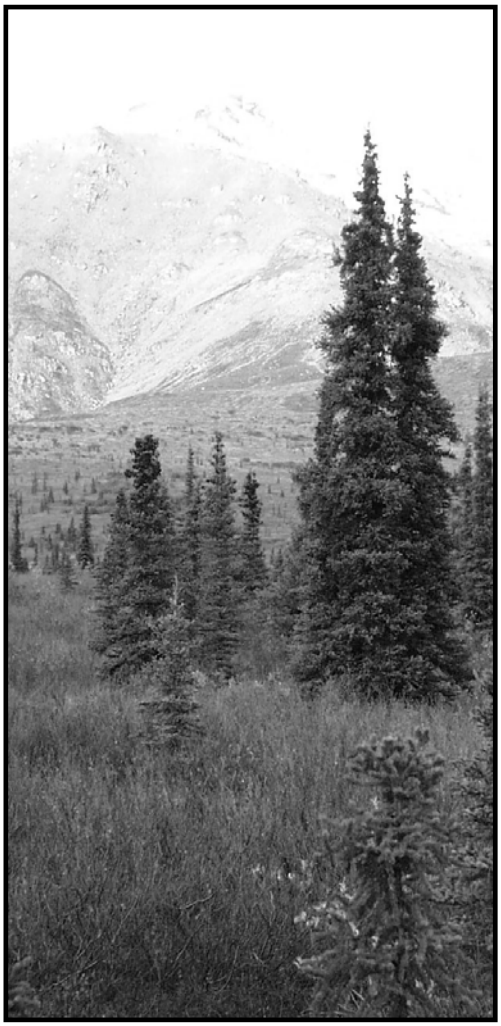
National Park Service
U.S. Department of the Interior

Denali National Park and Preserve

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



# Summary of Current Resource Projects 2006

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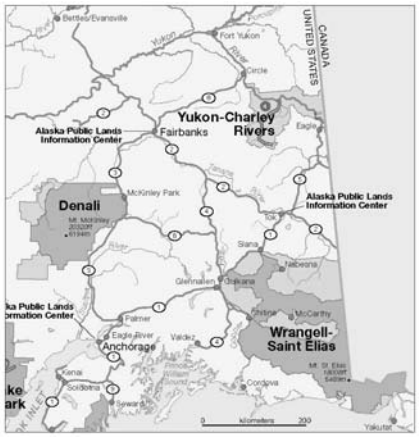
# ◂ Natural Resources ▸

## Integrated Programs and Findings

**Central Alaska Network Inventory and Monitoring at Denali**

The Central Alaska Network (CAKN) includes three national parks that encompass 21.7 million acres of land: Denali National Park and Preserve, Wrangell-St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve.




CAKN's Vital Signs Monitoring Program marked its fourth year of program development in 2005. The milestone achievement for the network was the completion of the *Vital Signs Monitoring Plan* bringing the network into the fully operational stage for FY2006.

The network produced full protocols for monitoring 11 of the Vital Signs (Climate, Air Quality, Snowpack, Vegetation, Water Quality, Macroinvertebrates, Passerines, Peregrine Falcons, Golden Eagles, Moose, and Wolves). After protocols are given scientific peer-review, they are revised as necessary before final approval from the Alaska Region Monitoring Coordinator. Currently, four Vital Signs protocols (Air Quality, Climate, Snow Pack, and Vegetation) have been given final approval.

The Central Alaska Network meets every two years to present monitoring data collected so far and discuss it from a technical point of view. At the May 3, 2006 meeting in Glenallen, CAKN resource staff focused on the first 11 Vital Signs being implemented.

*Biological Inventories*

Biological inventories were completed in 2005. These inventories documented the occurrence of 90 percent of the plant species, 90 percent of the small mammal species, and 90 percent of the freshwater fish species hypothesized to exist in Central Alaska Network parks. In 2005 the vascular plant inventory and small mammal inventory results were certified and all data have been transferred to NPSpecies and ANCS+.

*Vital Signs Monitoring*

Interactive kiosks were purchased for installation in four locations: the Murie Science and Learning Center in Denali, the Yukon-Charley Rivers Visitor Center (VC) in Eagle, the Fairbanks Public Lands Information Center, and the Wrangell-St. Elias VC in Copper Center. These kiosks will encourage visitors to learn about the Vital Signs Monitoring

Program, to view maps and graphs of the Biological Inventory data, and to see how parks utilize the I&M data for management purposes.

*Recent Activities and Support*

- Analysis of climate data. The array of 13 climate stations installed in the Central Alaska Network parks in the past two years meets CAKN's climate monitoring objectives, according to a report by Dr. Richard Keen of the U. of Colorado.

- "Near real-time" data from climate stations. More stations were added to the web server to transmit "near real-time" data via satellite to the website http://www.wrcc.dri.edu/NPS.html. New updates are available hourly.

- Internet tool to analyze moose data. The CAKN partnered with the Alaska Department of Fish and Game, the U.S. Fish and Wildlife Service, the Arctic Network and Western Arctic Parklands to develop an "on-line" tool to analyze moose survey data.

- New radio-collars for wolves. New radiocollars are able to transmit a wolf's location to biologists every day via a satellite system. CAKN has supported this new technology that increases the efficiency of monitoring wolf populations (the number of locations collected on each wolf pack each year has increased nearly 10 times, yet overall cost for radiotracking is reduced).

- Sondes for water quality monitoring. To determine the best time of day for taking water samples for water quality monitoring, sondes suspended from a buoy collected four basic water quality parameters continually over a 24-hour period. The pilot work in Yukon-Charley indicates that during this interval, some lakes vary little while adjacent lakes vary greatly in measures of water quality.

- Using satellite images to study shallow lakes. CAKN will acquire weekly RadarSat images from April-August through a proposal to NASA (jointly with University of Alaska Fairbanks). This imagery will allow the network to test how surface water area of shallow lakes changes with changes in precipitation. Historic trends in surface water area can be estimated from precipitation data in the past (weather station data). CAKN can then assess the rate of drying/formation for small lakes.

- Plans for developing protocols for moving water. The network Stream Ecologist will develop a multi-year plan for developing the moving water portion of the monitoring program, including methodologies for gauging of large, glacial rivers and smaller, headwater streams and for the biotic component of moving water systems.

## Effects of Global Climate Change at Denali

Denali's natural resources are responding to global climate change. Some of these changes are easily visible and others are more subtle:

- **Warming of permafrost.** Permafrost temperature profiles measured in boreholes near Healy show consistent warming since 1991. The borehole temperatures are very close to 0°C. At the point when borehole temperatures reach 0°C, there is the potential for significant landscape change. (See pages 34-35.)

- **Snow free days and length of growing season.** Weather observations have been recorded at Denali for 80 years (since 1925). In recent years, the number of snow free days has increased and the growing season has lengthened. Average warming in Alaska since the 1950s has been 4°F (2°C). (See pages 40-42.)

- **Shrinking Glaciers.** Denali glaciers continue to show negative balance and steady thinning. (See pages 32-33.)

- **Wildfire Size and Duration.** Fire statistics over the last five years show an increase in fire size and duration. The Moose Lake Fire in 2002 (see photo at left) was the largest single fire on record for Denali (117,920 acres) and the Highpower Creek Fire (2005) lasted 81 days – well beyond the average of 24 days. There has not yet been an increase in the average numbers of fires per year, but lightning activity levels have increased. There were a record number of lightning strikes in June 2005 in Interior Alaska. 2005 was the second largest fire season on record – 4 million acres burned with widespread smoke in June and July.


Moose Lake Fire 2002

- **Vegetation and landscape change.** Over a 30-year period, based on visual comparison of aerial photography (1976, 2005), spruce has expanded its range across the landscape, open water areas are smaller, "pond-drying" is common, and woody vegetation has invaded open wetland sites. (See pages 5-6.)

- **Shifts in Bird Distribution.**
  - Trumpeter Swans shifted to include higher elevation lakes (2005 survey)
  - Orange-crowned Warblers, Golden-crowned Sparrows, and Lincoln's Sparrows are much more common in Denali than they were 75 years ago (based on bird surveys in 2001 to 2005).

**Integrated Study of Park Road Capacity**

In 2006, Denali will begin a multidisciplinary study designed to optimize the visitor experience along the park road while protecting wildlife. Since 1972, traffic on the park road has been limited mostly to buses, and since 1986, a use limit of 10,512 vehicle trips annually has been effect. Faced with increasing visitation and pressure to defend or change the limits to road traffic, the park wishes to develop a greater understanding of the impacts of traffic volume and traffic patterns on the physical, biological, and social environment of the park. A GPS telemetry study of grizzly bears and Dall sheep is intended to detect impacts of traffic on animal movements near the road. A social survey will study the expectations and experiences of park visitors and of experienced road users. A study of logistical and physical constraints on traffic will examine traffic congestion, maintenance and construction needs, dust and noise levels, and other factors that constrain traffic. A comprehensive model of park road traffic will be developed to predict the effects of changes in traffic volume and timing. Finally, if the model and an environmental impact statement suggest that an increase in traffic volume is feasible, an experimental increase in road traffic, timed so as to produce the greatest value in understanding impacts, will be undertaken as part of a Before-After-Control-Impact (BACI) study. The goal is to make the most well-informed decision about the future of traffic on the park road.

## Plants/Vegetation

**Off-Road Vehicle (ORV) Impacts**

In 2005, park staff used GPS to map nearly 45 linear km of tracks made by ORVs in the park (see Figure 1). Staff recorded information about 13 trail attributes for each section of trail, including trail type (main active, secondary inactive, etc.), trail width, number of parallel paths along the trail segment, degree of vegetation stripping on the trail, depth of trail compared to adjacent areas, muddiness, and depth of damage to soil below the organic mat.

Now, park staff members are incorporating the field data about the impacts of ORV's into the Environmental Assessment (as part of the NEPA process) being written to develop alternatives for managing ORV use for subsistence activities in the Cantwell Traditional Use area of Denali.

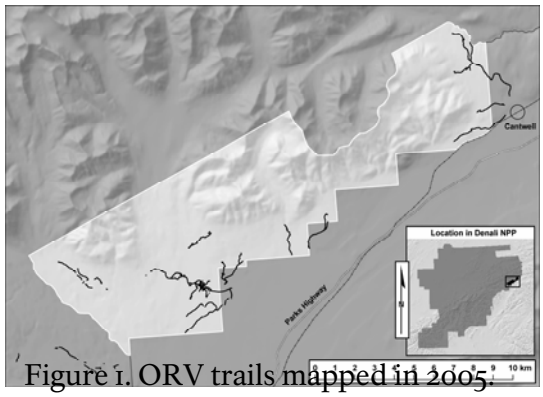



Figure 1. ORV trails mapped in 2005. The lighter area is the Cantwell Traditional Use Area.

## Long-term Vegetation Monitoring

Field work continues for the vegetation component of the long-term monitoring of park resources, including landscape monitoring of vegetation, repeat photography, and white spruce cone production.

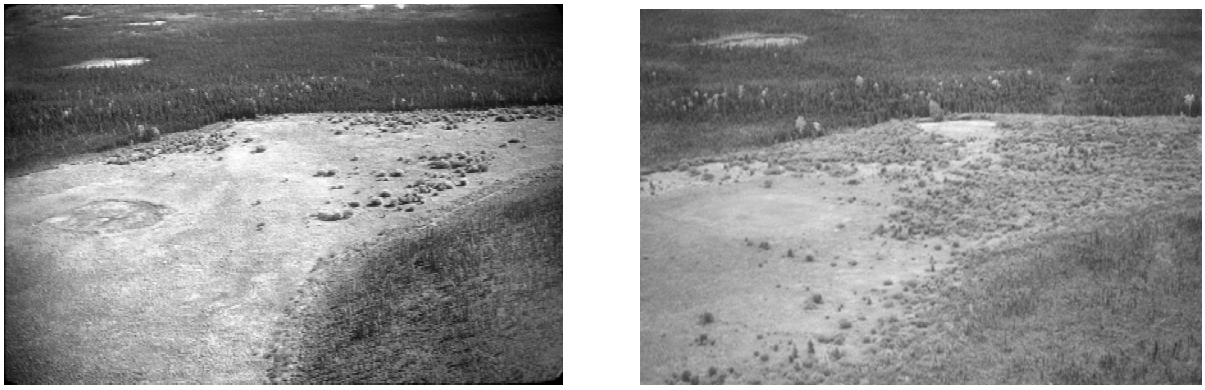
- **Landscape-scale vegetation monitoring project**

  The goal of this project is to detect changes in fundamental properties of the vegetation cover of the park over long intervals of time. The design for this landscape-scale work is a systematic grid of sites at 20-km intervals laid out over the park landscape. For vegetation monitoring, parameters measured at these mini-grid sites include species composition and structure, abundance, tree density, tree size, tree vigor, and evidence of pathogens. The vegetation field crew also measures soil characteristics and landscape variables in these plots. In 2005, the crew completed sampling of the Rock Creek and Middle Teklanika River mini-grids.

  During the 2006 season, the vegetation crew will be measuring plots in the seven minigrids near Wonder Lake, Mount Healy Ridge, Primrose Ridge, Kankone Peak, Bearpaw River, Sandless Lake and Bear Creek. The vegetation protocol for the Central Alaska Network vegetation monitoring has received a full peer-review, and the official implementation phase of the program begins in 2006.

- **Repeat photography**

  The repeat photography in 2005 of a subset of aerial photos of park landscapes taken in the mid-1970's is helping document qualitative changes in Denali's landscape. The original photographs were taken to prepare the first vegetation map of the park by Fred Dean, long-time researcher in Denali. Dean's early photos are a treasure trove of ecological information about the park at an earlier time. Carl Roland has been making careful comparisons of the "then" and "now" images to discern what changes are evident on the landscape over a 30-year span of time.



1976 2005

Figure 2. Two aerial views of the same meadow in Denali National Park (1976 and 2005). Note the extent of woody vegetation including shrubs and spruce trees (likely *Picea glauca*) that has established in the meadow in 29 years.

Preliminary, anecdotal observations of the repeat photography show these trends:

- Spruce has expanded its range across the landscape, especially in thawed terrain such as river terraces and well-drained slopes
- Shrubs have colonized open gravelly areas of river bars over a wide geographic area (this major net gain in shrub vegetation is likely a "recovery" from very large disturbance event associated with flooding in 1967)
- Open water areas are contracted in size and “pond-drying” is common
- Woody vegetation has invaded open wetland sites (see Figure 2)

The repeat photography project is part of vegetation monitoring in the Central Alaska Network. Approximately 2,500 slides of Denali in 1976 have been scanned and metadata on each picture recorded in an Access database. The CAKN is working on ways to objectively quantify the vegetation change.

❖ **Monitoring white spruce growth and reproductive effort**

The vegetation crew continues to monitor the permanent plots installed in 1992 within the Rock Creek drainage near park Headquarters, including observing the growth and cone and seed production of selected white spruce trees. Spruce cone production has been quite variable among years during this study, with especially high productivity observed in the years 1998, 2000, and 2002.

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. However, 2004 was an exception to this pattern and there were more cones per tree in the higher elevation treeline sites. This is surprising because the trees at treeline are, on average, considerably smaller than the spruce trees in the low elevation forested site. Two factors may be involved: (1) increased drought stress in the low elevation trees due to the dry winter of 2003 (when the 2004 cone crop was initiated) and (2) there were several consecutive years of high cone productivity in the low elevation spruce trees, perhaps depleting the reserves of these trees. Cone formation and maturation in white spruce is a two-year process. Cones are initiated in one year, and grow, are fertilized and produce seeds in the following year. Thus we see a pattern of alternating high and low spruce cone crops in Denali. There has not been documentation of two consecutive years of high productivity.

## Removal of Exotic (Non-native) Plants

❖ **Dandelions**

In 2005, volunteers helped resource staff remove more than 250 pounds of non-native dandelions *(Taraxacum officinale)* from over thirty-five miles of the road corridor at the east and west ends of the park. The east-end portion focused on the park road from Igloo Ranger Station to Mile 8.5 on the park road. The west-end effort includes Wonder Lake Campground and the park road to the Kantishna Airstrip.

In 2006, for the eighth consecutive year, volunteers will be enlisted to pull dandelions in the park.

❖ **Other non-native species of plants.**

Four non-native species other than dandelions were removed in 2005 and will be targeted for removal in 2006:

- Vetch (*Vicia cracca*): 10 lbs near power house at Headquarters
- White sweet clover (*Melilotus albus*): 400 lbs pulled from Parks Highway
- Hawk's-Beard (*Crepis tectorum*): 285 lbs pulled from the sewage lagoon at the Park entrance
- Mustard (*Erysimum cheiranthoides*): 50 lbs pulled from Mile 41 (east of Giglione Bridge) and Mile 43.4 (east of East Fork Bridge) on the Park Road

## Revegetation of Construction/Disturbed Sites

❖ **Seed collections**

In anticipation of the need for native seeds to revegetate areas of the Frontcountry after development and construction are completed, resource staff, volunteers, and the Denali trails crew conducted a major native plant "Need for Seed" collection in 2005. Collections were made near the park entrance and at Toklat, Eielson, and Kantishna of early successional species. These successional species are ones that will grow well on the newly-graded and bare soil sites being created by construction projects in the entrance area of the park (e.g., near the new Visitor Center and Train Depot). The species include Eskimo potato (*Hedysarum* spp.), Oxytropis (*Oxytropis campestris*), Arnica (*Arnica* spp), and native grasses (*Elymus* spp).

Once the seeds are collected, they are cleaned (removing seeds from pods or leafy sheaths and removing plant stalks and stems).

Seed collections will continue in 2006 for revegetation of present and future construction projects.

❖ **Revegetation**

Areas seeded in 2005 included the detour area on both sides of the railroad tracks along the Park Road, the old Roadside Trail, the edges of the new Multi-Use Trail, and the area around the new (temporary) Visitor Center at Toklat. Annual rye was added on slopes where erosion was a potential problem before the native seeds were fully established and could hold the soil in place.

The big projects for the 2006 season are the revegetation of areas around the new Eielson Visitor Center and in the Toklat area, using vegetation mats and seeding in the fall.

The best time for harvesting and transplanting mats is when the mats are almost dormant (so little damage occurs to plants) when more plant energy is directed at root production (in spring and fall) than in leaf and fruit production (summer). Seeding in the fall mimics the natural dispersal of seeds at a time when the seeds won't germinate but will overwinter on site and be ready to germinate the following spring.

**Monitoring Dust Palliatives on the Park Road**

To reduce road dust created by vehicular traffic, park maintenance crews apply an aqueous solution of calcium chloride (CaCl) to the surface of the park road. The application reduces both dust and the need for mining of additional fine materials to replace the material constantly lost from the road as dust. However, this dust palliative program also has the potential for adversely affecting ecosystems in areas adjacent to the park road. NPS has developed a monitoring plan to address this concern and to assess and monitor the possible effects on soil, water, and vegetation of applying calcium chloride as a dust palliative on the park road.

On August 23–24, 2006, park staff buried 15 lysimeters (instruments designed to sample water from within the topsoil) not far from the park road 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, 88.4. These lysimeters will allow park staff to monitor the migration of chloride ions away from the roadbed. In this way, the lysimeters will provide an early-warning system for potential negative effects of these chemicals on roadside biota.

## Wildland Fire

**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 what is known as limited fire management options. Limited fire management 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 that lie in the fire's path. 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.

Pertinent fire information and fire perimeter maps are posted on wildland fire bulletin boards (Headquarters Building, resource building, the Murie Science and Learning Center, the Wilderness Access Center, the Denali Visitor Center, and in the bus driver's building) and at http://www.nps.gov/akso/Fire/firehome.htm.

To alert local residents and staff about the possibility of seeing smoke, the Fire Management staff arranged for the park to issue a press release prior to the Sewage Lagoon Slash Burn.

Table 1. Fires in or near Denali National Park and Preserve in 2005

| Fire Name | Burn Period | Acres | Action Taken | Comments |
|---|---|---|---|---|
| Toklat slash burn | April 25-27 | 0.1 | Burn biomass debris from general maintenance projects | Prescribed fire[1] |
| Highpower Creek | June 14 to Sept 30 | 114,443 | Monitor, provide structure protection | Wildland Fire Use[2] |
| Herron River | June 14 to July 12 | 3,653 | Monitor, provide structure protection | Wildland Fire Use; burned into the Highpower Creek Fire |
| McKinley River | June 15 to July 12 | 91 | Monitor, provide structure protection | Wildland Fire Use |
| Bear Creek | June 17 to July 9 | 24 | Monitor | Wildland Fire Use |
| Wigand Creek | June 21 | 1 | No action | Natural Out Fire |
| Muddy River | June 28 to July 4 | 21 | Suppress | Fire located near full protection area |
| Birch Creek | July 26 to Aug 27 | 73 | Monitor | Wildland Fire Use |
| Sewage Lagoon slash burn | December 4-8 | 0.1 | Burn biomass debris from general maintenance projects | Prescribed fire |

[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.

[2]Wildland fire is used by fire managers as a valuable tool to reduce fuels and thereby reduce the risk of catastrophic fire, to reduce suppression costs, and to maintain ecosystem health. Wildland Fire Use is a relatively new term used "internally" by fire managers to refer to the use of wildland fire as a management tool. However, fires in Alaska will continue to be managed based upon what the management option is in the area where the fire is burning (full protection, limited option, suppress, etc.)

## Creating Defensible Space Around Structures

History has shown the devastating effects when wildland fire combines with a buildup of vegetation around structures. Hazardous fuels around structures in the developed and backcountry areas of Denali National Park and Preserve have or are being reduced to create a "defensible space" around the 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.

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. Once all the defensible spaces have been created, a maintenance and educational program will continue the benefits of this program.

- **Developed areas**. In fall of 2004, defensible space totaling approximately 30 acres was created in Denali developed areas (Wilderness Access Center, new Visitor Center, Water Supply, C-Camp, C-Camp and Headquarters Water supply control facilities, Headquarters Historical District and the Headquarters Residential Areas). The Headquarters Historical District was treated for hazard fuels within a historical cultural landscape context. Care was taken to trim branches to varying heights from the ground so the appearance was more natural. The biomass (logs, branches, etc.) generated from thinning and limbing was delivered to Usibelli Coal Mine in Healy to be utilized as reclamation material.

  In fall of 2005, defensible space totaling approximately 9 acres was created in Denali developed areas (Toklat Road Camp). Care was taken to trim branches to varying heights from the ground so the appearance was more natural.

- **Cultural resource sites**. In 2005, the 12 Mile Slough, Birch Creek, Castle Rocks, Poly Wonder and Roosevelt Cabins were treated with Firewise treatments. Of the sites to be cleared in 2006, the ones most visible from the park road are those near the Toklat Patrol Cabin, the Pearson Cabin, and the East Fork Research and Patrol Cabins.

In 2005 the Fire Management Staff resampled the vegetation in 24 of the 26 plots that were installed and sampled in 2003 (pre-treatment). The goal is to measure how the vegetation in the defensible space (treated areas) changes over time. Tracking the plots is intended to identify recurring maintenance treatments needed to minimize the threat of wildfire.

Throughout the hazard fuels project, Denali employees received project updates and other fire information. Two hazard fuel project success stories are posted at http://www.nps.gov/akso/Fire/firehome.htm

**Utilizing Satellite Imagery to Estimate Burn Severity**

To more efficiently and safely monitor the severity and associated effects of wildland fire on the vegetation within Denali National Park and Preserve, an exciting new technology that utilizes satellite imagery is being developed. If it proves to be accurate, precise, and reliable, this technology will substantially increase firefighter safety by reducing the amount of time spent in aircraft flying over fires to collect data about fire severity.

Fire specialists have compared pre- and post-fire Landsat (satellite) imagery to develop this new index of burn severity called the Normalized Burn Ratio (NBR). This continuous index relies on the fact that vegetation reflects light in different ways if it is unburned or burned to various degrees. [For any satellite image "techies", NBR is calculated in a manner similar to the Normalized Difference Vegetation Index (NDVI), but uses Landsat bands 4 and 7 (not 3 and 4 as NDVI does).]

To be confident that the NBR system works for Denali or elsewhere, the satellite image NBR index has to agree consistently with ground observations. The NBR method has been applied to Landsat imagery for Denali and other Western Area parks to produce GIS maps showing the mosaic of fire effects (NBR index).

Fire Management staff did not install any plots in Denali during 2005 and do not anticipate installing any plots in 2006. However Landsat scenes have been gathered for the 2005 fires and will be added to the dataset of trends in fire severity. If fires greater than 300 acres occur in 2006, plots could be installed in 2007.

**Videography Landcover Reclassification and Moose Browse Utilization**

The current landscape level fuels map for Denali is based on LANDSAT imagery compiled from scenes over a period of years. For lack of a more accurate landcover classification the areas that have burned in the last 3 to 15 years are classified as "burn" because the analysis and imagery used to develop the landcover classes is unable to detect vegetation for up to 15 years after a fire. Though the classification of "burn" is accurate, the classification does not differentiate among year(s) the areas were burned or give any indication of vegetation recovery or re-colonization.

Approximately 12.9% of the park, which is prone to natural ignitions, is classified as "burn" or has burned since the Landcover Classification map was made. In the short term, these "burn" areas need to be reclassified into another Landcover classification other than "burn" to update maps that model where fuels are so fire managers can predict fire behavior with some confidence. In the long term, fire managers would like to combine data from current and historical studies about vegetation recovery after fires to model plant succession after a fire on a landscape scale then apply this information to fuels model map products.

Post-fire plant succession depends on the site's fire severity, climate, surviving flora and seed sources, proximity to early successional colonizing seed sources, and the substrate (rock, soil). Fire severity is the degree of ecological change (setback) to an area due to the presence of fire. In general, the greater the fire severity, the further the plant succession is reduced to it earlier stages, hence the longer it will take for the area to return to its pre-fire condition. In a forested or shrub-dominated area, e.g., much of the natural fire-prone portion of Denali, if the area has burned under sufficient fire severity to encourage shrub development, browsing by moose (moose browse utilization) may increase. Extremely high fire severity may delay the onset of the shrub stage of successional development; extremely low fire severity may induce little change in the species composition and structure of an area. Moose play a major role in the dynamics of boreal forest ecosystems and are an important resource for subsistence users. Fire is a major disturbance of boreal forests in Denali and interior Alaska, but how the age and fire severity of fires affects the density and distribution of moose on a landscape scale is poorly understood.

The purposes of this pilot study are to reclassify the "burn" portions of the Landcover Classification, test the use of videography as a method for landcover reclassification, validate predictive fire models used by fire managers, validate successional patterns compared to burn severity, and identify fire effects on the level of moose browse observed under varying burn severity levels and age of burn. Understanding the natural variability related to fire is necessary in order to identify potential abnormal effects associated with long-term climate change or management activities.

In the fall of 2004, two transects (approximate 100 km) were flown with videography equipment over the northwestern (most fire-prone) portion of the park. The two transects crossed "burn" areas ranging from 3 to 50 years old for which there are maps of burn severity dating back to 2000. This product includes an unbroken line of high resolution video with time/date and latitude/longitude stamped imagery.

In 2005, field crews ground-truthed areas covered by the transects. The field crews sampled vegetation in 46 plots established along the two transects, recording whether browsing by moose was low, moderate, or high. Data from this portion of the study will (1) provide ground-verified data to reclassify the "burn" landcover classification to a vegetated class and (2) establish baseline information on the extent of shrubs (browse) utilized by moose for areas where fire age and satellite-derived (Normalized Burn Ratio) burn severity are known. Analysis for this project is in process and will continue through the 2006 season.

## Fire Education

- ✧ **Firewise Workshops.** Firewise is a multi-agency effort designed to involve homeowners, community leaders, planners, and developers in the effort to protect people and property from the risk of wildland fire—before a fire starts. These interactive workshops were created for local communities adjacent to the parks.

Participants learn about local fire history, wildland fire and fire management in Alaska, homeowner protection, wildland fire prevention in wildland/urban, rural or remote areas, and where homeowners can seek out further assistance. At the conclusion of the program, participants have the knowledge to become Firewise. In 2005, the Alaska NPS Fire Management staff teamed up with the Chugachmuit and Matanuska-Susitna Borough Department of Emergency Services to co-present a Firewise workshop at the Susitna Valley High School on April 23 (Earth Day). The Fire Management staff and the Division of Forestry presented a Firewise workshop at the Murie Science and Learning Center (MSLC) on April 30.

- **Fire! In Alaska Workshops.** Fire! In Alaska workshops are intensive workshops that include hands-on lesson modeling, computer simulations, and interdisciplinary activites. Teachers and educators not only gain access to a "fire trunk" full of knowledge and tools to teach a curriculum about fire ecology, behavior, management, and Firewise, but they also receive 1 credit. The NPS Fire Education Specialist, Alaska Fish and Game and USFWS Education Specialists jointly presented the workshop to Tri-Valley Borough teachers and one MSLC staff member on September 21-23.

- **Denali Discovery Camp.** As part of the annual Denali Discovery Camp in June 2005, the NPS Fire Education Specialist hiked for half a day with several students along the Rock Creek Trail teaching concepts about wildland fire and forest succession.

## Wildlife

**Keep Wildlife Wild**

Denali National Park and Preserve resource staff continue to educate people with the basic message: "Keep wildlife wild - do not approach or feed wildlife". Though no hard data have been collected, anecdotal observations indicate that the program has been 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, buttons, brochures, and signs bearing a universal symbol "Do not feed the animals" with text explaining why this is important. In 2006, staff will again distribute these materials around the park. Signs appear on trash cans, picnic tables, and toilet stall doors.

The message has also become part of every interpretive program. The "Keep Wildlife Wild" program serves as a model for other parks. Wildlife staff encourage everyone working at the park to take every opportunity to discourage the feeding and subsequent habituation of wildlife.

## Bears

✧ **Grizzly bear monitoring**

This long-term study on the north side of the Alaska Range focuses on a sample of grizzly bears between the Muldrow Glacier and the Herron River. Radio-collared females are located at den emergence and at the end of September to locate and follow the mortality of the sows and their cubs.

During bear capture in May 2005, collars were replaced on three of the five female grizzly bears scheduled for collar replacement. One of the five (30-year old) was found dead and her collar retrieved. The other could not be located and probably has a failed radio collar. One new female was captured and collared. One female whose collar failed in 2003 was recollared. Two dropped collars were retrieved. Captures were conducted from a helicopter with fixed-wing support. The number of collared bears in the study is 10, all female. The oldest bear in the study is 17 years old.

At den emergence in 2005, three sows had a total of six spring cubs (3 litters of 2 each) (see table below). By the end of September, only one spring cub survived. Five sows had a total of six yearlings at emergence, but only three yearlings were alive by the end of the season. The fate of one yearling could not be determined due to the sow dropping her collar. Two sows had a total of 4 two- year-olds all of which survived to the season's end. Three sows had a total of 6 three-year-olds, none of which could be accounted for by the end of the season and may have died or dispersed.

| 2005 | Sows with spring cubs | Sows / yearlings | Sows / two-year-olds | Sows / three-year-olds |
|---|---|---|---|---|
| Den emergence | 3 / 6* | 5 / 6 | 2 / 4 | 3 / 6 |
| End of September | 3 / 1 | 5 / 3 (?)[1] | 2 / 4 | 3 / ? dispersed or died |

* number of sows / total number of cubs

[1] The fate of one yearling could not be determined because the sow dropped her collar

Plans for 2006 are to replace radio collars where necessary, increase the sample size by collaring some new bears or locating those with failed collars, and investigate mortalities/dropped collars.

✧ **Population estimates:**

On the south side of the Alaska Range, the park is cooperating with the Alaska Department of Fish and Game to estimate population numbers for both black and grizzly bears. The study was conducted in 2000, 2001, and 2003. A final report on this study has not yet been received. Preliminary results indicate that for the entire study area, the density for brown bears is approximately 28 bears/1000 $km^2$. This density is slightly higher than that documented on the north side. Density for black bears is predicted to be about 80 bears/ 1000 $km^2$.

**Bear Management**

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.

The success of the Bear Management Plan is largely dependent on the cooperation of all NPS employees. Within the BMP, it states that all employees are responsible for reporting or correcting possible bear problems as they develop. Supervisors and liaisons are responsible for ensuring that their staff or crews get bear safety training and are aware of Denali's policy regarding bears and other wildlife. To get further information or to schedule bear training, contact Pat Owen (Wildlife Biologist) at 683-9547. Information and some equipment can also be provided for bear-proofing camps and worksites.

During the 2005 season (April 30 to September 25), 238 bear-human interactions were documented. These interactions were classified as 20 observations, 179 encounters, 25 incidents and 14 control actions (see Table). This year's total of 238 BIMS is 45 fewer than last year's total of 283. There were fewer incidents in 2005 than in 2004, but more control actions than in 2004. All 14 control actions took place in the frontcountry.

| 2005 (2004) | Frontcountry | Backcountry | Total |
|---|---|---|---|
| Observations | 5 (0) | 15 (16) | 20 (16) |
| Encounters | 44 (22) | 135 (208) | 179 (230) |
| Incidents | 14 (9) | 11 (28) | 25 (37) |
| Control Actions | 14* (3) | 0 (0) | 14 (3) |
| Total (O, E, I) | 77 (31) | 161 (252) | 238 (283) |

*Of the 14 control actions, 12 took place in the Toklat developed area, 1 near the Savage Trail and 1 in the old Kantishna Gold Camp.

Backcountry incidents involved one injury, property damage, and close approaches to people. The injury involved a grizzly bear in the vicinity of the Savage River Trail footbridge in May. A woman and her husband were hiking on a ridge west of the bridge when the bear charged down slope through heavy brush and passed by them at a distance of about 6 feet. It went down slope from them a short distance then turned and headed

for the woman who was standing on a large rock. The bear seized her by the leg and pulled her off the rock. She suffered injury to her leg and a broken nose.

Frontcountry incidents included a bear getting food, property damage, and close approaches to people.

**Aerial Moose Survey**

To estimate the number of moose (Alces alces) in two areas on the south side of the Alaska Range, wildlife staff and other observers conducted aerial surveys from November 28 to December 1. Snow conditions were good for viewing moose throughout both survey areas. The moose survey is part of the Central Alaska Network (CAKN) monitoring program at Denali National Park and Preserve and follows program protocols.

In the Cantwell area (1,023.3 $km^2$ or 395.1 $mi^2$), 257 moose were observed during the aerial survey for a density of less than one moose (0.65) per square mile. Moose density for this area has roughly doubled over surveys conducted in 1995 and 2003. Preliminary data analyses for the Cantwell area show that on average for every 100 cows there are 20 calves and 47 bulls. The Cantwell survey area is bounded roughly by the West Fork Chulitna River and the park boundary on the south, the Parks Highway on the east, and the 3500-foot elevation contour on the north and west.

In the Yentna area (1,917.6 $km^2$ or 740.4 $mi^2$), 41 moose were observed during the aerial survey or an average density of well below one moose (0.41) per square mile. Density for this area has dropped drastically from densities around 1 moose per square mile calculated from past surveys. Preliminary analyses for the Yentna area show that on average, for every 100 cows, there are 11 calves and 41 bulls. The Yentna survey area is bounded roughly by the park boundary on the east and south, and the 3000-foot elevation contour of the Yentna River and Fourth of July Creek drainages.

**Road Wildlife Study**

This study relies on those bus drivers who volunteer to help monitor wildlife along the park road and will continue in 2006. Drivers record the numbers of bears, moose, sheep, caribou, and wolves they see on their trips (westbound only). These numbers are summarized and compared to previous years to detect substantial changes. So far, differences in numbers from year-to-year are within the range expected due to natural variation.

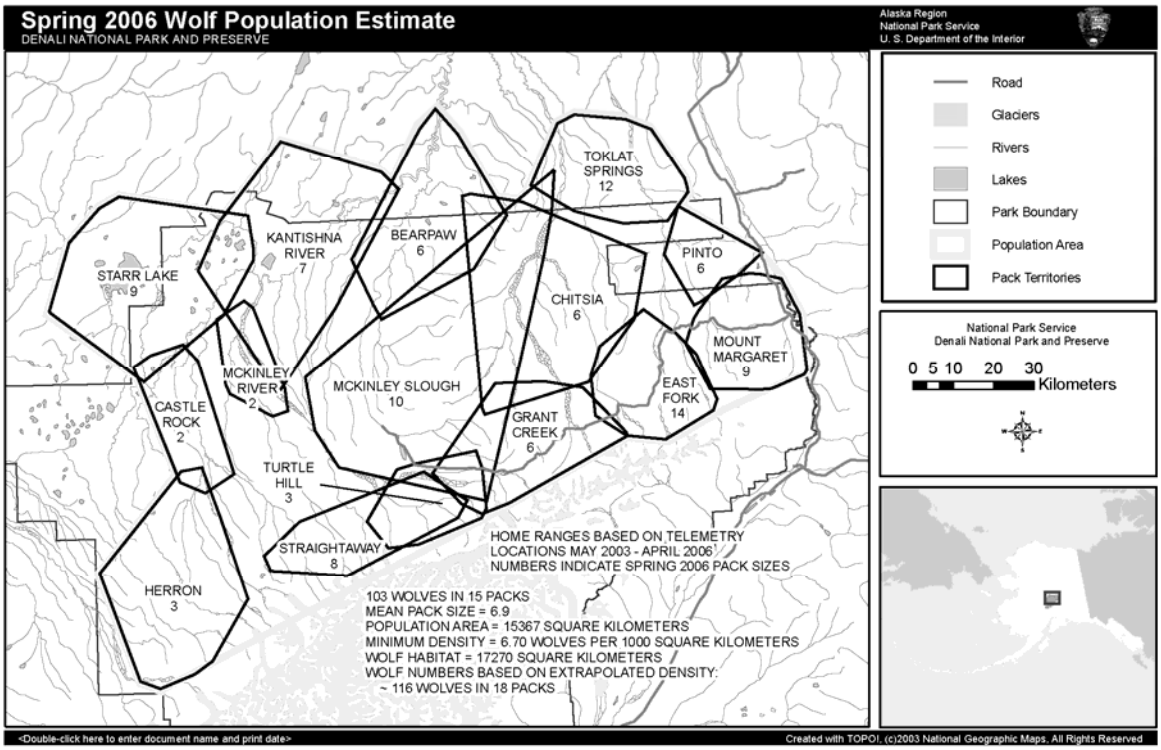
Though data have not been analyzed for the past few years this project is considered worthwhile and will continue. It will become part of a much larger road capacity study (see below) due to begin in full in 2006. An ecologist will be hired to work on many aspects of that project including analysis of past data collected by bus drivers.

Until more analyses are available, here are the past summaries once again: Based on the groups and individuals observed per bus trip in 1999, 2000, and 2001, a visitor taking one bus trip into the park could expect (based only on averages) to see 15 caribou (in 3-4 groups), 3 or 4 grizzlies, 18-19 Dall sheep (in 1 or 2 groups). A visitor taking 10 trips into the park would be expected to see a moose on 8 out of 10 trips, and a wolf on 2 out of 10 trips. In other words, the odds of seeing the big mammals are: Caribou (very close to 100%), Grizzly bear (very close to 100%), Dall sheep (very close to 100%), moose (80%), and wolf (20%).

## Wolves

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. While the intensive research program was concluded in 1993, research and monitoring efforts have continued.

The current study consists of maintaining 2-3 radio-collared wolves in each known pack inhabiting the park north of the Alaska Range. Radio collared wolves are located every 2 weeks, with additional locations during late September-early October to determine fall pack sizes and to count pups, and locations during mid-March to determine late winter pack sizes.



Telemetry locations acquired over two biological years (a biological year runs May 1 – April 30) 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, mortality factors, behavior, and population dynamics.

At the present time, 21 wolves in 14 packs in Denali wear conventional, VHF radio collars that are located by homing in with an antenna-equipped airplane. Another 7 wolves carry GPS collars that determine the animal's location once per day, store the data and upload it through the ARGOS satellite system.

In March 2006, there were approximately 103 wolves in the 15 packs being monitored by park biologists. The current density of wolves in Denali (about 6.7 wolves per 1000 square kilometers) represents a 50 percent increase from last year. The relatively severe winters of 2004-2005 and 2005-2006 were probably beneficial to wolves, as the deeper snow made prey more vulnerable.

**Caribou**

The National Park Service has supported intensive caribou research at Denali since 1983. Since 1986, this research program has consistently applied the same methodology to census the population annually and to estimate calf production, calf recruitment, adult female survival, and herd composition. This Denali study is the longest and most consistent caribou census anywhere in North America. Despite the general acceptance of the importance of age on productivity and survival, the Denali research design is the only one that has attempted to sample caribou females representative of the herd's age structure in a wild population. Since 1986 (approaching 20 years), a sample of approximately 50 radiocollared females has been maintained, providing an annual assessment of population vital rates faithful to the herd's age structure.

Much has been learned about the interactions between predation and weather that drive the dynamics of the Denali Caribou Herd. When this study began, the caribou population was increasing at about 7 percent per year through a period of relatively mild winters in the mid-1980s. Winter survival of caribou cows was high (96 percent per year) and about 50 percent of the calves were recruited into the herd. With the onset of a period of severe winters in 1988, caribou numbers reached a plateau of about 3,200 in fall 1989, then declined by one-third over 2 years, and dropped to about 2,300 caribou by fall 1992. During the period of decline, adult cow winter survival dropped substantially (85 percent per year) and calf recruitment dropped to a mere 5 percent (i.e., 95 percent of calves did not make it to adulthood). Since 1992, winter snowfall has been moderate and the caribou herd has declined slowly at about 2 percent annually. Adult cow survival has been similar to the mid-1980s, but calf recruitment has been lower in more recent years than in the mid- to late-1980's (35 calves:100 cows during each fall 1984-89 compared to 14:100 during fall 1994-2002).

With the overall decline in calf recruitment since 1990, the female age structure became heavily weighted towards older females. It was expected that the loss of these old females would result in another period of decline for the herd, given that the poorest adult female survival we have recorded occurred in the winter of 2002-03, a winter with the lowest snowfall on record for the park. However, calf recruitment has increased during the last 2 years and the herd is remaining stable in size. Although the female age structure of the herd is still somewhat weighted to older females compared to that at the beginning of the study, the situation has improved and the herd is likely to maintain its numbers, particularly if the increase in calf recruitment continues.

During capture operations in March 2005, researchers replaced radiocollars on six cows and collared 5 new females and 12 female calves from the 2004 cohort (adding them to the age-structured sample). During 2005, 8 radioed caribou died and 1 adult cow captured in March 2005 left the park (at the time of calving was in the Delta Herd's range). As of September 30, 2005, 74 Denali Herd female caribou (including 56 in the age-structured sample) were wearing radiocollars.

Herd size. The tentative estimate of 2,050 caribou in the Denali Herd in late September 2005, included an increase in the number of adult cows in the population (see Figure 3). Calf recruitment, which increased in 2004 and 2005 over the rates in the previous 14 years, contributed to the increase. During 1993-2003, the caribou population declined by about 1.6 percent per year. However, in 2004, for the first time since 1989, calf recruitment was more than 20 calves per 100 cows, bolstering population numbers. What the trend is for the herd over the next few years will largely depend on whether the modest increase in calf recruitment continues.

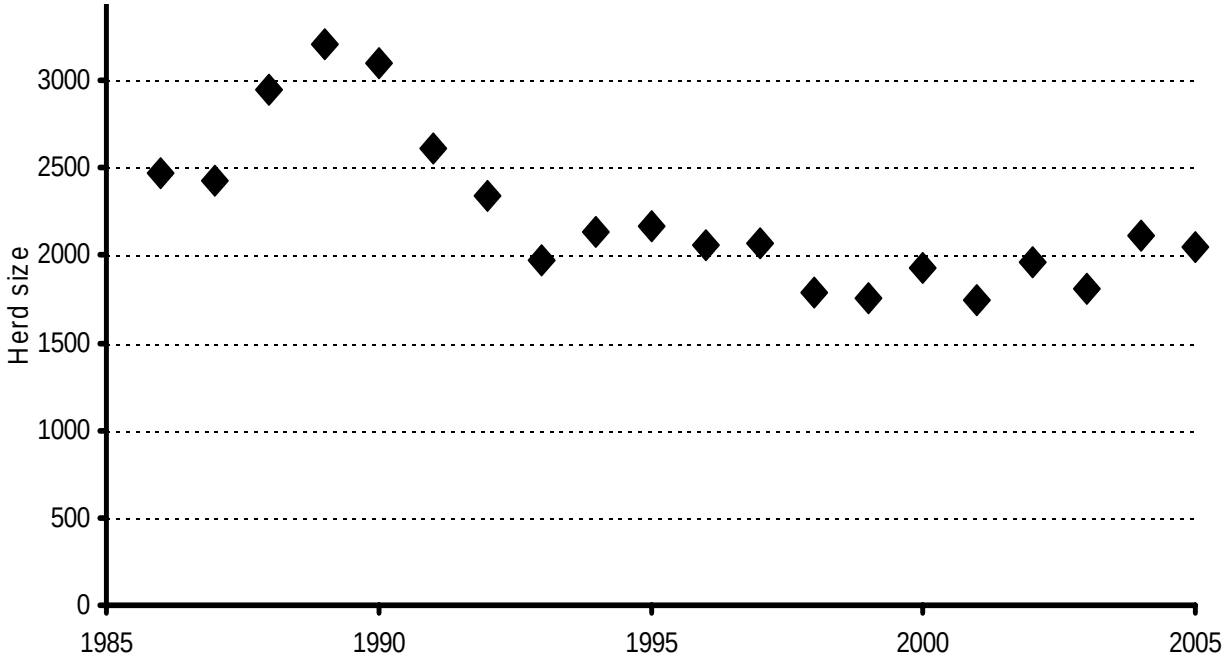



Figure 3. Population estimates (late September) for the Denali Caribou Herd, Denali National Park, 1986-2005. Estimate for 2005 is tentative.

Conducting the annual postcalving count that serves as the basis for estimating population size was more involved in 2005 than usual. Population estimation methods rely on using the age-structured sample to present the distribution of cows in the population, then attempting a total count of cows in an defined area where a high proportion of the sample are located. That count, along with the proportion of the age-structured sample in the survey area, is used to extrapolate an estimate of the total number of cows in the herd. During 1986-1991, more than two-thirds of the radioed cows were in a relatively small area in the foothills of Mt. McKinley, from the Muldrow Glacier west to the Straightaway Glacier. Over the years, the proportion of cows in this region has declined and it has become more difficult to define an area that is both small enough to be thoroughly searched and that contains an adequate portion of the age-structured sample. In order to include more than 50 percent of the cows in our survey area, 4 discrete blocks were surveyed including the core calving area (Coal Creek to the Muldrow Glacier), the Birch Hills, the Polychrome Flats and mountains to the south, and the mountains between the West Fork of the Chulitna and the Bull River. If this trend continues a different approach for censusing the herd may be needed.

Adult Sex Ratios. In September 2005, the adult sex ratio recorded was 33 bulls:100 cows. There was a decrease in the proportion of large, fully-mature bulls in the bull segment of the herd. Given the estimates of bull numbers over the last few years, it is most likely that the bull:cow ratio was an overestimate in 2004 and that bull numbers have actually been relatively stationary over the last 7 years. In addition, the bull:cow ratio is expected to decline given the improved recruitment of calves and higher survival of adult females over the last winter.

Calf Production And Survival. Based on observations of radiocollared females of the age-structured sample near the peak of calving in May 2005, approximately 74% of the cows • 1 year old in the herd produced calves. This natality rate was lower than recorded in most years since 1992, primarily due to the preponderance of nonproductive yearlings in the age structure as a result of improved recruitment of the 2004 calf cohort.

On 6 June 2004, the annual census and post-calving composition survey set the ratio at 24 calves:100 cows. By late September 2005, the calf:cow ratio was 19:100, indicative of the 26 percent survival of calves of the 2005 cohort. During 1990-2003, fall calf:cow ratios have been chronically low, averaging 13.1 calves:100 cows. Calf recruitment has shown modest improvement in both 2004 and 2005. Approximately 13 female calves were recruited per 100 older females.

Adult Female Survival. During October 2004 – September 2005, 8 radio-collared caribou died including 5 killed by wolves, 1 killed by a bear, 1 killed by an unknown predator, and 1 that died of unknown causes. Adult female winter survival (October 2004 – May 2005) was estimated at 91 percent, similar to the 19-year average during the time Denali cows have been monitored. Over-winter survival was slightly higher than the previous 2 years, particularly given the above-average winter snowfall.

Survival of adult females during the entire year was 88 percent and was essentially balanced by the recruitment of female calves in September 2005.

Female Age Structure. The predominant change in the female age structure in 2005 was the large cohort born in 2004 that entered the age structure as yearlings in 2005. The proportion of old cows (• 13 years old) differed little from the previous year. Although the proportion of old cows in the herd has declined markedly since 2001-2002, it is still nearly double that of 1987-1989 when calf recruitment was high and the herd was growing.

## Small Mammal Inventory

At this time all 25 species of *small* mammals (100 percent of those expected to occur in Denali) have been documented (observed in the park and specimens collected) (Table 2). Denali's three most common species (based on inventory collections) are northern red-backed voles, tundra voles, and the cinereus shrews.

Table 2. Checklist of the small mammals of Denali National Park and Preserve, Alaska
All species listed have been substantiated with a vouchered specimen.

**INSECTIVORA - Shrews**

Family **Soricidae**
- *Sorex cinereus*, cinereus shrew
- *S. hoyi*, pygmy shrew
- *S. monticolus*, montane shrew
- *S. palustris*, water shrew
- *S. tundrensis*, tundra shrew
- •• *S. yukonicus*, tiny shrew

**CHIROPTERA - Bats**

Family **Vespertilionidae**
- *Myotis lucifugus*, little brown bat

**CARNIVORA - Carnivores**

Family **Mustelidae**
- *Mustela erminea*, ermine
- *M. nivalis*, least weasel

**RODENTIA - Rodents**

Family **Sciuridae**
- •• *Glaucomys sabrinus*, northern flying squirrel
- •• *Marmota caligata*, hoary marmot
- *Spermophilus parryii*, arctic ground squirrel
- *Tamiasciurus hudsonicus*, red squirrel

Family **Dipodidae**
- •• *Zapus hudsonius*, meadow jumping mouse

Family **Muridae**
- *Clethrionomys rutilus*, northern red-backed vole
- *Lemmus trimucronatus*, brown lemming
- *Microtus miurus*, singing vole
- *M. oeconomus*, tundra vole
- *M. pennsylvanicus*, meadow vole
- *M. xanthognathus*, taiga vole
- *Ondatra zibethicus*, muskrat
- *Synaptomys borealis*, northern bog lemming

Family **Erethizontidae**
- *Erethizon dorsatum*, North American porcupine

**LAGOMORPHA - Pikas & Hares**

Family **Ochotonidae**
- *Ochotona collaris*, collared pika

Family **Leporidae**
- *Lepus americanus*, snowshoe hare

**Small Mammal Monitoring**

Mice and voles (*Microtus* sp. and *Clethrionomys* ***sp***.) by virtue of their size, shape, and daily habits are not highly visible in the boreal forest, yet their collective biomass is a larger proportion of the animal community than that of grizzly bears. Within Denali's ecosystems, mice and voles consume seeds, fungi and invertebrates, and provide a key prey source for raptors, and carnivorous mammals. Mice and voles play another important ecological role by having the ability to influence species above and below them in the food chain.

Since 1991 mice and voles populations have been monitored in Denali National Park and Preserve and will continue to be monitored in Denali as part of the Central Alaska Network "Vital Signs" Monitoring Program. From these data and other studies we know that populations of mice and voles vary across the landscape and over years. Data from Denali suggest that annual fluctuations in small mammal populations are strongly related to abiotic factors like weather and timing of snowfall. Additionally, the relative abundance of small mammal species is directly related to local composition of plant species. Thus, any park-wide changes in weather or plant species composition will likely affect small mammal distribution and patterns of abundance. Thus by monitoring populations of mice and voles, we may detect effects of human-induced change (like global warming).

The 2005 field season of small mammal sampling in Rock Creek added a fourteenth year to the data series begun in 1992. Sampling occurred at the trapping grids in the Rock Creek drainage only at the end of summer (August 28-31). The four study plots include two forested areas and two areas along Rock Creek. Sherman live traps were deployed on the plots for a 4-day period. Traps were baited with sunflower seeds and bedding, and checked 3 times per day. Captured individuals were identified by sex and species, reproductive status was determined, and net weight was calculated. Unmarked individuals were implanted with passive integrated transponder (PIT) tags approximately the size of a grain of rice and released. Every individual can then be identified with a "reader" for capture/recapture estimates of population size.

The summer of 2005 was a banner season for small mammals in Alaska's Interior. Before sampling in Denali, anecdotal reports indicated population size was high (increased evidence of subnivean (under-snow) burrows during snowmelt in spring 2005 and multiple observations of red-backed voles running across roads. Density estimates in 2005 in Denali were the highest recorded for red-backed voles on 3 of 4 plots, for singing voles on 3 of 4 plots, and for tundra voles on 1 of 4 plots. Overall density across all four plots was almost twice as high for red-backed voles as the previous highest density recorded and more than twice as high for singing voles.

What may have caused or contributed to these high population levels this year? Previous modeling of vole populations by Debevec and Rexstad in 1999 used a weather metric that combined the effects of daily temperature and snow depth. Low winter temperature is

detrimental to over-winter survival, but because voles live beneath the snow, low temperatures are ameliorated by increased snow depth.

If over-winter weather was a major factor in the high population levels seen this year, then one would expect the effect to be seen in all species examined. However, high levels were only seen with red-backed voles and singing voles, while the levels of tundra voles were similar to previous year averages. Was a food source common to red-backed voles and singing voles particularly plentiful this year? Are there microhabitat differences between the species that might come into play? Are some species able to take advantage of favorable conditions and increase reproduction? Did a "green-up" that occurred two weeks early this year affect population dynamics? Further examination of data may help gain insight into the ecology and reproduction capacity of these species so that we can better understand why the populations fluctuate so greatly.

## Birds

✧ **Information about H5N1 Asia subtype Avian Influenza.**
As of this writing, H5N1 Asia subtype Avian Influenza has not been documented in North America. Denali staff will distribute fact sheets about H5N1 this summer to address visitor questions.

***Do not pick up any dead birds***
If dead birds are discovered, note their location and immediately report them to staff at the Denali Visitor Center, the Murie Science and Learning Center, or the Denali Center for Resources, Science, and Learning. The statewide Avian Flu contact number is 1-866-527-3358 (866-5-BRD-FLU).

✧ **Surveillance sampling of Arctic Wablers for Asian H5N1 avian influenza.**
The Alaska subspecies of Arctic Warbler is the second highest-ranking bird for early detection of Asian H5N1 in North America (Eastern Yellow Wagtail is first but does not frequent Denali). This species overwinters in the epicenter of Asian H5N1 outbreaks in southeast Asia and Indonesia, where it is abundant in shrub and forest habitats around farms and homes. Arctic Warblers are thus likely to become infected with Asian H5N1 through direct contact with both wild and domestic birds in Asia and carry it to Alaska where the entire subspecific population breeds (2.7 million birds).

The proposed study intends to sample 140 adult and 70 juvenile Arctic Warblers in Denali at sites at upper Savage River, Igloo Canyon, Polychrome Glacier area, and Highway Pass. Through sampling at Denali and other locations in Alaska, an estimated 700 adults and 300 juveniles will be captured and sampled for actively shedding Asian H5N1 in 2006. In each geographic area one crew of 2–3 people will operate three to five constant effort mist-netting stations, each with 15 mist nests distributed in appropriate habitats over a 10-ha area, from 10 June to 8 August 2006. Mist nests at each station will be open for 6 h starting at 0500 (or local sunrise if later) during one day for each of six

consecutive 10-day periods. All captured Arctic Warblers will be aged, sexed, swabbed (cloaca) for actively shedding avian influenza virus, measured, banded, and released. Additionally, all other species of birds captured in mist nets incidentally to the capture of Arctic Warblers will be similarly handled and sampled. Personnel will follow the protocols of the National Wildlife Health Center (NWHC) to protect themselves from Asian H5N1 and to collect, store, and ship samples. Cloacal swabs from Arctic Warblers and other target species captured incidentally to work on Arctic Warblers will be sent directly to the NWHC for screening for Asian H5N1. Cloacal swabs from non-target species will be stored by the U.S. Fish and Wildlife Service in Anchorage and will be made available to the NWHC for screening upon request.

✧ **Assessing the spatial and temporal variation in passerines (songbirds).**
The goal of this project is to detect changes in the population trends of songbird populations at Denali. The passerine monitoring program uses the same spatial sampling design (minigrid) as the vegetation monitoring program in Denali. Carl Roland (NPS), Karen Oakley (USGS), and Trent MacDonald (Western Ecosystems Technology (WEST) developed this probabilistic sampling design in 2000. Each 2.5 km x 2.5 km minigrid includes 25 sampling points located 500-m apart. By co-locating our sampling points with those sampled by the vegetation crew, there is no need for the bird crew to collect data on vegetation and/or habitat. The integrated data set contains measurements of vegetation and passerine birds across the landscape in Denali.

At each minigrid point, surveys were conducted by four highly experienced field biologists who completed an intensive two-week distance sampling training course before the field season. Birds are surveyed using a 10-minute point-transect with data grouped by distance interval. All birds seen or heard at each plot are recorded during a 10-minute sampling period by time segments: 0-3 minutes, 3-5 minutes, 5-8 minutes, and 8-10 minutes. All birds detected within 150-m of the observer are recorded at 10-m intervals up to 100 m, then at 25 m intervals to 150-m.

In 2005, biologists sampling 261 points on 11 minigrids. Sampling was not possible at 14 inaccessible points. All sampling occurred from June 1 to 27 between the hours of 0300 and 0915. Two days were required to sample all accessible points on each grid.

A total of 86 species were detected during the 2005 surveys (62 species on 10-minute point counts and 24 species on the minigrids but not during the point counts) (see Table 3). Highlights include detections of many Arctic Warblers on the Polychrome and Savage Upper minigrids, high numbers of Northern Waterthrush (n = 32) and Rusty Blackbirds (n = 6) on the Hult Creek minigrid, several detections of Greater Yellowlegs on the Birch Lower grid, and Great-Gray Owl nest near the Birch Middle minigrid.

Table 3. Summary of grids surveyed and the number of birds and number of species detected on each grid and on each point

| Minigrid | Points surveyed | # Birds detected on minigrid | # Species detected on minigrid | Mean number of birds per point | Mean number of species per point |
|---|---|---|---|---|---|
| Birch Lower | 19 | 219 | 32 | 11.5 | 7.9 |
| Birch Middle | 25 | 372 | 28 | 14.9 | 7.8 |
| Hult Creek | 23 | 360 | 28 | 15.6 | 8.1 |
| Igloo | 25 | 261 | 18 | 10.4 | 4.5 |
| McKinley Bar | 25 | 420 | 20 | 16.8 | 6.8 |
| Moose Creek | 25 | 573 | 25 | 22.9 | 9.4 |
| Muldrow | 25 | 425 | 17 | 17.0 | 5.6 |
| Polychrome | 25 | 375 | 18 | 15.0 | 6.5 |
| Savage Upper | 24 | 386 | 17 | 16.1 | 7.2 |
| Teklanika Middle | 25 | 372 | 23 | 14.8 | 7.2 |
| Wonder Lake | 20 | 386 | 25 | 19.3 | 6.8 |

In June 2006, 200-250 point count surveys will be conducted on the minigrids. To monitor bird species arrival dates and the phenology of singing, one to two roadside bird surveys will be conducted each week from late April through early July at 150 sampling points along the Park Road.

✧ **Breeding Bird Survey (BBS).**
The North American Breeding Bird Survey (BBS) is a large-scale survey of North American birds. Approximately 3,700 BBS routes are located in the U.S. and Canada and about 2,900 routes are surveyed annually. The BBS has accumulated over 30 years of data on the abundance, distribution, and population trends of more than 400 species. These data are useful for determining if major population changes of a species in certain states are related to a continental decline or represent population shifts within their breeding range. Denali's BBS survey is two standardized routes along the Park Road.

The 50 points along the Savage BBS route were completed on June 21, 2005 (from the west end of Savage River Bridge at 0300 and ending near Sable Pass at 0813). The number of individuals (n = 650) and species (n = 31) detected on the Savage BBS route was similar to previous years. The majority of birds (59 percent) detected on the Savage BBS route in 2005 were sparrows: American Tree Sparrow, Savannah Sparrow, Fox Sparrow, Lincoln's Sparrow, White-crowned Sparrow, Golden-crowned Sparrow, and Dark-eyed Junco.

The 50 points along the Toklat BBS route were completed on 22 June 2005, starting in front of the Toklat Ranger Station at 0300 and ending at 0931. The number of individuals (n = 611) and species (n = 34) detected on the Toklat BBS route was similar to results from 2001 to 2004. The majority of birds (67 percent) detected on the Toklat

BBS route in 2005 were sparrows: American Tree Sparrow, Savannah Sparrow, Fox Sparrow, Lincoln's Sparrow, White-crowned Sparrow, Golden-crowned Sparrow, and Dark-eyed Junco.

In 2005, the White-crowned Sparrow was the most common bird detected on both the Savage BBS route (26 percent of all individuals detected) and on the Toklat BBS route (24% of all individuals).

The BBS surveys will take place in mid-June 2006 (Carol McIntyre has conducted them since 2001). Results from the Denali BBS routes are available at: http://www.pwrc.usgs.gov/bbs/retrieval/summary/routeform.cfm

✧ **Trends in willow ptarmigan and snowshoe hare.**
Indices of population size of snowshoe hare and willow ptarmigan on a broad scale are obtained by recording the number of each species observed during routine field activities. These data allow us to track broad-scale abundance trends over time. The abundance of snowshoe hare and willow ptarmigan was higher in 2005 than in the past four years. Populations of both species are expected to increase in the next couple of years as they reach the peak of their 8-11 year population cycles.

✧ **Reproductive success of Golden Eagles and Gyrfalcons.**
This was the 18th consecutive year for conducting standardized aerial surveys to determine occupancy of nesting territories and document reproductive activities and nesting success for Golden Eagles and Gyrfalcons in Denali. Both species are of conservation concern; Golden Eagles because of habitat changes on their wintering grounds in western North America and Gyrfalcons because Alaska is the only place they breed in the United States. Denali contains the highest reported nesting density of Golden Eagles in North America and Denali's monitoring program and associated research projects have made significant contributions to Golden Eagle ecology in North America.

The *occupancy and breeding activity* survey was conducted from April 26 through April 28, 2005 after most pairs complete their clutches but before most nest failures. The *productivity* survey was completed July 8, 2005. The productivity survey is conducted late in the nestling period to determine nesting success and productivity.

The Golden Eagle nesting territory occupancy rate (87 percent) was similar to other years, but laying rate (61 percent), success rate (71 percent), and total fledglings produced (n = 40) were the highest since 2000 and 2001. As expected, Golden Eagle reproduction in Denali in 2005 was higher than the last several years, apparently due to the increasing abundance of snowshoe hare. Like many other northern predators, Golden Eagles in Denali respond to changes in snowshoe hare abundance - more eagles lay eggs and raise more fledglings in years when snowshoe hares are abundant.

The Gyrfalcon nesting territory occupancy rate (31 percent) was lower than most years, but success rate (75 percent) was higher than most years. The lack of territorial or breeding Gyrfalcons in the study area in 2005 was surprising because the abundance of Willow Ptarmigan is apparently increasing in the study area. Few occupied Gyrfalcon nest sites were found. These results suggest either that Gyrfalcons were present but went undetected at unknown nest sites, that many Gyrfalcons experienced nest failures before the occupancy survey was conducted, or that their numbers in the study area decreased substantially from 2004. From 1988 to 2004, 9 to 17 pairs of Gyrfalcons were observed in the study area, and nesting success was higher in years when Willow Ptarmigan were abundant. Joseph Dixon also noted the relationship between Gyrfalcons and their prey in the same area. Gyrfalcons were common in 1926 when hare and ptarmigan were abundance, but were "absent from their former nesting sites and not one bird was seen during the entire summer" in 1932 when the abundance of hares and ptarmigan was low.

The nesting phenology of Golden Eagles and Gyrfalcons was similar to other years. Most clutches were completed by mid-April, most hatching occurred by early June, and most fledglings left their nests by early August.

In 2005, Gyrfalcons once again successfully nested on the east side of Marmot Rock, about 100 meters from the Denali Park road allowing tens of thousands of park visitors to observe the nestlings and adults throughout the summer.

Proposed activities for 2006 include (1) continuation of Golden Eagle and Gyrfalcon monitoring in the historic study area in Denali, (2) continuation of genetic studies of golden eagles in Denali, and (3) continued public education and outreach efforts.

✧ **Examining fidelity of Golden Eagles to nesting areas.**
DNA extracted from shed feathers of Golden Eagles can be used to identify individual eagles. This is a non-invasive, cost-effective method for obtaining data to assess the population trends of breeding eagles in Denali and nest fidelity of individuals. The shed feather work is an outcome of a genetic study on Golden Eagles conducted in conjunction with the USGS-Alaska Science Center Wildlife Genetics Laboratory. Feather collections will continue in 2006 and are conducted under the auspices of a U.S. Fish and Wildlife Service Eagle Scientific Collecting Permit and a State of Alaska Scientific Permit. After the DNA material is removed from the feather shafts, all feathers are transferred to the National Eagle Repository in Colorado.

✧ **Statewide Trumpeter Swan monitoring.**
The U.S. Fish and Wildlife Service (FWS) conducted their five-year statewide Trumpeter Swan surveys in late August 2005. FWS personnel conducted standardized aerial surveys from a fixed-wing aircraft to count adult swans and cygnets in the southwestern and northwestern regions of the Denali. Seven hundred swans were detected on the Denali survey including 40 lone swans, 195 pairs (62 pairs with cygnets), and 197 cygnets. Since 2003, NPS personnel have detected Trumpeter Swans nesting on

lakes near the Clearwater Creek, just south of the McKinley Bar. FWS personnel also detected nesting swans in this region, as well as several nesting pairs on the lakes west of the Muddy River, indicating that swans are starting to nest at higher elevations than noted in the past. NPS personnel detected a lone swan on a large lake in the Sanctuary River in mid-July 2005.

✧ **Christmas Bird Count**

The National Audubon Society organizes the Christmas Bird Count (CBC). Each year more than 50,000 observers participate in this all-day census of early-winter bird populations. The results are compiled into the longest running (more than a century) database in ornithology. The primary objective of the CBC is to monitor the status and distribution of bird populations across the Western Hemisphere. The count period is any day from December 14 to January 5. When data from CBC and other surveys are combined, scientists begin to see a picture of how the continent's bird populations have changed in time and space over the past hundred years.

Denali's CBC has been conducted every year since 1992. Local naturalist Nan Eagleson organizes and compiles the results. The 2005 Denali CBC was held on December 28 with mild temperatures (15°F) but a lack of snow cover. Thirteen participants spent a total of 25 hours counting birds and covered many miles on foot, ski, snowshoe, dog sled, and snow-machine. A detection of a Gyrfalcon and a Black-backed Woodpecker were the first for the Denali CBC. The other 15 species detected were: Ruffed Grouse, Spruce Grouse, Willow Ptarmigan, Great-horned Owl, Northern Hawk Owl, Hairy Woodpecker, Three-toed Woodpecker, Gray Jay, Black-billed Magpie, Common Raven, Black-capped Chickadee, Boreal Chickadee, Pine Grosbeak, White-winged Crossbill, and Common Redpoll.

Twenty-eight species have been documented on the Denali CBC since 1992. However, 18 species (64 percent) have been recorded in five or fewer years and only 5 species (Gray Jay, Black-billed Magpie, Common Raven, Black-capped Chickadee, and Boreal Chickadee) have been detected every year. However, the number of individuals of these species detected annually varied substantially: Gray Jay (8 to 52 individuals), Black-billed Magpie (9 to 35 individuals), Common Raven (4 to 38 individuals), Black-capped Chickadee (2 to 29 individuals), and Boreal Chickadee (14 to 145 individuals).

While the number of species detected on the Denali CBC in 2005 was the second highest (18 species were detected in 1997), the number of individuals detected in 2005 (n = 168) was among the lowest in the count's history (ranges from 71 in 2003 to 935 in 1998). Of the 168 individuals counted in 2005, 70 (42 percent) were Willow Ptarmigan (the highest number of this species ever recorded on Denali's CBC).

To learn more about the Christmas Bird Count, visit the web site:http://www.audubon.org/bird/cbc/

✧ **Denali Institute Migration Station**

The Denali Institute, along with the Alaska Bird Observatory (ABO) and Alaska Wilderness Centers have cooperatively operated a fall migration monitoring station at Camp Denali/North Face Lodge in the Moose Creek drainage from 1998 to 2005. The primary objectives are to capture and band migrating passerines to examine: 1) population dynamics; 2) phenology of migration; 3) timing of life history events (e.g. migration, reproduction, molt, juvenile dispersal, and seasonal differences in body condition); 4) provide public education programs relating to avian ecology and conservation; and 5) contribute data as a member of the Alaska-Yukon Migration Monitoring Network.

The 2005 DIMS banding crew operated 12 standard mist-nets from July 27 to September 17. The station was operated daily, weather permitting, for seven hours beginning at sunrise. Nets were open on 46 days, with seven days cancelled due to weather. Nets were checked and birds were removed from nets at 15- to 40-minute intervals, based primarily on weather conditions and capture rate. Nets were place at the same locations as the previous six seasons, but two new nets were added to increase the station's capture rate. The nets were placed into the array so that nets could be checked at 20-minute intervals if necessary. All birds captured were banded with U.S. Fish and Wildlife Service aluminum leg bands and processed according to the protocol established by the Alaska Bird Observatory. Data recorded included: species, age, sex, amount of skull ossification, wing chord and tail length, size of fat deposits, breeding condition (presence of brood patch or cloacal protuberance), molt condition, proportion of juvenal plumage, mass, and date, time, and location of capture (net).

The number of individuals banded in 2005 was substantially higher than all other years; 2,445 individuals of 31 species were banded during 3,551.75 net hours in 2005. Ruby-crowned Kinglets were the most abundant species (27 percent of all individuals banded), followed by Wilson's Warblers (22 percent), White-crowned Sparrows (10 percent), Dark-eyed Juncos (8 percent), and Orange-crowned Warblers (5 percent). Three times as many Ruby-crowned Kinglets were captured in 2005 than in any other year. Additionally, more Northern Waterthrush, Fox Sparrow, and Dark-eyed Juncos were captured in 2005 than any other season. Capture rates of Black-capped Chickadees and Alder Flycatchers were lower than previous years. Less than one percent of the netted birds had been banded at the station in previous years.

Peak numbers occurred in late August and early September; the highest capture rate occurred on August 25. Of the total birds captured, 83.5 percent were young birds hatched in 2005 and 13.1 percent were adult birds (after hatch year).

DIMS will operate in 2006, and a new addition to this project includes collecting fecal samples from captured birds as part of the statewide surveillance program for H5N1 avian influenza.

## Wood Frog Surveys

The wood frog is the only amphibian that occurs (or is expected to occur) in Denali National Park and Preserve. Information on the presence and habitat associations of the wood frog continues to be collected concurrently with many of the ongoing bird and vegetation projects.

Dr. Grant Hokit (Carroll College, Montana) has conducted pilot field work (2003, in the Wonder Lake area) and extensive surveys for wood frogs (2004, from Grassy Pass to the south end of Wonder Lake). He looked for frogs in all still-water sites inside randomly-located 1-km circular plots. By describing habitat information and recording where they found frogs, they learned what features are positively or negatively correlated with use by wood frogs. Of the 41 plots, 22 were within 5 km of the Wonder Lake Campground and 19 plots were within 2 km of the road between Wonder Lake and Grassy Pass. Researchers surveyed a total of 219 still-water sites within the 1-km sampling plots. Wood frogs were observed at 106 sites (48 percent), breeding activity (the presence of eggs and/or larvae) was observed at 98 sites (45 percent), and adults and/or juveniles were observed at 17 sites (8 percent).

Breeding activity occurred more frequently than expected at larger sites that were not isolated from other sites characterized by: 1) maximum water depth between 1 to 2 meters, 2) no connection to moving water, 3) 51-75% of the site less than 50 cm deep, 4) 76-100% of the riparian zone covered with woody vegetation, 5) from one quarter to three-quarters (26 to 75%) of the site covered with emergent vegetation, 6) alder or spruce present in the riparian zone, and 7) no sign of beaver activity. Sites with signs of beaver activity were negatively associated with frog breeding activity, probably because they were generally deeper, with less emergent vegetation and less woody vegetation in the riparian zone, than other sites. No breeding activity was observed at bog sites dominated by sphagnum mats. Breeding activity of wood frogs was *not* associated with elevation or the distance of a site from contiguous boreal forest. In fact, the majority of the sites where wood frogs were present were in shrubby tundra more than 5 km from boreal forest.

No new work is planned in 2006.

## Freshwater Fish Inventory

Freshwater fish inventories were conducted in 2003 completing the CAKN inventory of fish. The only fish that was "expected" to occur in Denali but not sampled in 2003 was the inconnu. The total number of fish species documented in Denali to 14 (Table 4).

Table 4. Denali fish species list including the results of inventory sampling in 2003

| Species Category | Common Name | Scientific Name | Status * |
|---|---|---|---|
| Lampreys | Arctic lamprey | *Lampetra japonica* | 2003 |
| Pikes | northern pike | *Esox lucius* | E, 2003 |
| Suckers | longnose sucker | *Catastomus catastomus* | E, 2003 |
| Mudminnows | Alaska blackfish | *Dallia pectoralis* | 2003 |
| Whitefishes | inconnu | *Stenodus leucichthys* | E |
| Whitefishes | round whitefish | *Prosopium cylindraceum* | P |
| Whitefishes | humpback whitefish | *Coregonus pidschian* | 2003 |
| Trouts and Salmon | lake trout | *Salvelinus namaycush* | P |
| Trouts and Salmon | Dolly varden | *Salvelinus malma* | P |
| Trouts and Salmon | Chinook salmon | *Oncorhynchus tshawytscha* | P |
| Trouts and Salmon | chum salmon | *Oncorhynchus keta* | P |
| Trouts and Salmon | coho salmon | *Oncorhynchus kisutch* | P |
| Grayling | Arctic grayling | *Thymallus arcticus* | P |
| Codfishes | burbot | *Lota lota* | P |
| Sculpins | slimy sculpin | *Cottus cognatus* | P |

* P - Present or previously documented
E - Expected but not previously documented
2003 - Newly Documented in 2003 E, 2003 – Expected and documented in 2003

# Physical Resources

**Seismic Monitoring**

Researchers at the Geophysical Institute at the University of Alaska Fairbanks have maintained seismic monitoring stations within Denali at Wickersham Dome, Thorofare Mountain, and Mt. Healy for over thirty years. An upgrade of sites to allow for digital multi-signal transmission and the installation of a new site on Double Mountain was occurred in 2003 (after an Environmental Assessment identified some mitigation measures). Real-time earthquake data and maps showing recent seismic activity are available through the Alaska Earthquake Information Center. The new equipment allows for much more precise location of earthquakes recording movement three directions.

In 2006, a new installation is scheduled at Castle Rocks in order to better characterize activity on the western portion of the Denali Fault and the "Kantishna Swarm" of earthquakes (a cluster near Kantishna). The Kantishna Swarm is of interest to researchers working on the geologic evolution of the Alaska Range and the apparent volcanic gap that occurs between the eastern and western portion of the Alaska Range (all of Denali).

## Long-term Glacier Monitoring

Long term glacier monitoring sites were installed on the Traleika and Kahiltna Glaciers in 1991 to monitor their long-term mass balance changes and flow. These glaciers were selected to compare glaciers on the north (Traleika) and south (Kahlitna) sides of the Alaska Range (dryer and wetter climates, respectively). The measuring sites for both glaciers are located at approximately 6000' (1830 m). The Kahiltna Glacier flows ~660 feet (200 meters) per year, while the Traleika Glacier moves ~165 feet (50 m) per year. The Traleika glacier has lost approximately 13 feet (4 m) of water-equivalent (if the change in ice/snow were water) in 11 years of monitoring (a negative mass balance), while the Kahiltna has gained ~7 feet (2 m) of water-equivalent. Interestingly, although the Tralieka Glacier is experiencing negative mass balance, it has thickened 82 feet (25 m) in the past 11 years (the measurement station has risen by that amount), illustrating the complexity of glacier flow.

Radar measurements in 2002 indicated that the East Fork of the Toklat Glacier was 660 feet (200 meters) thick and the Muldrow Glacier was 1640 feet thick (500 meters)—but 50 feet (15 meters) thicker near McGonnagall Pass. The Kahiltna Base Camp (on the Southeast Fork of the Kahiltna Glacier) sits on ~985 feet (300 meters) of glacial ice.

Monitoring on the Southeast Fork of the Kahiltna Glacier began in 2004 and will continue in 2006. Movement rates, winter accumulation, and summer ablation rates will be determined. Magnets are also placed in outhouse holes for determination of their movement rates. Preliminary measurements indicate that the ice under the main "Base Camp" is 300-400 meters thick (see Figure 4) and is moving approximately 0.60 meters/day.

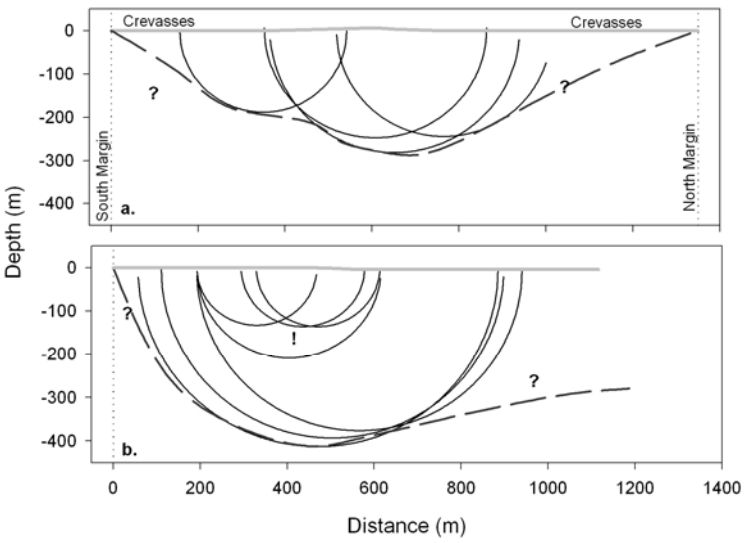


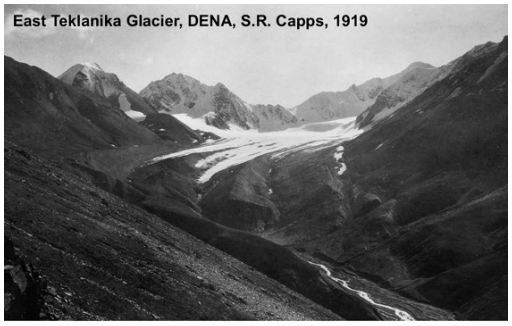

Figure 4. Two radar profiles of glacier ice thickness in the vicinity of Base Camp on the Southeast Fork of the Kahiltna Glacier. (The thinner profile is about 1000 meter upglacier).

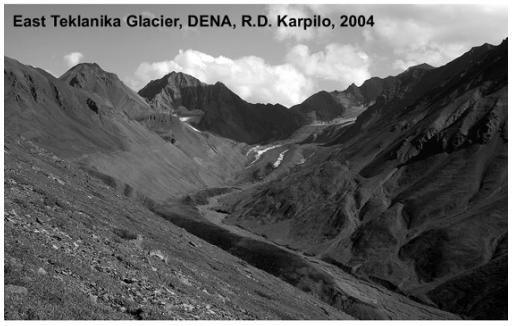
## Muldrow Glacier Monitoring

Denali staff members have monitored ice elevations and flow rates of the Muldrow Glacier since 1992. The Muldrow last surged in 1956-57 extending its terminus some 2.5 miles (four kilometers). Surges may occur at 50-year intervals; thus, another surge is anticipated within a few years of 2007. Monitoring efforts in the last few years have described the quiescent glacier between surges so that the data can be compared to information collected during and after the next surge. To detect flow rate changes that might signal the start of a surge, ice surface flow rate is measured from movement of survey markers on various points of the Muldrow Glacier and its two largest tributary glaciers (Traleika and Brooks). A survey in April 2006 indicated no glaciers in Denali are currently surging.

## Historic Photos of Glaciers

In 2006, we hope to continue re-visiting historic photo sites, including many taken by Bradford Washburn in the 1950's. During 2004, over 200 historical photos of park glaciers were obtained. These are ground-based images made in the early 1900's by survey and research expeditions to the Denali area, including Cathcart, Capps, Washburn, Post, and others. Many of these sites were "reoccupied" to repeat the images using modern digital cameras. New photo stations were established at locations lacking historical coverage. The photo-comparisons of the glaciers are often dramatic, showing significant changes in the ice extents – including over 700 vertical feet of ice loss on a glacier in the Teklanika valley.




The GIS data and photographic media will be available to researchers, park management, park natural resource and interpretive staff, park visitors, educators, and the general public through the accompanying website.

## Water Resource Management Plan Development

The park's existing Resource Management Plan (1998) calls for the development of a Water Resources Management Plan to protect and preserve the high quality of surface and ground water resources and to correct current water quality degradation problems. Planning and development efforts within and adjacent to Denali National Park and Preserve have been occurring at an accelerated pace for the past five years. The potential for large projects to impact resources continues to exist (e.g., North Access and South Side development).

As a result of development pressures, a comprehensive Water Resources Management Plan planning process was initiated in 2004 and is expected to be completed in 2006. A comprehensive review of Denali's water resources was completed in 2005, entitled *Water Resources Information and Overview Report*. This report outlines the foundation documents pertaining to water resources, historical and current events affecting water resources, summarizes completed studies and water resource investigations, and outlines water resource management issues that will be addressed during 2006 in the *Water Resources Stewardship Report*, which will act as the park's guidance for water resources management. The planning report will identify Denali's significant unprotected water resources and protection measures for them. The *Water Resources Stewardship Report* is being developed with professional analysis and ample public involvement (public meetings and scoping sessions). It will provide an adequate conceptual framework to address the identified issues in a realistic manner for the next 10 years.

**Permafrost Monitoring**

Work in the Toklat Basin during 2003 identified large areas of extensive permafrost that appear to be rather fragile (near 32°F) and these areas were mapped in 2004. Using the Denali soils map, staff also identified different types of permafrost and classified each type in detail. There are significant areas of thermokarst development (ground subsidence as a result of ground ice thawing, see photo at right) in the Toklat Basin, a large alluvial basin that currently has very poor drainage. A regional change in the permafrost regime would significantly change the surface hydrology and the vegetation that is largely controlled by the shallow, moist soil conditions.

It is estimated that up to 450 billion tons of soil carbon (C) are stored in high latitude ecosystems as organic matter in frozen or waterlogged soils that do not readily decompose. This amount of C is almost one-third of the soil C stored in the world's terrestrial ecosystems and is several orders of magnitude greater than current annual anthropogenic $CO_2$ emissions. Various studies show that soil C cycling in these northern ecosystems is likely to be strongly influenced by the effect of temperatures on rates of decomposition.

Climate change scenarios predict that the greatest magnitude of warming will occur at high latitudes and will be associated with warmer ground temperatures, thawing of permafrost, and development of thermokarst. Thermokarst has the potential to alter ecosystem C cycling by changing the vegetation structure and growth rates, and by altering soil microbial decomposition rates. Together, these changes can alter the balance of C cycling processes in these ecosystems. Long-term monitoring of changes in ecosystem C cycling in response to thermokarst development will be an important component of understanding the rate at which northern ecosystems are changing, and how they may affect local and global C cycling.

The Central Alaska Inventory and Monitoring Network staff are developing a comprehensive permafrost monitoring program. Two permafrost monitoring pilot projects have already gathered information to understand the relation of permafrost trends to climate trends. One project uses air and satellite photo interpretation to identify the general rates and nature of landscape change due to permafrost changes in the park. A second quantitative study initiated in 1991 has made annual measurements of borehole temperatures in a developing thermokarst near the park.

In 2006, a third aspect of permafrost monitoring will be initiated through a partnership with Dr. Edward (Ted) Schuur of the University of Florida. His project, *Development of Monitoring Techniques to Detect Change in Carbon Cycling in Relation to Thermokarst in National Parks and Preserve,* will provide critical elements to the design of a comprehensive permafrost monitoring program. Recommendations from this work will be combined with those from complementary remote sensing interpretation and borehole monitoring pilot studies to design the formal monitoring protocol.

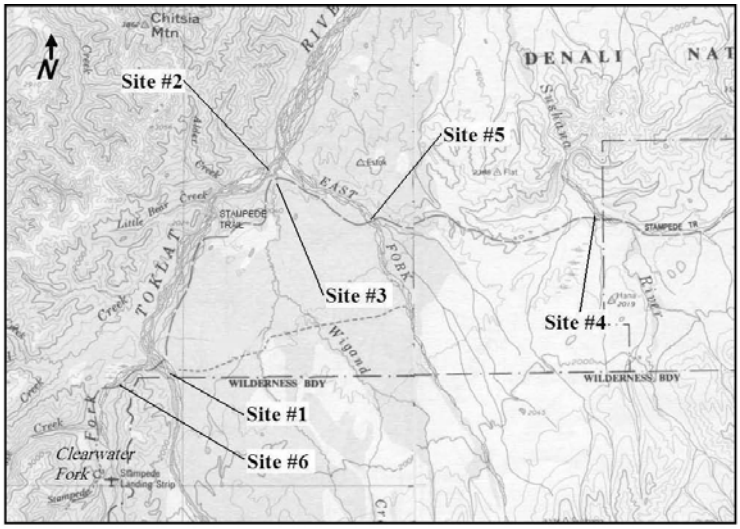
Shuur's project will center on the same borehole site outside the park in Healy where permafrost thawing and thermokarst have been observed to occur over the past several decades. This natural experiment will be used to develop monitoring techniques for changes in vegetation and ecosystem C cycling that are a result of thermokarst. The research outcomes of this project will be to: (1) Quantitatively determine current plant species composition, growth, and biomass patterns, (2) Provide an historical reconstruction of disturbance as a result of thermokarst, (3) Detect the contribution of old carbon to ecosystem carbon cycling. These three measurement approaches can be applied on a widespread scale to analyze change in northern ecosystems.

**Water Resource Investigation of the Toklat Basin**

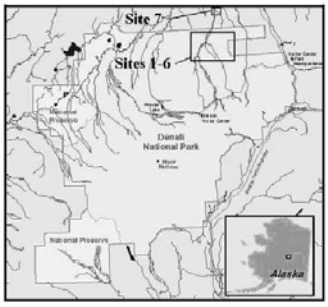
Construction of a new 90-mile north access road/railroad to the interior of Denali has been proposed by the Alaska State Legislature. The route would traverse additions to Denali added to protect wilderness recreation and ecosystem values. The seriousness of the threat is evidenced by the passage of HB244 by the Alaska State Legislature. This bill calls for land transactions on state land that will facilitate construction of a northern access route. Opening this corridor to visitor traffic would disturb pristine habitat and segment the park with an additional transportation corridor. NPS is opposed to this transportation corridor.

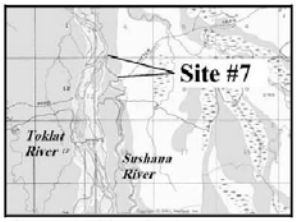
A water resource investigation of the Toklat Basin has collected critical water resource information that will be used in making management decisions related to this proposed access route. A unique feature of these rivers north of the Alaska Range is the presence of springs, which provide critical habitat for the spawning and rearing of salmon. The springs also provide critical over-wintering habitat for juvenile salmon. However the number of springs, their precise locations, the amount of flow they contribute to each river, and their sources were unknown.

To obtain this information, during 2004 and 2005, a contracted hydrologist performed field measurements and analysis of the surface waters of the Toklat Basin (see map).




| Field Work Site | Location (latitude, longitude) | Field Work Conducted |
|---|---|---|
| 1. Toklat River | 63° 48' 03.6" 150° 15' 51.7" | Cross-sections, pebble count, discharge |
| 2. Toklat River | 63° 53' 47.7" 150° 09' 18.4" | Water quality |
| 3. Wigand Creek | 63° 53' 47.7" 150° 09' 18.4" | Cross-sections, pebble count, discharge, water quality |
| 4. Sushana River | 63° 52' 38.0" 149° 48' 52.0" | Cross-sections, pebble count, discharge, water quality |
| 5. East Fork River | 63° 52' 52.5" 150° 03' 52.0" | Cross-sections, pebble count, discharge |
| 6. Clearwater Fork | 63° 47' 16.4" 150° 20' 16.0" | Cross-sections, pebble count, discharge |
| 7. Toklat Springs | 64° 09' 13.5" 149° 59' 29.0" | Water temperature, depth |




The work had six primary elements:

- Hydrologic Inventory
- Flood-Flow Statistics
- Water Quality Analysis and STORENET entry
- Aerial survey and water chemistry of Toklat Springs
- Channel Geometry analysis of Toklat, East Fork, Sushana, Wigand, and Clearwater Rivers
- Air photo analysis of flood-prone areas on Toklat, East Fork, Sushana, Wigand, and Clearwater Rivers

Figure 5. A hydrologist makes discharge measurements on the East Fork River.

The work resulted in a draft report, *Water Resources Assessment of the Toklat Basin in the Vicinity of the Stampede Trail Alignment.* The park service expects to have the report finalized in June 2006. The results from the study were used to inform an evaluation of the potential impacts to water resources from the proposed development (see below).

**Evaluation of Impacts to Water Resources from Proposed North Access Route**

The construction of a new north access to the interior of Denali is currently under consideration by the State of Alaska. One of the three proposed routes for the road building project would bisect the Toklat Basin area. The routes (from north to south) are labeled Rex, Rock Creek, and Stampede (see Figure 6) and are near the north boundary of the park. The proposed routes vary in length from 81 to 96 miles and cross a number of

major north-draining streams or rivers before entering the Kantishna Hills. Wetlands are found extensively throughout the region traversed by the three proposed routes.

The NPS has received the draft report from a contracted study to evaluate the potential impacts to water resources from the proposed development. The primary expected impacts have been summarized below. The full, final report will be available in early June.

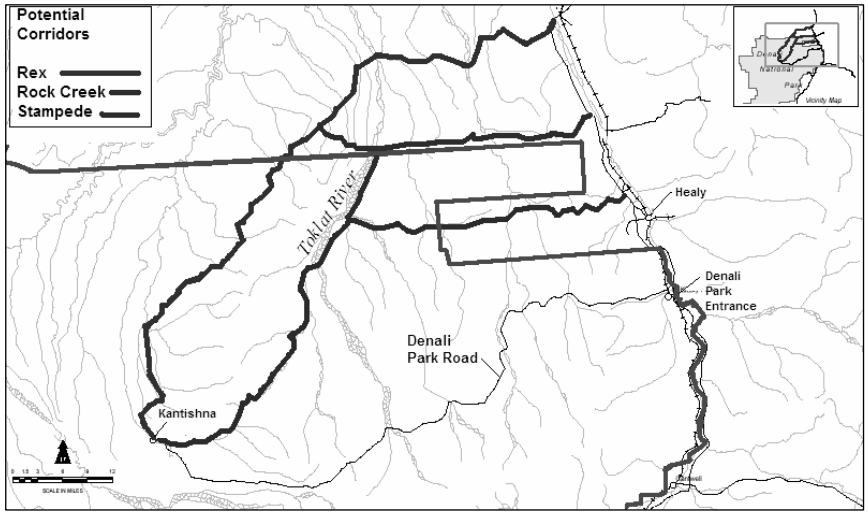



Figure 6. Three potential transportation corridors for the State of Alaska North Access Route Survey. (after AKDOT&PF, n.d.)

Because of the lack of specific information received at the time of this writing, it is difficult to exactly quantify the potential effects on the aquatic resources of Denali if a proposed North Access road is constructed but the type and likelihood of impacts from such a project can be projected:

**Over one thousand acres in and adjacent to Denali National Park and Preserve will be adversely affected or destroyed.** Wetlands underlie and are adjacent to almost the entire length of the three proposed routes inside the boundary of DENA. Road construction along either of these routes will require the excavation of the wetlands' surface complex and/or the placement of millions of tons of gravel to form the roadbed. The construction of ancillary roads and gravel pits in wetland areas will result in similar disturbance.

**The hydrology of terrain adjacent to the road, especially on slopes and through wetlands, will be altered.** Gravel roads act as gravel dams. Constructed gravel roadbeds intercept subsurface flows, and convert the flow to surface flow in ditches. Road cuts on sloped terrain also intercept subsurface flow. Such altered hydrologic regimes typically result in the alteration of the species composition and growth rates of downslope vegetation.

**In some streams, upstream spawning and rearing habitats will be significantly reduced or completely blocked by culverts.** The overwhelming evidence from Alaska and other states indicates that culverts on the proposed road will limit fish passage in streams, especially for juveniles, either from improper installation or from subsequent erosional effects.

**Sedimentation in streams and rivers crossed by the proposed roadbed will increase.** The placement of one million to 10 million cubic yards of gravel along a corridor that crosses numerous streams and rivers will result in the displacement of some sediment into those waterbodies. In addition, the ice-rich terrain that the three proposed routes pass through are veneered with fine-grained glacial and/or aeolian (windblown) materials, and are highly susceptible to mass movements, especially when the underlying permafrost soils are disturbed, or following periods of high precipitation.

**Short bridge spans, relative to extremely wide braided floodplains, will create flow constrictions.** Two rivers along the proposed routes have extremely wide braided gravel 'floodplains' that would have to be crossed by the road corridor, including the Toklat and East Fork Rivers. Large-span bridges are expensive to build, especially in remote areas. In lieu of long spans, bridges across the East Fork and Toklat Rivers will likely be constructed by using two or three short-span bridges connected by a gravel causeway. As a result, flows will be constricted through one or two openings during high water events. Increased water velocities through the bridge opening(s) will lead to some local scouring and downstream deepening of the channel. Flood flow constriction on these rivers could lead to resource impacts, including scouring of channel biota, blockage of fish passage, and habitat degradation.

## Wonder Lake Water Quality and Limnology Study

In 2006, the U.S.Geological Survey (USGS) is beginning a three-year comprehensive water quality and limnology study of Wonder Lake and other selected lakes in the northwest portion of Denali.

The objectives of this intensive water-quality study are to (1) determine the present limnology and water quality characteristics of Wonder Lake, (2) determine whether or not there have been human impacts to the water quality of Wonder Lake, (3) utilize hydrodynamic and water quality models to determine 'threshold' levels of nutrients of other water quality constituents that would severely impact the water quality of Wonder Lake, (4) choose a number of other 'index' or 'benchmark' lakes in Denali for water quality sampling to provide a better overview of the park's lacustrine systems, and (5) as an outreach effort, partner with the Murie Science and Learning Center to involve students and the general public with the science of this project.

- **Sampling of snow for chemical inputs to Wonder Lake**. Three 'snow' sites in the Wonder Lake Basin are being used for sampling the full-depth column of snowpack in April of 2006 and 2007 (during maximum snow accumulation before spring snowmelt). The snowpack contains an integrated record of chemicals deposited during the previous fall and winter. Two subsamples are collected from each snowpit: one inorganic sample for analysis of major ions, dissolved organic carbon, trace metals, mercury, and particulate matter; and one organic sample for analysis of organic contaminants (SOCs). Snow samples provide an estimate of 50-90 percent of the annual atmospheric deposition inputs to the basin.

- **Wonder Lake ecological properties**. Three locations will be chosen on Wonder Lake (access by boat) to sample selected physical, chemical and biological properties in 2006 and 2007. One site will be near the campground area and the other two sites will be at the middle and north end of Wonder Lake. Samples will be collected in late winter (at the time of snow sampling), after ice-out during June, at summer stratification (July), and in fall (early September).

  Onsite measurements will include light or Secchi-depth transparency and depth profiles (at 1-meter intervals) of water temperature, dissolved-oxygen concentration, pH, and specific conductance. Water-quality samples for determination of major ions and total nutrient constituents will be collected. Collecting water-quality samples at depth during spring and fall lake "turnover" (mixing of water) will be done to determine similarities or differences in nutrient concentrations in the water column during turnover. During summer stratification, water-quality samples will be collected at the top and bottom of the epilimnion (warm upper stratum) and near the bottom of the water. During fall and winter, water-quality samples will be collected near the surface and near the bottom of the water column. Zooplankton samples will be collected and analyzed for taxa presence, abundance, and density. Researchers will collect chlorophyll-a, which can be used as an indicator of primary productivity and trophic status, throughout the column using recently developed probes.

  In addition to the water quality sampling of Wonder Lake, shore areas would be examined to determine areas of degradation. Areas where the septic leach fields are located would be examined to see if there is any surface water runoff. If surface runoff is occurring, water samples would be collected and analyzed for nutrients and bacteria (e-coli, fecal, and enterococci). Mercury has been previously been detected in snow samples recently collected at Wonder Lake. All samples collected for mercury will be analyzed for three types of mercury at the USGS mercury laboratory in Wisconsin.

  Newly developed lake hydrodynamic and water-quality models will be used to predict future conditions of Wonder Lake.

**Shallow Lakes Monitoring**

In 2006, the Central Alaska Inventory and Monitoring Network (CAKN) will begin a shallow lake monitoring program in Denali. In the three CAKN parks there are more than 25,000 shallow lakes and ponds distributed across the landscape. Not only are shallow lake systems abundant, they are an excellent choice for monitoring changing conditions because they are more easily tracked, they are easy to sample, they have distinct boundaries (as compared to other wetland ecosystems), and they provide relatively easy opportunities for field experiments. Shallow lakes are a major wetland feature in northwestern Denali and many of them are relatively free of direct human modification. Vital signs to be monitored in shallow lake ecosystems include water

quality, water quantity (e.g., are lake levels falling?), vegetation, and macroinvertebrates. These vital signs were chosen because they represent important physical, chemical and biological elements of healthy wetland ecosystems.

**Weather Monitoring at Park Headquarters**

For 80 years, weather information has been collected at Park Headquarters. Beginning in 1922, Alaska Railroad personnel collected weather information in their camp near Riley Creek. In 1924, the National Park Service took over operation of the weather station. In 1925, the station was moved from the old headquarters site near the confluence of Hines and Riley Creek to the current Headquarters area (near the Kennels). This station is one of over 12,000 in the National Weather Service's Cooperative Weather Observation Program. Long-term weather (climate) datasets provide valuable information for detecting and predicting changes or trends in both temperature and precipitation, both factors that play a critical role in the ecology of Denali.

Below is a summary of the 2005 climate data collected at park headquarters and compared with averages from the long-term database.

Temperature

- maximum temperature 30°C (86°F) on August 14
- minimum temperature -36°C (-33°F) on January 11 and 12
- mean annual air temperature -1.0°C (30.1°F) which is warmer than the historical average of 2.7°C (27.1°F)

Denali Headquarters
Average Monthly Temperatures (°C)

| | **2005** | 80-Year Historic Average |
|---|---|---|
| January | -15.1 | -16.7 |
| February | -11.8 | -14.3 |
| March | -5.8 | -10.5 |
| April | -1.7 | -2.8 |
| May | 8.8 | 5.3 |
| June | 12.7 | 11.2 |
| July | 13.7 | 12.7 |
| August | 12.6 | 10.4 |
| September | 6.1 | 5.0 |
| October | -3.2 | -4.2 |
| November | -20.1 | -12.3 |
| December | -8.7 | -16.1 |
| ***Yearly Average*** | ***-1.0*** | ***-2.7*** |

The mean temperature of -5.8°C (21.5°F) for March 2005 was 5 degrees C warmer than normal. The warm spring was experienced throughout the state and green-up came about one week earlier than usual. May precipitation was double that of normal at 39.6 mm (1.56 in.). Summer temperatures although warmer than normal did not reach the records set in 2004. The summer fire season started about mid June due to an abundance of thunderstorm activity in Interior Alaska and by the end of the month over 1 million acres had already burned. Smoke filled skies were again the normal for most of the summer.

September and October (2005) temperatures were just above normal, but November was cold. The mean monthly temperature for the month was -20.1°C (-4.1°F) or 7 degrees C colder than normal. November snowfall was above normal due to a late month storm that dumped 11 inches of snow in the Interior. The cold temperatures did not continue into December. There was an abrupt change in temperatures when the southerly flow from the Gulf of Alaska pushed its way up and over the Alaska Range. Precipitation that we hoped would fall as snow fell as rain the first week of December. The mean temperature at park headquarters for December of -8.7°C (16.3°F) was 8 degrees C warmer than normal.

Denali Headquarters
Monthly Precipitation (mm)

| | **2005** | Historic Average |
|---|---|---|
| January | 37.8 | 18.7 |
| February | 1.5 | 14.7 |
| March | 11.7 | 11.0 |
| April | 23.4 | 11.1 |
| May | 39.6 | 20.4 |
| June | 80.0 | 55.9 |
| July | 84.6 | 76.1 |
| August | 30.5 | 67.9 |
| September | 65.3 | 40.4 |
| October | 5.1 | 24.8 |
| November | 29.5 | 19.6 |
| December | 13.7 | 21.0 |
| ***Yearly Total*** | ***422.7*** | ***382.3*** |

**Parkwide Climate Monitoring**

Climate monitoring continued at established locations around the park. These data are especially useful for weather forecasting related to fires and detecting trends. There are a total of 17 climate stations distributed throughout the park. Most of these stations record air temperature, relative humidity, wind speed and direction, solar radiation, precipitation, and soil temperatures. From these stations, resource staff gain a park-wide perspective on the physical factors affecting Denali's ecosystems and can provide timely

information on snow and weather conditions to park managers, the National Weather Service (NWS), researchers, and the public.

The climate monitoring program at Denali is part of the Central Alaska Network (CAKN) which also includes Wrangell – St. Elias National Park and Preserve and Yukon-Charley Rivers National Preserve. The main objective of the overall program is to monitor and record weather conditions at representative locations in order to quantify one of the drivers in Alaskan ecosystems (climate), identify long and short-term trends, provide reliable climate data to other researchers, and to participate in larger scale climate monitoring and modeling efforts.

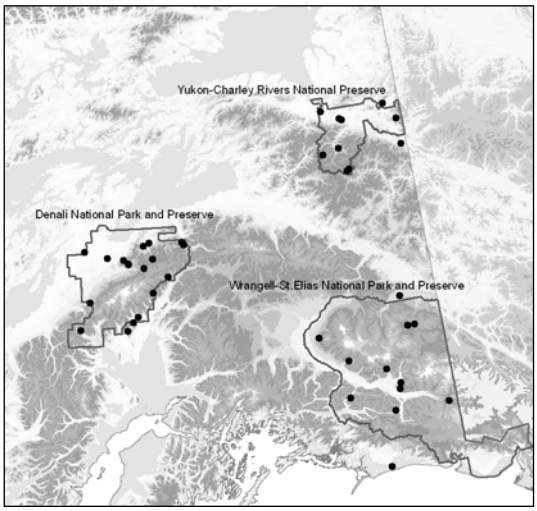



Figure 7. Distribution of climate stations and snow survey locations in the Central Alaska Network 2005.

In 2005, six stations were added in the network parks to provide better climate data coverage through the parks (see Figure 7 for distribution of climate stations in the three parks). The suite of stations that span the network will now give us a better perspective of overall climate patterns within the three parks. The data from the climate stations are available in near real-time at http://www.wrcc.dri.edu/NPS.

In 2006 two more stations will be installed: one in Denali on the south side of the Alaska Range on the West Fork of the Yentna River and one in Wrangell - St. Elias in the Wrangell Mountains between McCarthy and Chisana.

A comparison of 2005 with the period of record (which generally varies from 50 – 80 years in length) for long-term stations in and around the three parks (Eagle near Yukon-Charley Rivers; Gulkana, McCarthy, and Yakutat near Wrangell – St. Elias; and McKinley Park, Cantwell, and Talkeetna in/near Denali) resulted in the summary below:

Major climate events of 2005 based on long-term records include:

- Mean annual temperature in 2005 was warmer than normal at all stations
- Record warm spring for Gulkana and Eagle
- Warmest May on record for Eagle
- Record warm daily temperatures the last week of April 2005
- May was wet in the southern Interior
- Driest summer on record for Eagle
- July precipitation in Gulkana was 200 percent of normal
- November was cold and precipitation was above normal
- December was >5°C warmer and precipitation was below normal

The 2005 annual climate monitoring report is available on the web at http://www1.nature.nps.gov/im/units/cakn/monitoring.cfm.

## Weather Station on Mt. McKinley

Denali Park staff, the International Arctic Research Center (IARC), and the Japanese Alpine Club have continued to work jointly planning the transmission of data from a weather station on Mt. McKinley. One objective of the project is to make near-summit weather information available in "real time" to the hundreds of climbers who attempt the summit each year, as well as to park rangers, who must plan and perform search-and-rescue operations in the vicinity of the South Summit. Researchers also find the data useful for their studies of the high-elevation environment.

Originally, the Japanese Mountain Club installed a weather station in 1990 in memory of four Japanese climbers (including the famous mountaineer and adventurer Naomi Uemura) who, in independent climbing events, are all believed to have been literally blown off the mountain by gusts of wind. The Club donated the weather instrumentation to the International Arctic Research Center at the time of its opening ceremony in 1999. Since that time expeditions ranging from 2-3 weeks in duration have been organized each year in attempts to improve the station.

It is extremely difficult and time consuming to engineer a station that will withstand the harsh weather at 19,000 feet, especially when the team can get there only once a year.

The 2005 expedition took place in June. The data have been transmitting to the Cantwell receiving station since installation. However, the signal through Nenana to Fairbanks is not working properly. A digital line from Cantwell to Fairbanks has been requested. When operational, Mt. McKinley weather data is at: www.denali.gi.alaska.edu

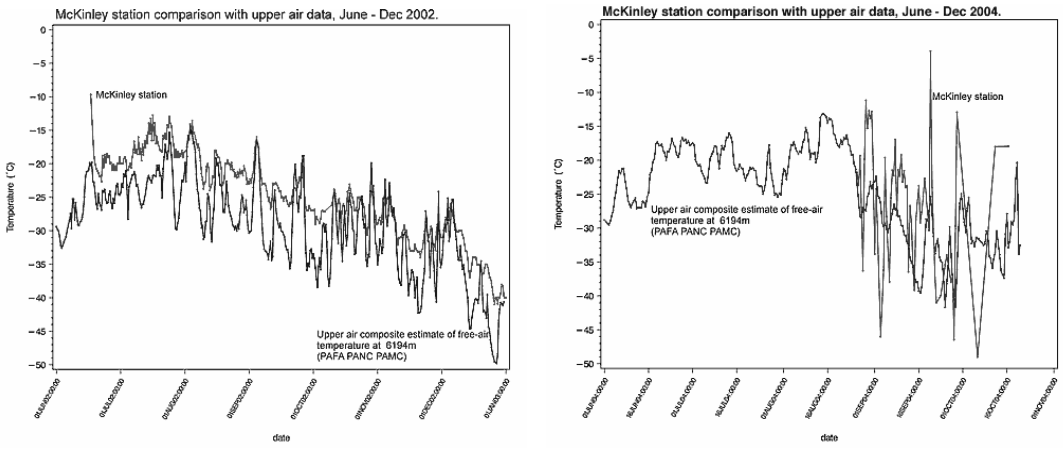



Figure 8. A comparison of temperatures recorded by the Mt. McKinley station (on the mountain) in 2002 (left) and 2004 (right) with temperatures estimated from upper air balloon data gathered above Fairbanks, Anchorage and McGrath.
The line identified as McKinley station is relatively stable in 2002 compared to 2004.
(Taken from http://www.iarc.uaf.edu/mt_mckinley/mt_mckinley_weather.php)

## Snow Surveys

In the winter of 2004-2005, snow surveys in Denali and the other two CAKN parks were conducted by park staff during the survey window during the last 4 days of each month during the winter season. Thirteen snow courses and aerial snow markers were surveyed in 2004-2005. Highlights of the data are presented below.

January 2005: There was more snow than normal south of the Alaska Range in Denali and areas west of Wonder Lake had above normal snowpacks. Lake Minchumina, in the Lower Tanana Valley, was 177 percent of normal and had the third highest snow water content measured since the record began in 1967.

February: The area south and west of the Alaska Range in Denali had record snow packs for Purkeypile (west of Mt. Foraker along the north slope of the Alaska Range), Ramsdyke Creek, and Dutch Hills (both in the Tokositna Valley). These snow courses have records dating back to 1980. Lake Minchumina remained above normal for February with snowcover 145 percent of normal.

March: Record snowpacks continued south of the Alaska Range especially in the Tokositna Valley and in the Kuskokwim drainage (Purkeypile and Lake Minchumina).

April: On May 1, the three sites in the Tokositna Valley area had record snow water contents. There was still 68 inches of snow on the valley floor and 112 inches at 3100' at Dutch Hills. Warm temperatures in late April reduced the snowpack quickly.

## Snowpack Characterization

This project provides snow depth and density information to park managers who are faced with the decision to open or close areas of the park and preserve to snowmobile use based on the current snow conditions. This study focuses on measuring the snowpack characteristics that will allow adequate support of snowmobile travel without causing adverse impacts to vegetation and soils. Snow depth and density were monitored at several fixed survey sites throughout the winter season (December 2004 through May 2005). South of the crest of the Alaska Range, the snowpack was adequate for snow machining by mid-November. Early November measurements showed that the southern areas of Broad Pass had ~24 inches of snow, but near Cantwell and Summit airstrip only 10 inches. By mid-November a few more storms had deposited more snow bringing the northern areas to the 24 inches. The area was opened officially on November 19, 2004. The north side did not have an adequate snowpack until early January. The northern areas were opened on January 4, 2005. Many of the snow survey sites on the south side of the Alaska Range had record snow depths and record water contents. On April 4 the Tokositna Valley sites had 7 feet of snow. The snowpack on the north side deteriorated quickly in April when the temperatures reached into the mid 60s. On April 26, 2005 the north side was officially closed for snowmachine use for the season. The south side continued to have a deep snowpack until late May.

## Air Quality Monitoring

Long-term monitoring of air quality continues at the stations near Park Headquarters and Trapper Creek. In June 2005, Denali celebrated 25 years of uninterrupted air quality monitoring through national monitoring networks. Parameters measured at the headquarters station include atmospheric deposition, ground-level ozone, sulfur and nitrogen oxides, fine particles and aerosols, and associated meteorological parameters. The Trapper Creek station measures fine particles and aerosols 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 strongly seasonal pattern. The peak concentrations of international contaminants generally occur in the late winter and spring. During summer, naturally-occurring wildfire smoke is the primary contributor to air quality degradation.

More information about the National Park Service nationwide air quality monitoring program can be found at the following web site: www2.nature.nps.gov/air.

## Toxic Airborne Contaminant Assessment

Although Denali seems an unlikely place to find Persistent Organic Pollutants (POPs) and other toxic airborne contaminants, these pollutants are a growing concern throughout the Arctic and Subarctic.

In 2004, the NPS Western Airborne Contaminants Assessment Project (WACAP) sampled fish, lake sediments, lake water, snow, lichens, willows, and spruce trees at Wonder Lake and McLeod Lake as part of a multi-park assessment of contaminants in park ecosystems. Subsistence hunters also donated samples from moose harvested near the park. In March 2005, the third and final year of snow sampling occurred at the two Denali study lakes. The principal investigators of the project will be completing the chemical analyses and working on analyzing the data in 2006. The final comprehensive project report is due next year.

Information about toxic airborne contaminants and the WACAP project can be found at www2.nature.nps.gov/air/studies/air_toxics/wacap.cfm

## Visibility Web Camera

A web camera was installed at Eielson Visitor Center in July 2004 to document summer visibility conditions in the park. The Denali camera is part of a nationwide network of visibility webcams operated by the NPS Air Resources Division. During summer, the camera takes a picture once every 15 minutes, and the image is transmitted to the web via

satellite. Current ozone and weather data from the air quality monitoring station near park headquarters are also displayed on the webcam home page and updated hourly. All images are archived throughout the summer for a long-term visual record of visibility, one of the air quality related values protected under the Clean Air Act.

In addition to the clear and cloudy views of the Alaska Range documented by the web camera, wildfire smoke frequently obscured the view of Mt. McKinley in 2004 and 2005, the second and third largest fire seasons on record in Alaska. During construction of the new Eielson Visitor Center in 2006 and 2007, the Denali web camera will be relocated to a new site, where it will run primarily on solar power. The web page and links to visibility cameras in other parks can be found at:
www2.nature.nps.gov/air/webcams/parks/denacam/denacam.cfm

**Toklat River Floodplain Monitoring**

Denali approved the comprehensive *Gravel Acquisition Plan* in 2003. This plan defines approved gravel sources and amounts for use from within Denali. The plan allows for up to approximately 22,000 cubic yards of gravel to be scraped from the floodplain in any two year period. The gravel is used for road maintenance throughout the park. The gravel is normally extracted using a "mirror-channel" technique in which a channel that roughly mirrors an existing channel is cut and the gravel is harvested for processing. The channel is then diverted to fill the newly cut channel. Geo-technical studies have determined the sustainable amount of gravel that can be mined, i.e., the Toklat River is bringing that much new gravel into the area near Toklat Road Camp each year. The physical resources group and a consulting engineer will be monitoring the floodplain dynamics to ensure that the gravel acquisition doesn't significantly impact the natural floodplain dynamics.

**Monitoring Landslide at Mile Post 45**

At Milepost 45 on the park road, survey stations were established in 1993 to monitor the rate of movement of the surface area of a mass movement (landslide)--a classic rotational slump with a headwall scarp, subsiding basins, pressure ridges and fractures, and flow features. The apex of the headwall scarp is within 35 horizontal feet of the park road, and park management and Federal Highways personnel are concerned about the threat that this movement poses to the road.

Annual surveys of the 45 mile slump were completed in the 2004 and 2005 field seasons, but the survey data has not yet been reduced and evaluated. Observations of the slump surface during these site visits suggest that no major change (flow or slide activity) has occurred since the last movement evaluation. Less perceptible creep motion is likely at several of the survey stations which may be verified when the survey data is evaluated. Plans for the 2006 field season include the annual re-survey of the stations and a re-fresh of the station stakes.

**Paleontological Survey of the Lower Cantwell Formation**

Field searches in 2006 for fossil evidence (vertebrates) in Denali were very fruitful. First, a UAF field geology class located a dinosaur footprint in Igloo Canyon while on a mapping exercise of the Cantwell Formation. This footprint was a single print of a three-toed Theropod, a small carnivorous dinosaur that walks upright on two legs. The footprint was close to the Park Road and within the high water line of Igloo Creek. Consequently, the paleontology field crew removed the footprint (a single large block of rock) and transported it back to Park Headquarters for display at the Murie Science and Learning Center.

Secondly, the paleontology crew found another dinosaur track as well as several additional trace fossils on some north buttress ridges of Double Mountain. This footprint is missing the toes at about mid-digit, but is clearly recognizable as another Theropod. The mudstone shows more detailed texture of the bottom of the Theropod foot and may provide more data than the Igloo footprint.

At one Double Mountain location, plant impressions were found, with the most spectacular being some probable stems of horsetail (*Equisetum*) with possible nodules (nitrogen-fixing) and some plant "windrose" patterns, where short stems were blown around at ground surface leaving a radial pattern that is now preserved in the rock. At another location, bird tracks were found in mudstone (rock that was formerly the muddy bottom of a shallow water body).

The paleontology crew plans to re-visit to the Double Mountain sites in 2006, to better map and document the tracks that were found in 2005. Given that the discoveries of last year were revealed by a rough reconnaissance effort, the general area will be searched more thoroughly in hopes of finding more fossils. Time and transportation permitting, the crew will also spend a few days on ridges near Mt. Sheldon where the Cantwell Sediments look promising for more fossils.

**Field Class for Geologic Mapping**

The University of Alaska Fairbanks conducted part of its Field Geology class in Denali Park from June 25 to July 7, 2005 (excluding the weekend). The class objectives were: (1) to teach advanced undergraduate geology students how to use field geologic information in creating a geologic map and cross section and (2) to better understand the well-exposed, but geologically complex region that sits between two major strands of the Denali fault system.

The class was based out of the Murie Science and Learning Center's Field Camp at Igloo Creek. Each day, twelve University of Alaska geology students (assisted by four UAF faculty members and a graduate Teaching Assistant) conducted field traverses for geologic mapping in four 3-person teams. Each group mapped a different but overlapping 10 square km area between the Field Camp, Sable Mountain, and Cathedral Mountain, exclusive of the Sable Pass closed area. The objective is to complete a detailed

geologic map in the vicinity of the Park Road between Teklanika Campground and the Toklat River by 2011, by conducting the field class at Denali in alternate (odd) years. The field class was also held in 2003.

The group augmented their geologic observations with non-invasive geophysical techniques (including magnetics, electromagnetics, and gravity) to better define geologic structures and rock types in areas of sedimentary cover. One field team discovered the dinosaur footprint near Igloo Creek.

**McKinley Quad Mapping**

In 2004, field work by retired USGS geologists updated portions of the McKinley Geologic Quadrangle (scale at 1:250,000). The final draft map and text are being prepared in Menlo Park, and are expected to be delivered to the Park within the next few months (early summer 2006).

**Mining Issues**

A recent federal court decision is allowing the owner of several hard-rock unpatented* claims, known as the Comstock claims (on Upper Eldorado Creek in Kantishna), to re-open an adit (horizontal shaft) for mineral sampling purposes. When the claimant is performing this work in 2006 (up to six weeks), the claimant will likely be camping in the Friday Creek or Eureka Creek areas and be commuting to the claim site. The work may involve blasting and mucking rock from the portal and adit, and evaluating re-exposed wall rock material. If the project happens, safety efforts will be put into place at Eldorado Creek during the blasting phase.

*There are "patented" mining claims" (privately owned surface and mineral estates) and "unpatented" mining claims (federally held and managed surface and privately held mineral estates).

**Reclamation of Disturbed Areas—Glen Creek**

The mandate of the National Park Service (NPS) and the Mining in the Parks Act of 1976 requires reclamation by a mining operator to "restore natural conditions and processes" and to "return the area to a condition equivalent to its pristine beauty." Historically, mining and access activities in Denali National Park and Preserve have resulted in major surface disturbance and environmental damage, with minimal or no reclamation being done to restore disturbed area to their natural state. The result is approximately 1500 acres of barren gravel tailings in riparian zones from placer and lode mines, 75 miles of trails and roads, and miles of disrupted stream channels and floodplains.

In 2005, the Haz-Mat (hazardous materials) clean-up of Glen Creek was partially accomplished by an environmental contractor. The contractor removed 30,000 pounds of waste material including containerized waste (55 gallon drums, 5- and 1-gallon containers, and other smaller volumes), 8 cubic yards of diesel-contaminated soils, 3 cubic yards of mercury-contaminated soils, 11,000 pounds of municipal wastes, and two

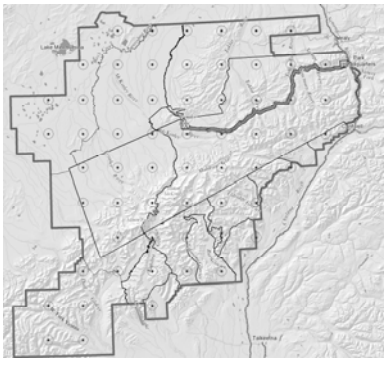
refrigerators. In this process, junk, trash, and garbage was removed from the A-frame, kitchen building, sleeping trailers, a truck-box shed, and the railroad boxcar. All the above-mentioned structures remain in place, in addition to numerous pieces of heavy equipment and two house trailers.

Field plans for Glen Creek in 2006 include a visit to observe and monitor the progress of the 2004 earthwork and floodplain re-construction, and possibly evaluate the need for additional transplanting or re-vegetation work.

**Soundscape Inventory and Monitoring Program**

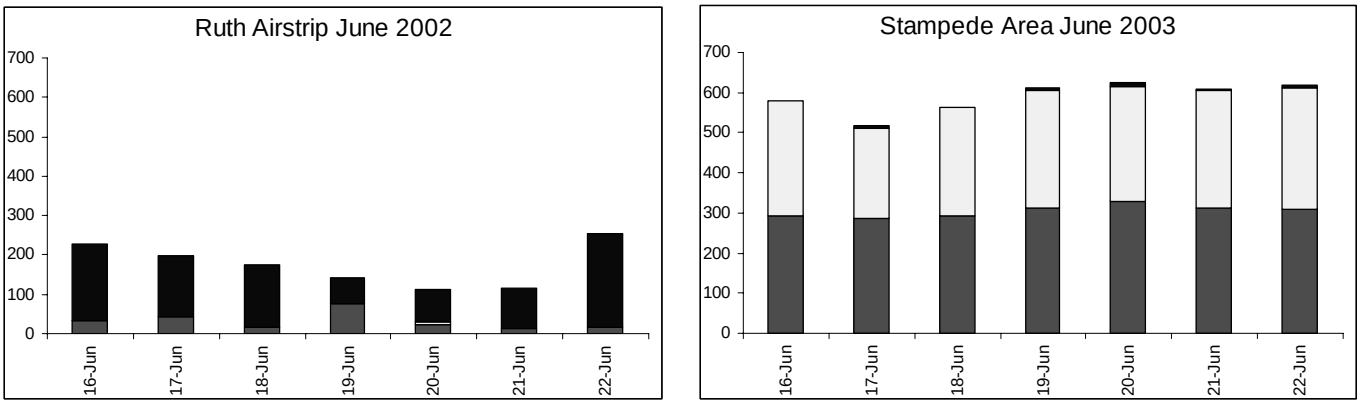
A soundscape research program has been underway at Denali National Park and Preserve since 2001. Natural and human-generated sounds have been inventoried at numerous locations around the park including along the Park Road, near Cantwell south of Broad Pass, at the Stampede Airstrip, in the Ruth Amphitheater, at Base Camp on the Kahiltna Glacier, on the Pika Glacier, and at the toe of the Tokositna Glacier. From the 3500+ hours of digital recordings and sound levels that have been documented in the park's three acoustical zones (alpine, sub-alpine, and scrub/forest), we can calculate for each audible sound the percent time and the number of times per day that it is audible. We then use the sound level data to compare the levels of human-made sounds to the natural ambient levels. Wind is the most widespread natural sound in all areas and aircraft overflights are the most common human-made sound.

This summer's focus (2006) is to implement a newly revised systematic (random) sampling plan. We will have five automated stations running at any one time (see photo at left). Over the next ten years these five stations will be placed at six new locations each year that will be randomly selected from a coarse grid of 60 points spread evenly throughout the park (see map at right). The funding for the first three years for implementing this sampling plan is being provided from an Alaska NPS regional block grant and Fee Demonstration funds. This sampling plan is part of the effort to implement the new Backcountry Management Plan. This sampling plan is designed to provide statistically robust quantifiable measurements of indicators of human effects on the soundscape.



The data collected with the sound stations can be used to characterize the soundscape. For example, Figure 6 shows the relative abundances of human-made sounds, physical sounds, and biological sounds for two locations, Ruth Airstrip (Figure 6A) and Stampede Airstrip (Figure 6B), during the month of June, 2002. From these two figures we can see that human-made sounds dominated the soundscape on the Ruth Glacier, whereas

natural sounds were dominant at the Stampede Airstrip. Most of the human sounds on the Ruth Glacier were made by aircraft. Notice the lower abundance of human-made sounds on June 19, 2002 at the Ruth Airstrip. June 19 was windy and cloudy so no planes were able to land on the airstrip, but other human sounds that day include people talking. Interestingly, the next day is the only day on which biological sounds were heard (a white-crowned sparrow). The wind storm may have blown the bird onto the Ruth Glacier.




A. B.

Figure 6. In June, human-generated sounds dominated the Ruth Glacier Airstrip (A), whereas natural sounds dominated the Stampede Area (B). Bar height indicates the number of 5-second recording intervals in which sounds of each category were heard during one week in June. Sounds were identified as human (black portion of bar, nearly absent at Stampede), physical (dark gray bar), and biological (light bar, at Ruth only on 6/20). Aircraft were identified at the Stampede Airstrip on the first five days shown but the relative abundance is so low they are barely represented on the graph.

From the sound data collected thus far from 16 locations in Denali, wind is the most common natural sound and aircraft overflights are the most common human-generated sound. At some locations wind can be heard all day long. At locations with brush or trees birds can also be heard nearly all day long during the spring breeding season. At locations near common flightseeing routes, it is common to hear 30 overflights per day. At glacier landing strips, it is common to hear over 100 overflights per day. At locations away from common flightseeing routes, the number of overflights heard per day rarely exceeds ten per day. At every site sampled, there are usually around five commercial jets heard per day.

For those with interest in natural soundscapes in national parks (and the National Park Service role in their protection), the National Park Service Natural Sounds Program Center website is www1.nrintra.nps.gov/naturalsounds/index.htm

# ◃ Social Sciences ▹

**Visitor-related Projects**

Two ongoing projects monitor visitation to Denali National Park and Preserve. One of these projects also focuses on park use by park staff.

- ✧ **Monthly public use report:** This project documents visits to the park including Talkeetna Ranger Station, mountaineering, aircraft landings, railroad passengers, Park Road traffic, bus passengers, and backcountry users, for both recreational and non-recreational purposes. According to this report, recreational visitors to the park were 403,520 in 2005, compared to 404,234 in 2004 and 359,840 in 2003. However, there have been some glitches in the program that formulates the representative numbers for Denali and reexamination of the formulas and input method is forecast for some time in 2006.

- ✧ **Road traffic monitoring:** Because the road corridor is a man-made feature within a pristine natural area, monitoring the direct and indirect effects of park road use on the natural resources is critical. Vehicle use of the park road by both visitors and park staff is being documented. The only traffic counter maintained in 2006 to assist with the Monthly Public Use Report is the one is the entrance area across from the road to the post office. In 2005, the counter had problems, but in 2004, approximately 1800 vehicles entered the park on July 4 compared to 14 on December 25. Vehicle trips are also counted at the Savage Check Station during summer months.

# ◃ Subsistence ▹

**Changes in Staff**

The subsistence program at Denali is undergoing a transition in 2006. Early in 2006, Hollis Twitchell left the park to take a position as Assistant Manager for the Yukon Delta National Wildlife Refuge based out of Bethel, Alaska. He worked at Denali for 15 years in various capacities, including as a pilot and as the park's representative in recent years to the Denali Subsistence Resource Commisssion (SRC). In early December 2005, during Department of Interior pilot ground school training, Hollis was the only one to be granted the Secretary's Award of Honor, for 26 years and 6,388 hours of accident-free flying. A new subsistence program manager is expected to be hired this summer.

**Traditional Subsistence Access Review for the Cantwell Area**

At the request of eight Cantwell subsistence users and the Denali Subsistence Resource Commisssion (SRC), and in compliance with ANILCA, NPS regulations and policies, the NPS undertook a project to compile and review traditional access information for the Cantwell area. A report was completed in July 2005 entitled *A compilation and review of information pertaining to use of ORVs as access for subsistence purposes in the Cantwell area by federally qualified subsistence users*. Based on the information gathered, on July 22, 2005, the park published a final "Cantwell Subsistence Traditionally Employeed ORV Determination" in which the park determined that the community of Cantwell had used ORV's for successive generations for subsistence purposes in portions of the Denali Park additions before the establishment of the Denali National Monument in 1978. On August 1, 2005, the park implemented a temporary 120-day closure to protect park resource in the area where Cantwell residents traditionally employed ORV's for subsistence purposes. Three existing trails were exempted from this closure. The closure allowed reasonable access to subsistence resources for the residents of Cantwell. It protected park resources, while allowing the park time to complete environmental documentation evaluating ORV effects on park resources and values. As part of an Environmental Assessment, preliminary alternatives regarding how to manage subsistence ORV use in the Cantwell area to minimize adverse impacts to park resources values while providing reasonable access for subsistence purposes.

**Kantishna River Fall Chum Salmon Stock Assessment**

This cooperative fall chum salmon fishery study will continue in 2006 for both the Tanana and Kantishna Rivers. Denali's participation will focus on the funding and operation of the two upper Kantishna recapture fish wheels under a contract with a local resident. This will be the seventh year of a cooperative study between the National Park Service and the Alaska Department of Fish and Game to assess abundance and timing of the fall chum salmon runs.

In 2005, mark-recapture studies on fall chum salmon *Oncorhynchus keta*, were conducted for the eleventh consecutive year on the Tanana River and for the seventh year on the Kantishna River. In the Tanana River, chum salmon were captured and tagged using a fish wheel located on the right bank of the river, immediately upstream of the Kantishna River mouth, and recaptured in a fish wheel located approximately 76 km upriver on the right bank. In the Kantishna River, chum salmon were captured in a fish wheel on the left bank of the river, approximately 9-km upstream of its terminus on the Tanana River, and recaptured through the use of four fish wheels; two fish wheels were located approximately 113 km upstream in the Toklat River (one on each bank) and the two fish wheels were located 139 km upstream on the Kantishna River. These studies were conducted from August 16 through early September 25.

Based on still preliminary estimates, there were an estimated 337,000 fall chum salmon reaching the upper Tanana River (using the Bailey model abundance estimate), and about 108,000 fall chum salmon reaching the Kantishna and Toklat Rivers. The Toklat River in

the Kantishna River drainage has a Biological Escapement Goal of 15,000 to 33,000 fall chum salmon. The Toklat River abundance was 17,600 fall chum salmon based on ground surveys and count expansion using a migratory time-density curve. Only once (2004) has the Toklat River drainage has exceeded its Biological Escapement Goal since the collapse of the salmon runs in the Yukon River drainage, and the largest numbers of fall chum salmon observed on the Toklat River spawning grounds since the Kantishna River drainage salmon stock assessment project began six years ago. This fishery has been identified by the State Board of Fisheries as a Stock of Concern.

**Aerial Fisheries Salmon Surveys**

Flights will be made over Denali streams in 2006 (pending adequate funding) to determine the presence and abundance of Chinook salmon (mid-summer flights) and chum and coho salmon (late fall flights). Similar surveys may be conducted in selected rivers within Gates of the Arctic and Yukon Charlie National Preserve.

## ◂ Cultural Resources ▸

**Denali's Historic Resources and National Register**

Park staff continue to research what sites are eligible for listing on the National Register of Historic Places but have shifted their evaluations from mining sites to the numerous trapping cabins in the park.

To date, only two historic resources are listed on the National Register: the Headquarters Historic District and the Patrol Cabins of Mt. McKinley. Historical sources of information (correspondence, archival material, oral history, photography, and architectural information) are collected and evaluated to develop Determinations of Eligibility to the National Register. Draft nominations include the Kantishna Mining District, Caribou Creek (part of Kantishna District), McKinley Park Station, CCC Camp, and the Stampede Mine Historic District.

A draft Determination of Eligibility for the historic Savage Camp is being prepared in 2006. Work continues in 2005 on these drafts that are now in the stage of gathering documentation to support the nominations (generating maps and diagrams and reproducing photographs). As an outgrowth of this National Register work, information is being compiled about mining in the Kantishna Hills for the park website.

**Eielson Visitor Center and the National Register of Historic Places**

Protecting cultural and historic resources is a key element of the National Park Service (NPS) mission. The NPS was the driving force in writing and passing the National Historic Preservation Act of 1966 (NHPA), and the NPS is the agency everyone turns to for information and guidance for historic preservation.

Any governmental agency including NPS must comply with Section 106 of the NHPA for any project undertaken by the agency. Under Section 106, the agency is required to examine the project and determine its affects on cultural resources, e.g., historic buildings, sites. If there will be an effect, the agency must decide if the cultural resource is historically significant and has integrity for listing on the National Register of Historic Places (NRHP) using specific criteria developed for the NRHP.

Eielson Visitor Center was built in 1958-1960 during a program called Mission 66, a system-wide program funded to improve park infrastructure by 1966. In the 1990s, numerous NPS visitor centers that were part of Mission 66 were evaluated for NRHP eligibility. In 1999 Sarah Allaback wrote *Mission 66 Visitor Centers: the History of a Building Type* in which she developed registration requirements for registering Mission 66 visitor centers on the NRPH.

For Eielson, in-depth discussions took place between the State Historic Preservation Officer (SHPO) and Denali cultural resource staff. They determined that EVC is not eligible for the NRHP. Specifically:

> "Eielson Visitor Center does not meet National Register of Historic Places (NHRP) Criteria A or C registration requirements as defined in *Mission 66 Visitor Centers: the History of a Building Type*. Although associated with Mission 66, Eielson Visitor Center does not exemplify the programmatic goals of Mission 66 nor did the Mission 66 program have a lasting effect on the development of Denali National Park and Preserve. In addition, Eielson Visitor Center lacks any notable association with other events that have made a significant contribution to the broad patterns of our history as required under Criteria A of the NRHP. Since Eielson Visitor Center is not the work of a master architect, does not possess high artistic values, and was radically altered in 1976; it is not eligible under Criteria C. In addition, in accordance to NRHP Criteria Consideration G, Eielson lacks the higher standard of integrity required for a building less than fifty years old to be eligible for the NRHP."

While the building itself is not significant, the site is significant under Criteria A of the NRHP for its long history of providing enhanced visitor experience and visitor services. The spectacular view of Mount McKinley and the surrounding landscape from this location has made the site a focal point for the visitor experience at the park. Beginning in 1934, a tent camp established at the site offered the visitor a wilderness experience with a few of the comforts of home. Mount McKinley National Park began seeing a significant tourist impact with the opening of the Denali Highway in 1957, and with the spectacular views at the site, Eielson would remain a destination within the park.

The Eielson Visitor Center was built to accommodate visitor needs at that time. Over the past decades, visitor numbers have increased to such a point that Eielson was inadequate to meet current needs. Replacing Eielson with a new visitor center will allow the park to continue to use the site as it has for over 60 years, enhancing the visitor experience and serving visitor needs.

**Historical Research and Oral History**

Cultural resource staff will continue to participate in planning for interpretive exhibits and interpretive trails for the new Eielson Visitor Center and the entrance area of the park. Current work includes developing plans for interpretive information and panels about prehistoric use of the Teklanika area. To provide a sense of Fannie Quigley when she lived at her house in Kantishna, historic photos of her are being prepared for display inside the Quigley House. Cultural resources staff will continue to produce educational programs interpreting park history for staff and visitors.

Historic photographs from Denali's Museum Collection will be identified and updated descriptions will be entered in the Rediscovery database. To enhance Denali's collection of historic photographs, cultural staff will continue to seek out historic park-related photographs and to help accession any donated private historic photograph collections.

Historian Frank Norris (Alaska Regional Support Office) continues to write the Administrative History of Denali National Park and Preserve. Publication is set for the fall of 2006.

During 2005 Jane Bryant conducted interviews with five individuals for a total of 7 hours of oral history recording:

- Lynn Stevens (February 2005). Her experiences living at the Summit CAA Airfield (1946-47) contribute to research regarding the history of the Summit Airfield and how it influenced resident subsistence hunting patterns in Cantwell.
- Dr. Frederick Dean (interview conducted jointly by Frank Norris and Jane Bryant). Dean was interviewed regarding his affiliation with the University of Alaska Fairbanks Cooperative Park Studies Unit and its research programs in Mt. McKinley National Park. Dean's own research projects span the years 1956-2005. [2 hours]
- Tom Habecker (June 2005). Retiring ranger Habecker was interviewed about the history of the Ranger Division and some of its operations during his 15-year tour of duty at Denali. [1 hour]
- Bill Nancarrow (July 2005). Nancarrow was interviewed regarding CCC buildings, their historic uses, and the fate of other buildings in the McKinley Station area, in order to answer questions from the park engineer regarding soil conditions in the C-Camp area. [48 minutes]
- Richard J. Stenmark (July 2005). Stenmark visited Denali National Park and Preserve Headquarters and talked about his NPS career, his time as the Wonder Lake District Ranger (1959-1963), and his participation in the ANILCA process during the late 1970s. [2 hours]

In 2006, the cultural staff will continue oral history interviews with park "elders", i.e., park staff, former employees, local residents, and others to document conditions and experiences in the park.

## Archeology

Two archeology projects will be initiated in the summer of 2006. One is a five-year survey of park areas with a high probability of having archeological sites. The other project is the stabilization of the Teklanika Archeological District that has been eroding since being excavated in the 1960s. Preparations for this year's stabilization were completed in 2005 when an archeology crew for the Alaska Office of History and Archeology (OHA), working under a Cooperative Agreement with the NPS, collected the 2500-3000 artifacts (including flakes and points) that had eroded out of both Teklanika East and West sites over the last 45 years. These artifacts are currently undergoing diagnostics by the OHA staff.

## Museum Collection

Cultural staff completed a 100% inventory in the fall of 2005, contributing greatly to the improved organization of the museum collection. A Museum Curator will be hired in 2006 to manage the museum collection. The primary tasks will be updating the museum database and providing customer service to park staff and the public. Many additional tasks have been identified for the Curator including combining the park library with the museum function.

Until the Curator is hired, for an appointment to access the collection, please call Ann Kain at 683-9607 or 644-3615.

# ◂ Research Support ▸

## Geographic Information System

A Geographic Information System (GIS) is a computer-based database system for storing, analyzing, and displaying spatial information. Anything that can be depicted on a map can be incorporated into a GIS. The Denali National Park and Preserve GIS is used by all functions in the park for preparing maps for planning purposes, public displays, and analysis of park resources. Engineering drawings for construction, mining site rehabilitation, and design work are also produced by the GIS. 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.

One notable addition to the park's GIS dataset involves and on-going project to collect high-resolution (1 meter) satellite imagery of the park. The project was started in 2005

and to date the portion encompassing the road corridor and south to the Alaska Range has been collected. In 2005 several areas of the existing imagery were re-collected due to smoke in the earlier images. It is anticipated that the entire park will be collected over the next 2 to 3 years resulting in a base map far more accurate than the existing USGS Topo Quads.

The park maintains a copy of the entire NPS GIS dataset for the state of Alaska locally (over 400gb 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.

GPS (Geographical 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 park glaciologist uses Survey-Grade GPS to measure movements of glaciers within 0.1 meter. Biologists use GPS to document sample site and observation locations within 2 to 5 meters. The backcountry staff uses small, recreation-grade GPSs to document patrol routes, campsite locations and for search and rescue. The maintenance Division uses GPS to document infrastructure such as culvert locations and for laying out construction projects. In the future this tool will increasingly be useful for precisely locating park infrastructure and documenting management activities.

**Research Administration**

As of May 1, 2006, 730 study numbers have been assigned to scientific and scholarly studies. Some studies are in progress, some in review for 2006, and some have taken place in the park over the years. Each year there are approximately 50-75 studies that are ongoing or recently completed. These projects are either conducted by Denali staff (described at length in this document) and park cooperators (e.g., U.S. Geological Survey, Biological Resources Division, and the Alaska State Department of Fish and Game), or by other investigators (e.g., from 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 1900's.

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). 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 expected 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 about Denali Research and Resources

Several two-page color fact sheets about Denali resources and research have been created and are either available now or will be printed soon (see list below). Fact sheets on additional topics will be developed in 2006 and beyond.

- 2006 Alaska Park Science Symposium
- Central Alaska Network: Inventory & Monitoring Program
- Climate Change
- Dinosaur Track Found in Denali
- An Integrated Study of Park Road Capacity
- Large Mammals…How many are there?
- Murie Science and Learning Center
- Permafrost Landscapes
- Resource Stewardship Strategy
- Rivers and Streams (4-pages)
- Soil Survey and Ecological Classification
- Soundscapes

# ◃ Brief Synopsis of Research Findings in 2005 ▹

The following researchers (non-park staff) held research permits in 2005. This table provides brief information about their findings. (Some research is reported in more detail elsewhere in Current Resource Projects.)

Each researcher is required to submit an Investigator's Annual Report (IAR) to the National Park Service. To view IARs for research conducted in Denali and in other parks (and to search IARs by park, year, investigator, or key words), visit the website: http://science.nature.nps.gov/research.

| Researcher | Affiliation | Project |
|---|---|---|
| Adams | USGS-BRD | Population dynamics of wolves and their prey in a subarctic ecosystem (caribou only) |
| Information reported on page 18. | | |
| Akasofu | International Arctic Research Center, UAF | Weather conditions on Mt. McKinley |
| Information reported on page 43. | | |
| Dasher | Alaska DEC | Demonstration of randomized-design for assessment of wadeable streams in Alaska |
| As part of a state water monitoring strategy, field sampling (water chemistry, physical habitat, stream flow, and macroinvertebrate collection) was conducted at a small mountainous headwater stream that discharged into the Teklanika River near Double Mountain. | | |
| Densmore | USGS-BRD | Factors controlling establishment and growth of *Taraxacum officinale* in Alaskan national parks |
| Different revegetation treatments in the park are being compared for the establishment and growth of nonnative species, particularly dandelion (*Taraxacum officinale*). During the first three years of the study, very few non-native plants have invaded any revegetation treatments. | | |
| Dortch | University of Cincinnati | Timing and extent of glaciation on the northern slopes of Alaska Range |
| This project is reconstructing past climates by mapping landforms and defining the timing of glaciation (by analyzing how long the surface boulders have been exposed after glacial retreat). Eight boulders were successfully identified and sampled in 2005 for cosmogenic radionuclide dating. Results are pending. | | |

| Researcher | Affiliation | Project |
|---|---|---|
| Eberl | USGS | Minerology of Denali National Park river sediment |
| The purpose of this research study is to characterize the Yukon River system (see http://water.usgs.gov/nasqan), including water chemistry, channel shape, water flow, and sediment mineralogy as a baseline to future changes related to global warming. Samples of fine river sediment were collected from rivers that cross the Park Road between the park entrance and Wonder Lake, and from the McKinley River near the McKinley Bar Trail. Sediments have been analyzed for clays and non-clays. | | |
| Fiorillo | Dallas Museum of Natural History | Paleontological survey of the lower Cantwell Formation, Denali National Park and Preserve |
| Searches for fossils were made in the lower Cantwell Formation (Cretaceous) exposures along Igloo Creek, Tattler Creek, and on the north and northeast flanks of Double Mountain. As part of Tattler Creek surveys, a tree trunk with diameter of 50 cm was discovered. Two localities on Double Mountain have great potential for yielding the remains of fossil vertebrates. One site produced an additional partial dinosaur track. The other locality held dozens of tracks made by medium-sized wading birds. See also page 47. | | |
| Freymueller | University of Alaska Fairbanks | Repeated Global Positioning System (GPS) and absolute gravity measurements to measure active crustal deformation in southern Alaska |
| This project has conducted a GPS survey of four sites along the Denali Park Road (an east-west transect from Savage River to Wonder Lake) annually since 2002 to measure post-seismic deformation. Because of the 2002 Denali fault earthquake, there is a combination of post-seismic deformation from the Denali earthquake as well as from the 1964 Alaska earthquake. The site at Savage River appears to show an interesting reversal in its direction of post-earthquake motion (between 2003 and 2004 it switched from moving northwest to moving almost due south). At Wonder Lake (which has a long measurement record before the earthquake), there is a movement trend different from the pre-earthquake movement. | | |
| Haber | | Dynamics of wolf-prey systems and wolf societies in the Denali Region, Alaska |
| This research, which began in 1966, focuses on groups rather than populations. Fourteen groups of wolves were studied throughout the park/preserve in biological year 2005 (May 2005-April 2006), including the well-known road corridor groups. Results are summarized in detail in the NPS Investigator's Annual Report for this project that is available at NPS headquarters. | | |

| Researcher | Affiliation | Project |
|---|---|---|
| Haeussler | USGS Alaska Science Center | Behavior of the Denali Fault, Central Alaska Range |
| The goal of this project is to construct a model of how the Denali fault works in time and space, including how often large earthquakes occur, whether sections of the fault break repeatedly in earthquakes of the same size, whether recurrence intervals vary, and how long ago an earthquake occurred on the sections of the fault that did not rupture in 2002. Field work in 2005 included finding a feature offset by the Denali Fault along the east fork of Cantwell Creek. To determine when the offset happened, samples were collected for cosmogenic dating. On the north side of the west fork of the Bull River, alluvial fan channels that had been offset approximately 4, 8, and 12 meters in the last three earthquakes were selected for study. Three small trenches were cut across the fault traces to collect samples for radiocarbon dating. Interpretation of data is pending. | | |
| Hamm | Antioch New England Graduate School | Above- and below-ground controls on recent white spruce establishment in tundra in Denali National Park and Preserve |
| Tree-line areas (with at least 5 spruce per hectare) in four watersheds along a south-facing slope of a 4-mile long ridge were studied to measure the average rate of tree-line advance (meters elevation gain over time). The treeline advance was measured by documenting changes in tree and seedling age and density with elevation. Two-thirds of all trees sampled germinated between 1925 and 1975. Sixty percent of seedlings sampled germinated since 1990. | | |
| Hansen | University of Alaska Fairbanks | Denali Seismic Monitoring Sites (including repeater on Double Mountain) |
| The seismic network in Denali consists of three seismic stations (Wickersham, Thorofare, and near the park entrance), two telemetry "repeater" sites (Double Mountain and Mount Healy), a receiver site (MSLC), and a display (Eielson Visitor Center). In 2005, upgrades were installed at Thorofare and the installation was made at the MSLC. In 2006, a station will be added at Castle Rocks. | | |
| Heys/Acosta | Alaska NPS Regional Office | Exotic plant mapping and inventory |
| In conjunction with the Alaska Exotic Plant Management Team, areas in Denali (roadsides, parking lots, housing areas, campsites, and areas disturbed by construction) were surveyed for the presence of exotic plants. 2005 was the second year of the survey. Sites of exotic plants in 2004 were revisited in 2005, and if exotic plants were still growing there, additional attributes about the site and the plants were recorded, including GPS location and extent (how many square meters occupied?) Twenty-three exotic plant species were recorded in 2005. Dandelion (*Taraxacum officinale)*, white clover *(Trifolium repens),* plantain *(Plantago major),* and pineapple weed (*Marticaria discoidea)* were found throughout the entrance area of the park. One species, scentless false mayweed (*Tripleurospermum perforate),* was found at the train depot, but had not been previously recorded at Denali. Timothy (*Phleum pretense*) was found in near the Aramark bus washing depot. | | |

| Researcher | Affiliation | Project |
|---|---|---|
| Jeffries | University of Alaska Fairbanks | Lake ice and snow studies at Horseshoe Lake, Denali National Park and Preserve: scientific research contributing to science education |
| One objective of this study is to learn about the variability (within a year, and among years) of lake ice thickness, snow depth and density on the ice, and the conductive heat flow through the ice and snow to the atmosphere throughout Alaska. A second objective is to contribute to science education by involving K-12 teachers and students in a scientific inquiry that involves hands-on participation in the Alaska Lake Ice and Snow Observatory (ALISON). In 2005, The ALISON study site on Horseshoe Lake was set up on November 11 with the assistance of Kristen Friesen (NPS). Kristen subsequently accompanied Dorothy DeBlauw and her Tri-Valley School 3-5 grade students on six field trips to make measurements during the winter. Measurements included the depth, density and temperature of the snow accumulating on the ice. The conductive heat flow through the snow was derived from the snow data. No ice thickness data were obtained because the thickness gauge failed early in the season. The snow depth was slightly lower than in previous winters (2003-04, 2004-05) but the snow density and conductive heat flow values were similar to previous seasons. Once again the Tri-Valley School group has contributed to knowledge about winter processes at Horseshoe Lake. Our hope is that they will be able to continue their study, particularly as (1) long-term data sets are important at this time of environmental change in Alaska, and (2) the International Polar Year begins in March 2007. | | |
| Jorgenson | ABR, Inc., Environmental Research and Services | Collaborative study on permafrost characteristics of Wrangell-St. Elias and Denali parklands |
| The purpose of this study is to evaluate geomorphic processes related to permafrost and ground ice. In 2005, vegetation, soil, and permafrost characteristics were described from 11 locations of degradation of buried glacial ice at the Muldrow moraine, and along two transects at Gosling Lake. At both locations, small temporary temperature dataloggers were installed below the soil surface to monitor temperatures. At the Muldrow site, the data indicate rapid thawing of buried glacial ice, kettle formation, and dramatic exposure of glacial ice that had been buried in the Little Ice Age moraine. At Gosling Lake, the permafrost was very ice-rich and the development of thermokarst (slumping due to thawing of permafrost) was evident along both transects. | | |
| Landers | U. S. Environmental Protection Agency | Western Airborne Contaminants Assessment Project (WACAP) |
| WACAP is sampling a variety of ecosystem indicators (snow, fish, water, lake sediment, lichens, conifer needles, and moose meat) at eight "primary" national parks to provide information about contaminant accumulation. In 2005, snow samples were collected from Wonder and McLeod Lakes at the end of March. Two passive air samplers were installed in Denali in July (Wonder Lake, Kantishna). Analyses are in progress for cores from Wonder Lake and McLeod Lakes. Fishes collected in 2004 were aged (Wonder Lake: fish ranged from 2-29 years old; McLeod Lake: two 3-year-old burbot and two 2-year-old round whitefish) and are being prepared for analysis of metals, mercury, and semi-volatile organic compounds (SOC). | | |

| Researcher | Affiliation | Project |
|---|---|---|
| Lutzoni | Duke University | Using multigene phylogenies to reconstruct the origin and losses of the lichen symbiosis |
| Through genetic analysis, it has been found that some major lineages of non-lichenized species of fungi have evolved from lichen-forming ancestors that lost their mutualism with green algae or cyanobacteria. In 2005, 180 specimens of lichens and lichenicolous fungi (those growing on lichens) were collected from seven sites in Denali (Rock Creek, Savage (two sites), Polychrome, Toklat, between Toklat and Eielson, and Eielson). Molecular data obtained from these samples will be included in a phylogenetic reconstruction of the origin and loss of lichen symbiosis. | | |
| MacCluskie | Central Alaska Network (NPS) | Small mammal monitoring at the landscape scale and synthesis of monitoring data in Denali NPP |
| Information reported on page 22. | | |
| Mcdonald | Jet Propulsion Laboratory under contract to NASA | Monitoring freeze/thaw transition on a regional scale in boreal forests using the ADEOS Satellite |
| This study assesses how well space-borne microwave remote sensors can monitor the seasonal freeze/thaw dynamics within boreal forest ecosystems. Two of the eight ground validation stations, arranged along a latitudinal gradient, are in Denali. One station is at tree-line (near Savage) and one in closed spruce-hardwood forest (Rock Creek). These stations monitor land surface state (freeze, thaw) and vegetation biophysical function (sap flow). Using data from the ground stations, there is a correspondence between start up of vegetation ecophysiological process in the spring, associated growing season length, and annual productivity with estimates of spring thaw derived from remote sensing data sets. | | |
| Milner | University of Alaska Fairbanks | Long-term ecological monitoring of streams in Denali NPP |
| This study conducts long-term monitoring of key streams along the Park Road (a subset of 43 streams initially surveyed in 1995) to document long-term natural variation in stream communities to be used as a baseline to measure change. In 2005, macroinvertebrate samples were collected from 13 of the 14 study sites (not Rock Creek). Initial data from the 2002 and 2003 samples seem to indicate that variations in macroinvertebrate communities over the long term are driven by large scale climate patterns. Recent findings are included in the publication: Milner, A.M., L.E. Brown, and S.C. Conn. 2006. The persistence of macroinvertebrate communities in interior Alaska streams: implications for biomonitoring. Freshwater Biology 51: 373-387. | | |
| Newberry | University of Alaska Fairbanks | Geological mapping exercises in Central Denali Park |
| Information reported on page 47. | | |

| Researcher | Affiliation | Project |
|---|---|---|
| Procter-Nicholls | University of Durham | A study on the impact of climate change, in relation to General Circulation Models and published literature from surrounding sites at Wonder Lake, Denali National Park |
| A suitable site was not found in the time available for taking a sediment core (to find pollen from various time periods) from a shallow wetland area near Wonder Lake at Denali. No samples of lake sediments were made. | | |
| Roeske/Altekruse | University of California-Davis | Structural constraint on the Late Cretaceous to Early Eocene development of the Alaska Range Suture Zone |
| The goal of this project is to use the composition of Denali's sedimentary rock to document when certain movements along the Denali Fault occurred. A comparison of heavy metal provenance analysis from rocks to the north and the south of the suture zone help narrow down when activity along the suture zones occurred. In 2005, structural data and samples for analysis were collected from the Big Creek area northwest of Igloo Mountain. These are being compared to rocks south of the Denali Fault. | | |
| Roscoe | Family Practice Residency of Idaho | Carbon monoxide poisoning and acute mountain sickness: investigating a possible correlation in high altitude mountaineering |
| This study enlisted 146 climbers in Denali's 14,200-foot camp to assess CO exposure risk. To test the relationship between elevated CO in the blood (as carboxyhemoglobin or COHb) and Acute Mountain Sickness (AMS), blood samples were taken from climbers and climbers were asked to report exposure to CO, past history of AMS, and symptoms of AMS (headache, nausea, fatigue, dizziness, and sleeping difficulty). The majority (97 percent) of climbers reported ventilating their cooking space, yet 18 climbers (13 percent) tested positive for CO exposure. While 20 climbers (13.7 percent) met the criteria for AMS, contrary to hypothesized results, there was no significant relationship between elevated COHb and AMS. However, climbers with symptoms of AMS did report operating stoves longer than those without AMS. Descending climbers had higher CO exposure compared to ascending climbers. These results raise questions about how long COHb persists in climbers at high elevations and if CO toxicity is cumulative while climbers are on Denali. More than 75% of the climbing rangers who were tested had elevated COHb levels. | | |
| Trainor | UAF-Dept of Chemistry and Biochemistry | Chemical fate and transport of antimony in aqueous geochemical systems of Interior Alaska and the Yukon |
| Antimony lode deposits are found along Slate Creek and at the Stampede Mine located in the Kantishna Hills Region of Denali National Park. This project documents what happens during the transport of antimony (Sb) in the environment for both mined and undisturbed mineral deposits. In 2005, water and stream sediment samples were taken along Slate Creek to be analyzed for pH, Sb and arsenic (As) concentrations. The pH ranged from 2.8 to 8.3. Antimony concentrations ranged from 3 to 665 parts per billion (the maximum contaminant level for drinking water by EPA standards is 6 ppb). Arsenic concentrations ranged from <1 to 239 ppb (the maximum contaminant level for drinking water is 10 ppb). Elevated antimony concentrations are found up to several kilometers from the source materials (the mine tailings at the head of Slate Creek), suggesting that Sb remains highly mobile in this drainage, as it does in other sites in the Tintina Gold Province of Interior Alaska and the Yukon. The co-associated arsenic is being transported away from the source site too, but because source concentrations are lower than antimony, they are lower downstream as well. | | |

| Researcher | Affiliation | Project |
|---|---|---|
| Trost | Alaska Dept of Environmental Conservation | Alaska regional haze monitoring pilot study |
| Air quality monitoring equipment was not available during 2005. The study was postponed to Spring 2006. | | |
| Van Ballenberghe | | Ecology of Moose in Denali National Park and Preserve |
| 2006 was the 26th year of the study. Data on production and survival of calves was gathered in Spring (5/27-6/10). Few instances of predation on neonates were reported in the area east of the Sanctuary River (corresponding to fewer bear observations or bear sign). Radioed cows produced calves at rates similar to previous years. A radioed cow again had twin calves near Riley Creek Campground. During autumn (8/18 – 10/3), data were gathered on behavioral ecology, mainly rutting behavior, traditional use of rutting areas, mating success, sparring, fighting, and antler breakage. Moose were distributed in traditional rutting areas similar to previous years, with much activity in the Mile 7-9 area. Calf survival from May to September was ~25 percent, higher than in recent years. Less stable rutting groups were observed in 2005 compared to recent years. Several radioed females shifted from the Mile 7 area to Savage River just prior to mating, reducing the size of the Mile 7 group. The moose population in the eastern part of Denali appears stable, following a sharp decline 1970-1990 due to high predation on young calves, primarily by bears. | | |

# ◃ Murie Science and Learning Center ▹

**Background**

The Murie Science and Learning Center (MSLC) is a collaborative effort between Denali National Park and Preserve, seven other Alaska national parks, and several park partners to promote scientific research to aid park managers and provide science-based education programs and information to students, educational institutions, and the visiting public. This is the fourth season of operation for the center. The MSLC website is http://www.murieslc.org

***Partners***

Although based in the park, Denali is only one of the eight national parks with sub-arctic or arctic ecosystems that the MSLC represents. 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, and Gates of the Arctic National Park and Preserve. These area covered by these parks is more than 50 percent of the lands administered by the National Park Service nationwide.

Oher partners include:

- Alaska Natural History Institutes (provides educational programs and assistance with field camp operations and with the center's management)
- Denali Foundation (provides educational programs and housing for researchers, as available, and assists with the Discover Denali Research Fellowship Program)
- Doyon-Aramark Joint Venture (park concessioner who operates the MSLC food facility jointly with their employee dining room)
- Denali Borough School District (provides technical support and equipment to the center and partners on several education programs and in the development of the Wireless Cloud Network)

***Facilities, Services, and Programming***

The MSLC main facility provides a classroom, exhibit area and office space for staff and visiting researchers. The MSLC dining facility (next door) is shared with the park concessioner. The MSLC field camp located within the park (WHERE) consists of four tent cabins and a yurt. Services provided by the MSLC and partners are the following: providing space for both educational programs and events, and office space and resources for visiting researchers; internet access and data transmission capabilities; wireless network capabilities along the first 35 miles of the park road; video-conferencing; and food service. In 2006, the MSLC programming includes citizen science programs; curriculum-based education programs for K-12 grades; school-to-work experiential learning programs; multi-day field seminars and teacher trainings; youth camps; and research fellowship grants.

**Programs**

*Citizen Science*

**ALISON Project**. Through out the 2005-06 winter, students from Denali Borough School District hiked to Horseshoe Lake twice monthly to measure and record lake ice and snow data. The Horseshoe Lake site is one of 16 sites across the state that make up the Alaska Lake Ice and Snow Observatory Network (ALISON), a project under the direction of Dr. Martin Jeffries at the Geophysical Institute, University of Alaska Fairbanks. Tri-Valley teacher Dorothy DeBlauw and students working with NPS Education Specialist Kristen Friesen were only turned back on occasion by temperatures colder than -10°F and extremely icy trail conditions. Through this citizen science program students provide data that may help detect changes in the ice and snow levels throughout the state over time.

*Youth Camps*

**Denali Backcountry Adventures.** This week-long learning camp for high school students was developed in partnership with the Denali Foundation, with the support of the Denali Borough School District. The program develops participants' outdoor and leadership skills while they conduct impact monitoring activities in the Denali backcountry. Information collected is entered by participants into the current park database. Indicators selected for monitoring in the park's new Backcountry Management Plan are: soundscape qualities, visitor observations and contacts, wildlife observations, and backcountry impacts. Backcountry Adventure group size is limited to six participants and two instructors. Areas for exploration and monitoring are identified by park managers. The group spends three nights in Denali's backcountry. In 2006, the MSLC will offer two sessions: July 17 – 21 for students in grades 9 and 10 and August 13 – 18 for students in grades 11 and 12.

**Storytelling Camp 2006 – Denali Soundscape.** Offered in partnership with the Denali Borough School District, this week long camp for middle-school students combines traditional storytelling with technology to explore the natural environment. The emphasis of this year's camp will be Denali's soundscape and related monitoring efforts. Skills explored during the program included still and movie taking, storytelling, storyboarding, iMovie creation, sound recording and monitoring activities, and video-conferencing. The MSLC field camp will serve as a base of operations for two nights for camp participants. June 12 – 17.

**Denali Discovery Camp.** This will be the sixth season for this five-day camp that seeks to offer quality outdoor experiences to local youths in grades one through eight. Developed in partnership with the Denali Foundation, the camp curriculum engages participants in hands-on activities as they learn about sub-arctic ecology, the national park mission, 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. June 19 – 23.

**Denali-Susitna Exploration Camp.** This camp combines an outdoor-based science curriculum with cutting edge technology for the benefit of local students. Offered in partnership with Kigluait Educational Adventures and the Upper-Susitna Soil and Water Conservation district, the goal of the camp is to share the unique natural environment and ongoing research of Denali National Park and Preserve with the middle-school- age youth who live in communities south of Denali, including Trapper Creek, Sunshine, Talkeetna, and Willow. This year's activities (July 31 to August 4) will be based out of the Sunshine Creek area and participants will help to develop interpretive information about the area's natural history. Campers will use GPS units, compasses, video-teleconference technology, and mapping software to explore their environs and create publications.

*Field Seminars and Teacher Training*

**Field Seminars**. The MSLC will be offering 17 field seminars in the 2006 season. The seminars are active learning experiences that cover a range of topics including geology, wildflowers, bird ecology, fly-fishing, wildlife research, wolves, bears, art design and field journaling. Most courses are based out of the MSLC field camp, located within the park at Igloo Canyon at mile 34 of the park road. Many park research staff members serve as leads and content experts for the seminars. University credit is available to participants through the University of Alaska Anchorage.

**Teacher Training.** The MSLC will offer four teacher trainings in June and July. These three-day programs will investigate using I-Movie, science writing, paleoecology and using the park as a living classroom to teach to state standards and testing. The University of Alaska Anchorage offers an optional credit.

*Special Programming*

**Discover Denali.** Developed to provide a meaningful park experience for Royal-Celebrity Tours passengers, this program is offered twice weekly May – September in partnership with the Denali Foundation. The program consists of a lecture in the MSLC classroom, a skins-and-skulls hands-on session, interpretive walk through an area significant in early park history, and a ranger-introduced viewing of the new park film. Participants receive photo postcards of the historic photographs that Denali Foundation instructors use as teaching tools. A portion of the proceeds support the Discover Denali Research Fellowship Program.

**Experience Denali – Wildlife Tracker at Savage River.** This weekly MSLC program helps visitors explore wildlife and wildlife research in Denali through science activities and radio telemetry. Participants learn about different habitats as they travel out the park road by bus to the Savage River area, where they take a short walk and participate in hands-on activities.

*Research Grants*

**Discover Denali Research Fellowship Program**. In 2006, the MSLC launches the Discover Denali Research Fellowship Program, made possible through proceeds of the Discover Denali program offered in partnership with the Denali Foundation. Recipients will be awarded grants up to $5,000 for research that will assist park managers make decisions about critical resource issues. In 2006, the following projects will be funded:

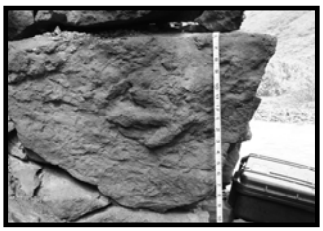
- Detecting a deadly amphibian disease: are park visitors inadvertent vectors?
  Tara Chestnut, Washington State Department of Transportation, Biology Program
  Awarded $3650

- Water quality and the fate of antimony and arsenic in the historic Kantishna Hills Mining District, Denali National Park
  Vanessa Ritchie, Department of Chemistry and Biochemistry, University of Alaska Fairbanks
  Awarded $2850

- Effects of invasive white sweetclover on floodplain plant communities in Alaska
  Blaine Spellman, School of Natural Resources Management, University of Alaska Fairbanks
  Awarded $3497

# Notes

# Selected Recent Resource Highlights



- Denali's first dinosaur (footprint of a theropod) was discovered near Igloo on June 27, 2005 (see photo at right). Page 49.
- The spring 2005 estimate of wolf population size is a 50% increase from 2004. There are approximately 103 wolves in 15 packs inhabiting Denali north of the Alaska Range. Page 19.
- Many great gray owls and northern hawk owls have been frequenting the Denali area, responding to an abundance of voles. Page 24.
- The latest issue (Spring 2006) of *Alaska Park Science* highlights research at Denali.
- Major elements of Glen Creek's stream channel were restored in 2005 along with the safe removal of hazardous materials remaining from placer and lode mining. Page 50.
- Denali's soundscape program received a regional park service grant for developing monitoring techniques. Page 51.
- "Near real-time" data from Denali's weather stations are now available via satellite. Page 44.
- June 2005 marked the 25th anniversary of continuous long-term air quality monitoring at Denali. Page 47.

- An integrated study of Park Road capacity (see photo at right) is underway through the development of cooperative agreements with researchers from the University of Vermont and the University of Minnesota, who will collaborate with Denali staff to conduct the research. Page 6.
- In 2005, Central Alaska Network (CAKN) for Inventory and Monitoring published the landmark *Vital Signs Monitoring Plan* and developed monitoring protocols for 11 Vital Signs. Pages 3-4.

## LOOKING AHEAD IN 2006:

□ Alaska Park Science Symposium to be held at Denali (mid-September 2006)

□ Denali's Resource Stewardship Strategy—getting input via scientist workshop and public scoping sessions

□ Surveillance for the arrival of avian influenza (H1N5) in Alaska by checking Arctic Warblers in Denali

□ Acquisition of high resolution (0.6-meter) satellite imagery for the entire park

□ International Polar Year events

□ Publication of Denali's Water Resources Management Plan

□ Publication of evaluation of impacts of North Access on Denali's Water Resources

LT/5/06