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 2013

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Table of Contents

Integrated Programs and Findings

Road Ecology Program

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One of the biggest challenges in managing National Parks is balancing the need to protect park resources with making them available for people to enjoy. This challenge is particularly great in Denali, which is one of the most visited subarctic national parks in the world. In Denali National Park and Preserve (Denali), park managers are challenged with the growing demand for visitor opportunities to view wildlife, tundra ecosystems, and mountain scenery by touring the park road while protecting the resources associated with the road and ensuring a high-quality visitor experience.

For nearly a century, the Denali Park Road has provided the primary access for visitors to observe Denali wildlife in their natural habitats and enjoy the spectacular scenery, including the continents highest peak. Beginning at the park entrance, the narrow, low-speed road extends 92 miles west, dead-ending at the former mining community of Kantishna. The primarily gravel road, completed in 1938, is paved to Savage River (mile 15) and is two lanes to Teklanika River (Mile 31). Most of the remaining 61 miles of road is 1 to 1.5 travel lanes wide. Concessioners have provided tours along the park road since construction began in the 1920s (Bryant 2011).

Since 1972, park managers have instituted vehicle traffic limits on the park road. The George Parks Highway was completed between Fairbanks and Anchorage in 1971, providing the first direct, paved access to the park. Park managers, anticipating a substantial increase in visitation resulting from the highway, implemented the first mandatory public transportation system in 1972. Visitor traffic beyond the Savage River was limited to people with overnight or other special use permits. The limits were put in place to address concerns regarding the impacts of vehicle traffic on wildlife in particular, as well as concerns for the impact to visitor experience, safety, and other park resources.

In 1986 park managers instituted an annual vehicle limit of 10,512 during the summer visitor season (U.S. Department of Interior 1986). The vehicle limit was promulgated as a special park regulation (36 CFR § 13.930 et seq.). Allocation of vehicles between user groups and the annual allocation season was further refined in the Park's 1997 Entrance Area and Road Corridor Development Concept Plan (U.S. Department of Interior 1997). User groups include the concessioner operated tour and transit buses, National Park Service (NPS) and park partners, and private vehicles including special permit holders and campers, Kantishna property owners, and subsistence users.

Between 1986 and 2006, visitation to the park continued to increase along with demand to travel the park road and concerns for wildlife, visitor experience, and safety. In 2006 park managers, faced with increasing visitation and pressure to defend or change (increase) the annual vehicle limit, initiated a process to comprehensively reevaluate the strategy for transporting people on the park road. The Denali Park Road Capacity Study addressed concerns for protecting important park resources and values by evaluating the transportation systems and determining the carrying capacity of the road (Phillips et al. 2010). The study was conducted by an interdisciplinary team of NPS scientists and managers and academic scientists over several years. It assessed the effects of traffic volumes and patterns on the park's social, biological, and physical environment.

The Road Capacity Study included three primary components: 1) an assessment of the relationship between vehicle traffic and movements by grizzly bears and Dall's sheep (Philips et al. 2010), 2) visitor use surveys to identify and quantify key indicators of visitor experience on the park road (Manning and Halo 2010), and 3) the development of a spatially explicit traffic model that integrated the results from the first two components and GPS data of vehicle movement on the park road (Morris et al. 2010). The model was developed to predict the effects of changes in traffic volume and patterns on wildlife movements and visitor experience. The study also assessed the effects of traffic levels and nighttime traffic on wildlife viewing opportunities (Philips et al. 2012).

The results of the Road Capacity Study were used to inform development of the Denali Park Road Vehicle Management Plan (VMP), including identifying indicators of desired resource and visitor experience conditions, and establishing quantitative standards for ensuring those conditions are being maintained.

The Denali Park Road Vehicle Management Plan (VMP)

The VMP was adopted in 2012 to improve management of vehicle traffic along the Denali Park Road for the next 15 to 20 years (U.S. Department of Interior 2012). The goal is to provide a high-quality visitor experience while protecting park resources, including wildlife, and maintaining the unique character of the park road. The VMP will be fully implemented in 2015, when a new concessions contract is in place to operate the park's public transportation system and special park regulations have been updated in the U.S. Code of Federal Regulations.

The VMP includes an adaptive management strategy for managing traffic on the park road. The strategy was developed to ensure that desired resource and visitor experience conditions are being met as traffic volumes and schedules are adjusted to optimize the system. Adaptive management is a process that promotes an experimental approach to management and flexible decision making that can be adjusted as results of management actions are monitored and better understood. Adaptive management is necessary because the outcomes of most management actions are shrouded in uncertainty and unpredictability due to environmental variability or incomplete knowledge of system dynamics.

The VMP uses a uses a four-tiered approach to monitor for impacts to visitor satisfaction and natural resources resulting from changes (increases) in the transportation system. This approach includes: 1) monitoring seven indicators of desired conditions using quantifiable standards, 2) monitoring changes in wildlife observations, and 3) wildlife populations (data from long-term monitoring programs), and 4) conducting Before-After-Control-Impact (BACI) studies. The results from the comprehensive monitoring program and the BACI study will enable park managers to make informed decisions regarding changes to the transportation system while protecting important park resources and maintaining a high-quality visitor experience.

The monitoring program includes seven tier one 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 (>80,000 pounds gross weight) vehicle traffic

The protocol for monitoring and reporting on the VMP indicators and standards is being refined during 2013 and 2014. The program includes the use of a satellite-based GPS tracking system to monitor real-time traffic conditions on the park road. As of 2012, 96 concessioner-owned buses and 46 NPS vehicles that routinely travel beyond the Savage Check Station have been outfitted with GPS systems. The buses also have texting device that are integrated with the GPS system. Drivers use the texting device to record wildlife stops. In 2013, NPS staff will expand the program by developing a portable GPS system for occasional road users. They will also work with the GPS system provider to develop automated reports on specific VMP indicators. Outfitting additional vehicles with GPS systems will occur in 2014 and 2015. It may not be feasible to outfit all vehicles that travel the park road with GPS systems. In order to monitor these vehicles, the park has installed seven traffic counters at strategic points along the park road. These counters are especially valuable for monitoring large vehicle traffic and nighttime traffic often associated with construction. New traffic counter hardware was installed in 2012, and 2013 will be the first season that use of this tool for monitoring will be fully implemented.

The monitoring program also uses data collected by NPS staff, volunteers through the Ride, Observe, And Record (ROAR) program and the ground-based monitoring program. These data provide detailed information on wildlife sightings and are used to validate data collected through the GPS system. Ground-based monitoring data is collected from NPS vehicles traveling the park road, and it is used to monitor the sheep gap spacing, and the number of vehicles at wildlife stops, rest stops, the Eielson Visitor Center, and in viewscapes. The ROAR program data is collected by NPS staff and volunteers while they are riding the concessioner-owned buses. This data is used to monitor wildlife sightings, the number of vehicles at rest stops, and hiker wait time. Data on hiker wait time is also collected by the concessioner at the Eielson Visitor Center and by bus

drivers when they stop to pick up hikers along the road. These data collection methods will continue in 2013.

In addition to collecting and analyzing monitoring data and establishing protocols, NPS staff will continue to develop a traffic scheduling tool to assist with implementing the VMP. The tool is for developing and testing vehicle traffic schedules that integrate all road users and optimize schedules while staying within the prescribed indicators and standards. In September, 2011 and April, 2013, NPS staff participated in a week-long course to learn how to use ExtendSim simulation modeling software and to begin development of the scheduling tool. Staff will continue to develop and test this tool in 2013 and 2014 with the goal of having this tool fully operational in 2015.

The Road Ecology Program is recruiting volunteers to participate in the ROAR program. Volunteers will be trained to collect wildlife observational data and they will contribute to a long-term dataset of wildlife sightings in Denali. In order to participate, volunteers must commit to at least five days of data collection during summer 2013.

Soundscape Inventory and Monitoring Program

By Davyd Betchkal
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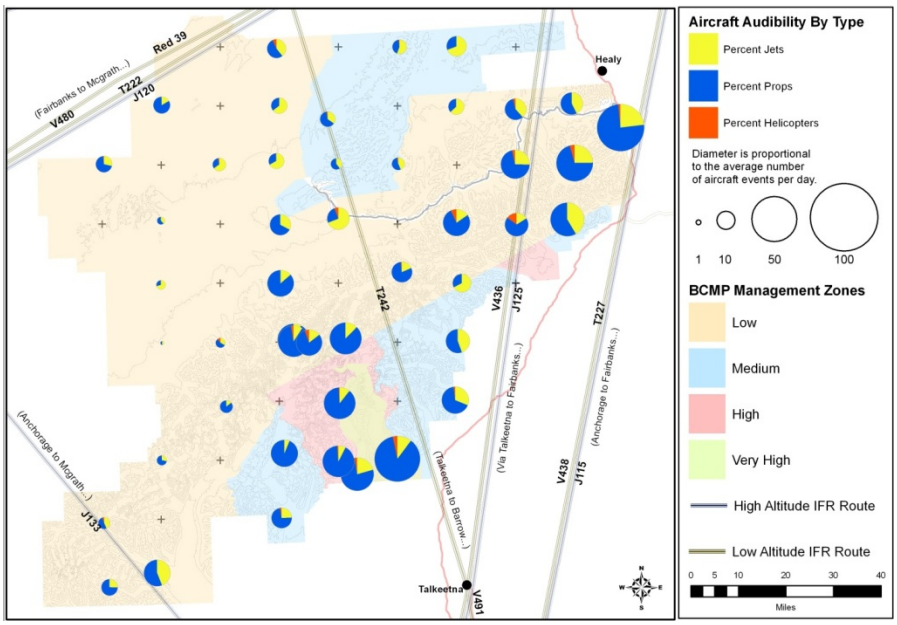
Soundscape research has been underway at Denali since 2001. Natural and human-generated sounds are being systematically inventoried across the entire landscape of the park, including popular backpacking areas, Mt. McKinley climbing routes, and along the park road. From the 18000+ hours of digital recordings 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 staff implemented the seventh season of a revised systematic sampling plan in 2012, deploying seven automated sound monitoring stations and rotating them among 11 locations. These locations were: three winter-season sites, 6 Central Alaska Network (CAKN) Inventory & Monitoring grid points, and 2 locations to monitor a voluntary aviation best practice. Over a ten-year period, stations are being placed at six new locations each year—each randomly selected from a 10x10 Km grid of 60 points spread evenly throughout the park.

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 linearly 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. Overlain upon these steady physical sounds are seasonal or daily cycles affected by sunlight or temperature. For instance, both the singing of birds or debris flows down steep-walled valleys follow a predictable daily pattern of occurrence related to light energy.

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



In 2013, sound stations will be placed at seven more Inventory & Montoring grid points. In addition, a station will resample the site at Fang Mountain to monitor the difference in the audibility of aircraft noise, now that best practice recommendations for the North Side of the park have been made by the Denali Overflights Advisory Council. Also in 2013, a set of two sound stations will be moved to 2 different locations along the road corridor to measure the acoustic energy radiated by passing hybrid buses. Park staff will quantify noise impacts by bus type over a variety of terrain (comparison of newly-purchased hybrid buses to the conventional fleet) to assess their relative impacts upon the park soundscape. This effort is a collaboration between the Resources and the Concessions divisions. The outcomes will inform the development of upcoming concessions contracts.

Detailed soundscape data reports can be found on the Denali website:
http://www.nps.gov/dena/naturescience/soundscape.htm

Overflights Committee

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The Denali Overflights Advisory Council, a FACA chartered (Federal Advisory Committee Act) group, was established in 2007 with the task of advising the Superintendent on how to mitigate the impacts on the park from aircraft overflights. The Council is comprised of representatives from various park user groups including air taxi operators, aviation interest groups, and backcountry and wilderness advocates. Denali's Soundscape Program has been working intensely to collect and interpret acoustic data that the Council can
use to make informed recommendations.

In April of 2012, the council recommended that aviators adopt certain practices when flying in the area between the park road and the spine of the Alaska Range, which has the highest protection in the Denali Backcountry Management Plan. On a voluntary basis, aviators were asked to maintain a minimum altitude of 8,000 feet above mean sea level in the area, and to utilize the lowest possible power settings. They were also asked – when weather conditions allowed - to completely avoid flying in the area directly over the spine of the range. Monitoring throughout the 2012 summer season detected only a small change in aircraft traffic, primarily manifested in a reduction in the sound level. This suggests that most aviators maintained their previous flight paths over the park, but may have started flying at the recommended altitude.

Wilderness and Backcountry Monitoring

By Rob Burrows and Dan Abbe
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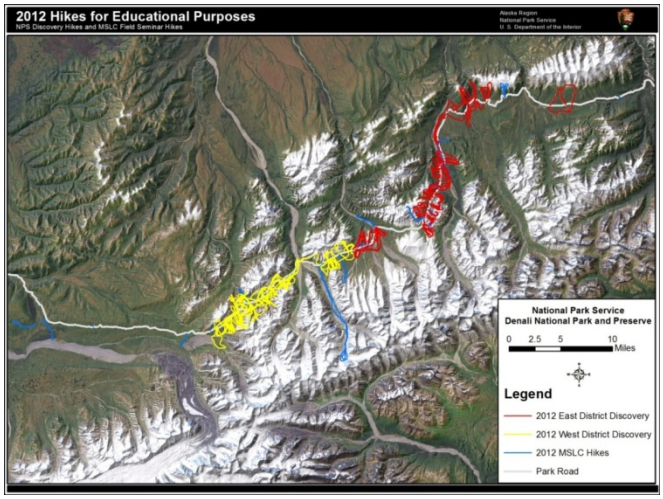
2013 marks the continuation of a new chapter for wilderness and backcountry stewardship at Denali. The new Backcountry District Ranger and Wilderness Coordinator position has been filled by J. Dan Abbe who arrived in late July 2012. He has begun to develop a holistic program for Backcountry Ranger Operations and integrated cross divisional approach to Wilderness stewardship with substantial assistance from Rob Burrows as Wilderness Resources Specialist.

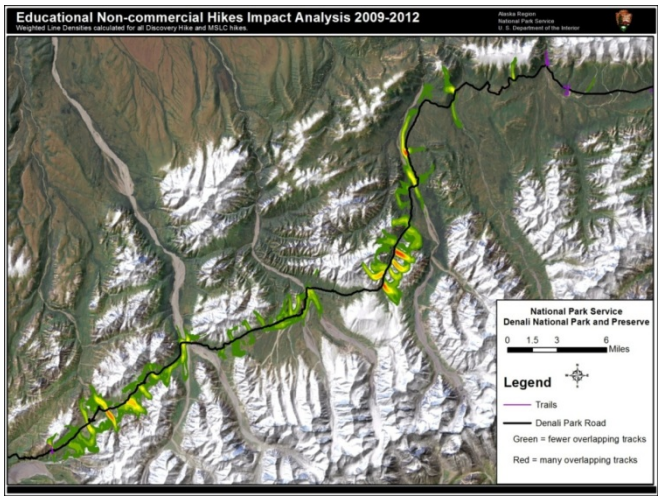
The primary affirmative mandate of the 1964 Wilderness Act is that land management agencies preserve the wilderness character of all areas designated as wilderness. In the last four years a framework for describing just what wilderness character is, has emerged and is proving to be a powerful tool in 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 next page for further explanation). 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 unique to each area.

Monitoring certain conditions and indicators using the best available science is an important effort in tracking and preserving wilderness character, protecting the resources of Denali NP&P, and in providing opportunities for high quality visitor experiences in the backcountry. Efforts are underway to monitor the indicators of visitor experience and resource conditions that are identified in Denali's 2006 Backcountry Management Plan. This monitoring is an inter-divisional and interdisciplinary team effort. More lengthy summaries of the monitoring will be published in Denali's first ever State of the Backcountry report later this year. However, below are short summaries for some of the focus areas of park staff for 2012:

Wilderness Character spatial modeling – In conjunction with Peter Landres and James Tricker of the Aldo Leopold Wilderness Research Institute, park staff are working to complete 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. The indicators were chosen by park staff and represented in digital map layers to show impacts to the wilderness character of the Park. It is hoped the final model will help the Park evaluate projects in Wilderness and to monitor trends showing the effectiveness of management efforts in protecting the Park's Wilderness character over time. A final Model and associated report are expected to be completed this summer.

Tracking Educational Hikes in Wilderness – Interpretive rangers have been leading visitors on hikes into Denali's trail-less wilderness since the 1970s. These programs provide an outstanding opportunity for connection with wildness and the Denali Wilderness for many hikers unaccustomed to trailless backcountry hiking, however the groups do have an impact on wilderness character, primarily the





Outstanding Opportunity for Solitude Quality. The benefit of offering these educational opportunities to visitors is thought to outweigh the impacts on

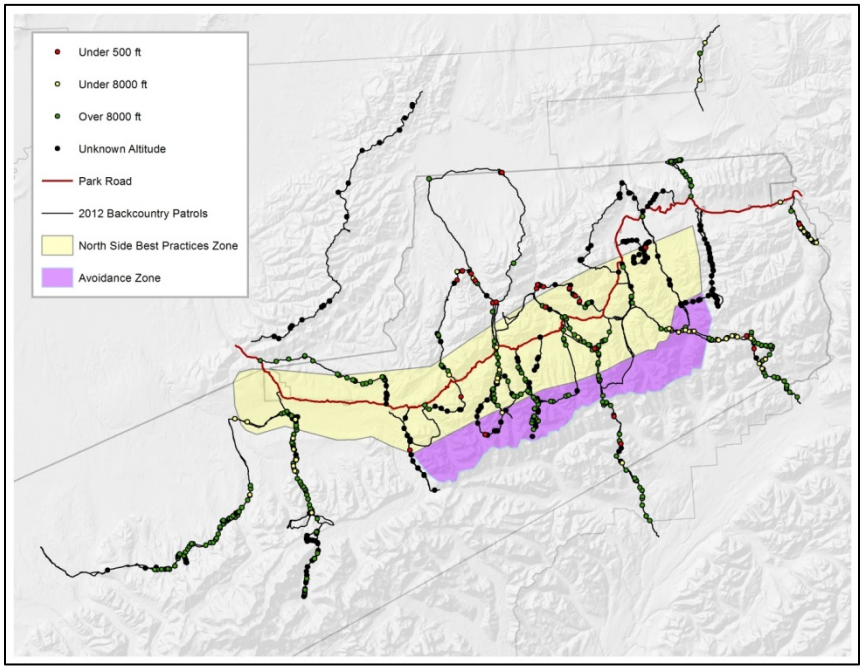
wilderness character. The Ranger-led discovery hikes are fully off-trail hiking and currently offered every day during the main summer season (June 8- Early September). Since 2009 rangers have recorded the path of their hike on a map along with the number of participants in a database. During the field season this enables the Interpretive Rangers to avoid hiking a route (with non-durable surfaces) more than twice by communicating their routes on a shared map. At the end of the season these routes are digitized and incorporated into GIS (see map below for 2012 routes). This dataset allows tracking of cumulative impacts. For example the next map shows line density for all hikes between 2009 and 2012. This analysis will be used to identify areas at risk for excessive informal trail impacts, impacts to opportunities for solitude, and to identify recommendations of areas for Discovery Hike leaders to avoid.

Informal (social) trail monitoring – In 2013 Seasonal Backcountry Rangers Alonzo Mandanna and Sam Hooper will continue the work done in 2012 to monitoring informal trails in the backcountry. This protocol was developed by Jeff Marion and Jeremy Wimpey of Virginia Tech and Denali's former Wilderness Coordinator Joe Van Horn. Rob Burrows has provide substantial assistance with these efforts. Informal Trails, are non-maintained trails, used by both humans and animals as travel corridors through various terrain and vegetation types. Informal Trails are a concern and monitored because they affect wilderness character, visitor experience, and left unchecked can cause human induced erosion problems. "Trail and campsite disturbance" is listed as a resource condition indicator in Denali's Backcountry Management Plan. Depending on the Management Area, the BMP specifies one of two desired conditions for this indicator: 1) Low: Visitors notice few if any signs of social trails, campsites, or cut or broken vegetation; 2) Medium: Visitors notice occasional social trails, campsites, or cut and broken vegetation. According to the BMP the "Medium" descriptor is intended to match conditions in the Designated Wilderness in areas accessible from the park road corridor.

In 2012 staff looked for and documented 205 informal trails leaving the Denali Park Road Corridor between Mile 3 and 88. This is the first inventory. Work in subsequent years will document any change in the number and degree of impact of these trails. In addition 12 informal backcountry trails were surveyed for length and degree of impact (census surveys). Four of these had enough data to compare to previous work in 1997, all showed growth, see the table below for a summary.

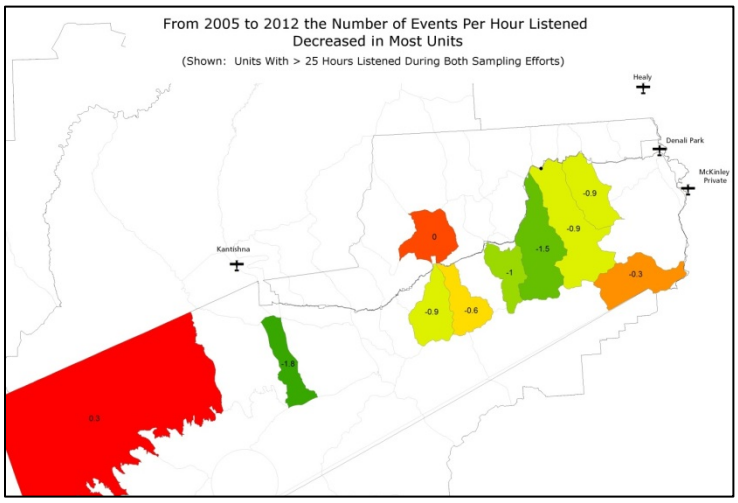
2012 Census Survey Results:Backcountry Unit & Total Length of informal trails in each unit

Area	1997	2012	Change
Unit 5 – Sanctuary	n/a	5124 ft.	n/a
Unit 6 – Cathedral - main trail	7363 ft.	8918 ft.	1555 ft.
Unit 6 – Cathedral - Spider trails	n/a	6582 ft.	n/a
Unit 10 – West Branch Toklat	n/a	6597 ft.	n/a
Unit 11 – Upper West Stony Creek*	5544 ft.	5944 ft.	400 ft.
Unit 11 – Fish (Krier) Creek*	2057 ft.	2709 ft.	652 ft.
Unit 12 – Eielson VC - south	n/a	20,164 ft.	n/a
Unit 13 - Grassy Pass	1609 ft.	n/a	n/a
Unit 13 - Grassy View Overlook	1583 ft.	4216 ft.	2633 ft.
Unit 16 – Windy Creek	n/a	2137 ft.	n/a
Unit 20 – McGonagall Pass*	82,613 ft.	Undeterminable	n/a
Unit 32 – Middle Toklat	n/a	320 ft.	n/a



Monitoring aircraft overflights – The Denali Aircraft Overflights Advisory Council updated their best practices recommendations for air taxi and flightseeing operators. This includes avoiding the crest of the Alaska Range and the area immediately north of the crest between Refuge Valley in the Sanctuary River drainage and Anderson Pass (avoidance zone). Data collected in the Park has been shared with the Advisory Council. This has been a productive and beneficial relationship with promise for continued success in mitigating overflight impacts to the Park. Soundscape stations and direct observations by backcountry rangers provide insight into how effective the best practices are in minimizing aircraft noise impact on backcountry visitors.

Observations by backcountry rangers on patrol show that only 11% of small fixed wing and helicopter aircraft (not jets) within site of the avoidance zone actually flew over the zone, 73% did not fly over the zone and the other 16% were unknown because the aircraft were obscured by clouds or terrain. The map shows all overflight observations for the 2012 season (circles.) GPS tracklogs and the north side best practice zone are also shown. The best practices also states that flighseeing aircraft should stay at a minimum 8000 feet altitude(msl) when not on take off and landing approach. The FAA advisory states that aircraft should stay above 500 feet above ground level when not on take off and landing approach. Backcountry observer data shows that ~10% of aircraft were observed flying below 8000 feet msl with ~50% confirmed above and the other 40% unknown. Approximately 3% of aircraft were observed below 500 feet with ~80% confirmed above and ~17% unknown. Finally, note that from a comparison analysis between backcountry observer data and stationary soundscape station data, the detection rates on any given day or hour agree closely.



A comparison of backcountry observer aircraft observations data between 2004/05 and 2012 show a decrease in the number of aircraft events, with ~1.5 times the number of events detected in 2004/05. See the map below for a spatial summary of this comparison. Although the study did not explicitly attempt to determine a cause for these changes, there are several possibilities that likely contribute. The first is that the NPS has been trying to avoid flight paths over the designated wilderness and instead fly north around the outer range when travelling between Kantishna and the entrance.

Another apparent and positive change to Denali's soundscape condition between 2005 and 2012 is that ERA Aviation has moved some of their helicopter flights out of the park, choosing instead to offer landings in the Alaska range east of the park. Technology, may provide another explanation. A general trend in Denali since the 1990's has seen the incorporation of larger aircraft into commercial fleets. This tendency to carry more visitors in fewer aircraft could also explain a reduction in the detection rate.

Wilderness Stewardship Training -

- On April 8, Dan Abbe and Rob Burrows provided a Wilderness Stewardship Training at the MSLC with contributions from Adrienne Lindholm from the Alaska Regional Office. It was attended by over 50 individuals (both in the room and attending via video conferencing), representing all Park Divisions and some Park Partners.
- On April 9, in the morning, the Park hosted Peter Landres from the Aldo Leopold Wilderness Research Center to present the Wilderness Character Spatial Model to the Denali Leadership Team and select Park Staff. It was a final briefing on the model before a final report and turning the model over to the Park. Only minor changes were requested. In the afternoon, a Wilderness Character Narrative Workshop was facilitated by Peter Landres. The purpose of the workshop was to develop a unique and special description of the Denali Wilderness which will help improve communication among staff and public. It will also help staff make more informed decisions about park planning, management and monitoring in wilderness. It was attended by 21 Park staff and a draft Narrative is expected to be ready for internal review sometime late this year.
- On April 10, the Park hosted a Wilderness Monitoring Workshop also facilitated by Peter Landres. This workshop's objective was to think about a suite of indicators (or measures in the language of the wilderness character framework) for wilderness character monitoring. It was attended by 11 park staff from four divisions.

Geographic Information System

By Jon Paynter jon_paynter@nps.gov

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 (SDMI) has been 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. Elevation data for almost all of Denali has been collected and is currently available at a 5 meter resolution replacing the older 90 meter USGS data. Five meter satellite imagery has also been collected and is available for almost half of the park.

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. Fifty-one quads will be produced in 2013 and an additional 54 in 2014. The final effort will result in approximately 170 new topo quads for the park.

The park maintains a copy of the entire NPS GIS dataset for the state of Alaska locally (over 3.0tb 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. As receivers have become smaller, cheaper, and more precise, the number of units in use in the park has grown dramatically. The tool has become a common addition to backpacks along with the first aid kit and map. 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.

Aspen Phenology Monitoring

By Carl Roland carl_roland@nps.gov

The Central Alaska Network is monitoring phenology because there is considerable evidence from studies around the world that global 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. Park staff began monitoring the timing of flowering, leaf-out and senescence (phenology) in aspen (*Populus tremuloides*) in Denali in 2005, and have started making observations in other areas of interior Alaska in the intervening years.

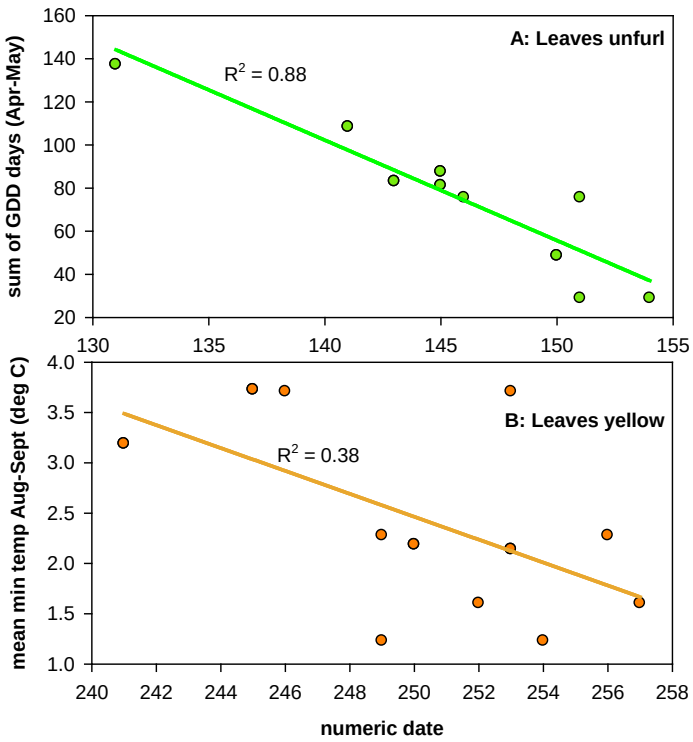


Fig. 1. Relationship between A) the date leaves unfurl and growing degree day sum for Apr-May and B) the date leaves turn yellow and mean min. temp in two Denali plots for the years 2005-2012.

Park staff chose aspen because it is a circumpolar species studied by other phenology monitoring programs in the country. 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.

Initial results suggest leaf-out in aspen is highly correlated with spring temperatures: leaf-out occurred up to 20 days earlier when the sum of growing degree days had accumulated 100 more degrees during the months of April and May (Fig 1). The onset of senescence was correlated with mean minimum temperature in August and September (Fig. 1) and the progression of senescence was somewhat negatively correlated growing season rainfall, suggesting cold temperatures trigger the start of senescence and wet summers may speed up process of senescence. Park staff also found the growing season length varied from year to year—for example, in one plot in Denali the longest growing observed was 114 days in 2005 and the shortest was 90 days in 2006, representing a possible 22% variability in growing season length. This represents a considerable difference in time available for growth and development among years. In this example, the difference in growing season length was mainly due to varying dates of green up, while dates of senescence were more stable.

Overall, these initial observations suggest warmer springs will lead to earlier green-up and longer growing seasons, while warmer, drier summers and autumns may lead to later senescence. This longer growing season may lead to increased aspen growth.

Surface temperature along elevation gradients

By Carl Roland carl_roland@nps.gov

The goal of this project is to measure ground surface and air temperatures along elevation gradients in three national parks: WRST, YUCH and DENA to better understand the relationship between elevation and temperature in mountainous areas and how this impacts vegetation patterns. The impetus for the project came from the following observation: treeline, shrubline, and tundraline are about 200 to 400 meters higher in WRST and YUCH relative to Denali. Is this difference related to growing season temperatures?

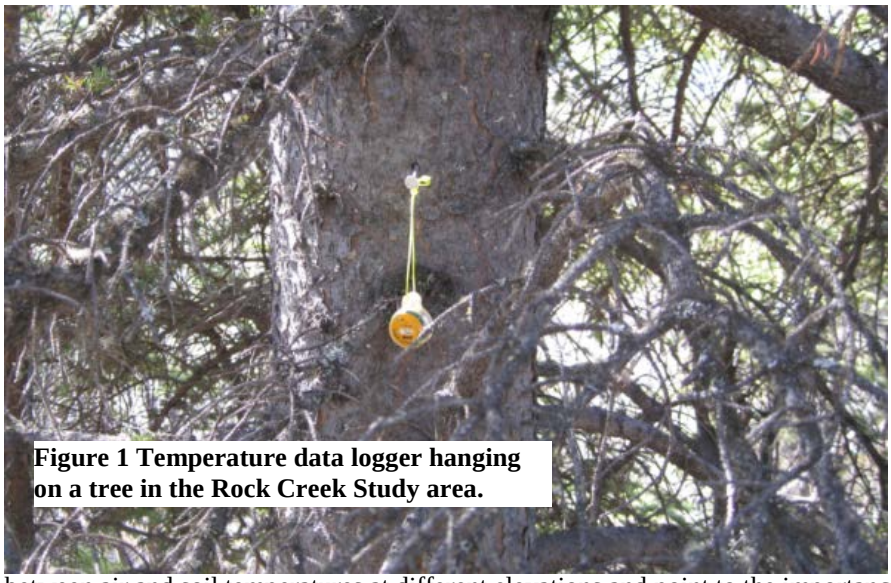


Figure 1 Temperature data logger hanging on a tree in the Rock Creek Study area.

This study is slated to begin in 2013 in all three parks. To prepare for this 3-park study, park botanists tested temperature data loggers (Fig. 1) along elevation transects on the north and south side Mt. Healy and in the Rock Creek study areas starting in 2010. These initial data show interesting differences between air and soil temperatures at different elevations and point to the importance of moss as a soil insulator.

Air temperatures at the treed sites (permafrost, forest and permafrost) were quite similar, while the tundra air temperatures were consistently about 4°C cooler than the forest plots (Fig. 2). In fact, the difference between the forest (739 m elev) and treeline (977m elev) sites was less than the expected difference based on a known temperature lapse rate of 6.5°C per 1000m, whereas the observed difference between the forest and tundra sites was close to the expected lapse rate. It is possible that the trees and thicker vegetation at the treed sites act to moderate the temperatures in these areas, that is, the insulation provided by vegetation and resulting diminution in heat transfer between the ground and atmosphere may dampen variation in air temperatures in the more densely vegetated areas.

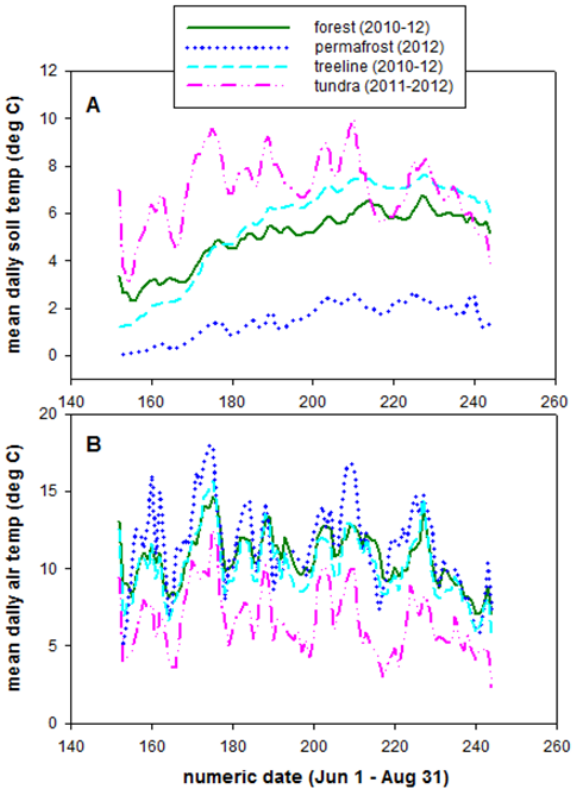


Figure 2 Means daily soil temperature (A) and mean daily air temperature (B) during Jun – Aug .

Air and soil temperatures showed opposite patterns as one climbed in elevation: permafrost sites had the highest mean air temps, but the lowest soil temps and tundra sites had the lowest air temps and the highest soil temps (Fig. 2). This pattern is likely the result of thick insulating layer of moss that are more prevalent at lower elevations and often absent at high elevations (Fig. 3).

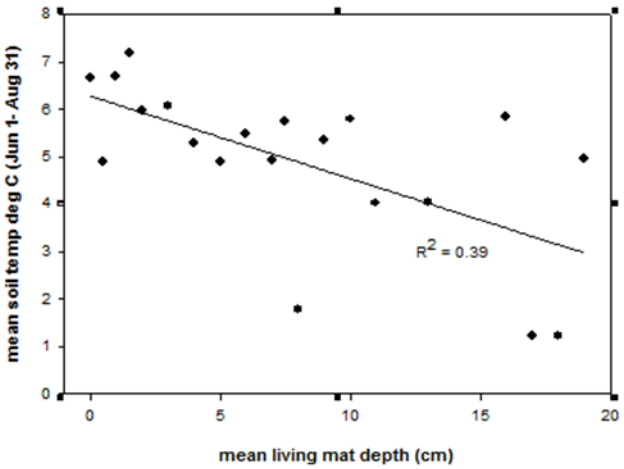


Figure 3 Relationship between mean summer soil temperature and living organic mat depth.

Muldrow Glacier Succession Plots

By Carl Roland carl_roland@nps.gov

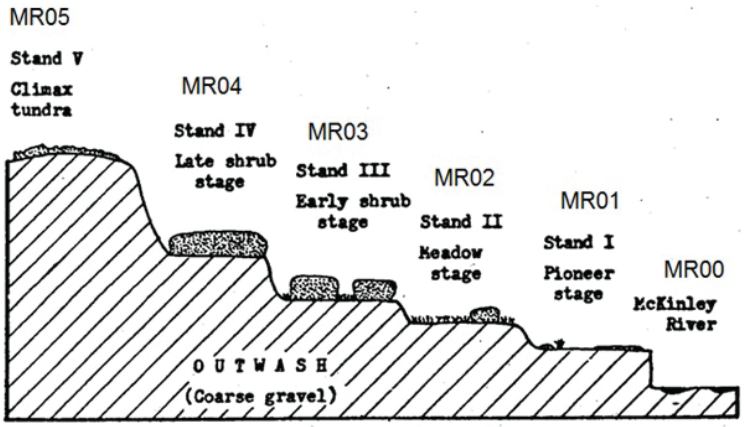
During the 2012 field season, Denali botanists re-measured historic vegetation plots located just west of the Muldrow Glacier terminal moraine in outwash of the McKinley River. The goal was to compare plant and soil succession on terraces of the river.

History of the plots

Dr. Leslie Viereck established permanent quadrats on the gravel outwash of the Thorofare River and on the McKinley River in 1958. In the two McKinley River plots, Viereck mapped vegetation and also recorded species cover. 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. Plots along the new transects are designed to document species composition and cover for tree and shrub data. In 2000, staff attempted to locate the 1958 permanent quadrats and the 1975 transects. The two permanent quadrats were located, but only one transect could be positively located. New transects were laid out in the vicinity as the missing transects using maps and photographs to approximate the right location. During the 2000 revisit, Denali researchers established a new transect to represent an early pioneer stage. This transect is located on a new gravel bar (it didn't exist in 1958) that is immediately adjacent to the McKinley River.

About the terraces

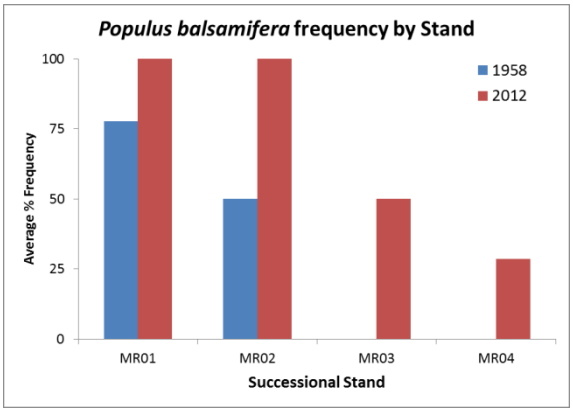
The terraces or steps (see diagram below) represent stages of vegetation: early pioneer stage (MR00), pioneer (MR01), meadow (MR02), early shrub (MR03), late shrub (MR04), and climax tundra (MR05). The age of these steps ranges from 25-30 years old (pioneer stage) to 200-300 years old in the late shrub stage, and range in elevation from 748m at the early pioneer stage to 779m at the climax tundra stage.

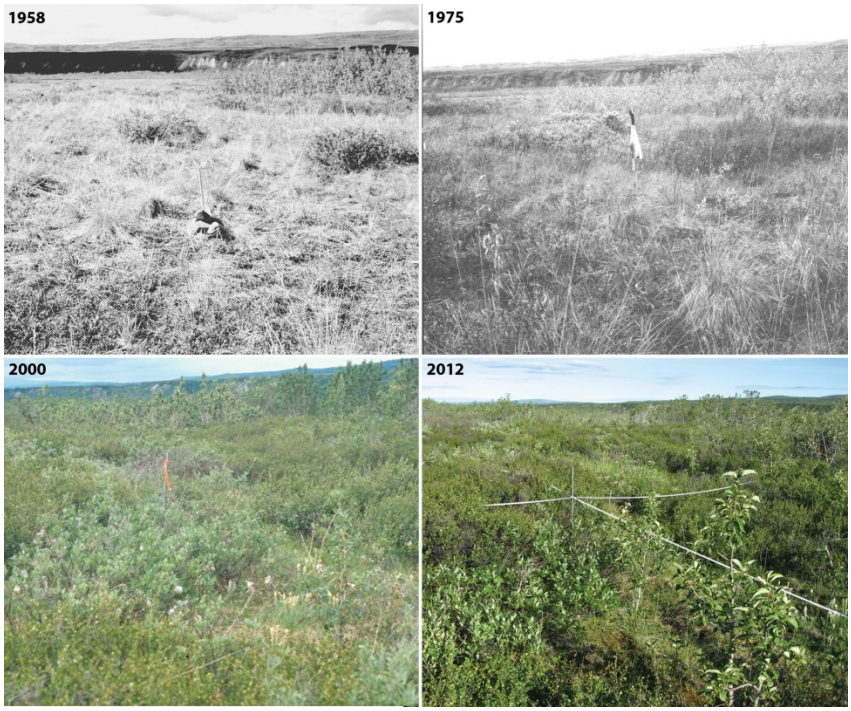


Planned activity in 2013

Now that Denali botany staff has revisited the Muldrow terraces and collected 2012 data that can be compared with the 1958, 1975, and 2000 data, there is much work to be done. The detailed vegetation measurements staff collected, including species composition, species cover, tree and shrub counts, and repeat photos are currently being analyzed. Preliminary results suggest that succession has progressed along the trajectory outlined

by Dr. Viereck (as shown in the above diagram and the photo series below) but that the frequency and abundance of particular species has changed in somewhat unexpected ways. The presence of balsam poplar (*Populus balsamifera*) for example, has greatly increased (see diagram). Further analyses will allow a more thorough investigation of this and other related phenomena.





This photo series of permanent quadrat #1 (located in MR02) shows succession of vegetation from the meadow stage into the early shrub stage. The stake in each photo marks the exact same position. Over 54 years, this site has converted from an open sedge meadow with scattered low shrubs to a nearly closed shrub community. Note also the growth of a stand of poplars in the background of the photos, and their invasion into the quadrat area.

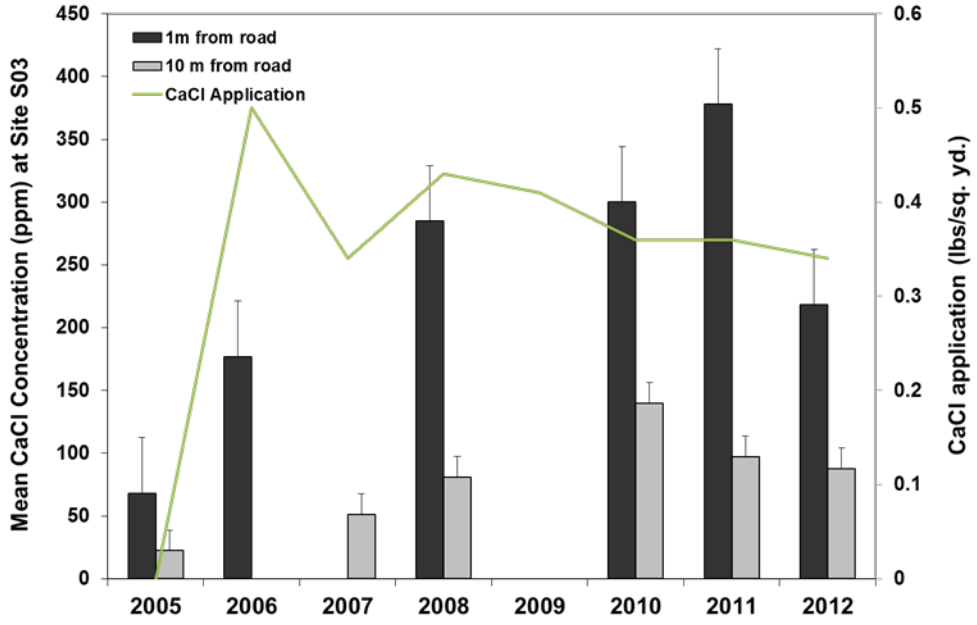
Monitoring Dust Palliatives on the Park Road

By Carl Roland carl_roland@nps.gov

To reduce road dust created by vehicular traffic, park maintenance crews apply an aqueous solution of calcium chloride (CaCl2) to the surface of the park road. The application reduces dust and the need for replacing the fine materials constantly lost from the road as dust. However, adding this compound also has the potential for adversely affecting ecosystems adjacent to the road. The National Park Service has developed a monitoring plan to assess and monitor the possible effects on soil, water, and vegetation of applying calcium chloride to the park road.

In 2005, park staff installed 15 pairs of lysimeters (instruments designed to sample water from within the topsoil) at Mile 15.2, 18.6, 22.2, 23.4, 26.9, 28.9, 31.2, 41.5, 49.1, 58.4, 60.4, 64.5, 71.3, 79.8, and 88.4—one lysimeter was buried near the road, and one about 10 meters away. Water samples are being taken annually from lysimeters and nearby water bodies to test for chloride ions.

Chloride concentration (2005-2012) and chloride application from the soil water sampler at Milepost 18.5 is shown below. Staff will continue to monitor these and other stations in 2013.



Rock Creek Annual Plot Measurements

By Carl Roland carl_roland@nps.gov

The Botany program continues to monitor permanent plots installed in 1992 within the Rock Creek drainage near Park Headquarters. One such variable documented annually is the growth rate, cone production, and seed production of white spruce (*Picea glauca*) trees. Spruce cone production has been quite variable among years during this study - with especially high productivity observed in the years 1998 and 2000; high productivity in 2002, 2004, and 2008; especially low productivity was observed in the years 2003, 2006, 2007; and low productivity in 1999, 2001, 2009, and 2011. On average, the trees in the forested sites have produced more cones per tree than did trees in the treeline plots over the course of this study.

A notable trend in Figure 1 is the general alternation between successive years of relatively high cone-counts to relatively low cone-counts. For example, in 1998 the mean number of cones per tree on both forest and treeline sites was relatively high. Then in the very next year, 1999, cone-counts were relatively low at both sites.

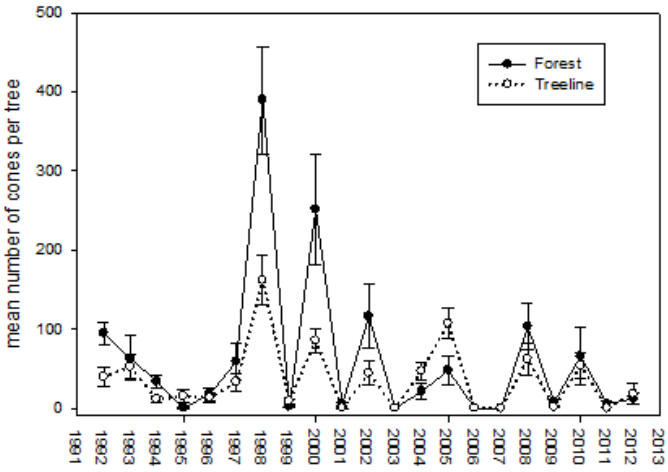
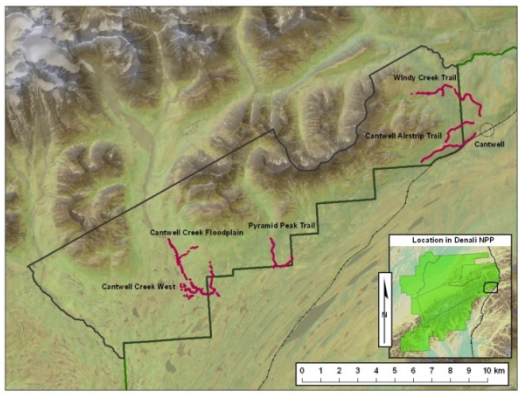


Figure 1. Average number of cones per white spruce tree observed in 3 treeline and 3 forest (valley bottom) plots in the Rock Creek drainage 1992-2012.

Off-Road Vehicle (ORV) Impacts

By Carl Roland carl_roland@nps.gov



Subsistence use ORV trails in the Cantwell Traditional Use Area

In 2012, staff completed the sixth season of the ORV impacts monitoring program in the Cantwell Traditional Use Area (TUA). Using Trimble GPS units with sub-meter accuracy, technicians mapped 10.7 km of trail in the Cantwell TUA. In regards to the three main subsistence ORV trails of the Cantwell TUA (Windy Creek, Pyramid Creek, and Cantwell Creek) there has been about a 20% decrease in total mapped trail length since 2007. This reduction in trail length is partially due to the consolidation of trail-use to the designated trail and less frequent travel over previous user-created trails. The following attributes are measured to asses ORV impact: trail type (main active, secondary inactive), trail width, number of parallel paths along the trail segment, level of vegetation stripping on the trail, depth of trail compared to adjacent areas, muddiness, and depth of soil damage below the organic mat. Repeat photography of all ORV trails is also conducted. Within the Cantwell TUA these photos show that impact conditions have generally remained similar over time. The Cantwell Creek Floodplain Trail saw damage to sections of trail directly adjacent to Cantwell Creek. Technicians presume the high flood-event during September of 2012 washed-out key sections of the trail along the creek (*Figure 2*). Continued annual monitoring of ORV impacts will be particularly necessary in order to observe and document interannual variability of existing impacts and potential future incursions.

Figure 2. Repeat Photos, Cantwell Creek Floodplain Trail.

In 2013, staff will monitor ORV use in the Cantwell TUA by way of repeat photography and trail mapping. In an area just west of the Cantwell Creek Floodplain, the resources have experienced considerable injury due to past ORV incursions. On several vegetation recovery plots in this area, technicians collect data such as species composition and cover, soil type and depth, and repeat photos. Park researchers will analyze these data accordingly and use the results to help carry-out resource management objectives within the park, and specifically within subsistence ORV use areas.

Invasive Plants

By Wendy Mahovlic wendy_mahovlic@nps.gov

Boy Scouts from Healy – June 6, 2012

- 5 Boy Scouts and 1 Boy Scout leader; 1 SCA (Student Conservation Association) intern
- Pulaskied, planted, and raked native seeds – Shaffer Building and C-Camp Parking
- 24 hours

Dandelion Deveg – East End – June 11 - 15, 2012

- 8 SAGA (Southeast Alaska Guidance Association) Volunteers; 1 SCA
- 320 hours
- Mile 15 – 44 Park Rd.
- 420 lbs. of dandelions dug

Dandelion Deveg – West End – June 18 - 23

- 1 volunteer; 1 SCA
- 48 hours
- Mile 76-91 Park Rd.
- 120 lbs. of dandelions dug

Stapley Family – July 19

- 6 family members – 1 parent and 5 children under the age of 10 yrs. old; 1 SCA
- 24 hours
- Pulled dandelions and *Crepis tectorum* from Mile 1 Park Rd.
- 15 lbs.

Invasive Eradication – July 23 – 26

- 8 SAGA volunteers
- 256 hours
- Mile 1 – 3 Park Rd. Pulled *Crepis tectorum, Melilotus alba, Hordeum jubatum, Vicia cracca, Hieracium umbellatum, Linaria vulgaris*
- 566 lbs.

Need for Seed – East End – Aug. 15 – Aug. 16

- 2 volunteers
- 48 hours
- 3 lbs. of *Oxytropis campestris, Hedysarum alpinum, Elymus sp., Leymus innovatus, Hedysarum Mackenzii.* Uncleaned seeds.

Need for Seed – West End – Aug. 20 – Aug. 25

- 4 volunteers
- 192 hours
- 10 lbs. of *Oxytropis campestris, Hedysarum alpinum, Elymus sp., Leymus innovatus, Arnica lessingii.* Uncleaned seeds
- Planted and raked native seeds – Mile 80 – 84 Park Rd. project (really Mile 74 – 84).

SCA Intern – Henry Ring – May 21-Aug. 13

- 1 volunteer
- 478 hours
- Pulled many invasive plants, mapped them with a GPS, pulaskied, planted and raked native seeds. Participated and assisted with Boy Scouts, Dande Deveg East and West, and Stapley Family.

That's a total of 36 volunteers for 1390 hours.

TOTALS

INVASIVES ERADICATED
Taraxacum officinale (dandelions): 1138 lbs. – found mainly mile 1-40 Park Rd. and mile 76 - 92 Park Rd. 528 lbs. were pulled by an NPS Maintenance worker (Jurine) at Denali Headquarters.
Crepis tectorum (narrowleaf hawksbeard): 117 lbs. – found mainly in the Sewage Lagoon and mile 1 of the Park Rd. and ARAMARK bus parking lot.
Melilotus alba (tall white sweetclover): 60 lbs. – found mainly at Mile 238 Parks Hwy.
Vicia cracca (bird vetch): 55 lbs. (lots of dirt) – found Mile 231.75 Parks Hwy and McKinley Chalet. Sprayed herbicide on 5 small populations Mile 1 Park Rd.
*Tripleurospermum perforate (*scentless false mayweed): 2 lbs. – found at the Railroad tracks – Denali Depot and Shaffer Bldg.
Linaria vulgaris (yellow toadflax): 2 lbs. – found at the Railroad tracks - Denali Depot
Hieracium umbellatum (narrowleaf hawkweed): 5 lbs. – found at Mile 231.75
Hordeum jubatum (foxtail barley): 599 lbs. – found at State pull-out Mile 238 Parks Hwy; scattered Mile 1 – 2 Park Rd.
Trifolium hybridum (alsike clover): 40 lbs. (lots of dirt) – Kantishna Horse Corral
Silene noctiflora (night-blooming cockle): .25 lb. – Kantishna Horse Corral
Galeopsis bifida (Hempnettle): 5 lbs. (lots of dirt) – Kantishna Horse Corral

Invasives pulled - total = 2066 lbs.

Exotic Plant Management Team (EPMT) staff inventoried: 62 acres
Infested with invasive plants: 19 acres
EPMT staff treated: 10.5 acres

NATIVE SEEDS COLLECTED
East End:
Oxytropis campestris: 1 lb.
Hedysarum alpinum: .5 lbs.
Elymus sp.: .5 lbs.
Leymus innovatus: .5 lbs.
Hedysarum mackenzii: .5 lbs.
TOTAL = 3 LBS.

West End:
Hedysarum alpinum: 2 lbs.
Elymus sp.: 3 lbs.
Leymus innovatus: 1 lb.
Hedysarum macksenzii: 1 lb.
Oxytropis campestris: 2 lbs.
Arnica lessingii: 1 lb.
TOTAL = 10 LBS.

Native seeds collected (uncleaned) total = 13 lbs.

Total area revegetated by planting native seeds = 1.95 acres

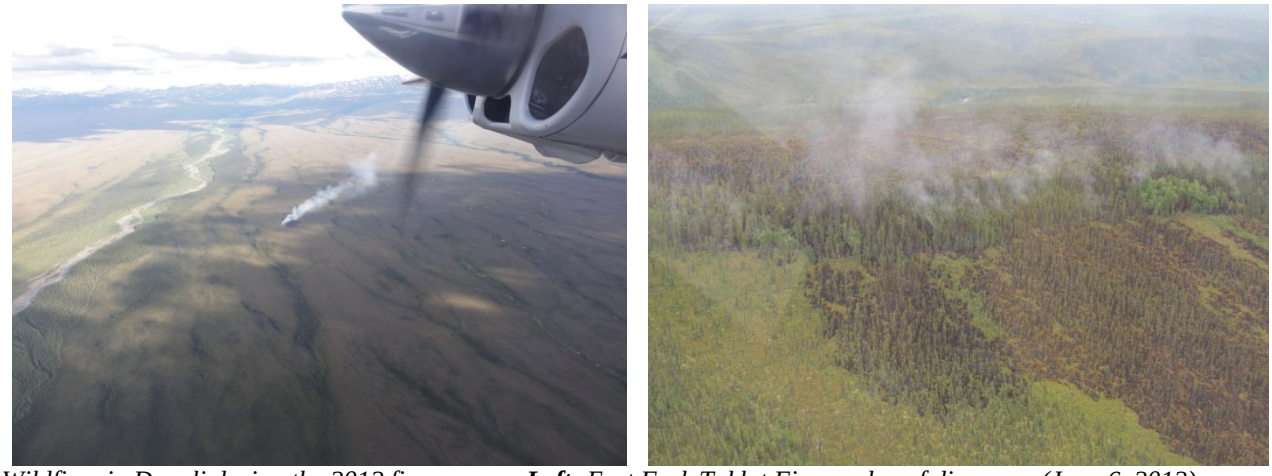
- Kennels road re-alignment: Reveg Tech and SCA intern. 15 hours total
- Shaffer Bldg. and C-Camp parking: Reveg Tech, SCA intern and 6 Boy Scout volunteers. 28 hours total
- Distribution box near MSLC (part of Waste Water Treatment Plant): Reveg Tech and SCA intern. 5 hours total
- CLA (Concession Land Assessment) Bldg.: Reveg Tech. 8 hours total.
- Mile 80 – 84 Park Rd.: Reveg Tech and 4 Need for Seed Volunteers. 32 hours total (travel time not included).
- Mile 92 Park Rd.: Reveg Tech. 2 hours total (travel time not included).

Wildland Fire

Contact: Larry Weddle, Fire Management Officer larry_weddle@nps.gov

Fire Highlights for 2012

There were two wildfires in Denali in 2012. The East Fork Toklat Fire, discovered by BLM Alaska Fire Service detection aircraft at 7:40 pm on June 6th, was fairly active at the time of discovery. However a late night rain shower, on the night of the discovery, moderated all fire behavior creating a very short duration fire. The fire was declared out on June 9th and ultimately burned 4.1 acres. The second fire was discovered by a charter pilot on June 24th and estimated to be 3 to 4 acres. Approximately 4 hours later the Glacier Creek had reached 30 acres and was 11 miles north of Kantishna. On the evening of June 24th precipitation on the fire significantly reduced the fire activity and remained at 212 acres until the fire was declared out on July 5th.



Wildfires in Denali during the 2012 fire season. ***Left:*** *East Fork Toklat Fire on day of discovery (June 6, 2012). Photo from BLM Alaska Fire Service.* ***Right:*** *Glacier Creek Fire one day after discovery (June 25, 2012). NPS Photo.*

On numerous occasions in 2012, 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 nearby fires. For example, the Fire Exclusive Use Helicopter was utilized as an initial reconnaissance platform on the Bear Creek fires, supporting the State of Alaska's Division of Forestry, Fairbanks Area. Denali's fire staff detailed to the Alaska Interagency Coordination Center Type 2 helicopter module for support of multiple fires in the lower 48.

There were two wildland fires and three prescribed fires in Denali in 2012:

Fire Name	Burn Period	Acres	Fire Type	Comments
East Fork Toklat	6/6/12 – 6/9/12	4.1	Wildfire	Fire ignited by lightning
Glacier Creek	6/24/12 - 7/5/12	212.7	Wildfire	Fire ignited by lightning
Lower Windy Pile Burn	3/2/12 - 3/9/12	0.7	Prescribed Fire[1]	Burning of biomass debris from hazard fuels treatment projects
Admin Road 1 Pile Burn	3/14/12 - 3/19/12	1.9	Prescribed Fire[1]	Burning of biomass debris from roadside maintenance projects and hazard fuels treatment projects
Toklat Pile Burn	4/24/12 - 4/27/12	0.9	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.

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 2012, fire management staff improved the defensible space (about 7 acres) at Park Headquarters, Visitor Center and at Toklat by trimming branches to varying heights from the ground to give a natural appearance.

During 2013, 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. 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: http://www.nps.gov/fire/wildland-fire/connect/fire-stories/2013-parks.cfm

Left: *Denali Headquarters in the 1940s. Evidence of the 1924 fire around the Denali front country is slightly visible in the background hills.* ***Right:*** *Denali Headquarters area in 2013. The ingrowth of trees blocks the view of the buildings. NPS photo 2013.*

Defensible Space Projects planned for 2013:

Project Name	Date	Acres	Project Type	Comments
Headquarters Residential	05/13 – 09/13	2.0	Maintain Initial Treatment	Maintain defensible space
CCamp	05/13 – 09/13	1.0	Initial Treatment and Maintain Initial Treatment	Create/improve defensible space
Toklat Road Camp	05/13 – 09/13	2.0	Maintain Initial Treatment	Create/improve defensible space
Moose Creek	05/13 – 09/13	.4	Initial Treatment and Maintain Initial Treatment	Create/improve defensible space
Busia Cabin	05/13 – 09/13	.65	Initial Treatment	Create Defensible Space
Stampede Mine	05/13 – 09/13	1.0	Maintain Initial Treatment	Maintain Defensible Space
Gallup Cabin	05/13 – 09/13	.65	Maintain Initial Treatment	Maintain Defensible Space
Crooked Creek Cabin	TBA	TBA	Evaluation	Evaluate need of defensible space

Prescribed Fires Planned for 2013

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 2013, staff will burn debris from past hazard fuels projects at the Headquarters, Visitor Center and Toklat. During the Parker Cabin Pile burn this spring, the fire crew was supported by the Kennels dog team to access the site. See this fire story that documents this adventurous way of conducting pile burns in 2011: http://www.nps.gov/fire/wildland-fire/connect/fire-stories/2011-parks/denali-national-park-and-preserve.cfm

Prescribed fires planned for 2013:

Fire Name	Fire Date	Acres	Fire Type	Comments
Admin Road 1 Pile Burn	10/23/12 - 11/3/12	5.2	Prescribed Fire	Burn Biomass debris from roadside maintenance projects and hazard fuels treatment projects.
Parker Cabin Pile Burn	2/20/13 – 2/23/13	1.1	Prescribed Fire	Burn Biomass debris from hazard fuels treatment projects.
Toklat Pile Burn	2013	0.9	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.

Fire effects are monitored by establishing vegetation/soil plots in front of active fires or after fires to evaluate the changes as a result of fire on vegetation, wildlife habitat, or soils. Similarly, *hazard fuels reduction (thinning) treatment* effects are monitored by establishing vegetation/soil plots prior to hazard fuels reduction treatments and evaluating them before and after hazard fuels treatments. The fire ecology monitoring fieldwork in Denali is largely accomplished by Western Area Fire Management seasonal technicians and permanent staff, under the guidance of the regional fire ecologists.

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 2012 and plans for 2013 in Denali. Photo monitoring at back-country hazard fuels reduction sites will continue in 2013.

❖ **Live Fuel Moisture Monitoring**

A large effort by the interagency fire community was put forward during 2012 to monitor live fuel moisture in Alaska. In the spring, the AK NPS Regional Fire Ecologist led a Fuel Moisture Sampling class in Fairbanks to train people on sampling foliar (conifer), woody (shrubs), herbaceous, and duff moisture. Two of the Western Area Fire Management staff attended the training. Four sites in Alaska, including the Denali DVC RAWS station area, were monitored for live fuel moisture every two weeks throughout the summer season. The data for Alaska was entered in the National Fuel Moisture Database for the first time (http://www.wfas.net/index.php/national-fuel-moisture-database-moisture-drought-103). This information is used to model fire behavior and fire danger in Alaska. Prior to this project, only minimal sampling of live fuel moisture has been done in Alaska. Efforts are planned to continue sampling in 2013.

Denali Western Area Fire Management Officers record data about fuel moisture samples (Left) and Denali fire staff sample duff moisture at the DVC RAWS site in Denali (Right). 2012 NPS Photo.

❖ **Hazard Fuels Treatment Monitoring**

Monitoring fire management fuels treatment projects is important for adaptive management. One of the first major hazardous fuel reduction projects was conducted at Denali Park Headquarters, Denali Visitor Center, Employee Housing, and the Toklat Roadcamp in 2004. A study to monitor the implementation and effectiveness of this fuels reduction project was developed and designed to (1) evaluate whether the hazard fuels prescription was implemented, (2) model the effects of the fuels treatment on potential fire behavior, and (3) monitor the effects of the fuels treatments on vegetation and fuels. Plots were established in 2003 (pre-thinning) and the thinning was completed in 2004. Re-measurements of the plots were taken in 2005 (1-year post thinning) and 2009 (5-years post thinning). In 2013 additional sampling is planned in the Toklat Roadcamp Area. A final report on this project will be completed in 2014.

Fire Education

✧ Western Area Fire Management, the Regional Fire Communication and Education Specialist, and MSLC staff will continue to incorporate wildland fire management messages in select presentations.

✧ The Alaska Western Area fire staff will seek to promote the revised Alaska FIREWISE concept in 2013 and assist with Firewise workshops that teach community members how to reduce the combustible material around their homes to reduce the risk of wildland fire.

✧ Each year Fire Management staff provides updated maps and information about fires in and outside of the park. Fire danger information is also updated and posted at various locations. Three fact sheets are available—
Wildland Fire Risk and Response: Why are you cutting those trees? Where is all that smoke coming from?
Wildland Fire Ecology

Wildlife

Keep Wildlife Wild

By Pat Owen patricia_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 2010, staff distributed these materials around the park and will do so in 2011. Signs appear on trash cans, picnic tables, and toilet stall doors. The message has also become part of every interpretive program.

The National Park Service recently formed a steering committee composed of representatives from each of the NPS regions to address the issue of wildlife habituation throughout NPS areas. The goals are to determine the extent of habituation and the species involved and to standardize our management methods for habituated wildlife throughout the service. Pat Owen, Wildlife Biologist, was selected to serve on the committee and will use the information compiled by the group to continue to improve on Denali's efforts to Keep Wildlife Wild.

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 patricia_owen@nps.gov

Grizzly Bear Monitoring - West

This long-term study on the north side of the Alaska Range focused on a sample of grizzly bears between the Muldrow Glacier and the Herron River. Radio-collared females were located from den emergence to the end of September to locate and follow the mortality of the sows and their cubs. The study was brought to a close in 2012 as bear monitoring efforts make the final shift to a new study area and objectives.

Bear capture was conducted on May 17 from a helicopter, with fixed-wing aircraft support. Wildlife staff removed the collar from one female grizzly bear. One bear dropped a collar which was retrieved from the study area. The last collared bear in this study area was in a location that prohibited capture and removal of the radio collar. For the 2012 season, wildlife staff followed this last collared female bear for most of the season. She was accompanied by two spring cubs. Plans are to remove this last collar in May 2013.

Grizzly Bear Monitoring – North

The transition to a new grizzly bear monitoring study area began in 2009. The new study area in on thenorth 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 from May 16, 17, and 18, 2012 from a helicopter, with fixed-wing aircraft support. A total of six bears was captured, two females and four males, including one male black bear. Three bears, captured for the first time, including the black bear, and one recaptured bear were fitted with GPS radio collars. One very large newly captured male bear was fitted with a conventional VHF radio collars due to size. One very small male was not collared.

Six females produced a total of 12 cubs, four litters of twins, one litter of 3, and one single cub. By late August five cubs remained. Two females had a total of 3 yearlings of which one remained at the end of the season. There was one litter of two 2 year olds that survived the entire season and a single 3 year old that likely dispersed.

Bears were radio tracked one to two times per month from May through September. No bears were located outside the park boundary on any flight. All GPS collars automatically released in September 2012. Finer resolution GPS data has been downloaded from the collars. Analysis of these data will determine travel by bears outside the park boundary. There are currently 4 bears wearing VHF collars in the study.

Plans for 2013 are to analyze GPS radio collar data from the previous 2 years. We will also replace 4

VHF radio collars deployed in 2012 with 4 refurbished GPS collars and possibly deploy additional GPS collars on 2 uncollared bears. All bears will be radio tracked one to two times per month.

Bear Management

By Pat Owen patricia_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 four bears have been destroyed, one sent to a wildlife park, and two relocated by the National Park Service.

Between May 22, 2012 and September 12, 2012, 69 bear-human interactions were documented. These were classified as 3 observations, 50 encounters, and 16 incidents. The total of 69 BIMS this year marks a 46% increase from the previous year's total of 47. Of those interactions rated as encounters, 22 occurred in the frontcountry and 28 occurred in the backcountry. Of the 16 interactions classified as incidents this season, 11 occurred in the front country while the other 5 occurred in backcountry.

Backcountry: Backcountry interactions between humans and bears increased from 30 in 2011 to 33 in 2012, an increase of 9%. Of these backcountry interactions, five were considered incidents. One of the incidents involved extensive injury to a person, resulting in the park's first bear caused human fatality. Of the other four incidents, three involved property damage and one was a general incident.

Frontcountry: In 2012, there were several instances of Black bears in JV housing and the front entrance area early in the season. There were also two calf killings in the campgrounds that we decided for safety reasons to move the bear off the carcass and dispose or relocate the carcass. The reported frontcountry interactions in 2012 increased 52% from 2011.

Interactions	FRONTCOUNTRY	BACKCOUNTRY	TOTAL
Observations	0	3	**3**
Encounters (when bear is aware of human and thus the bear's behavior is altered)	22	28	**50**
Incidents(when bear is involved in close charge, actual contact, or damage to human or property)	5	5	**10**
Control Actions	6	1	**7**
Total	**33**	**37**	**70**

Bear-human interactions in Denali that were documented in 2012 in the Bear Incident Management System (BIMS) database

Moose

By Pat Owen patricia_owen@nps.gov

In 2011, wildlife biologists used a spatial moose survey estimation method to estimate the number of moose (*Alces alces*) on the north side of the Alaska Range in Denali. The 10,004 km2 (3862 mi2) area was surveyed from November 10-23. Observers noted 496 moose during the aerial survey. Using the estimation method, there are an estimated 1477 +/- 238 moose for the entire survey area. (There is a 90% chance that the real population number falls within this confidence interval.) Overall density was 0.15 moose/km2 (.38 moose/mi2). The calf:bull:cow ratio was 29:53:100. The survey results indicate that 75% of cows were without calves, 21% of cows had 1 calf, and 4% of cows had 2 calves present.

In 2012, moose surveys were planned for two areas on the south side of the park that are important to subsistence users. Funding was provided by the regional subsistence management division to conduct surveys in the Cantwell and Yentna Rivers areas. Unfortunately, snow conditions were not acceptable for accurate surveys during the time frame in which the surveys should be conducted. It is expected that the funding will be available to attempt surveys of these areas again in Fall 2013.

Caribou

By Layne Adams ladams@usgs.gov

Population dynamics of the Denali Caribou Herd has been investigated continuously at Denali National Park since 1984. Denali National Park, totaling 18,800 km^2, encompassing nearly the entire Denali Herd range, provides 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 American black bears) are driven by primarily by natural processes and are largely unaffected by human harvest. Thus, research on Denali's large carnivore/ungulate system serves as an important naturally-functioning benchmark for comparison to manipulated systems throughout northern North America. Further, caribou investigations are a component of Denali's large mammal monitoring program, supplying objective information on the status and long-term trends of park wildlife populations and understanding of 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. In the mid-1980s, the Denali Herd was increasing at about 7%/year during a long period of relatively mild winters. Survival of caribou cows was high (96%/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 by fall 1989, then declined by nearly a third to 2,300 caribou by fall 1992. During the decline, adult cow survival dropped substantially, to an average of 85%/year, and calf recruitment dropped to just 5%. During 1993-2003, with a return to moderate winter snowfall, the caribou herd continued to decline, but a much slower rate of about 2% 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%). 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 $\geq$ 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 9 years (2004-12), calf survival to fall has improved, averaging 28% annually, allowing for limited growth of the herd at about 2.5% per year. The age structure is still weighted disproportionately to older females (17% females $\geq$ 13 years old in May 2012) and therefore susceptible to a sizable decline should the region experience one or more severe winters.

In addition to the basic population monitoring patterns of growth, survival and seasonal distribution of male caribou have been investigated since 2007. In general, little is known about the population ecology of male caribou because research and monitoring efforts are commonly focused on adult females and their dependent young. Information on male survival patterns is sorely lacking, even though males generally accommodate the majority of the take in harvested populations. Although prior to these studies little was known about male mortality of Denali caribou, two interesting and unexpected patterns arose from investigations of wolf kills in Denali during 1986-93. First, large male caribou showed up in the wolf kill primarily in August and September prior to the annual rut, when caribou bulls should have been in peak condition. High mortality following the rut resulting

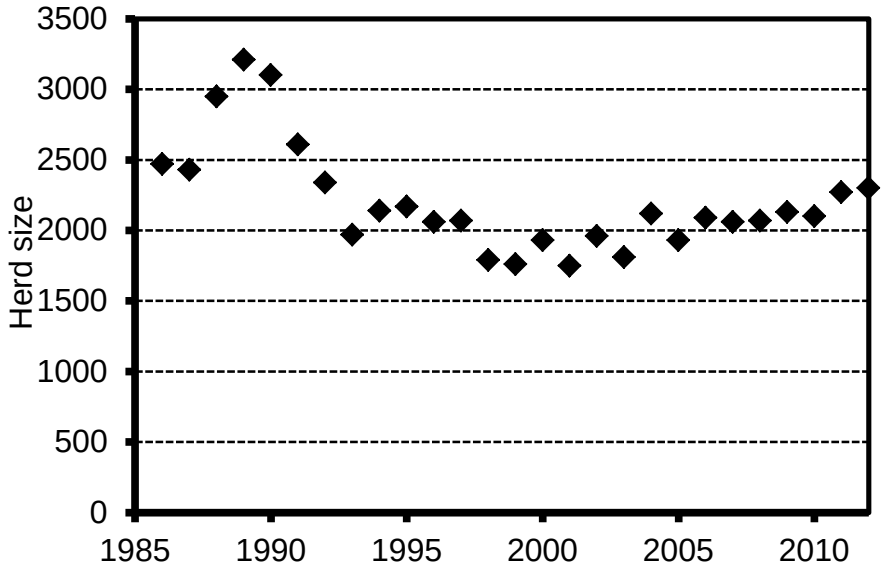
from the deteriorated nutritional condition of breeding males was expected, but such pre-rut mortality was not. Also, the wolf kill data indicated that mortality of caribou males unexpectedly ended in mid-winter. These patterns have been corroborated with 72% of the observed mortality of adult males occurring during July – November.

The current goals of this research are 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, and to evaluate growth, survival and seasonal distribution of adult males. This progress report summarizes research and monitoring of the Denali Caribou Herd conducted during October 2011-September 2012 (FY12). During this period, the specific objectives included:

1. Estimate the population size and composition in late September each year;
2. Determine productivity, survival patterns and age structure of adult females;
3. Assess calf production and recruitment;
4. Investigate the patterns of growth, survival, and seasonal distribution of male caribou;
5. Relate caribou population status, trends, and vital rates to climatic variables and predator population characteristics.

Herd Size

A preliminary herd size estimate of 2,300 caribou was derived for September 2012; that number will likely change some depending on results of the 2013 census as described above. This population estimate is indicative of continued slow growth of the caribou herd at about 2.5% per year and the highest number of caribou in the Denali Herd since 1992.



Population estimates for the Denali Caribou Herd, Denali National Park, Alaska, late September, 1986-2012 (2012 estimate is preliminary).

Adult Sex Ratio

The herd's adult sex ratio of 41 bulls:100 cows was similar to the last 2 years; these rates are also the highest noted since 1992. 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.

Calf Production and Survival

Productivity of cows ≥ 1 year old was estimated at 80% in mid-May 2012, based on 65 radiocollared females in the age-structured sample . Of the 13 non-parturient females in the sample, 12 were ≤ 2 years-old (7 yearlings, 6 2-year-olds) and the remaining female was 19 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 early-June 2012 postcalving composition survey, 37 calves:100 cows were noted. By the late September composition count, that ratio had declined to 24:100. Based on these ratios and accounting for adult female mortality between mid-May and late September, 29% survival to fall for the 2012 cohort was estimated. Calf survival has averaged 28% over the last 9 years, compared to 15% during 1991-2003.

Female Survival and Age Structure
During October 2011 – September 2012, 5 females from the age-structured sampled died for an annual mortality rate of 8%, lower than the study average of 12% (range 2-23%). The female age structure in May 2012 exhibited the effects of improved recruitment over the last 8 cohorts, as well as the losses of females ≥ 13 years old, thus the proportion of older females has declined some since 2008 .

The adult female mortality rate has varied from an average of 7% during 1986-89 when the herd was growing at 8%/year to an average of 19% 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 largely been due to age structure that was strongly skewed toward older females and the losses of most of these old females during this period.

Adult Bull Survival
During September 2007- September 2012, 188 male caribou have been radiocollared and monitored including 127 captured as adults (≥ 1 year old) and 61 captured as 10-month-old calves (12-13 each March 2008-12). As of 30 September 2012, 88 carried carrying functioning radios, 67 have died, 18 have dropped their collars, and 15 radiocollars have failed prematurely. In addition to 4 capture-related deaths, suspected causes of death include wolves (35), bears (11), unknown large predator (4), unknown (11), and accident (2).

During the 5 years survival of males (October 2007 – September 2012) has been evaluated, annual survival appears to be comparable to that of adult females for bulls that are ≤ 4 years-old, then declines with age for older age-classes. Mortalities occur predominantly during July-November.

Bull Growth Patterns
142 of 161 adult bulls captured in September 2007-12 were weighed recording masses ranging from 93 kg to 278 kg. Body masses increased markedly with age from 1 to 6 years of age, gaining an average of 25 kg each year, and plateaued at an average of 229 kg for bulls ≥ 6 years of age. Similarly, mean antler length varied from 29.1 cm to 136.5 cm for the 154 individuals we measured, and increased by 14.4 cm/year from 1-6 years of age. For bulls ≥ 6 years old, antler length did not vary with age, averaging 120.5 cm for these age classes.

The bull size classes we use for composition surveys (S, M, L) differed significantly in body mass (F = 299.1; df = 2,139; P <0.001) and antler length (F = 343.6; df = 2,151; P <0.001). These size classes include individuals of 1-3, 1-5, and ≥ 4 years of age, respectively.

Planned Activities (October 2012 - September 2013)
In the upcoming year, plans are to continue efforts to assess population dynamics of the DCH and studies of survival, growth, and seasonal distribution of bulls. 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. Maintain a sample of 45-50 radiocollared adult bulls and surviving collared individuals from the 2007-12 calf cohorts to assess age-specific growth and survival, and seasonal distribution.
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 and composition survey and the fall composition survey to determine herd size, calf recruitment, and adult sex ratio.

Wolves

By Bridget Borg bridget_borg@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.

In recent years, the use of GPS/ARGOS collars that upload daily locations has greatly increased the number of locations available for most collared wolf packs.

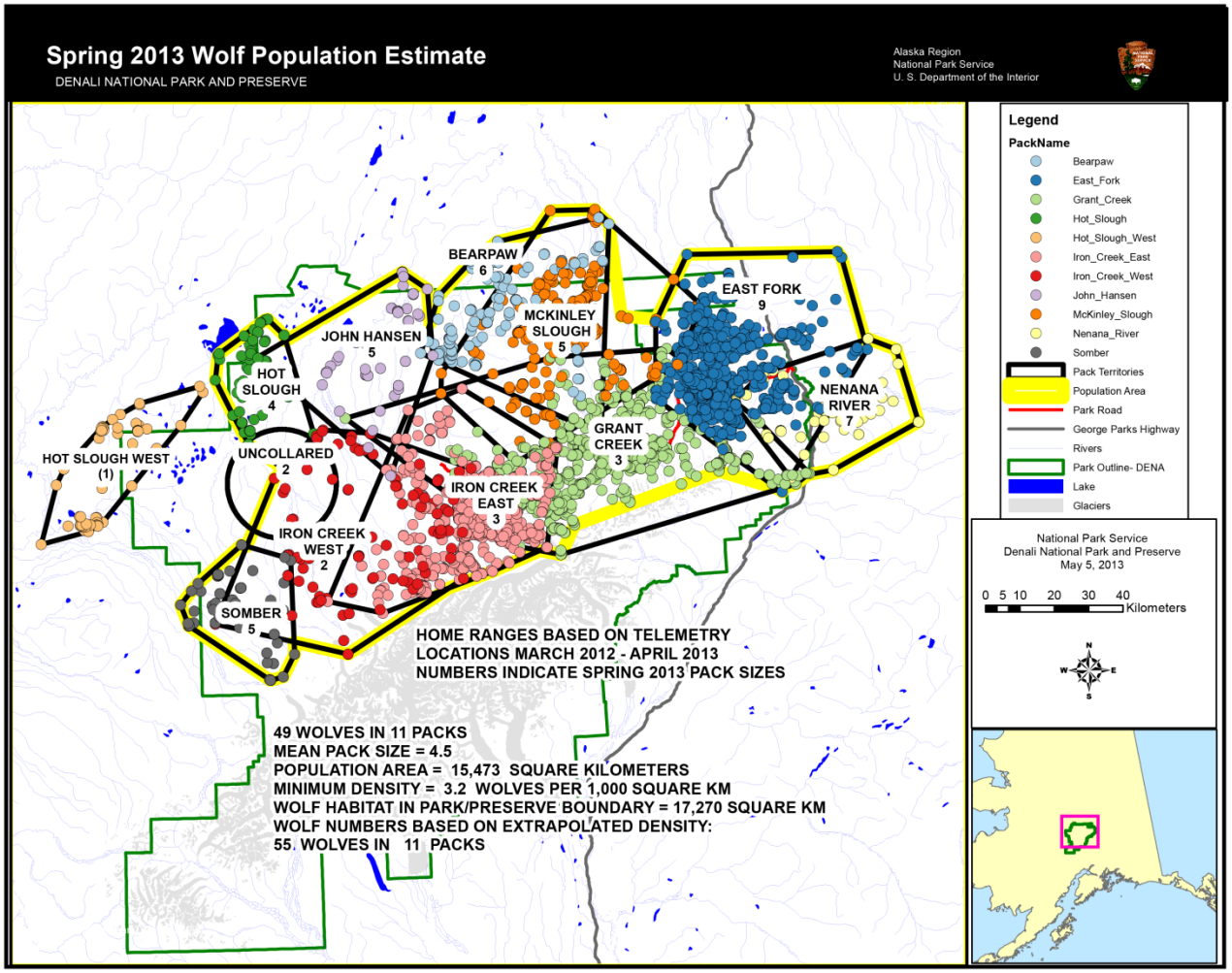
Telemetry locations acquired over two years are used to determine the area of each pack territory. Areas of the combined pack territories and pack counts are used to estimate abundance and density of wolves. In addition, monitoring data have been used to determine wolf movements, den locations, mortality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

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

As of April 15, 2013, there were 10 wolf packs in Denali with collared wolves in them. Eight wolves wore conventional VHF radio collars that are located from antennae-equipped aircraft. Another 13 wolves were collared with GPS/ARGOS collars that determine the wolf's location at least once per day and upload the data.

In April 2013, there were approximately 49 wolves in the 11 packs being monitored by park biologists. The estimated density of wolves in Denali (about 8.2



wolves per 1,000 square miles or 3.2 wolves per 1,000 square kilometers) was lower than last year's estimate of 70 wolves in 9 packs with a density of 9.9 wolves per 1,000 square miles (i.e., 3.8 wolves per 1,000 square kilometers).

Fourteen wolves from eight packs were captured and radio-collared in biological year May 2011- April 2012, and 10 wolves from seven packs were captured during winter 2012-2013. Nine mortalities of collared wolves occurred in biological year 2012. Two wolves were harvested (killed by trapping/hunting), one wolf died from injuries from other wolves, four died of unknown natural causes, and two wolves died of starvation/dehydration secondary to other injuries/illnesses (1108GM died of starvation due to a rare oral melanoma in its upper jaw, and 1206BM died of uremic poisoning and dehydration secondary to paralysis from unknown causes).

Dall's Sheep

By Bridget Borg bridget_borg@nps.gov

In 2011, wildlife biologists surveyed for Dall's sheep between the Muldrow Glacier and the Nenana River using an aerial transect method developed for CAKN sheep monitoring. The estimated number of sheep north of the Alaska Range was 2,321 (1,867 for eastern areas, 505 for western areas). In 2008-2009, the estimate for the eastern areas (using a different method) was 1,724 sheep, suggesting that sheep numbers have remained fairly stable. The next aerial survey is planned for 2014.

Based on ground surveys conducted in 2012, there were an estimated 10 lambs per 100 ewes, a measure of sheep productivity that is much lower than in previous years (lambs per 100 ewes ranged from 29-40 during 2008 to 2011).

Small Mammal Monitoring

By Melanie Flamme
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Vole populations of three species of voles in Denali have been monitored since 1992 using mark-recapture methods, and will continue to be monitored as part of the Central Alaska Network "Vital Signs" Monitoring Program. The three vole species are northern red-backed vole (*Myodes rutilus*), tundra vole (*Microtus oeconomus*), and singing vole (*Microtus miurus*). using mark-recapture methods.

In 2012, Melanie Flamme, wildlife biologist with Yukon-Charley Rivers National Preserve (and with the Central Alaska Network Monitoring Program), coordinated the 20th year of small mammal trapping in the Rock Creek study area in Denali. One hundred Sherman live traps were deployed on each of the four Rock Creek legacy plots (two riparian plots and two forested ridge plots). All traps were baited with irradiated (can't sprout) sunflower seeds and biodegradable bedding. All 400 traps were checked 3 times daily (6 am, 1 pm, and 8 pm) from August 6-12, 2012. Captured individuals were identified by sex and species. Reproductive status was determined, and net weight was calculated. Researchers inserted rice-grain-sized tags under the skin of previously unmarked individuals. These tags are called passive integrated transponder (PIT) tags. Each tag has a unique code and once implanted can be scanned to read the code. The tagged animals were scanned and released.

Results
There were low vole numbers of captures on each plot and all 4 plots collectively overall (under 150). There were very few vole trails seen.

Most of the voles captured in 2012 seemed very skinny with very little subcutaneous fat and very prominent ribs, spines, and shoulder blades. Many of these really skinny animals are very young juveniles, sub-adults, and adults. Usually the skinny animals are the older, larger animals that may have overwintered or started breeding at the beginning of the spring in May.

The summer was cool to cold. It was hot weather for fall, and there were dry conditions on the plots. The tundra was crunchy even after a drizzle.

-Very few large adults captured; mostly smaller animals and juveniles
-Voles in poor body condition overall and very skinny with little subcutaneous fat
-Did not catch very many pregnant females or scrotal males (mostly younger, more immature animals)

There were some shrew captures.

Tracking the Highs and Lows of Snowshoe Hare and Willow Ptarmigan Cycles

By Carol McIntyre
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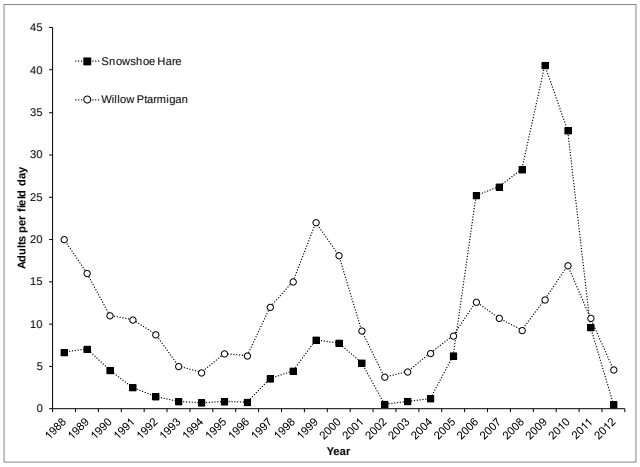
NPS biologists in Denali calculate annual indices of abundance for snowshoe hare and willow ptarmigan by recording the number of adults of each species observed during routine field activities from late April through June. These data allow biologists to identify the frequency and magnitude of the population cycles of each species over time. ADF&G biologists are conducting similar counts during Breeding Bird Surveys near Delta Junction and new efforts are underway to conduct similar counts across the road system in interior and northern Alaska.



The number of snowshoe hare detected per field day decreased substantially in 2012, indicated that the species was in the low phase of its cycle. Detections of willow ptarmigan also decreased in 2012 in synchrony with snowshoe hares.

Birds

By Carol McIntyre
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Monitoring 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. Have you ever wondered about those people you see standing along the Denali park road very early in the morning, clipboards in hand and binoculars held up to their eyes? These are the field biologists conducting the roadside bird surveys. From late April through June 2012, these biologists conducted standardized bird surveys along the three roadside survey routes in Denali (see table below). Each survey route contains 50 sampling points spaced approximately 800 meters apart. 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.

Biologist detected 66 species on the roadside surveys in 2013.

Summary of survey effort and most frequently detected species on the three Denali roadside bird survey routes in 2012.

Route	Number of repeat surveys	First and last survey dates	Number of bird species detected for all surveys	10 most frequently detected species
1	10	April 19 – June 21	41	White-crowned Sparrow, American Tree Sparrow, Fox Sparrow, Dark-eyed Junco, Redpoll spp., American Robin, Wilson's Warbler, Yellow-rumped Warbler, Varied Thrush, and Orange-crowned Warbler
2	8	May 2 – June 22	47	White-crowned Sparrow, American Tree Sparrow, Dark-eyed Junco, Fox Sparrow, Wilson's Warbler, Orange-crowned Warbler, Willow Ptarmigan, Varied Thrush, American Robin, and Black-billed Magpie
3	3	June 9 – June 24	45	White-crowned Sparrow, American Tree Sparrow, Fox Sparrow, Savannah Sparrows, Wilson's Warbler, Orange-crowned Warbler, Redpoll spp., Arctic Warbler, and Golden-crowned Sparrow

This repeat survey method will allow the detection in trends in abundance of a suite of common passerine birds. Our first analyses of data collected on the Denali roadside routes from 1994 to 2009 showed a 48% decline in Wilson's Warbler abundance, a 250% increase in Fox Sparrow abundance, but no change in the abundance of Ruby-crowned Kinglet, Arctic Warbler, Swainson's Thrush, Varied Thrush, Orange-crowned Warbler, American Tree Sparrow, Savannah Sparrow, White-crowned Sparrow and Dark-eyed Junco.

Result 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 2013, this project will continue with surveys in Denali, Wrangell-St. Elias National Park and Preserve and Yukon-Charley Rivers National 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 ½ mile apart. At each point, the observer conducts a three-minute count and records all birds detected within ¼ mile of the sampling point. Two BBS routes were conducted in Denali in 2012. Results of the two Denali BBS routes are available on the North American Breeding Bird Survey website. Two BBS routes will be conducted in Denali in June 2013.

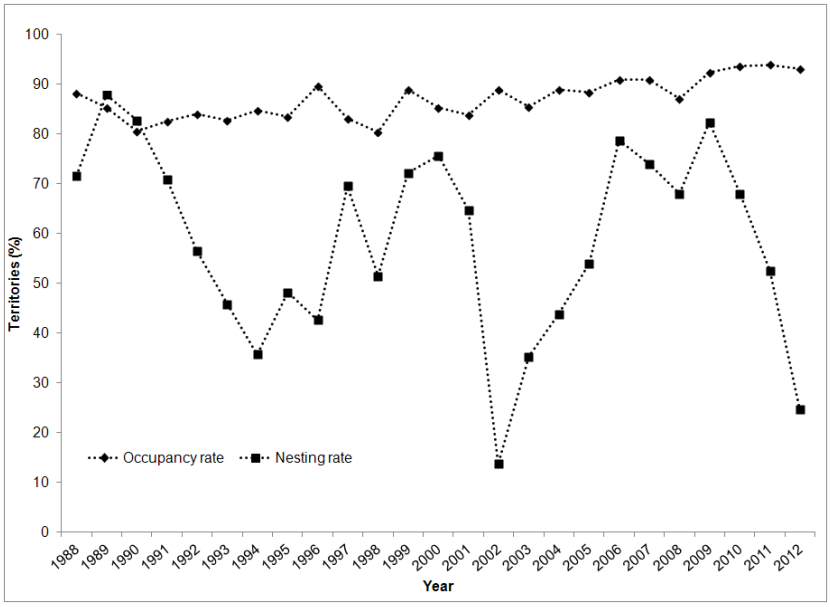
Monitoring territory occupancy and reproductive success of Golden Eagles and Gyrfalcons

Denali contains the highest nesting density 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 the Alaska Range northern foothills 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. NPS biologists started the Denali Golden Eagle study in 1987 and is has evolved into the longest running ecological study of a migratory population of Golden Eagles in the world. This study is currently the only one providing current information on the ecology of a migratory

population of Golden Eagles in northwestern North America. Monitoring the nesting territory occupancy and reproductive success of Golden Eagles is a priority of Denali's Resource Stewardship Strategy and are a Vital Sign of the Central Alaska Monitoring Network (CAKN).

In 2012, NPS biologists monitored the occupancy of nesting territories and reproductive success of Golden Eagles and Gyrfalcons in the northeast region of Denali, marking the 25th 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 and to document nesting success and fledgling production in mid-July. In 2012, NPS biologists monitored 87 Golden Eagle nesting territories. Within these territories, NPS biologists documented egg laying at 20 nests, nesting success at 7 of these nests, and counted 7 fledglings. As expected, all measurements of reproductive success decreased in relation to a decrease in the abundance of snowshoe hare and willow ptarmigan. During the eagle surveys, park biologists also monitored 15 Gyrfalcon nesting territories in 2012. Gyrfalcon reproductive success in Denali in 2012 was lower than most years.

Since 1988, occupancy of territories has remained stable, but nesting rate varies in relation to the abundance of snowshoe hare (see figure). Further, from 1988 to 2010, NPS scientists documented a 25% decrease in the rates of Golden Eagle egg-laying and fledgling production in Denali, and their research indicated that the declines were not related to food supply, weather and habitat in Denali. This suggests that other factors in Denali and on migration corridors and wintering grounds are causing the decline (McIntyre and Schmidt 2012).



Collaborating on a landscape scale. The NPS cannot achieve its mission through ecological stewardship targeted only parklands; rather it must engage in conservation efforts that may reach far beyond park boundaries. NPS biologists are collaborating with US Fish and Wildlife Service, US Geological Survey, Alaska Department of Fish and Game, West Virginia University, and University of Alaska-Fairbanks to identify the factors driving the population trends of Denali's Golden Eagles. Our collaborative research studies will provide 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 collaborating on the development and implementation of effective conservation programs for this species and its habitats across western North America in the US, Canada, and Mexico.

Bird Species of Conservation Concern

In 2012, 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. Several NPS park rangers also participated in the study in 2012. 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.

Since 2009, 27 different observers participated in the project, including five who participated in all four years. From 2009 to 2012, observers submitted 1057 completed checklists and detected 33 of 34 target species. The only target species not detected during this period was Red-winged Blackbird.

Summary of the most commonly detected species on the bird species of conservation concern project, 2009 to 2012.

Observation 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

Denali scientists are using data collected by this project to help assess changes in bird presences 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 2013.

Citizen-based bird counts: 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.

Find Christmas Bird Count results at http://birds.audubon.org/christmas-bird-count

Results of 2012 Christmas Bird Counts near Denali

	Cantwell	Denali
Date	12/23/2012	12/29/2012
Participants	6	7
Party hours	6	5
Species detected	9	9
Temperature range	-28 to -18º F	23 to 31º F
Morning weather	Clear, no rain or snow	Cloudy, no rain or snow
Afternoon weather	Clear, no rain or snow	Cloudy, no rain or snow
Species detected	Ptarmigan spp., Downy Woodpecker, Gray Jay, Black-billed Magpie, Common Raven, Black-capped Chickadee, Boreal Chickadee, Red-breasted Nuthatch, Pine Grosbeak, and Common Redpoll	Spruce Grouse, Willow Ptarmigan, Gray Jay, Black-billed Magpie, Common Raven, Black-capped Chickadee, Boreal Chickadee, Pine Grosbeak, and Common Redpoll
Most frequently detected species	Boreal Chickadee, Pine Grosbeak and Common Redpoll	Boreal Chickadee, Pine Grosbeak, Black-billed Magpie

Physical Resources

Parkwide Climate Monitoring

By Pam Sousanes pam_sousanes@nps.gov

Climate and snow monitoring continued at 17 stations in Denali as part of the Central Alaska Network Inventory and Monitoring Program. Most of these stations record air temperature, relative humidity, wind speed and direction, solar radiation, precipitation, and soil temperatures.

Data from the climate and snow stations are used to support other natural resource programs including caribou 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. The climate and snow data are transmitted real time and available via the web for summaries, analyses, and downloading.

Annual data reports and seasonal weather summaries are available from the Central Alaska Network website at http://science.nature.nps.gov/im/units/cakn/reportpubs.cfm. Most of the stations are automated and send hourly data via satellite.

Weather data summaries and data analysis tools to apply to Denali's data are available at *http://www.wrcc.dri.edu/*

Weather Monitoring at Park Headquarters

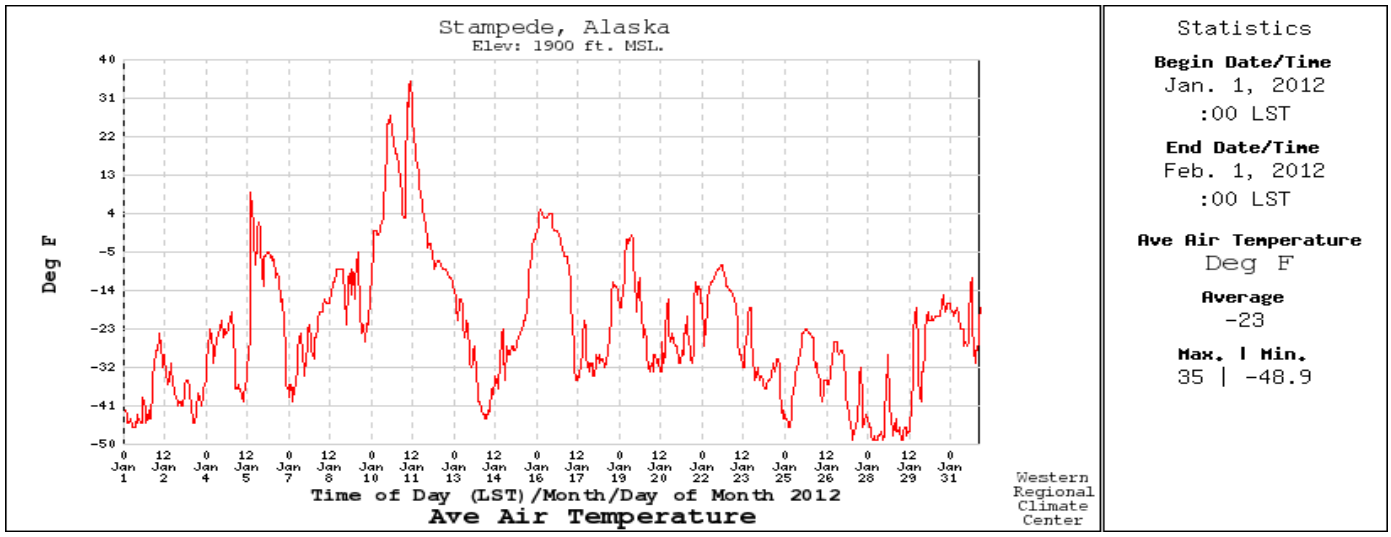
By Pam Sousanes pam_sousanes@nps.gov

Weather information has been collected at Park Headquarters for more than eight decades. It is one of the longest and most valuable climate records we have for the Central Alaska Network. This long record would not be possible without the diligent attention of the kennels crew who take these daily observations.

On the next page are summaries of the 2012 climate data for temperature and precipitation collected at Park Headquarters, and compared with averages from the long-term database. Weather data are summarized by calendar year, hence the presentation of 2012 data.

Weather Notes for 2012:

- The mean annual temperature was 3.4° F below the long-term average, the seventh coldest year on record.
- Every season of 2012 was cooler than the long-term seasonal averages.
- January 2012 was 20.5° F colder than the long-term average and the second coldest January on record (behind 1933).
- November was 14.2° F colder than the long-term average
- June was wet with 2.57 inches more rain than average, while July was dry with 2.20 inches less rain than average.



Temperature

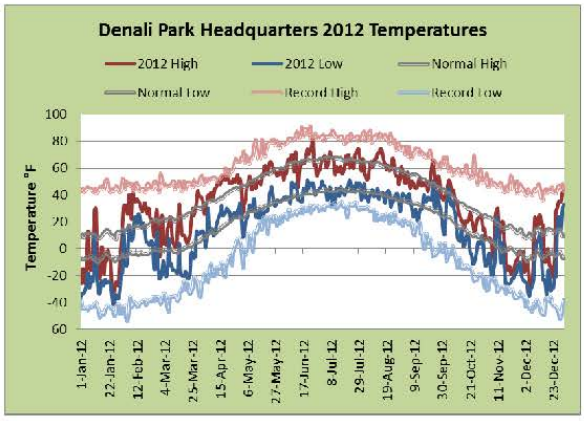
- Maximum temperature 81° F recorded on June 24
- Minimum temperature -41°F on January 25
- Mean annual air temperature 23.8°F (3.4° below historical average of 27.2°F)

Precipitation

- Total Precipitation 14.41 inches
- Departure from Normal -0.65 inches
- Max. 24 hr. precipitation 1.50 inches on June 2
- Total Snowfall 69.5 inches (7/1 to 6/30)
- Departure from normal -10.1 inches
- Maximum 24 hr. snowfall 5.0 inches on 1/12

Denali **Headquarters** Average Monthly ***Temperatures***		
	2012	**Historic Average**
January	-18.6	1.9
February	16.6	6.8
March	3.0	12.6
April	33.3	27.3
May	40.4	41.7
June	52.8	52.2
July	53.9	54.9
August	50.3	50.7
September	41.5	41.1
October	20.0	24.1
November	-5.1	9.1
December	-3.1	3.3
Yearly Average	23.8	27.2

Denali Headquarters Average Monthly *Precipitation*		
	2012	**Historic Average**
January	1.01	0.69
February	0.73	0.53
March	0.29	0.38
April	0.11	0.26
May	0.60	0.67
June	4.76	2.21
July	0.78	3.20
August	1.78	2.60
September	2.40	1.77
October	1.05	1.05
November	0.50	0.73
December	0.40	0.90
Yearly Total	14.41	14.9



2012
Record-Breaking Weather Observations at Denali Park Headquarters

Feb 14	Record snowfall of 2.5 inches
April 17	Record high temperature of 55°F.
Apr 18	Record high temp of 54°F (tied with 1998)
May 15	Record snowfall of 1.3 inches
Jun 2	Record rainfall of 1.5 inches (tied with 1938)
July 9	Record low temperature of 32°F
July 11	Record low temperature of 34°F (tied with 1934)
Sep 20	Record rainfall of 0.72 inches.
Dec 31	Record high temperature of 43°F

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 2011-2012, park staff conducted snow surveys in Denali during the survey window (last 4 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 2011-2012 season:

At Denali Park Headquarters, the day of the first persistent snow was October 17, a few weeks later than normal. On December 1, there was 8 inches of snow at park headquarters, the long term average is 10 inches. The first measurable snow that persisted on the south side of the Alaska Range in the Tokositna Valley was on October 15, 2011. The December 1 survey of the aerial markers on the south side of the Alaska Range at Denali had snow depths that ranged from 9 inches at Chelatna Lake to 28 inches at Tokositna Valley. The December snowfall total for Denali Park headquarters NWS site was 18 inches, 144% of normal.

There was more snow accumulation through January, and the February 1st survey reported snow depths between 20 and 23 inches for the headquarters area. By March 1 most of the south side sites were reporting snow depths and snow water contents that were above normal. The snow depth at Chelatna Lake was 59 inches, 140% of normal with 13.8 inches of water content. The Dutch Hill marker had 90 inches of snow and 23.8 inches of water content, 118% and 103% of normal respectively. In March and April, the sites near Denali Park headquarters were again near normal at the Rock Creek sites, to above normal at park headquarters. Lake Minchumina was visited for the March 1 survey and had 22 inches of snow, just above the normal for the month.

As April temperatures climbed the snowpack dwindled, and by the end of April there was no snow at Lake Minchumina, 5 inches remaining at Kantishna, and 7 inches at Denali Park headquarters, which is just below normal. The aerial markers on the south side of the range were on average about 85% of normal by April 30th. Nugget Bench had 31 inches of snow and the normal for this time of year is 46 inches. Dutch Hills had 69 inches of snow, normal is 74 inches and Chelatna Lake was above normal with 35 inches of snow, normal is 33 inches for the May 1 snow survey.

The Kantishna SNOTEL site recorded 5.2 inches of total winter precipitation (snow water equivalent) from October 1, 2011 through May 1, 2012, which is 84% of average. The total annual precipitation for the site was 23.5 inches; the winter snow accounted for 22% the total annual precipitation. The McKinley Park long-term NWS site was 87% of normal for the year with an annual total of 69.5 inches of snow. The precipitation gage at Tokositna Valley recorded 24.6 inches of precipitation from October 1, 2011 through May 1, 2012. This is 41% of the total annual precipitation of 60.6 inches for the 2012 water year.

Air Quality Monitoring

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

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

In 2012, the Environmental Protection Agency (EPA) entered into a consent decree with the owners and operators of the coal-fired Healy Power Plant adjacent to the park. One unit of the plant has been shut down for over thirteen years, initially due to litigation between Golden Valley Electric Association (GVEA) and the Alaska Industrial Development and Export Authority (AIDEA). GVEA and AIDEA settled their differences in 2009, and the 2012 consent decree with EPA resolves additional environmental and permitting issues, clearing the way for GVEA to restart the 50 megawatt Unit 2. The consent decree protects Denali's class I airshed by requiring new emission controls on Unit 2, setting lower emission limits, and applying new federal mercury regulations to both units, which otherwise would have only applied to Unit 2. GVEA intends to restart Unit 2 in 2015.

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
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The Denali visibility webcam is part of a nationwide network operated by the NPS Air Resources Division. During summer, the camera takes a picture of the Alaska Range once every 15 minutes, and the image is transmitted to the web via satellite. The webcam home page also displays current ozone and weather data from the air quality monitoring station near Park Headquarters. All images are archived throughout the summer for a long-term visual record of visibility, one of the air quality related values (AQRVs) protected under the Clean Air Act. The Denali visibility webcam can be found through an internet search for "Denali webcam," or at www.nature.nps.gov/air/WebCams/parks/denacam/denacam.cfm.

Long-term Stream Monitoring

By Trey Simmons trey_simmons@nps.gov

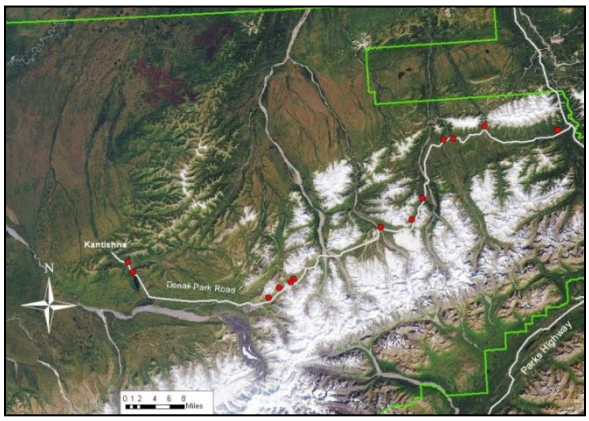
Ecologist Trey Simmons began collecting data from Denali streams in 2007 as part of the Central Alaska Network (CAKN) long-term stream monitoring program. The CAKN program collects a variety of types of information about streams and rivers in all three network parks (in addition to Denali, the network also includes Wrangell-St. Elias National Park & Preserve and Yukon-Charley 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.

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 changes in stream and river flow patterns; these changes 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 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 2013, 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.

Monitoring Landslide at Mile 45

By Denny Capps denny_capps@nps.gov

A mass movement (landslide) near Mile 45 of the park road threatens the foundation of the main park transportation route. The landslide is a classic rotational slump with a headwall scarp, subsiding basins, pressure ridges and fractures, and flow features. Survey stations were first established in 1993 by park personnel to monitor the horizontal and vertical velocity of the slump. Approximately 70 stations have been established between 1993 and the present. Some have been lost due to surface fracturing, squeeze-out, and animal damage. New ones are added every few years, maintaining about 35 stations.

Slumping velocity has varied through space and time, with peaks in movement occurring in high precipitation years. After successful efforts to divert surface water away from the area in 1999, slump movement slowed markedly. The annual survey of the slump did not occur in 2009 or 2010, but it was re-surveyed in the falls of 2011 and 2012. Immediately below the park road, but above the active slump, movement is slight but detectable due to surface cracks in the ground. Inside the active slump, velocities for many of the surveyed points between 2008 and 2012 were 5-10 cm (2-4") per year. The head of the scarp is about 11 m (36') from the road. Although the downslope movement of the slump continues, the rate of upstream growth of the scarp indicates no immediate threat to the park road. The park has existing plans to relocate the road further uphill before the slump puts it at substantial risk.

In 2012 park personnel finished implementing a new monitoring plan for the slump. In 2011, measurements were recorded using differential GPS, accurate to within one centimeter. Previously, measurements were recorded using traditional surveying techniques in a local coordinate system. In early 2012, all previous data were imported into the park's geographic information system (GIS) to allow comparison with the 2011 GPS data. In the fall of 2012, new survey stations were established that minimized visual impacts and maximized the speed at which surveys could be conducted.

Paleontological Survey of the Lower Cantwell Formation

By Denny Capps denny_capps@nps.gov

A student on a field trip found the first dinosaur track in the park in 2005. Since then, several thousand tracks 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 2012 season's work focused on four main topics: 1) paleontological resources inventory in the field as in past years; 2) substantial reorganization of existing and new data; 3) development of targeted fieldwork using spatial datasets; and 4) the development of

outreach products. Most work was conducted by two GeoCorps America interns, Lisa Merkhofer and Dr. Tyra Olstad, with additional work and supervision provided by Physical Science Technician, Maisie Richards, and the Park Geologist, Denny Capps.

Park staff spent about 45 person-days in the field. The team hiked many kilometers searching for and documenting fossils within the (lower) Cantwell Formation. New explorations were conducted in several areas of the park. The team added 21 new localities to our paleontology database, which now contains over 213 sites and over 425 specimens.

All entries into the database were carefully reviewed and many replicated specimens were found. Even though 21 new localities were added, the total number of sites was less than in 2011 (225) because of the database cleansing. The team also completed a substantial reorganization of the existing spatial datasets.

Tyra Olstad spearheaded the use of various spatial attributes to target field work in areas that are most likely to yield fossils. Past areas searched and fossils found were plotted spatially. The attributes of the localities were tabulated and graphed. The team combined this information with the park's robust geospatial datasets such as satellite imagery, digital elevation models, vegetation cover, geology, etc. to target further fieldwork. This framework will be built upon in subsequent years.

Lisa Merkhofer created an outreach product, "Visual Guide to Identifying Fossils in Denali National Park" that will be useful for park interpreters and visitors.

Noteworthy finds from this season include finding possible layers of charcoalified wood, recognizing microbial mats, and discovering permineralized wood. An approximately 40-cm-wide hadrosaur track, which was collected and accessioned to the park museum in 2011, was put on display at the Toklat River Contact Station with interpretive material. Interpretative rangers stationed there used the track in their visitor programs

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 were extracted from the river by a "mirror channel" method whereby channels were excavated to mirror existing braids in the river. This method allows for minimum impact on the river system because it mimics natural river processes and forms 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.

The park is monitoring natural and human-induced floodplain changes and completed a comprehensive analysis of the Toklat River system in 2012. The analysis reported several key findings: (1) the river has changed from a braided stream to a single- or few-channel stream both upstream and downstream of the road crossing through time, primarily because the causeway limits the cross-sectional area that the river can access; (2) past bank reinforcement along the road system has promoted a change in river character mainly because the banks are no longer erodible, a key process of braided streams; (3) past gravel harvests have thus far been a sustainable practice.

NPS Abandoned Mineral Lands Project

By Denny Capps denny_capps@nps.gov

The NPS Abandoned Mineral Lands (AML) initiative completed a physical inventory and site assessment of all known AML sites (mines) in Denali and other national parks. The project documented, inventoried, and assessed hazardous mine features in NPS units throughout the nation. The data collected in this effort was entered into the NPS AML database, where it can be accessed by managers and kept up to date as new information becomes available, or sites are mitigated. This information will be used to develop project funding requests for identified high-priority sites posing the greatest hazards to employees, visitors, and wildlife, which was the goal of the project, as requested by the NPS Director in 2008.

This work was accomplished by regional Natural Resource staff in conjunction with Cultural Resource staff, and greatly facilitated by resource managers and specialists at the parks. These staff all received a high level of safety training prior to conducting this field inventory. Please keep in mind that AML sites pose serious hazards including mine shafts, hazardous chemicals, and explosives. If you suspect, or know of hazardous conditions at an AML site, please inform the park geologist, Denny Capps. Now, the focus will shift towards mitigation of hazards at these sites.

Glacier Monitoring

By Rob Burrows
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Denali's glaciers are vast and remote. They cover approximately one sixth of Denali's area. They are integral components of the region's ecosystem. Many changes in glacier extent, terminus morphology, ice volume, and movement reflect changes in climate. Glacier behavior in turn affects other components of the ecosystem in which glaciers reside, 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.

- In 2012 the Kahiltna and Traleika glaciers were monitored for mass balance at index sites for the 21st year.
    - Spring visits were made in collaboration with Seth Campbell (University of Maine), who also collected surface elevation data and full glacier ice depth data using radar. Due to technical issues he was only able to collect ice depth data on Kahiltna but not on Traleika/Muldrow. Results are forthcoming.
    - Thanks to the assistance of Denali backcountry rangers in fall 2012, the Traleika index stake was accessed on foot for the first time in the history 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 Denali Kennels operation was able to place three stakes on Traleika Glacier in March 2013 with transport to the glacier assisted by dogsled. Thanks to them for an incredible effort!
- The Middle Fork Toklat glacier was surveyed with a citizen science seminar in conjunction with the MSLC in August 2012. Six participants helped complete a GPS survey of the terminus last done in 1992 and of surface elevation of the lower glacier last done in 2002. The expedition will strike out once again August 12-16, 2013. See: http://www.alaskageographic.org/static/1174/glaciology-backcountry-citizen-science
- For virtual exploration of some of Denali's glaciers check out these 360 degree panoramas: http://www.nps.gov/dena/photosmultimedia/vr-panos.htm
- There is a **new Fact Sheet** available for Denali Glaciers, see here for the digital version: http://www.nps.gov/dena/naturescience/upload/GlacierMonitoring2012.pdf

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 period: Muldrow Glacier (2001-2008) and its tributary Traleika Glacier (2001-2010). This is attributed to thickening of the upper elevations of this surging glacier system after the last surge of Muldrow in 1956/57. Lower elevations of the glacier system was consistently thinning, and over the entire 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.

Researchers from several universities are conducting a large project to better understand the climate of the last 1,000 years in the Alaska Range by drilling an ice core on the Mt. Hunter summit plateau. For more information on the project go here: http://umaine.edu/news/blog/2012/04/20/climate-change-research-and-measuring-the-amount-of-ice-in-the-alaska-range/
For a teacher's eye view of part of the expedition see this PolarTrec blog:
http://www.polartrec.com/expeditions/reconstructing-the-past-climate-of-central-alaska

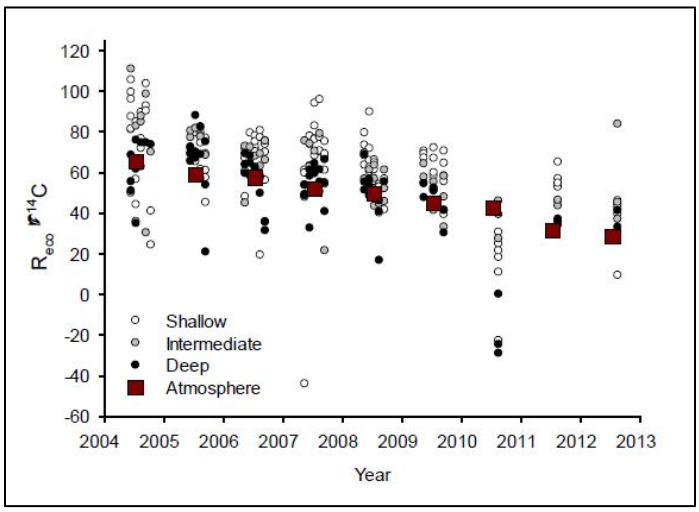
Permafrost

By Dave Schirokauer dave_schirokauer@nps.gov

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 multi-scale permafrost monitoring program which will focus portions of the Denali, Yukon Charlie National Preserve (YUCH), and Wrangell National Park and Preserve (WRST).

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 Denali, the permafrost map, which was completed in 2004 as part of the park's soil survey is an important tool for identifying sensitive permafrost. Boreholes designed for temperature profile measurements are located near Denali (8-mile Lake) and near YUCH and WRST are monitored annually. At broader scales, satellite imagery is being used to detect change in permafrost condition at decadal time scales.

Sequestered carbon being emitted from thawing permafrost into the atmosphere and into aquatic system is also being monitored at a research site at 8-mile Lake since 2004. As the processes chemical and physical carbon release from thawing permafrost a better understood, results will be applied through models to broader landscapes and global atmospheric CO2 projections. It has been hypothesized that thawing permafrost will be a significant contributor to atmospheric CO2 over the next century.



Radiocarbon 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 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. *From Schuur and Bracho 2013.*

➢ Social Science ➢

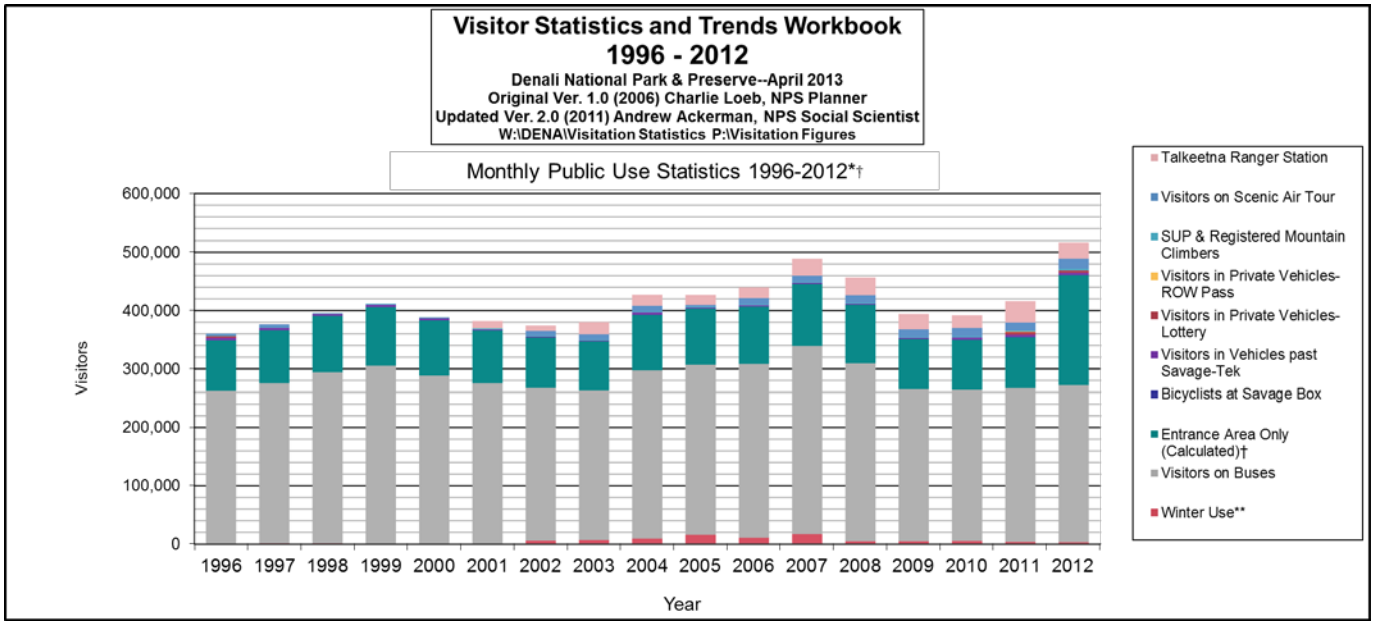
Park Visitation

By Dave Schirokauer dave_schirokauer@nps.gov

The park completed a visitation study in 2011 (Fix et al. 2012. Estimating visits to Denali National Park and Preserve: Spring/Summer 2011) which determined a new formula for calculating the park's "recreation visits".

The old formula was based on the visitation characteristics in 1996. The new formula caused a significant jump in the numbers between 2011 and 2012. In reality, this increase did not occur suddenly but represents a pattern of visitation that began when new entrance areas facilities came on line.

The enhancement of entrance area activities (MSLC, DVC, and various trails) has resulted in a higher percentage of visits to the entrance area (no trip beyond Savage that day). Applying the new formula to 2012 data yields **516,906 visits**, quite the jump! The 2011 study that lead to the new formula should have been conducted a few years ago, probably two or three years after the DVC and Mountain Vista came on-line, but it is good that we have updated information now. Thus, the jump is artificially applied to 2012 in this figure, but the new formula yields visitation rates that are closer to reality than the 1996 version of the formula.



➢ 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.

Denali Subsistence Resource Commission

On August 28, 2012 the Denali Subsistence Resource Commission (SRC) met at the Murie Science and Learning Center.

A special spring meeting of the Denali National Park Subsistence Resource Commission was scheduled via teleconference on Thursday, February 23. The purpose of the meeting was to develop SRC comments on the Environmental Assessment (EA) on "Subsistence Collections and Uses of Shed or Discarded Animal Parts and Plants from NPS Areas in Alaska."

Updating the Denali Subsistence Management Plan

Amy Craver obtained additional funding from the regional subsistence program to continue updating Denali's Subsistence Management Plan. Meeting minutes will be used to update the documentation of actions proposed or taken by the Denali Subsistence Resource Commission. A revised electronic format will allow adding new materials more easily. Lucy Tyrrell, research administrator at Denali, has been working to draft a new layout and format for the plan.

The format will be shared with other parks. Amy Craver and Lucy Tyrrell will complete the update in 2013, and Lucy will begin working with other parks to revise their Subsistence Management Plans based on the Denali template created.

Subsistence Projects

Understanding Change: How Communities Perceive Climate Change at the Local Level
Corrie Knapp (a Ph.D. student from University of Alaska Fairbanks) is learning from community members the kinds of change they have noticed in relation to climate change. Climate change threatens two assets that National Parks in Alaska seek to conserve: natural resources and cultural diversity as embodied in subsistence communities. 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. Visits were made to Cantwell, Healy, Lake Minchumina, McKinley Village, Nikolai and Talkeetna to interview community members. Eighty three interviews have been conducted with subsistence community members, park staff , park bus drivers, and and other long-term local residents of road communities including pilots, mountain guides, bus-drivers, long-term business owners and amateur naturalists . Nineteen interviews have been transcribed.

Denali Community Subsistence Ethnography—Denali National Park Region 2013—Cantwell, Telida, Nikolai, and/or Lake Minchumina
Melanie Reed (a M.S student from the University of Utah, Department of Parks, Recreation, and Tourism) has been funded by the NPS to do a study that will use 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.

This study will focus on subsistence use of natural resources in and around Denali National Park in the

interior region of Alaska. The study will also address ways in which identity is formed through use of natural resources. The ecosystem of the area is highly variable and includes alpine and glacier regions in the Alaska Range to wet and dry tundra areas with portions of forested environments made up primarily of species of spruce, birch, and alder. The study area is characterized by its remote location and by the four communities who are representative of customary and traditional subsistence use communities by Denali National Park and Preserve. Only one of the communities, the town of Cantwell, is located on a road system. The latter three communities, Lake Minchumina, Nikolai, and Telida are accessible only by airplane, boat, or snowmachine during the winter months. Given the cultural and economic connection of these communities to the land and its resources, researchers believe the area provides the opportunity to study the significance of subsistence use among Native and non-Native individuals. By gathering information from many different perceptions of subsistence users, researchers believe that this project would broaden state and federal definitions and understandings of subsistence use and provide insight on relative management issues and policies.

In late March Amy Craver flew with Colin Milone, Kim Arthur, and Superintendent Don Stricker to Lake Minchumina, Nikolia, Tanana, and McGrath so that Don could introduce himself to Denali's local subsistence communities and to hear from residents about their questions related to Denali and subsistence issues.

Cultural Resources

Park Historian Jane Bryan 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.

Archaeological Investigations

By Phoebe Gilbert
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Archaeology and Geomorphology of Ancient Lake Minchumina

2012 marked the second of a three year project to map and develop a chronology for the relict the ancient shoreline of Lake Minchumina, and explore the region for archeological sites. Charles Holmes of Holmes Cultural Resource Consulting, and Sam Coffman of the University of Alaska's Museum of the North spent three weeks in the northwest corner of the park conducting archeological fieldwork. 2012 work on the project called for archaeological survey of Sevenmile Hill, follow-up survey and testing in the Beaverlog Lakes area, geological and geomorphic investigations on the Muddy River and at Lake Minchumina, and archaeological excavation of MMK- 0179 at Lake Minchumina. These investigations are important to understanding the cultural resource potential of the northern preserve of Denali National Park, as well as, mapping and dating ancient Lake Minchumina.

Three shovel test pits at Sevenmile Hill produced cultural material, chert and obsidian flakes, and help delineate a new archaeological site, MMK-0186. Additional survey and testing conducted in the Beaverlog Lakes area: (a) identified a prehistoric component a MMK-0184; (b) showed that the associated pit features at MMK-0184 were not likely produced by natural causes; and (c) affirmed that site MMK-0183 is likely to yield additional artifacts and has potential for radiocarbon dating.

Geological survey along the Muddy River identified several erosion cut banks that have exposed laminated sand deposits with potential for sampling sediments and organic material for possible radiocarbon dating. One erosion face with complex layers of alternating sand and silt was sampled to test for pollen and material for radiocarbon dating. The raised beach deposit at Lake Minchumina was sampled with the same purpose in mind. The sediment sample study from both sites in incomplete at this time, but preliminary results show that some samples have preserved pollen in various quantity and preservation. Also small amounts of charcoal have been observed in some samples.

Geological survey around Lake Minchumina was focused on the western side of North Bay to search for evidence of the ancient lake. A set of beach ridges was identified and mapped at one location almost two kilometers across the bay from the beach ridges reported in 2011. Both the 2011 and 2012 beach ridges are correlated and show a larger lake existed that was 4-5m above the modern, 2012, lake level.

Archaeological work at 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. Charcoal was collected for radiocarbon dating.

2013 is the last year of work on this project and will be composed of lab work and production of a final report.

Archaeological Survey and Site Condition Assessments

Over 500 acres of previously unsurveyed area in the park was examined for archaeological sites in 2012. Twenty eight new archaeological sites were located and recorded during this survey work, and 11% (34 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 10%, 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 2012 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.

Museum Collections

By Kim Arthur kim arthur@nps.gov

In Spring 2012 the museum collection was enhanced with 1020 slides of flora, fauna and scenery taken by Adolph Murie. These were accessioned, cataloged, scanned and disseminated into three finding aids based on his records. One finding aid has 191 images that corresponds with the McKinley Flora Manuscript by Adolph and Louise Murie, received via donation from Jan Murie. The two other finding aids have a total of 829 images that cover fauna and general scenery of

Denali (Mount McKinley National Park at the time) and other locations. The museum collection was also enriched with the accessioning and cataloging of five of Adolph's personal collection of herbarium specimens in binders. With photography assistance from Daniel Leifheit (winter Media volunteer and summer Park Interpretation Ranger), all five binders have been expertly photographed. A multimedia project is in the works that will better share historic works likes this on with the public. For now, the park is actively seeking funding for the publication of the manuscript with its associated images. One last associated object are eight herbarium illustrations highlighting specimens (DENA 32276-32283) such as potentilla uniflora and sedum roseum (roseroot) complemented by Adolph and Louise's daughter, Gayle Murie.

With a collection totaling over 372,353, the curatorial office is continuing a comprehensive on-site inventory of museum property. This process helps staff with updating the considerable backlog, fixing minors errors that may arise and helping other personnel know what is in the collection. As the collection keeps growing, ongoing accession and cataloging also continues. With these duties, the digital imaging of the entire collection carries on as digitization will increase information access to researchers and the public, preventing further irreparable disintegration through repeated physical handling, and preserving 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 part of the collection online.

Another gain has been the increase in the paleontology collection with recent research conducted by Tony Fiorillo of the Perot Museum of Nature and Science. Several tracks have been taken from the field and are now held in the collection room, on exhibit at the MSLC and will be at the Toklat tent. Other specimens, including casts and molds of those remaining in situ, are on loan to the Perot Museum of Nature and Science located in Dallas, Texas.

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 little, and enhance the synoptic collection in these areas.

2012 saw more catalog records being standardized in Re:discovery ICMS (Interior Collection Management System) with the correction of locations, adding associated loan paperwork to accession folders, fixing previous double number problems, and stream-lining digital and paper files to ensure accurate records and reports.

Museum Collection Partnerships

In the Spring of 2012, the park partnered with University of Alaska Fairbanks Museum of the North and began the planning stages of the 2013 special exhibition of "Denali Legacy: 100 Years on The Mountain" which will be "Celebrating the Centennial of the First Ascent of Denali" by the Karstens-Stuck party in 1913. This exhibit will also showcase varying aspects of mountaineering, history related to the mountain, cultural knowledge of the mountain and create educational programming that will increase the public awareness and experience of this historical event. Joining the exhibit from the park's museum collection include the Stuck thermometer, and two artifacts from the 1910 Sourdough Expedition: crampons and a wood chopping ax. It will run from May 18, 2013 through April 30, 2014.

Within the park, an exhibit at Eielson Visitor Center will celebrate the 1913 climb and mountaineering as part of park history. In partnership with Alaska Geographic, visitors will see Bradford Washburn's stove, a few packs on exhibit in addition to photographs, graphs and other borrowed artifacts. 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.

The previous Museum Curator, Kirk Dietz, has moved on to another park and a new museum curator is being hired. In the interim, Kimberly Arthur, Museum Technician, has been fulfilling many of the museum collection management duties.

Research and Resource Communications

By Lucy Tyrrell lucy_tyrrell@nps.gov

Research Administration

As of May 1, 2013, 874 study numbers have been assigned to scientific and scholarly studies (some continuing and some have been completed). Each year there are approximately 50-75 studies that are ongoing or recently completed. These projects are either conducted by Denali staff (described 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.

Any scientist 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). Beginning in 2001, scientists file an application using the RPRS website (http://science.nature.nps.gov/research).

Information for prospective researchers is posted on the park's website on the nature and science page http://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). Anyone can access and read the Investigator Annual Reports for projects conducted in Denali and all national parks by going to the website http://science.nature.nps.gov/research. Beginning in 2002, each researcher at Denali is encouraged to include an educational component to their project, in addition to filing an IAR.

Study files about each research project are kept in fireproof file cabinets in the resources building. Reports, dissertations, and publications resulting from scientific studies become part of Denali's resources technical library. Arrangements can be made to use these materials by contacting the Lucy Tyrrell, Research Administrator at (907) 683-6352. Computer databases are maintained about the research studies and the library volumes. Archived documents and collections are housed in the Denali National Park Museum or are loaned temporarily to other institutions.

Fact Sheets

In 2012, Research Administrator, Lucy Tyrrell, worked with researchers and resources staff to produce additional color fact sheets about Denali resources and scientific findings, bringing the total number of Denali fact sheets she has created to 67. Limited copies are available from the Murie Science and Learning Center, and fact sheets can be downloaded for printing at http://www.nps.gov/dena/naturescience/factsheets.htm

A complete list of fact sheets is provided on the next two pages.

Denali Fact Sheets as of 5/1/2013
(In order of creation)

- 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, 2008)
- DENA-FS-006-2006 An Integrated Study of Park Road Capacity2006
- DENA-FS-007-2006 Large Mammals…How many are there? (updates in 2007, 2008, 2009, 2010, 2011, 2012, 2013)
- DENA-FS-008-2006 Moose Surveys (updates in 2010, 2012)
- 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 (updates in 2010, 2011)
- 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-007-2012 Large Mammals…How many are there?
- DENA-FS-008-2012 Moose Surveys (update)
- DENA-FS-028-2012 Surveying Dall's Sheep Populations
- 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
- DENA FS-067-2013 Monitoring Songbird Populations

The correct citation for fact sheets (fill in correct date, title, and chronological code) is:

Denali National Park and Preserve. 2011. Melting glaciers in the Kichatna Mountains. DENA-FS-050-2011. Denali National Park and Preserve, Denali Park, Alaska.

For more information, contact Lucy_Tyrrell@nps.gov (907) 683-6352

Website Information

Check out a few new or updated web pages!

Photos and descriptions of non-NPS 2012 researchers: http://www.nps.gov/dena/naturescience/facesresearch.htm

An annotated list of Denali's top ten natural features: http://www.nps.gov/dena/naturescience/naturalfeaturesandecosystems.htm

An updated web page for wolves: http://www.nps.gov/dena/naturescience/wolves.htm

A new web page about visitor experience and social science: http://www.nps.gov/dena/naturescience/visitorexperience.htm





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,
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 2013, MSLC programming includes citizen science programs; curriculum-based education programs for K-12 grades; school-to-work experiential learning programs; electronic field trips; internships; multi-day accredited field seminars and teacher trainings; youth camps; science presentations; and research fellowships.

Citizen Science

Alaska Lake Ice and Snow Observatory Network (ALISON) Project. Denali National Park and Preserve is both a research site and hands-on outdoor classroom. The Alaska Lake Ice and Snow Observatory Network (ALISON) project was designed as a 10-year research and education program to provide Alaska teachers and students with an opportunity to learn about scientific inquiry in "their own backyard." ALISON was conceived by Dr. Martin Jeffries, University of Alaska Fairbanks (UAF), and colleagues as a way to monitor lake ice and snow conditions around Alaska, enlisting students and teachers to collect data.

Tri-Valley students visit Horseshoe Lake several times each winter to take measurements of ice depth, snow depth, and temperatures at the snow surface and ice surface.

The 10-year formal statewide collaboration of scientists, students and teachers has ended. However, Tri-Valley School teachers continue to inspire young scientists by helping youngsters collect data about lake ice and snow. Students return several times each winter, when Horseshoe Lake is frozen, to measure the ice thickness and the depth, density, and temperature of the snow layer on the ice. The teachers have incorporated ALISON as part of the science curriculum at the school, and Kim Morris process the date at UAF. The ALISON project continues to benefit from the collaboration of Denali employees and Alaska Geographic staff at the Murie Science and Learning Center (MSLC). In 2013 MSLC will continue working with local 5th graders to collect and analyze this data.

Youth Programs

Skype with a Ranger 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.

In December 2012, Murie Science and Learning Center education rangers teleported themselves via Skype into 3rd – 6th grade classrooms across the United States to present fun, standards-based science lessons on sled dog adaptations and the geology of Mt. McKinley. Over four weeks, the two rangers Skyped with 1,139 students in 13 states.

Teacher and student feedback has been overwhelmingly positive. Based on these successes, Denali plans to offer distance learning programs from November through January on an annual basis.

The MSLC will offer two curricula in 2013: *The Science of Sled Dogs* uses the furry inhabitants of Denali's sled dog kennels to teach concepts of anatomical, physiological, and behavioral adaptations, while *Denali Geology* teaches concepts of plate tectonics, weather, and glacier dynamics using North America's tallest mountain as an enormous prop. These curricula and others have written lessons and activities for teachers available for download at www.nps.gov/dena/forteachers/learning

Ranger Rachel from Denali National Park and Preserve Skypes about the Park Service mission and sled dog adaptations with 3rd grade students in Aurora, Nebraska. Photo credit: Barrett Stinson at theindependent.com <

Third graders in Aurora, Nebraska learn about sled dog adaptations from Ranger Rachel from Denali National Park and Preserve. Photo credit: Barrett Stinson at theindependent.com V

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 2012, the entirety of Tri-Valley, Anderson and Cantwell elementary schools, or 83 students total, visited Denali for a day in April. These students were treated to programs and hikes by the Northside Education Specialist and three other interpretive staff. The Southside Education Specialist visited ten classrooms in four schools in the Matanuska Susitna Borough, reaching 248 students and teachers. More extensive in-school outreach is planned for 2013.

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 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 24-28, 2013). 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 have special events planned for Denali Backcountry Adventures 2013! In celebration of Denali first being summited 100 years ago this year, students will experience 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 tenth year, DBA is a partnership program of Denali Education Center and the National Park Service through the Murie Science & Learning Center. In 2013, the camp will take place from June 2 – 7. For more information, visit: www.denali.org/youth

Students hike across the tundra during Denali Backcountry Adventures (NPS Photo).

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. This year the week-long camp (July 15 – 18, 2013) will be run as an archaeology field school. Students will learn first-hand from NPS archaeologists what it takes to conduct an archaeology dig and then use their new skills to help excavate structures on a parcel of land owned by the Park Service in downtown Talkeetna, AK. At the end of camp students will demonstrate their new knowledge to the local community through a virtual or live show-and-tell session. 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.

Ranger Station Kids Camp This day camp lets young kids get their hands dirty learning about park science. During Kids Camp participants learn about the critters and ecosystems of Denali through games, crafts, stories and walks. In 2013 camp will be for kids approximately age 5 – 7 and will take place in July at the Talkeetna Ranger Station.

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.

Field Seminars and Teacher Training

Field Seminars. The MSLC offers 15-20 field seminars in Denali each summer season. New seminars in 2013 include a family program about dinosaurs and an in-depth exploration of mosses and lichens of Denali. Alaska Geographic coordinates these active learning multi-day seminars. Topics include geology, wildflowers, birds, paleontology, glaciology, botany, large mammals, bears, science of fly fishing, 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.

Participants examine jaw on MSLC Field Seminar.

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 2012 MSLC provided over $7,500 towards 23 scholarships to subsidize the cost of teacher trainings and seminars for Alaska teachers.

Day Programs

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.

Discover Denali. Developed to provide a meaningful park experience for Royal-Celebrity Tours passengers, this fee-based program is offered up to 5 times a week, May – September in partnership with the Denali Education Center. The program consists of a lecture in the MSLC classroom, a skins-and-skulls hands-on session, an interpretive walk through an area significant in early park history, and a ranger-introduced viewing of the film Heartbeats of Denali. A portion of the proceeds support the Discover Denali Research Fellowship Program (approximately $20,000 annually).

Running with the Pack: Family Excursion. This Alaska Geographic program was developed to provide an educational front-country hiking experience for family groups visiting Denali. The program consists of a guided hike in the entrance area with a focus on wolf ecology and current research. The 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 is hosting a Researcher-in-Residence Program in partnership with the North and West Alaska Cooperative Ecosystem Studies Unit (http://www.uaf.edu/snras/cesu/) over the course of the next two years. This program is designed 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.

In 2012, Denali funded the first of three Researchers. Dr. Jessica Rykken, an entomologist from Harvard University, spent two months conducting bee and flower fly collections in Denali. Jessica taught a day-long field seminar for local families and gave one public and one internal presentation on her research. She performed outreach in the lobby of the MSLC and invited park staff to help sort insects by order. She will create a fact sheet and outreach materials for distribution on the park website.

In 2013 two researchers-in-residence will spend time working in Denali. Karen Carr is a science illustrator who will create a large mural for the MSLC depicting Denali during the Cretaceous period when dinosaurs roamed the landscape. Link Olson is a professor at University of Alaska Fairbanks who will study whether the park's small mammals are displaying morphological changes that can be connected to climate change. For more information on this program visit http://murieslc.org/static/1615/researcher-in-residence-program

MSLC Researchers in Residence

Karen Carr (in 2013 at Denali)
Scientific Illustrator, Karen Carr Studio Inc., Silver City NM
Creation of mural depicting Denali in the Cretaceous Period

Link Olson (in 2013 at Denali)
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

Jessica Rykken (in 2012 at Denali)
Research Associate, Museum of Comparative Zoology, Harvard University
Insect pollinator diversity and distribution in Denali National Park and Preserve

Discover Denali Research Fellowship Program. 2013 is the eighth year of the Discover Denali Research Fellowship Program. Recipients are awarded grants up to approximately $8,000 for research, especially for projects that will assist park managers with critical resource issues. Discover Denali Research Fellowships are made possible by the Denali Education Center through the MSLC. The Denali Education Center is an NPS park partner that fosters understanding and appreciation of Denali through informative and inspiring programs. This year the awards total $22,240.

The 2013 Discover Denali Research Fellows and their topics are:

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

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

Christina Leshko
Michigan State University (Ph.D. student)
Dynamics and red senescence in three northern plants

Verity Salmon
University of Florida (Ph.D. student)
Warming arctic ecosystems: consequences for nitrogen cycling

Ricardo Santos (postponed from 2012)
Instituto Superior Tecnico, Portugal
Giardia and Cryptosporidium in surface and treated water of Denali

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

Murie Science and Learning Center – Research Fellowship Program. In 2013, for the sixth year, financial support was awarded for research projects in any of the eight arctic and subarctic Alaska national parks (across two NPS Inventory & Monitoring Networks—Central Alaska Network or Arctic Network). These research awards are provided by Alaska Geographic, the nonprofit organization created in 1959 to help connect people to Alaska's public lands. In 2013, the following four researchers are recipients of Murie Science and Learning Center Research Fellowship Awards (a total of $20,000 awarded):

Megan Boldenow
University of Alaska Fairbanks (Ph.D. student)
Breeding ecology and migratory connectivity of Beringian shorebirds [working in Cape Krusenstern]
John Schade
St. Olaf College
Effects of permafrost thaw on methane production in tundra soils

Andrew Tremayne
University of California Davis (Ph.D. student)
Dating the Arctic Small Tool Tradition settlement of coastal habitats [Bering Land Bridge]

Helen Wheeler
Arhus University, Denmark (Post doc)
The role of local and broad scale habitat structure in determining distribution and abundance of arctic ground squirrels

Short biographies and photos of this year's research fellows are 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/
This page provides access to many other useful pages, including the other links listed here.

Current Resource Projects
http://www.nps.gov/dena/naturescience/researchresults.htm
This page links to the electronic version of *Current Resource Projects 2013*, as well as to archives from previous years.

Fact Sheets about Denali Science
http://www.nps.gov/dena/naturescience/factsheets.htm
More than 60 two-page printable color fact sheets about research, monitoring, and resource management at Denali (see list of fact sheets on page 50-51).

Alaska Park Science
http://www.nps.gov/dena/naturescience/park-science.htm
The special Denali issue of Alaska Park Science, plus links to other issues that include 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
Links to current fire information, fire ecology, fire weather and danger, and more about 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), monitoring reports, and more information about the Inventory and Monitoring Program.

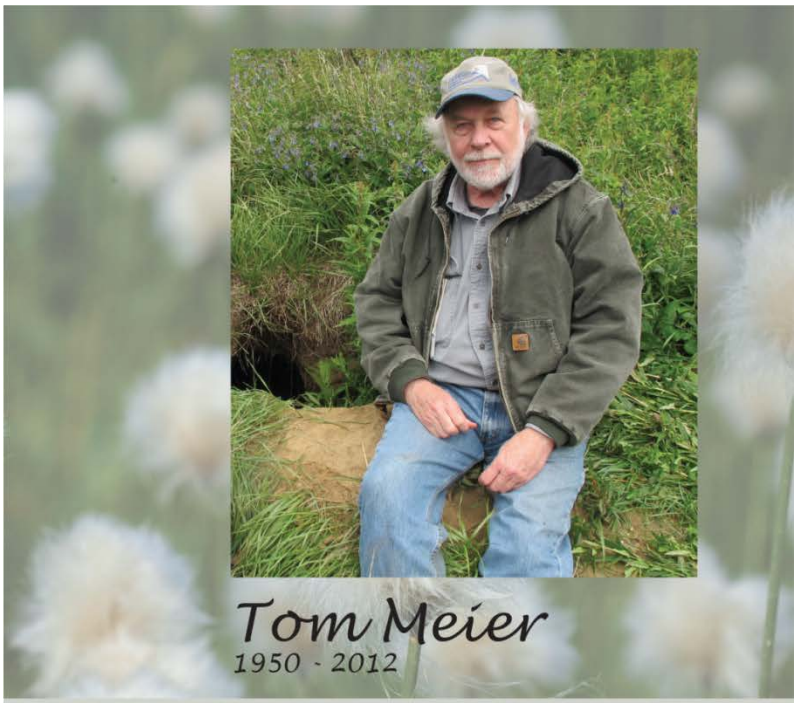
Murie Science and Learning Center
http://www.murieslc.org
More about the Murie Science and Learning Center and its northern Alaska parks, partners, and programs.

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

≺ In Memoriam ≻

Tom Meier

Wildlife Biologist 1986 – 1994
Biological Program Manager 2004 – 2012



Tom had great wit, a wry sense of humor, deep intelligence, a gentle spirit, and a generous heart. Tom was known to the world as an expert wolf biologist, but his influence went beyond the world of wolves. To the people that worked with him, Tom was an understated and respected leader, quick to provide insight, perspective, or a witty retort to any issue or crisis. To his friends, he was an enthusiastic adventurer and had a story for any situation. A talented photographer, he brought to life the scenery and wildlife that surrounded him. Although Tom made his home in Alaska for many years, he returned often to Minnesota, where he planned to retire, to family and friends at Crooked Thunder, his hunting camp near Hinckley, or at his childhood home on Woodpecker Ridge. Tom's life was filled with gatherings around bonfires, listening to an eclectic range of music, reading just about everything ever written, and toasting special people and moments with White Port. Cheers to you, Tom.

Selected Resource Highlights from 2012-2013

Wilderness Character Spatial Model

In April 2013, park staff, in cooperation with Peter Landres and James Tricker from the Aldo Leopold Wilderness Research Institute, completed a wilderness character spatial model for Denali. This model compiled Denali-specific spatial data to represent the five qualities of wilderness character. A report will be published later this year.

Habitat Recovery in Areas Previously Used by ATVs

Habitat disturbed by ATVs used for subsistence activities near Cantwell is recovering after trails were designated. There was a substantial decrease in illegal ATV use away from the designated trails, due in part to Cantwell community support.

Repeat Photography Website

Check out photo pairs that show landscape change at: http://www.nps.gov/dena/naturescience/repeat-photos.htm

Publications by Resources Staff

Here are several notworthy publications for 2012 and early 2013:

Roland, Carl A., Joshua H. Schmidt, and E. Fleur Nicklen. 2013. Landscape-scale patterns in tree occupancy and abundance in subarctic Alaska. Ecological Monographs 83(1) 19-48.

Schmidt, Joshua H, Carol L. McIntyre, and Margaret 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.

Fix, P.J., A. Ackerman, and G. Fay. 2012. Estimating visits to Denali National Park and Preserve: Spring/Summer 2011. Natural Resource Technical Report NPS/AKR/NRTR—2012/641. National Park Service, Fort Collins, CO.

Wolf Program Review

Experienced wildlife biologists, park managers, and educators gathered on January 23, 2013 at the Murie Science and Learning Center to evaluate the park's Wolf Program and generate the content for a guidance document with general programmatic recommendations for future research and monitoring.

Decline in Wolf Numbers

Wolf numbers and viewing opportunities have declined in recent years. As of April 2013, there were approximately 49 wolves in the 11 packs being monitored by park biologists. This estimate is substantially lower than the estimate of 70 wolves in 9 packs in 2012.

Air Quality: Healy Power Plant Update

A 2012 consent decree between the Environmental Protection Agency and the power plant owners and operators will help protect Denali's class I airshed. New emission controls and lower emission limits will be phased in when the second unit of the coal-fired plant is restarted in 2015.

Looking Ahead – 2013 and Beyond

Implementation of the Vehicle Management Plan To assess whether the standards of the plan are being met, indicators for these standards will be monitored when buses and other vehicles drive the park road.

New documents ahead!

State of the Park Report 2012

Geologic Guide to the Denali Park Road

State of the Backcountry Report