in surface and treated water of Denali

Glenn Shaw
University of Alaska Fairbanks, Geophysical Institute
Long term trends and spatial variability in arctic haze at four sites in western Alaska

Katherine Shea
Stanford University Emergency Department
Post-exercise oxygen saturation and hydration status as predictors of summit success

Trey Simmons
Central Alaska Network, NPS
Implementation of a long term ecological monitoring program for the streams and rivers of Denali National Park and Preserve

Kelly Sivy
University of Alaska Fairbanks
Mesocarnivore community response to wolf presence, prey availability, and snowpack

Victor Van Ballenberghe
University of Alaska
Ecology of Moose in Denali National Park and Preserve

Helen Wheeler
Aarhus University, Denmark
The role of local and broad scale habitat structure in determining distribution and abundance of Arctic ground squirrels

Murie Science and Learning Center

By Sierra McLane, sierra_mclane@nps.gov
www.murieslc.org

"Your connection to northern Alaska park science"

Background

Located at the entrance to Denali National Park and Preserve, the Murie Science and Learning Center (MSLC) combines science, education, and partnerships to protect areas of national significance. Although it is located in Denali, the MSLC works with seven other national parks and many partners to reach the goals of increasing research, science-based education, and science-informed management decisions for these special places.

Established in 2005, the MSLC has given Denali the capability to effectively communicate park research to broad audiences and increase the number and quality of research projects. A special combination of science, education, and partnerships has created new ways of connecting people to their national parks. The MSLC also supports the National Park Service mission by leveraging partnerships and collaborating to achieve fiscal efficiency in generating high-quality scientific information and products for park management.

Partners

The MSLC consists of a primary partnership between the National Park Service and 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 fantastic bookstores where all proceeds benefit Alaska's public lands.

The MSLC serves Denali and seven other national parks across two NPS Inventory & Monitoring Networks. Partner parks are:

- Cape Krusenstern National Monument
- Noatak National Preserve
- Kobuk Valley National Park
- Wrangell-St. Elias National Park and Preserve
- Yukon-Charley Rivers National Preserve

Discovery Camp students created mini-parks and explained to their peers what resources they decided to protect and why

- Bering Land Bridge National Preserve
- Gates of the Arctic National Park and Preserve

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

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

Facilities and services for guest researchers

The Murie Science and Learning Center has four facilities available for use by guest researchers:

- The MSLC Visitor Facility provides a classroom, exhibit area, and office space for education staff and guest researchers. Researchers are encouraged to host educational programs and events in these spaces. Internet access and videoconferencing technology is available for use by guest researchers.
- The MSLC Dining Hall is shared with the park concessioner and provides meals for guest researchers.
- 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.
- The MSLC Yurt, located near the MSLC Dining Hall, provides housing for guest researchers and educators.

Programs

In 2014, MSLC programming includes curriculum-based education programs for K-12 grades; a week-long experiential learning program for local high school students; electronic field trips; internships; multi-day accredited field courses and teacher trainings; youth camps; science presentations; and research fellowships.

Youth Programs

Denali Science School New in 2014, Denali is an education program for Alaskan fifth and sixth-grade classes. Denali Science School will bring whole classrooms of students into Denali National Park and Preserve for overnight field trips in autumn 2014. During these three-day programs, classmates will be immersed in Denali's natural wonders through hands-on activities, hikes, and journeys into the park.

Denali Science School will be instructed by skilled National Park Service and Alaska Geographic educators who will work with the teachers to enhance each school's curricula. These educators will provide most instruction and logistical support, while teachers and chaperones will focus primarily on supervision. Session itineraries will vary depending on the group, but all sessions include a visit to the park's sled dog kennels, a fieldtrip into the park, and day and evening science and team-building activities.

Denali Science School is made possible by the partnership between Alaska Geographic and National Park Service through the MSLC. In 2014, the program will be offered free of charge to participating school groups, including instruction, equipment, accommodations, and in-park travel. The individual school groups are responsible for the cost of transportation to and from the park, as well as the cost of on-site food service at the MSLC Dining Room.

Week-long experiential learning program for local high school students The Murie Science and Learning Center will offer week-long "Intensives" for all DBSD high school students in the fall of 2014. The

During Denali Backcountry Adventures in 2013, students visited Base Camp and learned haul systems and glacier dynamics as part of what it takes to climb the highest mountain in North America

Intensives will provide immersive opportunities for local youth to engage in complex issues and hands-on learning in Denali. The students will explore how and why NPS works to preserve and protect Denali for the enjoyment of this and future generations. They will achieve a better understanding of themselves and the ways in which they are personally connected to public lands. Seven topics will be offered, each with one or more Park Service lead instructors. Topics include Physical Sciences, Biological Sciences, Cultural and Social Sciences, Building Trades, Trail Design and Construction, Media, and Visitor and Resource Protection.

Distance Learning Denali National Park and Preserve is an environment of extreme temperatures, tall mountains, glacial landscapes, and more. As it is difficult, if not impossible, for many teachers and students to come to the park, Denali has created new free, interactive, distance learning programs to help classes learn about this special place and enhance existing curricula.

Every winter Murie Science and Learning Center education rangers teleport themselves via Skype into 3rd – 6th grade classrooms across the United States

to present fun, standards-based science lessons. During the winter of 2013 – 2014, three programs were offered: *The Science of Sled Dogs* uses the furry inhabitants of Denali's sled dog kennels to teach concepts of anatomical, physiological, and behavioral adaptations; *Denali Geology* teaches concepts of plate tectonics, weather, and glacier dynamics using North America's tallest mountain as an enormous prop; and *Ask an Alaskan* allows students to ask whatever questions they have about surviving and thriving in Alaska. Over three months the two educators reached over 3,000 students in 24 states. Teacher and student feedback has been overwhelmingly positive.

In 2014 – 15 MSLC will add one more program to the menu: *Denali Dinosaurs*, which will feature a mural recently installed in the MSLC that illustrates Denali during the Cretaceous. All curricula have written lessons and activities for teachers available for download at www.nps.gov/dena/forteachers/learning

Denali Days. MSLC educators also connect elementary students to Denali by teaching about park resources in local schools. During Denali Days, students explore current research being done in the park, and how curiosity leads scientists and students to better understand the world. Programs include an in-class component and a Denali visit when possible. The MSLC runs Denali Days as a partnership between the Park Service and the Denali and Matanuska-Susitna Borough School Districts.

In 2013, Denali's Education Specialists went into classrooms locally and south as far as Wasilla to teach about plant germination and growth. In addition, local elementary students visited Denali for a day in April. These students participated in a phenology citizen science project during which they collected bud burst data for aspens. In 2014, Denali Days will focus on paleontology and the in-park field trip will feature a visit to the new dinosaur mural in the MSLC.

Denali Discovery Camp. Denali Discovery Camp provides children from the Denali Borough School District with quality learning experiences through hands-on adventures and fun in the park. Developed

Kids get to learn from peers, teachers, the evironment, and themselves

in partnership with the Denali Education Center, the camp curriculum engages participants in hands-on science activities as they learn about sub-arctic ecology, the national park mission, and preservation and protection of park resources. Many park resource staff members meet with groups of campers in the field to talk about ongoing research projects. Depending on their ages, participants spend one to three nights in the park during camp week (June 16-20, 2014). For more information, visit: www.denali.org/youth

Denali Backcountry Adventures. Denali Backcountry Adventures (DBA) is a week-long backpacking trip for high school students interested in exploring Denali's vast wilderness. We had special events planned for Denali Backcountry Adventures in 2013! In celebration of Denali first being summited 100 years prior, students experienced first-hand what it takes to launch mountaineering expeditions on the highest mountain in North America, including flying to Base Camp for a day of one-on-one instruction from Denali mountaineering rangers; practicing the teamwork and technical skills needed to reach

the highest places on earth; and assisting Denali mountaineering rangers as they launch a summit attempt from Wonder Lake. In its eleventh year, DBA is a partnership program of Denali Education Center and the National Park Service through the Murie Science & Learning Center. In 2014, the camp will take place from June 2 – 7. For more information, visit: www.denali.org/youth

Denali-Susitna Exploration Camp. Exploration Camp offers high-school students from the Northern Susitna Valley the opportunity to explore the natural and cultural history of the Denali area. In 2013 the week-long camp was run as an archaeology field school (see page 60). In 2014, Exploration Camp students will come to Denali and get their hands dirty helping with a trail crew project. Denali-Susitna Exploration Camp is run as a partnership between the Upper Susitna Soil and Water Conservation District and the Murie Science and Learning Center.

By-request Ranger Programs . Teachers who wish to bring their classes to Denali can request a special program from an MSLC Education Ranger. These programs include hikes and hands-on classroom activities and cover topics from winter adaptations to current park science.

Non-personal Services for Kids and Families The MSLC is responsible for overseeing the Junior Ranger and Discovery Pack programs for Denali National Park and Preserve. 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. There is a brand-new Junior Ranger book available in 2014 – make sure to check it out! The new book features climate change, park management, NPS careers, and many other resource topics.

Field Seminars and Teacher Training

Field Courses. The MSLC offers 15-20 field seminars in Denali each summer season. New seminars in 2014 include Geology and Geohazards and Landscape Painting. Alaska Geographic coordinates

Learning during an MSLC field course.

these active learning multi-day seminars. Topics vary annual but often include geology, wildflowers, birds, paleontology, glaciology, botany, large mammals, bears, painting and music composition. Most courses are based out of the MSLC field camp, located within the park near the Teklanika River at Mile 29 of the Park Road. Many park research staff members serve as content experts for the seminars. All field seminars are available for optional university credit through the University of Alaska.

Teacher Trainings. The MSLC annually offers 2-4 teacher trainings in Denali each summer season. Alaska Geographic coordinates these three- to four-day courses focusing on topics such as science writing; mammals, paleontology; and climate change. All teacher trainings include one to three credits through the University of Alaska. Every year MSLC offers scholarships for teachers to attend these field seminars. In 2013 MSLC provided over $7,500 towards 23 scholarships to subsidize the cost of teacher trainings and seminars for Alaska teachers.

Teacher Ranger Teacher 2014
The Teacher-Ranger-Teacher program allows teachers to work on park projects and then take what they've learned back to the classrooms where they teach. There are two Teacher-Ranger-Teachers for 2014:

Thomas Lane, a teacher from Vermont, will be conducting a research project related to permafrost near the park *Evaluating unintended consequences of a long-term permafrost thaw manipulation experience*.

Nanette Melero, a teacher from California, will help develop science curricula for the new Denali Science School program that the MSLC is launching this fall.

Day Programs

Denali-ology Short Courses Denali-ology Short Courses are mini-seminars (for adults or for families) of 4-8 hours in length that delve into unique and fun science subjects of Denali. Denali-ology is the study of all things Denali. These Alaska Geographic courses are announced each May on the Denali-ology page of the MSLC website.

Murie Excursion. This program, coordinated by Alaska Geographic, allows custom visiting groups to explore wildlife and wildlife research in Denali through small-group outdoor-based activities with MSLC science instructors. Participants learn about different habitats, take a short walk, participate in hands-on activities, and travel by bus to the Teklanika Rest Area. This program returns all proceeds to the Murie Science and Learning Center operations, and is available for advanced group booking with the MSLC.

Daily 'Science at Noon' Presentations. Daily presentations and films at the MSLC provide a regular educational service to Denali visitors. Alaska Geographic instructors give presentations and show films on subjects such as climate change and park wildlife studies. This free program is offered every day at noon in the MSLC facility.

Evening Speaker Series. The MSLC and Alaska Geographic host guest speakers throughout the summer. Guest speakers include park researchers, visiting researchers and conservationists, writers, artists, and adventure travelers. This free program is offered twice weekly at the MSLC facility, usually on Monday and Thursday evenings at 7 pm.

Special Programming

Education Internships. Whenever possible, the MSLC offers summer education internships. These 14-18-week internships expose interns to all facets of education programming, experiential education, research, and park management. Internships are created through a number of partnerships involving the National Park Service, Alaska Geographic, GeoCorp, GeoHeritage, and the Student Conservation Association.

Custom Education and Facility Services. The MSLC coordinates the needs for visiting science and education groups. The MSLC arranges special programs, food services, transportation services and meeting space to these groups. Inquiries should be directed to the MSLC at (907) 683-6432.

Research Awards

Researcher-in-Residence Program. The MSLC hosted a Researcher-in-Residence Program in 2012-2013 in partnership with the North and West Alaska Cooperative Ecosystem Studies Unit (http://www.uaf.edu/snras/cesu/) to increase the opportunities for researchers to work in the park and increase the opportunities for visitors to learn about current science occurring in the park.
The researchers-in-residence active in 2013 were:

Karen Carr
Scientific Illustrator, Karen Carr Studio Inc.
Silver City, NM
Creation of mural depicting Denali in the Cretaceous Period

Link Olson
Curator of Mammals, University of Alaska Museum; Associate Professor, Department of Biology and Wildlife, University of Alaska Fairbanks
The effects of a century of climate change on Denali's small mammal fauna

MSLC Program of Research Fellowships. Through the MSLC, financial support is provided to research fellows, who are primarily graduate students embarking on their careers as researchers. In the future, these fellows may become researchers who routinely conduct work in national parks. The MSLC Program of Research Fellowships includes research fellowship funding from the Denali Education Center (since 2006) and from Alaska Geographic (since 2007). Recipients are awarded grants up to approximately $8,000 for research, especially for projects that will assist park managers with critical resource issues. Alaska Geographic Fellows conduct research in any of the eight arctic and subarctic Alaska national parks (across two NPS Inventory & Monitoring Networks—Central Alaska Network or Arctic Network).

The following researchers, listed here with their topics have been awarded funding for 2014 as Alaska Geographic Research Fellowships by Alaska Geographic (AG), or as Discover Denali Research Fellowships by Denali Education Center (DEC):

Jacob Adams (AG)
Ph.D. student, Washington State University
Archaeological survey of the Stony Creek and Toklat River Corridor

Michael Grocott, Ph.D. student (DEC)
University of Birmingham, UK
The hydrology of biological hotspots in glacierized catchments: upscaling understanding in Denali

Robin Henderson, Graduate student (DEC)
Washington State University
Measuring the biotic integrity of Eldorado Creek, Denali with stream restoration

Michelle Kissling (AG)
USFWS (volunteering for this project)
Nesting activity of the Kittlitz's Murrelet in Cape Krusenstern

Leanne Phelps (AG)
M.Sc. student, University College, London, UK
Human-bear interaction in McCarthy/Kennecott, Alaska: conservation through understanding conflict, attitudes, and education on bear safety

Lisa Strecker (AG)
Ph.D. student, University of Alaska Fairbanks
Fragile ecosystems: are hot springs and their surroundings especially vulnerable to plant invasion?

Scott Weidensaul (DEC, AG)
Ned Smith Center for Nature and Art, PA
Critical connections: protecting Alaska national parklands through place-based science and public education

Short biographies and photos of each year's research fellows are being posted on the park website at www.nps.gov/dena/naturescience/2013fellows.htm.

For more information about research fellowships, contact Denali's Research Administrator, Lucy_Tyrrell@nps.gov or the MSLC Education Coordinator, Sierra_McLane@nps.gov.

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/NPS
Data summaries and data analysis tools about Denali's weather and climate.

Fire Information
http://www.nps.gov/akso/Fire/firehome.htm
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.murieslc.org
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.

Resources Staff 2014
Permanent and Term

National Park Service
U.S. Department of the Interior

Denali National Park and Preserve

Philip Hooge
Assistant Superintendent for Resources, Science, and Learning

Amy Craver
Subsistence, Cultural Resources Program

Steve Arthur
Biological Resources Program Manager

Dave Schirokauer
Physical Resources Program Manager

Larry Weddle
Western Area Fire Management Officer

Kim Arthur
Museum Technician

Jennifer Barnes
Fire Ecology

Davyd Betchkal
Soundscapes

Andrea Blakesley
Air Quality

Bridget Borg
Road Study Technician

Rob Burrows
Backcountry, Glaciers

Denny Capps
Geology

Phoebe Gilbert
Archeologist, Sect.106

Carol McIntyre
Birds, Small Mammals

Heather McKenny
Road Ecology Program

Wendy Mahovlic
Revegetation

Keith Mitchell
Fire Management

Susanna Nancarrow
Fire Mgt Admin Ass't

Pat Owen
Wildlife

Carl Roland
Plants

Britta Schroeder
GIS, Data

Pam Sousanes
Weather, Snow

JoAnn Struebing
Administrative Assistant

Sarah Stehn
Botany (CAKN)

Lucy Tyrrell
Research Administration

Selected Resource or Park Highlights 2013-2014

- Monitoring the new winter opening of the park road to Mountain Vista (page 3)
- Completion of the first State of the Backcountry Report (page 8)
- An MOU (Denali and UAF) supports coyote study in and near Denali (page 31)
- Massive debris slide on the park road (page 45)
- Additional dinosaur finds in the park (page 46)

Looking Ahead - 2014 and Beyond

- Implementation of Denali's Vehicle Management Plan with associated "road study" monitoring (see page 1)
- Wilderness is 50 in 2014 (see page 7)
- Gathering data about gravel in the Toklat in 2014 for a long-term, comprehensive strategy for the Toklat River system (see page 48)
- Eldorado Creek reclamation begins in 2014 (see page 51)
- Completion of Denali's Foundation Statement
- Completion of Denali's State of the Park Report for 2012

The park road facilitates wilderness recreational opportunities and supports freedom of discovery, a sense of adventure, and a connection to nature.